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S-E-01 **Specification for Calibration, Certification and Use of Electricity Calibration Consoles**

P-E-01 **Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements of S-E-01**

P-E-01 Annex **Worksheets for Calibrating and Certifying Electricity Calibration Consoles**

P-E-02 **Procedures for Generating and Issuing a Certificate of Calibration for Consoles Compliant with the Requirements of S-E-01**

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S-E-01 (Rev. 1) Specifications for the Calibration, Certification, and Use of Electricity Calibration Consoles

Specifications for the calibration, certification, and use of electricity calibration consoles have been provided in the past under various designations, including LMB-EG-12, and PS-E-03. The most recent of these is the July 8, 1998 release of S-E-01. As a result of issues and comments submitted by the electricity measurement industry and Measurement Canada personnel, S-E-01 has been revised and amended. These revisions are now completed and the final amended version of these specifications are hereby released as S-E-01 (Rev.1): Specifications for the Calibration, Certification , and Use of Electricity Calibration Consoles.

The companion document, P-E-01: Procedures for Calibrating and Certifying Calibration Consoles Pursuant to the Requirements of S-E-01, was also released on July 8, 1998. Since the issue of this publication of P-E-01, a number of revisions have been made to the procedure in conjunction with those made to S-E-01. The final amended version of these procedures are hereby released as P-E-01 (Rev.1): Procedures for Calibrating and Certifying Calibration Consoles Pursuant to the Requirements of S-E-01.

The specifications in S-E-01 (Rev. 1) apply to all electricity meter calibration consoles which are currently being used by Accredited Meter Verifiers for the verification or reverification of electricity meters.

Calibration consoles that currently hold valid certificates based on PS-E-03 (dated 1997-02-28), or S-E-01 (dated 1998-07-08), shall continue to be certified as such until the end of the certificate extensions, subject to the requirements of Bulletin E-17 (rev. 1). Prior to the expiration of the final certificate extension, the calibration console shall be calibrated in accordance with these specifications S-E-01 (Rev.1).

Additional copies of this specification are available at the address above.

For any enquiries, please contact the Program Development Directorate at (613) 952-0657.

Alan Johnston
President

Information

2008-06-13

Revisions to the Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles

This information bulletin is intended to advise electricity sector stakeholders that Measurement Canada (MC), has revised MC Specification S-E-01(rev. 2) to remove requirements identified under the Government of Canada burden reduction initiative.

The procedures for the calibration, certification and use of these measuring apparatus (P-E-01), have been revised to reflect the revisions to S-E-01.

The annex (worksheets) to the procedures have been revised to reflect the revisions.

MC Specification S-E-01 (rev. 3), P-E-01(rev.3) and the Annex are effective immediately.

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S-E-01

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Specifications for the Calibration, Certification And Use of Electricity Calibration Consoles

Canada

S-E-01 (rev. 3): Summary of Amendments to S-E-01 (rev.2)	
Section	**Description**
All	Reformatted to new formatting requirements.
5.2.6	This section was 5.2(d) in the previous revision. All of the subsections of 5.2(d), required information be provided in a specific format and were identified under the Paper Burden Reduction Initiative for removal. The worksheets for the pre-evaluation of consoles will serve to provide all the information required for this specification.
6.1.2	This section has been revised to a minimum frequency of weekly as identified in the Paper Burden Reduction Initiative.
6.3.1	Removed the requirement for the on state to be prominently illuminated. With the indicating instruments, illuminated there is no additional value in also requiring the master switch to have an on status illuminator.
6.3.8	This section has been removed. Section 6.3.8 "test links" was identified under the Paper Burden Reduction Initiative.
6.4.1.3	Section 6.4.1.3 has been removed. It was identified that other methods do not require the indicator, therefore the current indicator will also suffice for indication when a switch is used.
6.4.3.1(d)	Clarified that where a power standard is used for the setup of test loads, inspection of the indicating instrument is done during the accuracy testing of the test points for the standard.
7.1.2.1	Formula modified to reflect correct expression of test console error.

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Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles

1.0 Scope

1.1 The scope of this document includes calibration, certification, and use of electricity calibration consoles. These specifications are intended for the certification or recertification of measuring apparatus consisting of calibration consoles and accessories thereto intended for the verification and/or reverification of single and/or polyphase energy and/or demand meters, including meter testing pursuant to the requirements of any Measurement Canada approved statistical sampling plan for the verification and reverification of electricity meters.

1.2 This document is supported by procedures set out in P-E-01: Procedures for Calibrating and Certifying Calibration Consoles Pursuant to the Requirements of S-E-01.

1.3 These specifications do not apply to calibration consoles used solely for the purpose of verifying the register ratios on electricity meters.

2.0 Authority

This document is issued pursuant to section 5 of the *Electricity and Gas Inspection Act* and Part I of the *Regulations* established thereto. It has been produced under the authority of the President of Measurement Canada for the purposes of setting out specifications for the calibration, certification and use of electricity measuring apparatus.

for Alan E. Johnston
President

Canada

3.0 Purpose

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

4.0 Terminology

Burden
The load usually expressed in VA, which is placed on transformer secondaries by the associated meter coils, leads and other connected devices, at a specified test point and power factor.

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.

Distortion
An undesired change in waveform which will result in a non-sinusoidal waveform.

Electromechanical demand meter
An electricity meter which measures demand power using a thermal element, or mechanical gearing from an electro-mechanical rotating energy disk.

Electronic demand meter
An electricity meter which measures demand power 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. (eg. RFL console).

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 using input pulses from an electro-mechanical rotating energy disk.

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.

Recti-thermal demand meter
An electricity meter which measures demand power by the use 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.

Regulator
A device which operates to ensure that an electrical quantity which deviates from a set point or set load is brought back to that set point or set load.

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.

Semi-automatic Console
A console which is capable of setting and resetting loads after initial setting by operator. (eg. Multi-Amp console).

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

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The Specifications For the Calibration, Certification, and Use of Electricity Calibration Consoles. (S-E-01)

Standard
A certified measuring instrument, having errors traceable to the National Research Council of Canada, that is used to calibrate a Calibration Console.

Test load
Applied test voltage multiplied by the applied test current.

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

5.0 Administrative Requirements

5.1 General

5.1.1 These specifications shall apply to all calibration consoles which are used for verification or reverification of meters as described in the scope. This includes meters which are tested for the purposes of performing a dispute investigation.

5.2 Roles and Responsibilities

5.2.1 Prior to the calibration of measuring apparatus, the person conducting the calibrations shall be responsible for ensuring that the following standards and measuring equipment to be used have been certified by Measurement Canada or the National Research Council of Canada.

(i) Energy, Demand and Phase standards

(ii) Voltage and Current standards, and Current Transformer if required

(iii) Distortion Analyzer

(iv) Level or inclinometer (angle gauge block)

NOTE: For the purpose of calibration, data included on the manufacturer's certificate for the angle gauge block is acceptable. To qualify the validity of the manufacturer's angle gauge block certificate, the gauge block shall be visually inspected each time it is used to identify any physical damage. 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.

5.2.2 Organizations authorized to re-certify calibration consoles on behalf of MC shall conduct that calibration in accordance with the procedures set out in P-E-01. Organizations that wish to use procedures that differ from the procedures 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 When an owner, (other than MC), requests console certification to be performed by Measurement Canada, the owner shall be responsible for providing all information required by these specifications.

5.2.4 For calibration consoles that have never been certified or have not had a valid certificate for at least three years, the owner shall ensure that the calibration console is fully compliant with all applicable requirements set out in these specifications prior to the calibration of the console.

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 is compliant with the requirements of sections 7.5, 7.6, and 7.8 as applicable. For the purpose of pre-testing to ensure compliance to section 7.8, the console shall be tested to the following requirements as a minimum.

(a) All test points pursuant to the requirements of section 7.8.2.1, 7.8.2.2 and 7.8.2.4 shall be evaluated as applicable.

(b) Consoles that are expected to be certified in accordance with requirement 7.8.2.3 may be evaluated using a reduced set of test points as determined below:

(i) One function shall be evaluated at the nominal voltage of the voltage tap that is used with the greatest number of current taps. At this voltage the maximum and minimum loads at unity power factor as well as all other power factor loads shall be evaluated for each current tap used to evaluate meters pursuant to section 5.2.6. At each of the other voltage taps required to be used to evaluate meters pursuant to section 5.2.6, one current tap shall be selected and the console shall be evaluated at the minimum and maximum loads, at unity, 0.5, and 0.866 power factors as applicable for the set voltage and current tap combination.

(ii) All other functions shall be evaluated at the minimum and maximum loads at three different current taps at each voltage at unity, 0.5 and 0.866 power factors as applicable.

(iii) If during the process of calibration console certification by Measurement Canada, a console fails any calibration test pursuant to section 7.8, the console shall be subject to a complete pre-test of all required calibration test points pursuant to section 7.8.

(iv) Compliance with section 7.8 may also be demonstrated by providing the results of the weekly accuracy tests performed on the calibration console since the last certification which indicate that the console has been verified at test points consistent with those that would be evaluated pursuant to the requirements of 5.2.5 (b)(I) and (ii) above.

5.2.6 The owner shall provide all information required to determine the manner in which the console will be used for verifying meters. Note: The worksheets (i.e. for pretesting) and procedure, P-E-01 include information needed for determination of the manner in which the console will be used for verifying meters.

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 district office of Measurement Canada 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 those meters.

5.2.9 The user 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 these specifications and with any terms and conditions set out in the certificate.

5.2.10 The owner shall retain copies of the calibration console worksheets and the calibration console certificate until the expiration of the calibration console certificate.

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

5.2.12 The owner shall forthwith notify the local district office of Measurement Canada 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 Measurement Canada regional electricity specialist.

5.2.13 The owner shall notify the local district office of Measurement Canada, (which must notify the regional electricity specialist), prior to undertaking any modification or relocation of the measuring apparatus.

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 Log Book or File

5.3.2.1
A log book or file shall be maintained by the owner of the calibration console and kept readily available. The log book shall have recorded in it, the 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

5.3.3.1
The operating manuals and schematic drawings of the calibration console shall be readily available.

5.3.4 Calibration Console Markings

5.3.4.1
All controls, displays and switches shall be indelibly identified.

6.0 Technical Requirements

6.1 Use Requirements

6.1.1 General

6.1.1.1
Calibration consoles shall be used in accordance with the terms and conditions of their certificates.

6.1.2 Accuracy Check

6.1.2.1
An accuracy check shall be conducted by an inspector or an accredited meter verifier, at least once per week during any week that the console is used to verify meters. The accuracy check shall be conducted at one different test point for each day the console was used, selected from the test points that were used to evaluate meters during the week. If this number of different test points were not used during the week, additional test points shall be selected from the test points used to evaluate meters as identified pursuant to section 5.2.6.

6.1.2.2
The accuracy check shall consist of, as a minimum, connecting a certified standard, certified reference meter, or meter of known accuracy in a meter-under-test position and comparing its registration with the results determined by the calibration console at the selected test point.

6.1.2.3
Where the error determined pursuant to the accuracy check differs from that appended to the certificate for the calibration console, by more than ± 0.2 percent, or exceeds the allowable tolerance specified in section 7.8, 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.

6.1.2.4
All accuracy check results shall be recorded in the log book.

6.1.3 Minimum Duration of Verification Tests

6.1.3.1 The minimum duration of any test performed on energy meters for the purposes of verification, or reverification, shall be such that meter test results are provided to a resolution of 0.1%. For the case of calibration consoles equipped with energy reference meters that emit pulses the minimum duration of tests shall be such that at least 1000 pulses are emitted by the energy reference meter.

6.2 Environmental Requirements

6.2.1 Temperature

6.2.1.1
The ambient temperature surrounding the calibration console shall be 23°C ± 5°C.

6.3 Mechanical Requirements

6.3.1 Master Control Switch and Indication of Energization

Calibration consoles shall have a master on/off control for switching off all power sources to the console. It shall be readily accessible and clearly marked.

6.3.2 Circuit Protection

6.3.2.1
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 protect the operator from a shock hazard by use of a ground fault interrupting (GFI) circuit breaker. The device shall automatically protect the operator from any ground fault currents flowing between the console supply conductors(s) and ground which exceed 10 mA.

6.3.4 Isolation

6.3.4.1 Isolation from Ground

6.3.4.1.1
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, nor 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

6.3.4.2.1
All secondary test circuits of the calibration console shall be electrically isolated from primary supply circuits.

6.3.5 Meter Mounting Arrangements

6.3.5.1
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

6.3.6.1
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 6.4.3.2. The spread of the applied voltages, currents, phase angles, and loads, shall also be within the tolerances set out in Table 1 of section 6.4.3.2.

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 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 Maximum Test Voltages and Currents

6.4.2.1
Calibration consoles shall be capable of continuously supplying the highest rated voltage and the largest test current used to verify the meters specified in the information provided pursuant to section 5.2.6.

6.4.3 Indicating Instruments

6.4.3.1
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 (where a power standard is used to setup and monitor the power, it's accuracy is evaluated under the test points for the standard)

(i) Watt meter for the case of consoles used for watt or watt hour meter testing.

(ii) Volt ampere (average or rms as applicable) meter for the case of consoles used for va or va hour meter testing.

(iii) Var meter for the case of consoles used for var or var hour meter testing.

6.4.3.2
These instruments shall be capable of indicating their respective quantities to 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.

Table 1

Required Indicator Accuracies

Quantity	Tolerances
Current	±2%
Voltage	±2%
Phase angle/power factor (at unity Pf)	±2.5°/±0.1%
Phase angle/power factor (at 0.5 Pf)	±1.0°/±3%
Power (active, reactive, or apparent)	±2%

6.4.3.3
The tolerances expressed in percentage are in percent of true value.

6.4.3.4
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.

6.4.3.5
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.

6.4.3.6
Calibration consoles intended to verify reactive meters shall be capable of meeting the above requirements with the exception that the tolerances for phase angle and power, at 0.5 power factor (60°) set out in Table 1, apply at 0.866 lagging power factor (30°) as well.

6.4.4 Accuracy and Repeatability of Calibration Consoles

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 6.4.3.2, 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 6.4.3.2. 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 7.1.4 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 6.4.3.2 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 energy reference meter(s). 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 demand (power) reference meter(s). Calibration consoles intended to verify average responding demand meters shall be equipped with average responding reference meter(s). Calibration consoles intended to verify demand meters with root mean square (rms) response shall be equipped with rms responding reference meter(s).

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 0.00300 watt hours (or volt ampere hours, or var hours), 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. When the console is used for meter verification tests the displayed error shall be shown with a resolution of at least one significant digit to the right of the decimal point.

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 0.00300 watt hours (or volt ampere hours, or var hours) 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 power meter(s) (i.e. watt, va, or var meter) which shall serve as the demand reference meter(s). The demand reference meter(s) shall be capable of displaying power to a resolution of 5 significant digits for the case of consoles used to verify electronic or hybrid demand meters, and 4 significant digits for 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.

6.4.8.2
Calibration consoles equipped with devices that automatically detect the disk revolution of electromechanical energy meters or the test energy pulses provided by an electronic meter, shall be capable of doing so without error.

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.

6.4.10 Statistical Calculations

6.4.10.1
Calibration consoles or accessories thereto intended to perform statistical calculations of average error and standard deviation of a sample of meters, shall do so in accordance with the applicable requirements of Measurement Canada authorized statistical sampling plans for the verification and reverification of electricity meters.

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.

<u>At any test point;</u>

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 set out in section 7.1.2.2.5 of P-E-01: Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements of S-E-01.

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) For 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) For 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.

7.1.4 Test Positions and Test Loads

7.1.4.1
Unless otherwise stated, the conditions and requirements set out below shall apply to all Metrological Requirements in section 7.0.

(a) All tests of calibration console accuracy shall be conducted at one test load and at any one meter-under-test position.

(b) Console calibration tests shall be conducted with all current elements connected in series.

(c) For calibration consoles intended to verify self-contained single-phase meters only, the test load used shall correspond to the highest verification test point at 0.5 power factor indicated in the information provided pursuant to section 5.2.6; (e.g. 240 V, 50 A, 0.5 power factor for a watt hour console intended to verify 200 ampere meters).

(d) For consoles intended to verify transformer type meters, in addition to any other meter types, the test load shall be 120 V, 2.5 A, 0.5 power factor.

(e) For consoles intended to verify self contained single-phase and polyphase meters, or self contained polyphase meters only, and which are not intended to verify transformer rated polyphase meters, the test load shall be at 0.5 power factor at the rated voltage and 25% of the rated current of the meter which will be used as the burden determined pursuant to 7.1.5.1(c) below.

(f) For consoles that are not used to verify meters at 0.5 power factor the test load shall be set at unity power factor.

(g) Burdens which simulate meters under test shall be installed in the meter-under-test position(s). This includes placing a potential burden in the meter-under-test position in which the test socket and standard are connected.

(h) For calibration consoles having a potential selection switch, tests shall be conducted with the potential selection switch in the "parallel" position when isolation transformer(s) are out of the test circuit, and in the "multiple" position when isolation transformer(s) are in the test circuit.

7.1.5 Test Burdens

Conditions for Metrological Characteristics

7.1.5.1
Except as otherwise set out in these specifications, all metrological requirements shall be evaluated at the test load determined pursuant to section 7.1.4.1 above, with the burdens installed in the meter-under-test positions. The required test burden(s) shall be determined pursuant to the applicable sections below.

(a) For calibration consoles intended to verify self contained single-phase meters only, the voltage burden that causes the greater of the two errors determined pursuant to (i) and (ii) below, shall be used as the test burden.

(i) The console shall be tested at the test load determined pursuant to section 7.1.4.1(c) with meters having the highest voltage burden identified in the information provided pursuant to section 5.2.6 installed in any one meter-under-test position.

(ii) The console shall be tested at the test load determined pursuant to section 7.1.4.1(c) with meters having the lowest voltage burden identified in the information provided pursuant to section 5.2.6 installed in the meter-under-test position used above.

(b) For calibration consoles intended to verify polyphase transformer type meters in addition to any other meter types, the burden that causes the greater of the two errors determined pursuant to sections (i) and (ii) below shall be used as the test burden.

(i) The console shall be tested at the test load determined pursuant to section 7.1.4.1(d) with transformer type polyphase meters having the highest voltage burden identified in the information provided pursuant to section 5.2.6 installed in any one meter-under-test position.

(ii) The console shall be tested at the test load determined pursuant to section 7.1.4.1(d) with transformer type polyphase meters having the lowest voltage burden identified in the information provided pursuant to section 5.2.6 installed in the meter-under-test position used above. The lowest voltage burden may be represented by using zero burden. (ie: Shorting bars and no additional potential burden.)

(c) For calibration consoles intended to verify single phase and/or polyphase, self contained meters only, the burden that causes the greater of the two errors determined pursuant to sections (I) and (ii) below shall be used as the test burden.

(i) The console shall be tested at rated meter voltage and at 25% of rated meter current, with self contained polyphase meters having the highest voltage burden identified in the information provided pursuant to section 5.2.6 installed in any one meter-under-test position.

(ii) The console shall be tested at rated meter voltage and at 25% of rated meter current, with self contained polyphase meters having the lowest voltage burden identified in the information provided pursuant to section 5.2.6 installed in the meter-under-test position used above. The lowest voltage burden may be represented by using zero burden. (ie. Shorting bars without any additional potential burden.)

7.1.5.2
When calibrating calibration consoles which are equipped with 1:1 isolation transformers the test load shall be as determined pursuant to section 7.1.4.1 (c) when the 1:1 isolation transformers are in the test circuit, and as determined pursuant to section 7.1.4.1 (d) or (e) when the 1:1 isolation transformers are not in the circuit.

7.1.5.3
When calibrating calibration consoles which are equipped with 1:1 isolation transformers the test burden shall be as determined pursuant to section 7.1.5.1 (a) when the 1:1 isolation transformers are in the test circuit, and as determined pursuant to section 7.1.5.1 (b) or (c) when the 1:1 isolation transformers are not in the circuit.

7.2 Burden Effects

7.2.1 Maximum Permissible Errors

7.2.1.1
The change in calibration console error resulting from the installation of different voltage burdens equivalent to those of meters from the list of test points provided pursuant to section 5.2.6, shall not exceed 0.1%.

7.2.1.2
The calibration console error resulting from the installation of any voltage 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

7.2.2 Conditions for Metrological Characteristics

7.2.2.1
All calibration consoles shall be tested for the effects of varying burden conditions.

7.2.2.2
Calibration consoles which are not equipped with 1:1 isolation transformers, or are equipped with 1:1 isolation transformers which are not in the test circuit, shall be evaluated for burden effects at any one meter-under-test position. The test shall be performed in accordance with section 7.1.5.1 (b) above if the console is intended to be used to verify polyphase transformer type meters, or in accordance with section 7.1.5.1A (c) above if the console is not intended to be used to verify transformer type meters.

7.2.2.3
Calibration consoles equipped with 1:1 isolation transformers which are in the test circuit shall be evaluated for burden effects at each meter-under-test position that has isolation transformers in the test circuit. The test shall be performed in accordance with section 7.1.5.1(a) of the Specifications.

7.3 Sensitivity to Number of Meters under Test

7.3.1 Maximum Permissible Errors

7.3.1.1
The change in calibration console errors, resulting from varying numbers of meters installed in the meter-under-test positions shall not exceed $\pm$0.1%.

7.3.1.2 Calibration console errors, resulting from varying numbers of meters installed in the meter-under-test positions shall not exceed the applicable tolerance set out in section 7.8.

7.3.2 Conditions for Metrological Characteristics

7.3.2.1
Calibration consoles shall be tested for sensitivity to the number of meters under test at the maximum test load for the burden that is applied pursuant to section 7.1.5 with all other meter-under-test positions empty. The calibration shall be repeated with the test burden determined pursuant to section 7.1.5 connected in each of the other meter-under-test positions.

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 0.2 percent.

7.4.1.2
For calibration consoles that are certified at one meter-under-test position only, pursuant to the requirements of section 7.8.2.3 or 7.8.2.4, as applicable, the spread of errors from position to position shall not exceed 0.1 percent.

7.4.1.3
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
Each meter-under-test position of calibration consoles shall be calibrated at the test load determined pursuant to section 7.1.4 with the test burden determined pursuant to section 7.1.5 connected in each of the other meter-under-test positions.

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
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 that are always in circuit while the console is being used. For the case of regulators or line conditioners that are switched in or out of circuit depending on the meters being verified, the tests shall be conducted once with these devices out of circuit and then repeated with the devices in circuit and turned on.

7.5.2.2
The following distortion tests shall be conducted as applicable at all power factors required for verification pursuant to section 5.2.6.

7.5.2.3 Recti-thermal Demand Meters

7.5.2.3.1
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. Distortion shall be measured at any meter-under-test position at 2.5 amperes and at the lesser of the maximum verification test current for the installed meters, or the maximum current rating of the distortion analyser used,

7.5.2.3.2
Distortion shall be measured at any meter-under-test position at 120 volts and at the lesser of the maximum voltage rating of the installed meters, or the maximum voltage rating of the distortion analyser used.

7.5.2.3.3
In addition, the distortion shall be measured with no meters installed in the meter-under-test positions at 2.5 amperes and at the lesser of the maximum test current used for verifying meters as specified in the information provided pursuant to section 5.2.6, or the maximum current rating of the distortion analyser used.

7.5.2.3.4
In addition, the distortion shall be measured with no meters installed in the meter-under-test positions, at 120 volts and at the lesser of the maximum test voltage used for verifying meters as specified in the information provided pursuant to section 5.2.6, **or** the maximum voltage rating of the distortion analyser used.

7.5.2.4 1:1 Current Transformers and/or Potential Transformers

7.5.2.4.1
Calibration consoles equipped with 1:1 current transformers and/or potential transformers equipped with multiple secondary taps shall be tested for distortion at any one meter-under-test position equipped with such circuits. The tests shall be conducted with the burden determined pursuant to section 7.1.5.1(a) installed at each meter-under-test position.

7.5.2.4.2
Distortion shall be measured at 2.5 amperes and at the lesser of the maximum test current used for verifying meters that require the use of 1:1 transformers and/or multiple transformers, or the maximum current rating of the distortion analyser used.

7.5.2.4.3
Distortion shall be measured at 120 volts and at the lesser of the maximum test voltage used for verifying meters that require the use of 1:1 transformers and/or multiple transformers, or the maximum voltage rating of the distortion analyser used.

7.5.2.5 Other Meters

7.5.2.5.1
Calibration consoles intended for verifying meters other than those identified in 7.5.2.3 or 7.5.2.4 above, shall be tested for distortion with the burden determined pursuant to section 7.1.5.1(b) installed at each meter-under-test position.

7.5.2.5.2
Distortion shall be measured at any meter-under-test position at 2.5 amperes and at the lesser of the maximum test current used for verifying meters having the burden determined pursuant to section 7.1.5.1(b), or the maximum current rating of the distortion analyser used.

7.5.2.5.3
Distortion shall be measured at any meter-under-test position at 120 volts and at the lesser of the maximum test voltage used for verifying meters having the burden determined pursuant to section 7.1.5.1 (b), **or** the maximum voltage rating of the distortion analyser used.

7.5.3 Distortion shall be calculated according to the formula:

$$\%\ \text{Distortion} = \left| \frac{\text{rms of harmonic}}{\text{rms of fundamental and harmonics}} \right| \times 100$$

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 following requirements:

7.6.1.1
The calibration console shall be capable of maintaining test loads for a period of not less than 60 minutes, such that for a 60 minute period, the energy delivered shall be within ±0.25% of the energy that should have been delivered during that period, at the set load. 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.

7.6.1.2
In addition to the above requirement, energy delivered during the 60 minute period above shall be monitored at nominally, one minute intervals. The duration of each one minute period shall be within ±0.05% of all other one minute intervals.

(i) For the case of consoles intended for verifying electronic or hybrid 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) For 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.

(iii) The energy monitored in section 7.6.1.1 and 7.6.1.2 shall be in watt hours. Calibration consoles shall be evaluated for compliance to the requirements of section 7.6.1.1 and 7.6.1.2 at the test load determined pursuant to section 7.1.4 with the burden determined pursuant to section 7.1.5 and at the test load determined pursuant to section 5.2.6 with the burden equivalent to the meter that is verified at this test load.

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 0.2%.

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. Such consoles shall be calibrated at all applicable test loads with the applicable test burdens determined pursuant to sections 7.1.4 and 7.1.5. Using the normal operating mode of the console, the current shall be switched to 10 percent of the test current determined pursuant to section 7.1.4, and back to its original value.

7.7.2.2
The console shall then be recalibrated. 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, then this shall be done when conducting this test.

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 equipped with 1:1 isolation transformers which may be switched in or out of the test circuit during tests shall be calibrated with the isolation transformers in the test circuit, at each meter-under-test position, at each test point for which 1:1 isolation transformers are needed to verify meters as indicated in the information provided pursuant to section 5.2.6.

7.8.2.2
Calibration consoles equipped with 1:1 isolation transformers which are designed to be in the test circuit at all times shall be calibrated at each meter-under-test position, at each test point which will be used to verify meters as indicated in the information provided pursuant to section 5.2.6.

7.8.2.3
Calibration consoles which have current and/or potential transformers connected between the reference meter(s) and the meter-under-test position(s) and which are not equipped with 1:1 isolation transformers or which are equipped with 1:1 isolation transformers which may be switched out of the test circuit, shall be calibrated at any one meter-under-test position with the isolation transformers switched out of the test circuit. The calibration shall be at each combination of voltage and current tap, and selector switch setting at the maximum, and minimum test loads (i.e. test voltage multiplied by test current) for the respective voltage and current tap and selector switch combination used to verify meters as indicated in the information provided pursuant to section 5.2.6. The calibration at these test loads shall be conducted at all power factors used to verify meters as indicated in the information provided pursuant to section 5.2.6.

7.8.2.4
Calibration consoles which:

(i) do not have current and/or potential transformers connected between the reference meter(s) and the meter-under-test position(s); and,

(ii) are not equipped with 1:1 isolation transformers, or are equipped with 1:1 isolation transformers which may be switched out of the test circuit; and,

(iii) have reference meters which have valid certificates of calibration (with traceability to the standards of the National Research Council of Canada) that have expiry dates at or later than, the expiry date of the certificate of calibration for the console, at unity power factor at the maximum and minimum test currents at each test voltage as well as at all test loads at other than unity power factor as indicated in the information provided pursuant to section 5.2.6.

shall be calibrated with the isolation transformers switched out of the test circuit, at any one meter-under-test position, at the minimum, median and maximum test loads(i.e. test voltage multiplied by test current) of the range of loads at unity power factor as well as at all other power factors to be used to verify meters included in the list provided pursuant to section 5.2.6.

7.8.2.4.1
The errors of the calibration console (E_{cons}) at each of the test loads shall be calculated according to equation 1 of section 7.9. If the error of the console at each of the test points is not greater than ±0.1 percent, and all errors are within 0.05 percent of each other, the errors of the console at the other test points shall be calculated by averaging the values of (E_{cons}) at the three test points, and summing the resulting value with the known errors of the reference meter(s).

7.8.2.4.2
Calibration consoles which meet the foregoing requirements except that they do not have valid certificates of calibration as described in (iii) above, or which have errors (E_{cons}) which do not meet the criteria set out in the paragraph above, shall be calibrated at any one meter-under-test position, at the minimum, median, and maximum test currents at each test voltage at unity power factor as well as all other power factors which will be used to verify meters indicated in the list provided pursuant to section 5.2.6.

7.8.2.5
For calibration consoles which have position to position errors pursuant to section 7.4, less than 0.1%, the errors determined in 7.8.2.3 and 7.8.2.4 above shall be applicable for each meter-under-test position. Calibration consoles which have a position to position error spread between 0.1% and 0.2% pursuant to section 7.4, shall have calibrations of 7.8.2.3 and 7.8.2.4 above, performed at each meter-under-test position.

7.8.2.6
For all of the tests set out in 7.8.2.1 through 7.8.2.4 above, the test burden determined pursuant to section 7.1.5 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
If the errors determined in any of the tests pursuant to the applicable subsections of section 7.2 differ by 0.05 percent or less, then the meter-under-test position with the standard does not require a burden for the purposes of performing the tests set out in 7.8.2.3 and 7.8.2.4 above.

7.8.2.6.2
If the errors determined pursuant to section 7.3 differ by 0.05% or less, then test burdens are not required to be placed in any of the other meter-under-test positions not containing the standard for the purposes of performing the tests set out in 7.8.2.3 and 7.8.2.4 above.

7.8.2.7
Calibration consoles which are 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 that will be 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 sections 7.1.4 and 7.1.5 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 Interchangeability of Console Reference Meters

7.9.1 Energy and/or demand reference meters may be interchanged under the following conditions:

7.9.1.1
A reference meter of one make, type or model shall not be substituted for a reference meter of another make, type or model unless the calibration console has been calibrated and certified for use with reference meters of each make, type and model.

7.9.1.2
All reference meters intended to be interchanged shall have certificates of calibration (with traceability to the standards of the National Research Council of Canada) that have expiry dates at or later than, the expiry date of the certificate of calibration for the console. The certificate of calibration for the interchangeable reference meters shall be for calibration of the reference meter at each test point which would be used to calibrate the calibration console pursuant to the applicable portions of section 7.8.

7.9.1.3
The combined error, calculated from equations 1 and 2 below, of the calibration console and each reference meter intended to be interchanged, at each test point which would be used to calibrate the console pursuant to section 7.8, shall be not greater than those specified in sections 7.8.1.1 and/or 7.8.1.2.

7.9.2 The error of the console without a reference meter shall be determined from the following formula:

$$E_{cons} = E_{cons\&refA} - R_{cor} \qquad (1)$$

Where:

E_{cons} = Error of console without reference meter.
$E_{cons\&refA}$ = Error of console including reference meter (determined pursuant to section 7.8).
R_{cor} = Reference meter % correction $\Rightarrow$ ($- E_{refA}$).
E_{refA} = Certified error of original interchangeable console reference meter, traceable to the National Research Council of Canada.

7.9.3 The console errors including interchanged reference meter shall be determined from the following formula:

$$E_{cons\&refB} = E_{cons} + R_{cor} \quad (2)$$

Where:

E_{cons}	=	Error of console without reference meter, determined using equation (1) above.
$E_{cons\&refB}$	=	Error of console with new interchangeable reference meter.
R_{cor}	=	Reference meter % correction ⇒ (- E_{refB})
E_{refB}	=	Certified error of new interchangeable console reference meter, traceable to the National Research Council of Canada.

7.9.4 The owner shall append the console errors of the console plus the interchanged reference meter to the original calibration certificate issued for the console. The date and time of installation and removal of any reference meter shall be recorded.

7.10 Pulse Counters and Generators

7.10.1 Maximum Permissible Errors

7.10.1.1
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, which are 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

7.11.1.1
The errors of calibration consoles or accessories thereto which automatically calculate meter errors shall not exceed the tolerances set out in section 7.8 throughout the ranges identified below.

7.11.2 Conditions for Metrological Characteristics

7.11.2.1
Calibration consoles or accessories thereto which automatically calculate meter errors shall be capable of accurately performing such calculations over a range of errors suitable for the intended purpose of the calibration console.

8.0 Revision

The purpose of this revision is to remove requirements identified under the Government of Canada paper burden reduction initiative.

Measurement Canada
An Agency of Industry Canada
Mesures Canada
Un organisme d'Industrie Canada

Specifications

Category: **ELECTRICITY**	Specification: **S-E-02 (rev. 3)**	
Document(s): **S-S-01, S-S-02, S-S-03, S-S-04, S-02, E-26**	Issue Date: **2008-11-28**	Effective Date: **2009-01-01**
	Supersedes: **S-E-02 (rev. 2)**	

Specifications for the Verification and Reverification of Electricity Meters

Canada

S-E-02 (rev. 2): Summary of Amendments to S-E-02 (rev.1)

Section	Description
5	Removed subsection 5.3, Testing facilities and realigned the numbering. Testing Facilities requirements were identified for removal under the Federal Government Paper Burden Reduction Initiative as they are adequately addressed in section 19 of the Act.
6	Removed subsection 6.2, Nameplate and realigned the numbering. These requirements were identified for removal under the Federal Government Paper Burden Reduction Initiative. These marking requirements are adequately addressed in the specifications for approval and the notices of approval.

S-E-02 (rev. 3): Summary of Amendments to S-E-02 (rev.2)

Section	Description
3	Reference to E-26 was added to 3.10
5.6	The section was added to clarify the reduced reverification period for meter that are not assessed for MADT.
5.9	A reference to LMB-EG-07 was added to clarify the requirements.
Annex A.2.1	The applicability section was expanded to include polyphase and demand electronic meters.
Annex A.3.2	This section was amended to add the non-performance observations required for demand meters.
Annex A.5.1	This section was amended to state the conformity determination for meters inspected 100% that are not new and cannot be calibrated.
Annex A.6.2	This section was amended to include the applicable requirements for demand meters
Annex A.6.7	This section was amended to state the conformity, marginal conformity, or nonconformity determination for meters inspected by acceptance sampling that are not new and cannot be calibrated.
Annex A.7(e)	This section was added to state the outgoing quality requirements for meters 100% inspected.

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Specifications for the Verification and the Reverification of Electricity Meters

1.0 General

1.1 Scope

These specifications apply to any electricity meter submitted for verification or reverification under the *Electricity and Gas Inspection Act.*

2.0 Authority

These specifications are issued under the authority of section 18 of the *Electricity and Gas Inspection Regulations.*

3.0 Normative References

3.1 *Electricity and Gas Inspection Act*

3.2 *Electricity and Gas Inspection Regulations*

3.3 Measurement Canada, LMB-EG-07: Specification for the Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices.

3.4 National Standard of Canada, CAN/CSA-Z234.4-89: All-Numeric Dates and Times. (Reaffirmed 2000-05-25).

3.5 International Organization for Standardization, ISO 3534-2:1993: Statistics - Vocabulary and Symbols - Part 2: Statistical Quality Control.

3.6 S-S-01, Specifications for the Generation of Pseudo-Random Samples

3.7 S-S-02, Measurement Uncertainty and Meter Conformity Evaluation Specifications

3.8 S-S-03, Prerequisites to the Use of Sampling Inspection

3.9 S-S-04, Sampling Plans for the Inspection of Isolated Lots and Short Series Lots

3.10 E-26, Reverification Periods for Electricity Meters and Metering Installations

4.0 Definitions

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

Auto Service Detect Meter
Meters which are capable of determining service configurations.

Advanced Meter Function
A function built into a meter which uses metered information to provide additional information directly related to the establishment of a charge for electricity. Examples include, pulse constance, meter multipliers, loss compensation.

Case (of a Meter)
The complete enclosure.

Configurable Meter
A meter that is designed such that its service configuration can be modified either by software or hardware to make it compatible with different circuit arrangements. This may be performed automatically or by operator intervention. For example, a meter may be reconfigured from a 2½ element meter for metering a 3 phase, 4 wire wye circuit to a 2 element meter for metering a 3 phase, 3 wire circuit.

Constants:

Disk Constant K_h (Induction Type Meter)
The number of energy units being measured per disk revolution. For a watt hour meter the disk constant, K_h, is watt hours per revolution.

Pulse Initiator Output Constant K_p (Pulse Constant)
The number of energy units being measured per pulse output. The pulse may be from a KYZ output or any other pulse output device.

Single Phase Test Constant
A multiplication factor required to determine correct registration when testing certain multi-element meters using series-parallel, single phase testing techniques.

Test Constant K_s - (Electronic Meter)
The number of energy units being measured per indication of the meter's test means (LED, LCD indicator, or other).

Cover (of a Meter)
That part of the case which is removable or can be opened, for access to the interior of the meter.

Current Range
The range of currents over which the meter or transformer is designed to function within specified error limits.

Current Transformer
An instrument transformer designed for the measurement and control of current.

Defect
A departure of a meter's quality characteristic from its intended level or state, that occurs with a severity sufficient to cause the meter to not satisfy normal usage requirements. (Note: Depending on the nature and severity of the defect, it may cause a nonconformity to occur immediately or at some time in the future.)

Delivered Energy
Delivered Energy is the energy measured when current flows through the meter from the electricity grid to the load.

Demand
Demand is the average value of the power measured over a specified time interval. The following are the most commonly used types:

Integrating Demand (Block-Interval Demand)
Demand determined by measuring energy consumed over a fixed interval of time, divided by the time interval.

Lagged or Exponentially Responding Demand Meter
A demand meter in which the indication of the demand is determined by monitoring the exponential or thermal response to an applied load.

Demand Interval
The time duration over which the demand measurement is determined.

Maximum (or Peak) Demand
The greatest of all demands which have occurred during a specific period of time, usually the billing period.

Maximum (Full-Scale)Demand Rating
The largest demand that a meter is capable of metering within specified error limits.

Response Period - Exponential Demand Meter
The time required for the meter indication to reach 90 percent of the final response to a step change in the measured quantity.

Sliding Window (or Rolling) Demand
A method of demand measurement where the demand interval is the sum of contiguous fixed length sub-intervals.

Director
The Director as referenced in the Act and Regulations refers to the President of Measurement Canada, Department of Industry.

Display
A means for visual representation of metered quantities and other relevant information.

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

Electronic Meter
A solid state electricity meter.

Element
The combination of the voltage sensing unit (i.e. sensor or coil) associated with a current sensing unit (i.e. sensor or coil).

Split coil element
The split coil element is comprised of a current sensing circuit which is associated with more than one voltage sensing circuit. Some times also referred to as the 'Z-coil' sensor.

Error

Absolute Error
The value registered by the meter minus the true value.

Relative (True) Error
The absolute error of measurement divided by the conventional true value of the measurand, and traditionally referred to as the "true error". Expressed as a percentage, relative error is calculated as:

$$E_r = \left(\frac{Q_m - Q_s}{Q_s}\right) \bullet 100\% = \left(\frac{Q_m}{Q_s} - 1\right) \bullet 100\%$$

where,
E_r is the relative error of the meter under test, expressed in percent
Q_m is the quantity indicated by the meter under test
Q_s is the quantity indicated by the reference standard, expressed in the same units as Q_m.

Full Scale (F.S.) Error
The ratio of the absolute error to the full scale value.

Percentage Error
The relative or full scale error multiplied by 100 percent (%).

Firmware
A program embedded in non-volatile memory of the meter.

Frame (of a Meter)
That part to which are affixed the working parts and adjustments.

Full Scale (F.S.) Value
The largest value of the actuating electrical quantity that can be indicated on the scale or, in the case of an instrument having its zero between the ends of the scale, the full-scale value is the arithmetic sum of the absolute values of the actuating electrical quantity corresponding to the two ends of the scale.

Energy Meter
A device which sums the elemental energy quantities of a measured input either continuously, or over a fixed interval of time for the case where the energy meter is used to determine demand.

Induction Type Meter
An energy meter which operates by the rotation of the disk of an induction measuring element.

Instrument Transformer
A transformer which is intended to reproduce in its secondary circuit, in a definite and known proportion, the current or voltage of its primary circuit with the phase relations substantially preserved.

Maximum Current Rating (I_{max})
The largest current value for which a meter has been approved such that it maintains its performance within specified error limits. Nominally rated meters have an (I_{max}) equal to four times the nominal current rating for the meter.

Measuring Apparatus
A device or instrument that is used for the measurement of electricity for the purposes of calibrating electricity meters.

Meter
As defined in the *Electricity & Gas Inspection Act* (EGIA).

Meter Multiplier
The factor by which the meter reading must be multiplied to obtain the correct magnitude of the measured quantity.

Metrological Function, Feature, Characteristic, Parameter
Any function, feature, characteristic, parameter of a meter that provides a metered quantity or contributes to the determination of a quantity, which may be used for billing.

Minimum Current Rating (I_{min})
The smallest current value for which a meter has been approved so that it maintains its performance within specified error limits.

Multifunction Meter
A meter capable of performing two or more measurement functions.

Multi-register Meter (e.g. Multi-rate Register Metering)
Means a metering application which records the measured values of electricity into different registers or "bins" (electronic or mechanical) based on various conditions such as time (i.e., time-of-use, real-time pricing), temperature, etc.

Nonconformity
A departure of a meter's quality characteristic from its intended level or state, that occurs with a severity sufficient to cause the meter to not satisfy one or more specification requirements.

Normal Operating Mode
The operating mode assumed by the meter while in service without any operator intervention.

Phase Shifting Transformer - Phasing Transformer
An instrument transformer that is an assembly of two or more auto-transformers used as auxiliary instrument transformers, intended to be connected across the phases of a polyphase circuit so as to provide voltages in the proper phase relations for energizing var meters, var hour meters, or other measurement equipment.

President
The President of Measurement Canada having the authorities of "Director" as referred to in the Act.

Power Factor
The ratio of the active power to the apparent power. Under pure sine wave conditions, the power factor is given by cos φ where φ is the phase displacement between the voltage and the current.

Pulse Initiator
That part of a meter which produces pulses proportional in number to the value of the quantity being measured.

Pulse Recorder
A device which accumulates pulses from an external source representing integral units of energy.

Q Hour Meter
An electricity meter that measures energy by effectively lagging applied voltage by 60°.

Range, of an indicating or recording meter
The region covered by the span and expressed by stating the two end-scale values.

NOTE: If the span passes through zero, the range is stated by inserting "zero" or "0" between the end-scale values.

Rated Frequency
The frequency or frequencies at which the meter is designed to operate.

Rated Voltage
The voltage at which the meter or device is designed to operate, or for the case of meters designed for operation with a variety of voltage circuits, any preferred (as identified in Specifications for Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices) voltage at which the meter can operate may be considered as a rated voltage.

Received Energy
Received Energy is the energy measured when current flows through the meter from the load side of the service back to the electricity grid.

Reference Meter
A measuring instrument having errors traceable to the National Research Council of Canada, and used to establish the true value of a measurement.

Register

Electronic Register
An electronic medium used to store the value of a metered quantity.

Mechanical Register
A mechanical device that stores and presents the value of a metered quantity.

Register Ratio R_r - Induction Type Integrating Meter
The number of revolutions of the first gear of the register for one revolution of the first dial pointer.

Regulations
The *Electricity and Gas Inspection Regulations* (EGIR).

Reset Time - Mechanical Demand Register
The interval of time within each demand interval during which the driving element and demand indicator disengage from each other to allow the driving element to be restored to its initial position.

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

Seal
A means whereby unauthorized access to the interior, adjustments, or controls of a meter may be effectively detected.

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

Series Test
A test performed on a meter whereby all voltage input circuits are energized with voltages of the same magnitude and phase relation, and all current input circuits are energized with currents of the same magnitude and phase relation. This may be accomplished by placing all meter voltage input circuits in a parallel circuit, and all meter current circuits in a series circuit.

Service Type
The number of wires and phases and the interconnection between them used to supply a metering load.

Single Phase Services
Single phase services may be provided as follows:

Two-Wire Service
A single phase two-wire service may be provided from many distribution systems, and normally has one conductor grounded, with a nominal voltage of 120V between conductors.

Three-Wire Service
A single phase three wire service may be provided from a single phase or polyphase distribution system. One conductor, the neutral, is grounded, and the normal service voltages are 240 V between the ungrounded conductors and 120 V between either of the ungrounded conductors and the grounded conductor.

Network Service
A network service is a three wire service supplied from a three phase, four wire, wye distribution system, with one of the conductors being the neutral conductor, and the other two conductors being phase conductors.

Polyphase Services
Polyphase services may be provided as follows:

Three Phase Three Wire
A three phase, three wire service has no neutral conductor, and may be supplied by either an open-delta or closed-delta transformer bank.

Three Phase, Four Wire, Wye
A three phase, four wire wye service has three phases and a neutral conductor where the phase to neutral voltages are nominally equal to each other, and the phase to phase voltage is equal to $\sqrt{3}$ times the phase to neutral voltage.

Three Phase, Four Wire Delta Service
A three phase, four wire delta service is a delta service which has one transformer centre tapped and connected to a neutral conductor (and grounded). In this case, where the voltage between any two phases is 240 V, the voltage between the grounded wire and either of the two phases from which it is centre tapped will be 120 V, and the voltage from the third phase to the grounded phases will be 208 V.

Specification Limit
The maximum permissible error permitted for a meter's performance characteristic.

Test Link
A means to totally or partially isolate the voltage circuit from the current circuit of a meter.

Test Mode
A mode of operation which facilitates meter accuracy testing by introducing shorter test periods and/or greater resolution of readings.

Test Value (e_i)
The result of a measurement after correction for any known systematic errors, at test point "i".

Thermal Stability
A meter is considered to have reached thermal stability following a change in temperature, when the metrological characteristics of the meter have not changed by more than ±0.2% over a 10 minute interval.

Transformer
See instrument transformer.

Transformer (Primary) Rated Meter
A transformer-type meter which indicates or records the primary quantity being measured by using specific instrument transformer ratios.

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

Type
The designation assigned to a meter or device by the manufacturer for the purpose of distinguishing its particular design and construction from other designs, models or patterns. Such type designation shall embrace only those ranges and ratings that are essentially similar in appearance and performance.

Var Hour Meter
An integrating instrument which measures reactive energy in var hours or in suitable multiples thereof.

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 these Specifications.

Volt Ampere Hour Meter
An integrating instrument which measures apparent energy in volt ampere hours or in suitable multiples thereof.

Voltage Transformer
An instrument transformer intended to have its primary winding connected across circuit with the voltage to be measured.

Watt Hour Meter
An integrating instrument which measures active energy in watt hours or in suitable multiples thereof.

Zero Load
A condition of null current or energy passing through the meter to the load being measured.

5.0 Administrative Requirements

5.1 General

5.1.1 Verification and reverification is intended to confirm that a meter conforms to all of the performance and non-performance requirements of an approved pattern (design, features, functions, marking, etc.). The extent of verification or reverification inspections shall be as specified in these specifications and any additional requirements authorized by Measurement Canada (MC) in regards to these specifications. Although the application of these requirements allow for verification and reverification of electricity meters the owner of the meter remains legally responsible for ensuring meters compliance with the statute and related MC policies and programs. Meter owners shall also subject meters to market place monitoring programs established by MC.

5.1.2 Any meter that fails to meet a performance or non-performance requirement, or that possesses a defect which could affect its ability to meet specified requirements, shall be classified as nonconforming.

5.1.3 All meter conformity tests shall be performed in accordance with documented procedures that have been evaluated for technical adequacy by the relevant MC technical experts.

5.2 Administrative Requirements Related to Performance

5.2.1 Conditions for Testing

All conditions specified herein for testing shall be satisfied prior to the meter being evaluated for performance.

5.2.2 Measuring Function Accuracy Range of Accuracy Test

5.2.2.1
In principle, verification or reverification shall confirm the performance capabilities of each approved measurement function of a meter that may be used for the basis of establishing a charge for the consumption of electricity however, the extent of testing required for this purpose shall be based on meter design and the evaluations performed during the approval examinations.

5.2.2.2
Approved measurement functions that the meter owner has requested not to be verified shall be disabled. Such functions shall not be accessible by any means, including the meter display or meter communication ports, upon verification and sealing of the meter.

5.2.2.3
Where the meter design permits and as approved by MC, certain measurement function tests may be waived, if the function's performance characteristics can be determined through other related tests. These functions shall be considered to have been verified upon completion of approved related tests.

5.2.2.4
The tests which may be waived during verification and/or reverification shall have been determined through the approval process.

5.2.2.5
Approval tests may also indicate that additional tests over and above standardized verification and/or reverification tests specified herein may be required.

5.2.3 Implicit Accuracy of Each Measurement Function

Although the decision regarding the acceptability of a measurement function's accuracy is based upon results of tests at a few discrete points, all measurement functions shall be accurate to within specified limits throughout their respective measuring ranges.

5.2.4 Correction for Known Errors

The results of meter tests performed for the purpose of verification and reverification shall be corrected for all known systematic errors. These errors shall include the known errors of the calibration console.

5.2.5 Documentation of Errors

Each error determined for a meter at any test point shall be reported as a minimum to the nearest 0.1% for electromechanical meters and 0.01% for electronic meters.

5.2.6 Limits of Calibration

Although a test point error is considered acceptable if it does not fall outside the specification limit for that test point, this fact shall not imply that a meter may be intentionally calibrated to register with errors near the specification limits. The calibration target is the midpoint of the specification range.

5.3 Sampling Plan for the Inspection of Isolated Lots of Meters in Service

Meters in service may be reverified as a lot by compliance sampling with use of a MC-authorized compliance sampling plan.

5.4 Verification and Reverification Methods

Meters may be verified or reverified by 100% inspection. Meters falling under the scope LMB-EG-04 may be sampled, however the sample meters shall meet the requirements for 100% inspection. In-service meters may be sampled in accordance to section 5.3, however the sample meters shall meet the requirements for 100% inspection. Meters that fall under the scope of Annex A shall be verified or reverified by 100% inspection or by sampling in accordance to that annex.

5.5 Verification Seal and Marking Requirements

All meters examined and determined to meet the verification or reverification requirements, shall have suitable verification markings affixed to physically indicate that the meter has been examined and found to meet the requirements of these Specifications. Meters verified or reverified shall be sealed in accordance with the requirements of the *Electricity and Gas Inspection Act* and *Regulations* and any specifications established thereunder.

5.6 Reverification Periods for Electricity Meters

All meters examined and determined to meet the verification or reverification requirements, shall be permitted to remain in service for the periods prescribed by Measurement Canada's requirements for Reverification Periods for Electricity Meters and Metering Installations (reference 3.10). For meter that are not new and cannot be calibrated (i.e. MADT assessment is not made) the period for reverification will be as prescribed in reference 3.10 for reserviced meters.

5.7 Disposition of Meter with Questionable Accuracy

Any meter which has been mishandled or which is suspected of being in a state that does not conform with these Specifications shall not be put in service or continued in use until it has been reverified.

5.8 Requirements for Documentation of the Inspection Certificate or Record of Inspection

5.8.1 A certificate shall be issued for each meter inspected, verified, or reverified by an inspector or accredited organization who does not own the meter. The certificate shall contain all the information required pursuant to section 21 of the *Electricity & Gas Inspection Regulations*, as well as the applicable information listed in section 5.8.3 below.

5.8.2 A record of inspection shall be generated for each meter inspected, verified or reverified by an accredited organization who is also the owner of the meter. Such records shall contain all the information required pursuant to section 21 of the *Electricity & Gas Inspection Regulations* as well as the applicable information listed in section 5.8.3 below.

5.8.3 Pursuant to 5.8.1 and 5.8.2 above, the following information shall be included in the record of inspection or certificate of inspection as applicable:

(a) Whether the meter is verified or reverified.

(b) In the case of meters equipped with pulse initiators, the pulse value associated with the output pulse for each initiator as well as the pulse type or form (e.g. KYZ, 3-wire or 2-wire).

(c) The conformance status of the meter with respect to these Specifications.

(d) The year in which the meter will be due for reverification.

(e) All operational parameters including the following:

(i) meter multiplier (or multipliers , if different multipliers are applied for different functions)
(ii) voltage rating
(iii) current rating

(f) Where the verification or reverification was performed by sampling methods:

(i) the lot identification number
(ii) the number of meters in the lot
(iii) the values of all statistics determined from the errors of the sample meters
(iv) the conformance status
(v) for compliance sample groups, the level and the extension period in years determined for the sample and its parent lot

(g) Type of demand meter.

(h) Frequency rating, if other than 60Hz.

(i) Element configuration.

(j) All electromechanical multifunction (combination) energy-demand meters with the demand component de-activated shall be noted on the inspection certificate.

(k) A listing, or reference to a listing of any metrological parameters which were altered from the meters normal operating state in order to facilitate efficient verification.

(l) A listing, or reference to a listing of approved functions for which the meter has been programmed.

(m) Firmware revision.

5.8.4 The certificate or record of inspection shall serve as the formal record of the meter's verification status and shall be maintained by the owner of the meter pursuant to the Act and Regulations.

5.9 Nameplate Markings

5.9.1 General

Meters shall be verified to ensure the location, legibility and markings meet the approval of type specification LMB-EG-07 reference 3.3 and any additional markings which may be required in the Notice of Approval.

6.0 Technical Requirements

6.1 General

6.1.1 Meter verification shall include inspections to ensure that the technical requirements specified in this section are complied with.

6.1.2 Meters shall be inspected for mechanical fitness and shall be free of any physical damage, defects in workmanship, or material deficiencies which could affect the meter's ability to comply with the requirements of these specifications during the meter's usage.

6.2 Mechanical Registers and Electronic Displays

6.2.1 Identification of Measurement Units

6.2.1.1
All meters shall be verified to ensure the presence of the applicable measurement unit identifiers for each approved energy or demand quantity which is displayed or registered. These measurement unit identifiers may also use the standard abbreviation for the measurement units.

6.2.1.2
Meters equipped with electronic displays may use a coded identifier to identify the measurement unit of approved measurement quantities, provided the coded identifiers can be traced to a table of codes of associated measurement units resident in the meter memory and displayable by the meter. The table of codes may be located on the meter nameplate or any other readily viewable location of the meter that is under the meter seal.

6.2.2 Meter Multipliers

6.2.2.1
All meters are required to identify the applicable meter multiplier, if this multiplier is other than unity.

6.2.2.2
For electromechanical energy meters, the meter multiplier shall be marked permanently and prominently, preferably in red, on the register or scale face.

6.2.2.3
For electromechanical demand or combination demand/energy meters, the meter multiplier shall be marked permanently and prominently, on either the register or nameplate, preferably in red.

6.2.2.4
Where an electromechanical meter has different multipliers for different measurement quantities, the applicable multiplier for each register and/or scale shall be marked in the proximity of the energy and demand units markings, in a manner which readily identifies the associated function multiplier.

6.2.2.5
For electronic meters, the meter multiplier shall be distinctly marked on the meter's nameplate or electronic display.

6.2.3 Mechanical Registers

6.2.3.1 Register Markings

(1) Meters shall be verified to ensure that there are no markings on the register face except for the manufacturer's name, trade mark, the direction of rotation indicator, register ratio, rotation index mark, multiplier, or marks pertaining to the reading of the register. Where the register face and nameplate are integral, the above requirement shall not apply but any markings shall not interfere with the reading of the register.

(2) It is not permissible to indicate above or below any individual dial or drum, the magnitude of either the complete indication or of the divisions.

6.2.4 Register Ratio - Induction Type Meters

(1) Induction type energy meters shall be verified to ensure that the register ratio is marked on the register in such a manner that it is legible without removing the register. If sufficient space is available, the register ratio shall be marked on the register faceplate.

(2) The register indication shall be strictly in accord with the result computed from the number of disc revolutions, the disc constant as given on the nameplate and with the multiplier.

6.2.5 Demand Registers

The driving pointer shall be examined to ensure that it is of a colour distinctly different from that of the driven pointer.

6.2.6 Electronic Displays

6.2.6.1 General

(1) Meters equipped with electronic displays and having programmable display parameters shall be clearly readable under normal conditions of use.

(2) Meters displaying date and time shall be in the all numeric format set forth in CAN3-Z234.4, unless otherwise clearly marked.

6.2.7 Register Resets

6.2.7.1 General

(1) The reset device shall be checked to ensure that it is not possible to reset (i.e. reset to zero) or modify energy registers with the meter sealed, unless the readings are stored in another sealed memory or register location for recall at any time. Only demand quantities shall be resettable on a sealed meter.

(2) For the case of mechanical demand registers, the device for resetting demand shall be such that, in its normal position, it does not affect either the maximum demand indicator or the driving element.

6.2.7.2 Resetting of Demand Registers

The peak demand reset event shall be verified to ensure that it:

(a) resets the maximum demand indicator to zero (at no load conditions) or to the equivalent current demand position; and

(b) increments any associated cumulative demand register by a value equal to the peak demand reading.

6.3 Data Retention Requirements

6.3.1 General

The data retention capabilities of meters having metered data, chronological data, or metrologically significant information which could be lost in the event of a power outage, shall be verified over a period of one minute, or any other period approved by MC , to ensure prevention of the loss of this information.

6.3.2 Carry-over Battery

Any device fitted with a carry-over battery shall be verified to confirm battery condition using one of the following means:

(a) Confirm that the battery condition indicator indicates a good battery.

(b) Measure battery voltage.

(c) For meters equipped with batteries which cannot be accessed without breaking the meter seal, use manufacturers data on expected battery life and ensure that remaining battery life will be sufficient for the reverification period of the meter.

6.4 Electrical Requirements

6.4.1 Circuit Association Check

(1) All polyphase meters shall be subject to a circuit association test to ensure that each current circuit is associated with the correct voltage circuit

(2) This test is not required upon reverification if the meter seal has not been broken or damaged.

6.4.2 Pulse Initiator Requirements

(1) Meters having pulse initiators which represent functions that are not verified by other means shall be subject to verification at all applicable energy meter test points using the same specification limit.

(2) Pulse initiators which are used as the fundamental means for establishing time-related demand shall be verified for accuracy to specification limits of ±1.0% with a resolution of 0.1%.

6.4.3 Pulse Recorder

(1) Pulse recorder(s) or meters equipped with internal pulse recorder(s) shall be assessed to ensure that pulses are recorded accurately. Pulse recorders shall record total pulses accurately to a specification limit of ± 2 pulses when at least 100 pulses have been applied. Devices with multi-channel input and recording capabilities shall be assessed to the above criteria at each input channel.

(2) Devices intended for use in determining demand shall be subject to demand interval verification as per 6.5.5.

(3) Pulse recorders which convert pulses to energy values are subject to the requirements of multi-register metering (section 6.5.2), as well as pulse constants (section 6.5.7).

6.4.4 Reverse Operation

(1) Meters intended to be used for reverse flow energy shall be verified to ensure correct operation of the flow direction indicator.

(2) Meters equipped with pulse outputs shall be verified to ensure that detents prevent pulse output for the case of reverse operation.

(3) Each detented register on a meter shall be verified to confirm that there is no change in registration if the meter is connected to a load in the reverse direction.

6.4.5 Induction Type Var hour and Q hour Metering

Where an induction type watt hour meter is used with approved phase shifting transformers to meter var hours or Q hours, the meter shall be verified for the presence of markings indicating the units being measured. The meter shall also be verified for the presence of a marking to indicate that external phase shifting transformers are required. For the case of a watt hour meter that has been cross connected in order to meter Q hours the meter shall be verified for the presence of marking indicating that it has been cross connected and for the units being measured.

6.5 Verification of Advanced Meter Functions

6.5.1 Programmed Parameters

(1) Programmable metrological parameters and functions shall be verified to ensure that they are programmed correctly according to the meter owner provided specification and, if present, the information printed on the meter nameplate. This may be accomplished through a number of means, at the option of the meter verifier, depending on the function.

(2) These checks are not required upon reverification if the meter has not been reprogrammed and the meter seal has not been broken or damaged.

6.5.2 Multi-register Meter Functions

Meters equipped with multi-register functions shall be verified for the correctness of programmed information used to exercise switching of rate registers. This may be verified by one of the following means:

(a) Comparing the programmed information stored in the meter against specified information provided by the owner of the meter.

(b) Performing test(s) which assess each multi-register.

(c) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.3 Prepayment meters

In addition to all applicable administrative, technical and metrological requirements contained herein, prepayment meters shall also be assessed for the correctness of programmed parameters related to the prepayment function. The correctness of programmed parameters shall be verified by one of the following means:

(a) Comparing the programmed information stored in the meter against specified information provided by the owner of the meter.

(b) Performing test(s) which exercise the programmed parameters related to the prepayment function.

(c) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.4 Multiplier

The meter multiplier shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the multiplier on the meter display, if it is programmed into one of the meter's display sequences.

(c) Performing an accuracy test that makes use of a register to which the multiplier is applied, e.g. a demand or "dial" test. The resolution of this test shall be sufficient to determine the value of the multiplier to a resolution of 0.1%.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.5 Demand Interval

The normal mode demand interval shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the demand interval on the meter display, if it is programmed into one of the meter's display sequences.

(c) Performing a demand accuracy test.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

Meters equipped with more than one demand interval, either for different demand quantities or multiple demand input channels (i.e. mass memory) shall have each interval assessed as above.

6.5.6 Demand Type

Demand Type refers to whether a meter is programmed for block/rolling block or exponential demand in normal mode. This shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the demand type on the meter display, if it is programmed into one of the meter's display sequences.

(c) Performing a demand test.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.7 Pulse Constants

(1) Pulse constants for pulse outputs (e.g. KYZ) shall be verified to ensure correctness of the programmed value in relation to the pulse type and form.

(2) Each pulse constant shall be verified for meters equipped with more than one pulse output and have pulse constants which are separately programmable. If a single programmed parameter determines the pulse constant for all pulse outputs, then only a single check is required. The pulse constant shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the pulse rate on the meter display, if it is programmed into one of the meter's display sequences.

(c) Performing an accuracy test on one of the pulse outputs. This test may also be used to verify the corresponding energy function.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.8 Pulse Output Detent

(1) Detent setting shall be verified on meter's having pulse outputs with programmable detent.

(2) The detent of each output shall be verified for meters equipped with more than one pulse output and which have detents that are separately programmable. If a single programmed parameter determines the detent for all pulse outputs, then only a single check is required.

(3) The pulse detent shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the detent setting on the meter display, if it is programmed into one of the meter's display sequences.

(c) Applying energy to the meter in the reverse direction relative to the direction of the pulse output, and confirming that no pulses are generated.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.9 Programmable Register Detent

(1) Detent setting shall be verified on meters having registers with programmable detent.

(2) The detent of each register shall be verified for meters equipped with more that one register having detents that are separately programmable. If a single programmed parameter determines the detent for all registers, then only a single check is required.

(3) The programmable register detent shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or pushbuttons.

(b) Reading the detent setting on the meter display, if it is programmed into one of the meter's display sequences.

(c) Applying energy to the meter in the reverse direction relative to the direction of the register, and confirming that there is no change in registration.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.5.10 Loss Compensation

The loss compensation factor(s) in meters equipped with loss compensation shall be verified through one of the following means:

(a) Examining the program in the meter, e.g. by using software or push-buttons.

(b) Reading the loss compensation factor on the meter display, if it is programmed into one of the meter's display sequences.

(c) Performing an accuracy test that makes use of a register to which the loss compensation factor is applied, e.g. a demand or "dial" test. The resolution of this test shall be sufficient to determine the value of the multiplier to a resolution of 0.1%.

(d) Other means that the meter verifier can demonstrate are valid and are approved by MC may be used.

6.6 Firmware Verification

Meter firmware shall be identical to a version(s) identified in the notice of approval or applicable modification acceptance letter(s) (MAL).

7.0 Metrological Requirements

7.1 General

(1) The requirements including test points and specification limits provided in this document shall be applied in conjunction with procedures either issued or accepted by MC.

(2) MC may establish additional test points and procedures as may be required for specific meter types.

(3) Unless otherwise noted the specification limits specified in this document are provided in terms of % relative error.

(4) Meters shall be fully assembled and calibrated before undergoing verification or reverification tests. Removal of the meter cover or access to sealable components, adjustments, or reprogramming during the verification process is permitted only when test procedures used have been issued or accepted by MC.

(5) All verification tests for accuracy of energy functions shall be determined to a minimum resolution of 0.1% for electromechanical meters and 0.01% for electronic meters unless otherwise stated.

(6) The errors for exponential responding demand meters shall be determined after the test load has been applied for three full demand response periods.

7.2 Reference Conditions for Metrological Requirements

Except as otherwise stated, the following reference conditions shall apply to all metrological requirements:

(a) The ambient temperature shall be 23°C ± 5°C.

(b) All voltage circuits shall be connected in parallel and all current circuits shall be connected in series assisting.

(c) Before conducting any tests for the purpose of ascertaining meter performance, meters shall be warmed up as specified by the manufacturer up to a maximum of two hours.

(d) The meter or device shall be in its normal working condition or in a mode approved for verification or reverification. Except where the nature of the test requires otherwise, all registers, transmitting contacts, detents, etc., shall be operating in the normal state. For cyclometer-type registers, only the fastest moving counter shall be turning.

(e) The meter shall be installed during test such that the working position of the meter is within ± 3° of the front-to-back and side-to-side vertical planes. This requirement is applicable to electromechanical integrating meters or other meter types having accuracy which may be effected by tilt.

(f) For the purpose of setting the test loads, all test points shall be within ±2.0% of the established test current, nominal voltage, and test load.

(g) Power factor set points shall be within ±2.0 degrees of that specified for the test, and unless otherwise specified, shall be in the lag condition.

(h) Unless otherwise specified, meters shall be evaluated at their nominally rated nameplate voltage.

(i) Unless otherwise specified, meter test loads are established as a percentage of the maximum current rating (I_{max}) for the meter. Transformer type meters having a meter I_{max} of 10 amperes or greater and intended to be installed with transformers having a secondary rating of 5 amperes shall be evaluated using a value for I_{max} of 10 amperes.

7.3 Performance Requirements

7.3.1 General

Unless otherwise stated, each function of an electricity meter shall comply with the requirements set out in section 7.3, as applicable.

7.3.2 Electromechanical Meters

7.3.2.1 Zero Load Performance

(1) Energy meters shall be subjected to a zero load test, with a load of zero current and nominally rated voltage.

(2) The disk of an electromechanical meter shall be stopped or it shall not exhibit one complete revolution of its disk in a ten minute period.

7.3.2.2 Comparative Registration

Electromechanical meters shall be subjected to a comparative registration test (dial test). The specification limit is zero error relative to the disc, tested to a resolution of 3.0%.

7.3.2.3 Electromechanical Energy Meters, General

7.3.2.3.1 Single Phase 1 and 1½ Element Energy Meters

All single phase, single element, and one and one-half element, energy meters shall be evaluated at the test points and specification limits identified in table 7.1.

Table 7.1

Energy Tests: Single Phase, 1 Element and 1½ Element Meters

Test Configuration	Current	Power Factor Pf	Specification Limit
Series Test	25% I_{max}	1	±1.0%
Series Test	25% I_{max}	0.5	
Series Test	2.5% I_{max}	1	

NOTES: Reverification tests at 0.5 Pf test are not required for magnetic suspension, single phase 1 and 1½ element energy meters.

Reverification tests at 0.5 Pf test are required for magnetic suspension, single phase 1 and 1½ element combination energy-demand meters.

7.3.2.3.2 Polyphase 2½ Element Wye Energy Meters

Polyphase 2½ element wye meters shall be evaluated at the test points and specification limits identified in table 7.2.

Table 7.2

Energy Tests: Polyphase 2½ Element Wye Meters

Test Configuration	Current	Power Factor Pf			Specification Limit
		Wh, VAh	varh [1]	Qh [1]	
Series Test	25% I_{max}	1	0.5	0.5	±1.0%
Series Test	2.5% I_{max}	1	0.5	0.5	
Each element	50% I_{max}	1	0.5	0.5	
Each element	50% I_{max}	0.5	0.866	1	
Split coil element [2]	50% I_{max}	1	0.5	0.5	

NOTES: (1) Var hour and Q hour meters that operate on the crossed phase principle shall be tested as watt hour meters.

(2) The split coil element test is not required on reverification.

7.3.2.3.3 Polyphase 2 Element, 2½ Element Delta, and 3 Element Energy Meters

Polyphase 2 element, 2½ element delta, and 3 element energy meters shall be evaluated at the test points and specification limits identified in table 7.3.

Table 7.3

Energy Tests: Polyphase 2 Element, 2½ Element Delta, and 3 Element Meters

Test Configuration	Current	Power Factor Pf			Specification Limit
		Wh, VAh	varh [1]	Qh [1]	
Series Test [3]	25% I_{max}	1	0.5	0.5	±1.0%
Series Test [3]	2.5% I_{max}	1	0.5	0.5	
Each Element [2]	25% I_{max}	1	0.5	0.5	
Each Element [2]	25% I_{max}	0.5	0.866	1	
Each Element [2] (2½ element 4-wire Delta only)	2.5% I_{max}	1	0.5	0.5	

NOTES: (1)Var hour and Q hour meters that operate on the crossed phase principle shall be tested as watt hour meters.

(2) The tests for each element of 2½ element 4-wire Delta meters shall be applied to:

(a) the 2-wire element.
(b) the 3-wire element in series.

(3) The series test for 3 element 4-wire Delta meters shall be conducted at the rated voltage of the lower rated potential coil. The individual element tests shall be conducted at the rated voltage of the respective potential coil.

7.3.2.3.4 Electromechanical Bi-directional Energy Meters

Electromechanical bi-directional energy meters shall be verified for each direction of energy flow. The test points and specification limits shall be as specified in tables 7.1 - 7.3 as applicable.

7.3.2.4 Electromechanical Demand Meters

7.3.2.4.1 General

(1) Thermal demand meters shall be tested for hysteresis (grease memory) by manually resetting the driven demand pointer a minimum of two major scale divisions and holding for a maximum of three seconds. After removing the demand reset mechanism, the driven demand pointer shall not move up scale more than 1.0% F.S. (Full Scale).

(2) Thermal demand meters shall be tested for pull-back after the demand test load is removed. The driven pointer shall not move down scale by more than 1.0% F.S.

(3) A thermally stable electromechanical thermal demand meter shall be evaluated to ensure that zero load is registered to within 1/32 inch of true zero.

(4) For the purpose of evaluating thermal demand errors determined at the test points indicated in tables 7.4 and 7.5 readings of the driven pointer shall be taken only after the driving pointer has disengaged.

7.3.2.4.2 Electromechanical 1 and 1½ Element Thermal Demand Meters

Single phase one element and 1½ element electromechanical thermal demand meters shall be evaluated at the test points and specification limits identified in table 7.4.

Table 7.4

Demand Tests: Electromechanical 1 and 1½ Element Thermal Demand Meters

Test Configuration	Test Point	Power Factor Pf	Specification Limit
Series test	66.6% F.S.	1	±1.5% F.S.
VA only: Series test	66.6% F.S.	0.5	±1.5% F.S.
Any one element	20% F.S.	1	±1.5% F.S.

7.3.2.4.3 Electromechanical 2, 2½ and 3 Element Thermal Demand Meters

Polyphase two element, 2½ element and three element electromechanical thermal demand meters shall be evaluated at the test points and specification limits identified in table 7.5.

Table 7.5

Demand Tests: Electromechanical 2, 2½ and 3 Element Thermal Demand Meters

Test Configuration	Test Point	Power Factor Pf	Specification Limit
Series test	66.6% F.S.	1	±1.5% F.S.
VA only: Series test	66.6% F.S.	0.5	±1.5% F.S.
2 el: Any one element	20% F.S.	1	±1.5% F.S.
3 el: Any two elements	20% F.S.	1	±1.5% F.S.
2½ el: Each single element (delta meters)	20% F.S.	1	±1.5% F.S.
2½ el: Each single element (wye meters)	16.6% F.S.	1	±1.5% F.S.

7.3.2.4.4 Electromechanical Integrating Demand Meters

Where the demand pointer is driven by the meter disc, one series test shall be performed at 66.6% F.S., 1.0 Pf. The specification limit for this test is ±1.5% F.S.

7.3.2.4.5 Accuracy of Demand Interval

The demand interval for electromechanical block interval demand meters shall be within ±1.0% of the set interval.

7.3.3 Electronic Meters

7.3.3.1 Zero Load Performance

7.3.3.1.1
Electronic meters shall be subject to a zero load verification test performed with zero current in all circuits, and any rated voltage.

7.3.3.1.2
Meters may be evaluated for zero load performance using one of the methods outlined in (a) to (d) below. The duration of the evaluation test shall be determined based on a hypothetical load of 0.05% I_{max} at the test voltage and the test condition described in (a) to (d) as applicable. No registration is permitted for the duration of the tests performed in (a) to (d) below.

(a) Demand Test: The duration of the test shall be at least one complete demand interval, or in the case of exponential demand three time constants. However, a demand test may be used only if the demand register has sufficient resolution to indicate a non-zero value at the load described in 7.3.3.1.2.

(b) Pulse output or disk revolution simulator: The minimum duration of the test shall be the amount of time that would be required to obtain one pulse or disk revolution at the load described in 7.3.3.1.2.

(c) Energy register Test: The minimum duration of the test shall be the amount of time that would be required to register a non-zero value at the load described in 7.3.3.1.2., based on the resolution of the energy register.

(d) Other means such as instantaneous demand, that the meter verifier can demonstrate are valid and are approved by MC.

7.3.3.2 Accuracy Requirements

7.3.3.2.1

Electronic energy meters are to be programmed with the watthour function and shall be verified for each applicable energy function at the test points found in table 7.6 below:

Table 7.6

Energy Tests: Electronic Energy Meters

Test Configuration	Current	Power Factor Pf				Specification Limit
		Wh	VAh	Varh	Qh	
Series Test [1]	25% I_{max}	1		0.5	0.5	±1.00%
Series Test [1]	25% I_{max}	0.5	0.5	0.866		
Individual Elements [1,2]	25% I_{max}	0.5				
Series Test [1]	2.5% I_{max}	1				

NOTES:

(1) The series test for 2 ½ and 3 element 4-wire Delta meters shall be conducted at the nameplate rated voltage. The individual element tests shall be conducted at the rated voltage of the respective potential coil.

(2) Individual element testing is not required for 1 and 1 ½ element meters.

7.3.3.2.2

Electronic demand meters shall be evaluated for all applicable demand functions identified in table 7.7 except as noted in (1) below. The 50% Imax test load shall be used except where a 25% Imax test load can be shown to provide a 0.1% resolution of reading, in which case either test point may be used.

Table 7.7

Demand Tests Points for Electronic Demand Meters

Test Configuration	Current	Power Factor Pf			Specification Limit
		W	VA [1]	Var [1]	
Series Test	50% I_{max}	0.5	0.5	0.866	±1.00%
OR in accordance with 7.3.3.2.2 above					
Series Test	25% I_{max}	0.5	0.5	0.866	±1.00%

NOTE: Meters which have been assessed for VAh and/or Varh functions, and the Watt demand function, are not required to be assessed for their respective VA and/or Var demand functions.

7.3.3.2.3 Meters with Multiple or Auto-ranging Voltages

Electronic meters which are capable of operating at multiple voltages shall be verified with all elements in series/parallel configuration at one additional nominal service voltage using a previously verified current and power factor test point (i.e. energy or demand).

7.3.3.2.4 Voltage Squared Hour Meters

Meters which are capable of metering voltage squared hours shall be evaluated at 95% and 105% of the nominal nameplate voltage. The specification limit for these V^2 h tests is ±1.00%.

7.3.3.2.5 Ampere Squared Hour Meters

Meters which are capable of metering ampere squared hours and have not been evaluated for the watt hour function, shall be evaluated at 2.5% I_{max} and 25% I_{max}. All other ampere squared hour meters may be evaluated at only one convenient test point which is at or greater than 25% I_{max}. The specification limit for these I^2 h tests is ±1.00%.

7.3.3.2.6 Electronic Demand Meter Type

Each demand type (exponential, block, etc.) which has been programmed and not otherwise verified shall be verified in accordance with the requirements of section 7.3.3.2.2.

7.3.3.2.7 Meters Equipped with Gain Switching Circuits

Meters which are equipped with gain switching circuits shall be tested at one test point in each gain switching range. This may require additional test points for the case of meters having gain ranges not exercised by the standard test points. The additional test points within the various gain ranges of the meter shall be as established within procedures, Notices of Approvals or other official documentation as approved by MC.

7.3.3.2.8 Electronic Bi-directional Energy Meters

Electronic bi-directional energy meters shall be verified for all of the applicable tests in the delivered direction and at the test points specified in table 7.8 as applicable for the received direction.

Table 7.8

Test Configuration	Current	Power Factor Pf			Specification Limit
		Wh	VAh	Varh	
Series Test	25% I_{max}	0.5	0.5	0.866	±1.00%

7.3.4 Combination Electromechanical-Electronic Meters

(1) Combination electromechanical-electronic meters which have the disk of the electromechanical induction portion of the meter monitored electronically to provide approved metering functions shall be verified as follows:

(a) for each approved energy function provided electronically the requirements of section 7.3.2 shall apply.

(b) for each approved demand function provided electronically the requirements of section 7.3.3 shall apply.

(2) Combination electromechanical-electronic meters which have electromechanical metering elements and electronic metering elements which are independent of each other shall be verified as two independent meters. The electromechanical portion of such devices shall be verified in accordance with the applicable requirements of section 7.3.2 and the electronic portion of such devices shall be verified in accordance with the applicable requirements of sections 7.3.3.

8.0 Revision

8.1 The purpose of revision 1 is to remove the Testing facilities requirements, which were identified under the reduction initiative as being adequately addressed in section 19 of the Act. The purpose for revision 2 is to remove remove the Nameplate requirements, which were identified under the reduction initiative as being adequately addressed in the approval specification and the notice of approval where additional markings may be required.

8.2 The purpose of revision 2 is to add requirements for sampling of electronic polyphase and demand meters.

for

Alan E. Johnston
President
Measurement Canada

Annex A Acceptance Sampling and 100% inspection requirements

A.1 Scope

This annex specifies the requirements for acceptance sampling and 100% inspection of electronic meters.

A.2 Applicability

A.2.1 The requirements of this section are applicable to all electronic meters of section 7.3.3 which include, single phase, network and polyphase, self contained and transformer type energy meters (Wh, VAh, Varh and Qh), demand meters (Watts, VA, Var), and loss meters (V^2 h, I^2 h) with or without advanced functions.

A.2.2 This annex states the requirements for verification and reverification when the test or measurement result is subject to uncertainty, in accordance to the requirements of MC specification S-S-02 (reference 3.7).

A.3 General

A.3.1 Meters shall be verified or reverified in accordance to all of the applicable requirements in this document and as amended by this annex.

A.3.2 In general for the purpose of verification, test results for the following quality characteristics shall be treated as non-performance observations for functionality verification (i.e. pass/fail). The following list as applicable, is not exhaustive and is not intended to include all the possible combinations of non-performance attributes to be inspected within a quality system:

(a) Data retention capabilities

(b) Carry-over battery condition

(c) Pulse recording operation

(d) Validation of programmed parameters

(e) Multiplier verification

(f) Pulse constant verification

(g) Pulse output detent operation

(h) Loss compensation factors and/or function

(i) Zero load performance / creep test verification

(j) Phase association verification

(k) Confirmation of approved firmware

(l) Mechanical integrity confirmation

(m) Multi-register metering function

(n) Demand reset operation

(o) Demand type verification

(p) Demand interval verification

A.4 Symbols and Abbreviated Terms

k multiplier calculated to provide specified coverage for the uncertainty of a measurement
e_i test value
u_{ci} combined standard uncertainty of e_i
L_{SL} lower specification limit
U_{SL} upper specification limit

MADT mean absolute deviation from target
U_{MADT} Upper MADT specification limit

CSL1 compressed specification limits for type 1 marginal conformities (LQ = 3.15%)
CSL2 compressed specification limits for type 1 marginal conformities (LQ = 8.0%)
L_{CSL1} lower compressed specification limit (LQ = 3.15%)

L_{CSL2} lower compressed specification limit (LQ = 8.0%)
U_{CSL1} Upper compressed specification limit (LQ = 3.15%)
U_{CSL2} Upper compressed specification limit (LQ = 8.0%)

A.5 Limits of Error and Conformity Determination

A.5.1 The specification limit is ±1.00% and the minimum coverage criterion for the extended measurement result is at least 99% coverage. For the purpose of 100% inspection, conformity shall exist if all of the inequalities below are satisfied. For meters which are not new and cannot be calibrated, conformity shall exist if inequalities in sub clauses (i) and (ii) are satisfied.

(I) $e_i - k\, u_{ci} \geq L_{SL}$

(ii) $e_i + k\, u_{ci} \leq U_{SL}$ and

(iii) mean ($|e_i|$) $\leq 0.50\ (U_{SL})$

where, $k = 3.0000$ and u_{ci} is determined in accordance to the requirements of MC Specification S-S-02 (reference 3.7)

NOTE 1: The MADT per A.5.1(iii) is calculated from all observations identified in A.5.2, below. The calculation method is to first determine the absolute value of each error, e_i, then determine the mean of those values.

NOTE 2: The definition of new meter identified in A.5.1 above is as defined in bulletin E-26 reference 3.10, also see section 5.6 for applicable reverification periods.

A.5.2 For single phase, polyphase and network electronic meters the MADT is determined using the unweighted mean of all Wh energy observations at unity and 0.5 power factor.

A.5.3 Conformity shall be determined using a one-stage procedure in accordance to the requirements of MC specification S-S-02 (reference 3.7).

A.5.4 Measurement results shall be reported in accordance with S-S-02 (reference 3.7).

A.6 Acceptance Sampling Inspection for Electronic Meters

A.6.1 Devices may have their conformity evaluated by 100% inspection or, where the prerequisites of MC Specification S-S-03 (reference 3.8) have been and continue to be met, by sampling inspection in accordance with the requirements of MC Specification S-S-04 (reference 3.9).

A.6.2 A lot of meters submitted for acceptance sampling shall not contain a mixture of self contained and transformer type meters. As well, meters in the lot shall be homogeneous with respect to the following:

(a) manufacturer and model, unless otherwise authorized by MC in accordance with clause A.6.3.

(b) voltage or voltage range.

(c) maximum current rating.

(d) configuration with respect to number of elements, wye, delta or auto configuration.

(e) units of measure.

(f) firmware version that is identified as being homogeneous by the manufacturer.

(g) frequency rating.

(h) same model or type of telemetering device (if so equipped), unless otherwise authorized by MC in accordance with clause A.6.3.

(i) demand type, unless otherwise authorized by MC in accordance with clause A.6.3.

(j) permissible batch types:

(1) new and/or renewed meters produced within a six-month period; or,

(2) previously-verified meters which have all been reconditioned (and/or repaired) and re-calibrated within a six-month period.

A.6.3 If an accredited organization wishes to combine, in one lot, various models or vintages of meters, and/or meters equipped with and without a telemetering device, or more than one telemetering device, the accredited organization shall submit a request to MC with accompanying documentation in support of their claim that these differing meters can be considered homogeneous for purposes of acceptance sampling.

A.6.4 For the purposes of sampling inspection, a conforming unit is as defined in these specifications, for performance and non-performance characteristics. A lot shall be sentenced based on the specification limit of ±1.00%. The criterion for the extended measurement result is at least 95% coverage. An accredited organization shall have the option to determine conformity using either a one-stage or two-stage procedure in accordance with the requirements of MC Specification S-S-02 (reference 3.7).

A.6.5 The compressed specification limit (CSL) values determined from the device's performance specification limits are defined as follows:

Marginal conformity type	Lower CSL	Upper CSL
Type 1 (LQ of 3.15%)	L_{CSL1} = 0.8350 (-1.00) = -0.8350	U_{CSL1} = 0.8350 (1.00) = 0.8350
Type 1 (LQ of 8.0%)	L_{CSL2} = 0.6797 (-1.00) = -0.6797	U_{CSL2} = 0.6797 (1.00) = 0.6797
Type 2 (MADT)	-------	U_{MADT} = 0.5 (1.00) = 0.50

A.6.6 A device is classified as a marginally conforming unit if it has no nonconformity but exhibits performance falling outside the interval defined by the lower and upper CSL values (type 1 marginally conforming) or has an MADT value exceeding the MADT limit (type 2 marginally conforming).

A.6.7 The conformity, marginal conformity, or nonconformity of the device's performance shall be determined in accordance with the requirements of S-S-02 (reference 3.7) and the following classification criteria based on the device's relative error (e_i), applied in the order presented below. For meters which are not new and cannot be calibrated, the conformity, marginal conformity, or nonconformity determination is applied to sub clauses (a), (b), (c) and (e).

(a) nonconforming if $e_i + k\,u_{ci} > U_{SL}$, or $e_i - k\,u_{ci} < L_{SL}$

(b) marginally conforming type 1 if $e_i + k\,u_{ci} > U_{CSL1}$ or $e_i - k\,u_{ci} < L_{CSL1}$

(c) marginally conforming type 1 if $e_i + k\,u_{ci} > U_{CSL2}$ or $e_i - k\,u_{ci} < L_{CSL2}$ (optional under sampling inspection)

(d) marginally conforming type 2 if the mean ($|e_i|$) $> U_{MADT}$

(e) conforming otherwise

where, k = 1.6449, u_{ci} is determined in accordance to the requirements of MC Specification S-S-02 (reference 3.7). MADT is determined in accordance with A.5.2

A.6.8 Measurement results shall be reported in accordance with S-S-02 (reference 3.2).

A.7 Outgoing Quality Requirements

The outgoing quality standards for meter quality under both 100% inspection and sampling inspection are:

(a) No inspected meters shall be permitted to be placed in service with a result which is not contained within the 100% Inspection specification limits specified in subsections A.5.1.

(b) No meters shall be permitted to be placed in service with one or more nonconformities or defects. (Note: The accredited organization shall be responsible for deciding which types of quality characteristic deficiencies are to be identified as a defect.)

(c) Subject to a) and b) above, sample meters are considered acceptable regardless of the status of the lot.

(d) The outgoing quality requirements shall be met for the product of the associated limiting quality (LQ) value and the lot size, as specified in S-S-03 (reference 3.8) or S-S-04 (reference 3.9) for type 1 and type 2 marginal conformities.

(e) For meters which only undergo 100% inspection, the outgoing quality requirements of section A.7(d) are considered as being met if the 100% inspection requirements specified in section A.5 are met.

A.8 Disposition of Nonconforming Meters

A.8.1 For small lots inspected by 100% inspection or larger lots inspected but not accepted by sampling, nonconforming meters and excessive marginally conforming meters shall be removed or repaired to ensure the outgoing quality standards of section A.7 are met.

A.8.2 Individual non-conforming or defective meters may be resubmitted for inspection only after their deficient characteristics have been corrected.

A.8.3 Unacceptable lots may be resubmitted for inspection only after the meter owner or his agent has re-examined all meters and removed or corrected all non-conforming or defective meters. Re-inspection shall include evaluation of all quality characteristics where the non-acceptance is due to performance characteristics, or, for all other types of nonconformities and defects, evaluation of the characteristic(s) causing lot non-acceptance.

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Specifications

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Specification for the Installation and Use of Electricity Meters - Input Connections and Ratings

1.0 Scope

This specification applies to electricity energy and demand meters which are verified pursuant to the *Electricity and Gas Inspection Act* and installed subsequent to the effective date of this specification. This specification does not apply to the connections between external sensors and the main body of the meter of Multi-Customer Metering Systems.

2.0 Authority

This specification is issued under the authority of section 12(2) of the *Electricity and Gas Inspection Regulations.*

3.0 Background

Meters have traditionally been designed with input ratings typically suited to the standard electricity distribution system voltage and current ratings in Canada. While there is an inherent understanding as to the applicability of any given rated meter to be installed and used in a similarly given rated service, technical criteria have not been specifically established.

Metrological performance tests for meter approval and verification are based on the voltage and current ratings of the meter under test, and presuppose that the meter will be installed and used in a service which is most compatible with those identified meter ratings. For example, while a 240 volt rated meter is capable of being installed and used on a 120 volt service, it is not the intended conditions from the viewpoint of approval or verification of that meter. The same applies to a 100 ampere rated meter installed on a 5 ampere service. The installation and use of meters in a service which has dramatically different ratings from those identified on the meter may have a significant metrological impact since the meter was not assessed at approval or verification for performance under those conditions.

As technology evolves there are increasing numbers of meters designed with input ratings that do not directly correspond to the standard electricity distribution system ratings which exist in Canada, particularly with respect to current ratings.

Therefore there is a need to clearly establish the installation criteria for selection of meter ratings which are suitable for a given service rating, in addition to establishment of related input connection requirements.

4.0 Installation and Use

4.1 General

4.1.1 Each verified meter to be installed and used in obtaining the basis of a charge shall be installed and used in the manner(s) established:

(a) in the Notice of Approval (NOA) or Conditional NOA as applicable, in addition to the manner specified in this document.

(b) in other Measurement Canada Installation and Use requirements, as applicable, in addition to the manner specified in this document

(c) by the manufacturer's technical specifications and criteria.

4.1.2 In any situation where a requirement of a), b), or c) above exclusively contradicts another requirement of a), b), or c), the details shall be reported to Utility Metering Division of Measurement Canada through the appropriate Regional Electricity Specialist.

4.2 Transformer Type Meters

4.2.1 Meters shall be connected to instrument transformers in accordance with the appropriate diagram established in the Measurement Canada Standard Drawings for Metering Installations. Other connection configurations may be used only if a formal drawing showing the actual connections is provided by the owner of the installation, and the drawing is determined to be acceptable to Measurement Canada Engineering and Laboratory Services.

4.2.2 The minimum current rating of the meter installed shall not be greater than 4% of the output rating of any current transformer which is connected to the meter input circuits. Also, the minimum current rating of the meter installed and used in service shall be of a rating included in the applicable Notice of Approval.

4.2.3 The maximum current rating of the meter installed shall not be less than the rating factor of the connected current transformer times the secondary rating of the connected current transformer. Also, the maximum current rating of the meter installed and used in service shall be of a rating included in the applicable Notice of Approval.

4.2.4 The operating voltage of the meter installed shall have an approved voltage rating which is between 90% and 105% of the nominal output voltage of the transformer which is connected to the meter inputs.

4.2.5 Each wire or cable that connects from the output of any instrument transformer to a meter input shall be individually identifiable or traceable. It is preferable that wires be identified in accordance with the colour code established in the Measurement Canada Standard Drawings for Metering Installations.

4.2.6 Meter inputs shall be connected to instrument transformer outputs via an appropriate test switch or other similar mechanism which will facilitate safe meter removal, shorting of current transformer secondaries, and connection of circuit analysis and test equipment. This requirement applies to all new and reconstructed metering installations connected after the effective date of this specification.

4.2.7 The combined burden of meter, associated wiring and connections, and any other secondary connected devices shall not exceed the burden designation of any instrument transformer which is connected to the meter input circuits.

NOTE: The combined burden could be determined by adding the manufacturer specified burden ratings of all the applicable devices.

4.3 Self-contained Meters

4.3.1 The operating voltage rating of the meter installed shall have an approved voltage rating which is between 90% and 105% of the service voltage at the meter installation site.

Alan E. Johnston
President
Measurement Canada

Measurement Canada | Mesures Canada

Specifications

Category: **ELECTRICITY**	Specification: **S-E-04 (rev. 2)**	Page: **1 of 7**
Document(s): **P-E-04**	Distribution Date: **2008-06-27**	Effective Date: **2008-06-27**
	Supersedes: **S-E-04 (rev. 1)**	

Installation Requirements for Multiple Customer Metering Systems

1.0 Scope

These specifications apply to the installation of multiple customer metering systems which are used for the purpose of obtaining the basis of a charge in accordance with section 9 of the *Electricity and Gas Inspection Act*.

2.0 Authority

These specifications are issued under the authority of sections 12 and 18 of the *Electricity and Gas Inspection Regulations.*

3.0 Definitions

Act
The *Electricity and Gas Inspection Act* (Act).

Authorized Representative
Any Measurement Canada inspector or accredited organization authorized by Measurement Canada to perform the functions outlined in this document.

Commissioning
The process or procedure used during installation of MCMS prior to activation to ensure the system is operating correctly. (For example, the process for assessing that current sensors or instrument transformers are connected to the correct load and associated with the applicable voltage connections).

Contractor
Any person or body that has undertaken to supply electricity or gas to any purchaser.

Current Test Block
An appropriate terminal block or test switch, used in a current circuit which allows the connection of test equipment into the current measuring circuit of the meter without interrupting the circuit.

Current Transformer (CT)
A measuring instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

Instrument Transformer
A measuring transformer which is intended to reproduce in its secondary circuit, in a definite and known proportion, the current or voltage of its primary circuit with the phase relations substantially preserved.

Multiple Customer Metering Systems(MCMS) or device
Metering systems which fulfill one or both of the following criteria:

(a) Systems which require on site central processing of meterological information for more than one metering point.

(b) Systems which employ external sensors which are integral to the meter. These systems generally are used in multi customer applications. However, they can operate as stand alone, single point meters.

Sensor
A device for converting an alternating electrical quantity into another quantity for measurement purposes.

Voltage Transformer
A measuring instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs from it by an angle which is approximately zero for an appropriate direction of the connections.

Voltage Test Block
An appropriate terminal block or test switch used in a voltage circuit for isolating the voltage measuring circuit to the meter and providing a convenient point for the connection of test equipment.

4.0 Responsibilities of Accredited Organizations

4.1 The installation shall adhere to all applicable requirements of the *Electricity and Gas Inspection Act* and *Regulations*, including related Specifications and Bulletins.

4.2 Any installation found not to be in compliance with Measurement Canada requirements shall be reported to the local Measurement Canada district office.

5.0 Administrative Requirements

5.1 General

5.1.1 The contractor shall be registered to supply electricity in accordance with section 6 of the *Act.*

5.1.2 The device shall be approved for billing purposes in accordance with the *Act.*

5.1.3 The Multiple Customer Metering Systems shall be verified and sealed in accordance with the *Act* prior to installation.

5.1.4 Any additional installation requirements identified in the notice of approval shall be adhered to.

5.1.5 When auxiliary equipments, such as instrument transformers, etc., are used in conjunction with the metering system, they shall be approved for billing purposes in accordance with the *Act*, and installed in compliance with Measurement Canada requirements.

5.2 Notification

The contractor, or on behalf of the contractor, the multiple customer metering systems supplier or agent shall supply written notification to the local Measurement Canada district office, no later than 30 days from the date of activation of the system. This notification will include, as a minimum, the owner/contractor, full mailing address, contact person, phone number, location of installation, type of system, number of metering points and the date the installation was activated.

5.3 Contractor Representative

The contractor shall provide a representative with authority to access all metering points and shall be legally authorized to work on live electrical equipment for all inspections on-site.

5.4 Documentation

All original inspection certificates and meter configuration charts shall be provided by the contractor upon request. The contractor shall also provide a schematic diagram indicating the locations of all metering equipment, including all sensors and/or instrument transformers within the building's electrical system.

5.5 Access

The authorized representative shall have safe and ready access to all system components, including all external sensing devices and/or auxiliary equipment for the purpose of conducting on site inspections.

5.6 Safety

If any part of this document conflicts with official safety code requirements, the safety code requirements shall take precedence.

6.0 Technical Requirements

6.1 General

Metering systems shall be installed and wired to facilitate on site testing, which may include the possibility of service shut downs if the system cannot be easily removed from service. Additional information, including generic installation inspection procedures and requirements, can be obtained from Measurement Canada.

6.2 Hardware Mounting Arrangements

All components shall be securely mounted so as to facilitate safe and convenient access.

6.3 Connection of Test Equipment

6.3.1 Provision shall be made for the connection of test equipment to all current carrying conductors and voltage circuits.

6.3.2 For voltage circuits, a voltage test block or a disconnect switch shall be installed. The working voltage at this point shall be no less than 120 volts ac and no more than 600 volts ac.

6.3.3 For systems utilizing separately approved instrument transformers a current test block shall be installed. As a minimum, provision shall be made to allow the connection of a clip-on ammeter to the secondary current conductors of the transformers.

6.4 Measurement Circuits

6.4.1 The voltage for any given meter shall be taken from the same source in which the current is being measured.

6.4.2 In addition, the voltage supplied to the metering system should be connected in close proximity to the current sensing elements to ensure that the total measurement error does not exceed the tolerances prescribed by section 31 of the *Electricity and Gas Inspection Regulations*.

6.4.3 The voltage sensing circuit and the current sensing circuit shall be separate and distinct. For example, the secondary wiring of the voltage sensors shall not pass through the current sensing elements.

6.5 Visible Traceability

6.5.1 To facilitate tracing, all voltage and current primary and secondary sensor connections shall be identified through the use of labels, tags or colour coding, in relation to the phase in which they are connected. Refer to Measurement Canada's Generic Procedure for Conducting Installation Verifications of Multiple Customer Metering Systems for standard colour codes.

6.5.2 All sensor serial numbers shall be visible, legible, and permanently affixed to the sensors.

6.5.3 For sensors where visual inspection is not possible or does not provide conclusive evidence of the metrological validity of the system other options may be used, such as taking voltage readings, de-energizing circuits, using circuit tracers or validation through cross phase measurements.

6.6 Commissioning Process

6.6.1 All MCMS shall be subject to a commissioning process by the contractor, prior to activation of the service.

7.0 Installation Verification Requirements

7.1 Installation verifications shall be carried out by a representative, authorized under the *Electricity and Gas Inspection Act*.

7.2 All metering systems shall be subjected to an initial installation verification concurrent with the commissioning process but no later than one year from the date that the device was activated.

7.3 The installation shall be inspected to the system's original verification configuration and the installation schematic diagram to ensure that the following are correct.

(a) All voltage connections, including any external voltage sensors.

(b) All current connections, including the external current sensors.

(c) All phase association between all voltage and current circuits.

(d) All metering points are connected to the applicable service.

7.4 Systems utilizing separately approved instrument transformers shall conform to MC's standard drawings, the installation schematic diagram and shall be verified to ensure the following are correct.

(a) All voltage and current connections to the instrument transformers.

(b) Phase association between all voltage and current circuits.

(c) All metering points are connected to the applicable service.

(d) Colour coding or labelling of instrument transformer wiring.

(e) All grounding of the instrument transformer secondaries.

(f) Polarity of the instrument transformers.

(g) Nameplate markings of the instrument transformers.

7.5 Installation verifications records shall be maintained and show evidence of conformity with these requirements.

8.0 Installation Seals

8.1 Provision shall be made for the effective hard sealing of all terminal blocks, strips, paddle boards, etc. used for the purpose of connecting external sensors and/or instrument transformers to the main body of the meter. This sealing requirement is in addition to the initial verification (in shop) and sealing of the metrological components.

8.2 Following the completion of all mandatory on site installation inspections, pursuant to section 7.0 of this document the MCMS shall be sealed by an authorized representative.

8.3 Where the installation inspection pursuant to section 7.0 is not completed at the time of commissioning the MCMS shall be sealed by the registered contractor prior to activation.

9.0 Breaking of Installation Seal(s)

9.1 The seal as prescribed by section 8.0 of this document may be broken by an authorized representative for the purpose of allowing modifications to an existing installation, or for the purpose of initiating a reverification process.

9.2 Such modifications may include the adding, removing, replacing, or upgrading of existing metering points, replacing blown fuses, or making other modifications which have no metrological impact on the integrity of the overall metering system.

9.3 The seal shall be replaced once verification of the modification has been made in accordance with section 8.0 of this document or the non metrological component has been replaced.

9.4 Breaking of Installation Seal by Registered Contractor

9.4.1 The registered contractor may break the installation seal on the condition that they inform the local district office. The local district office shall be provided rationale prior to the breaking of the installation seal by the registered contractor.

9.4.2 The registered contractor shall maintain records or log of events kept when breaking a seal which includes:

(a) Any events or modifications which require that the seal as prescribed in section 8.0 of this document be broken.

(b) Name of registered contractor representative.

(c) Date of breaking the seal.

(d) Reasons for breaking the seal and description of the work performed.

(e) A statement that the system has been re assessed in accordance with the registered contractor's commissioning process and resealed related to meters inspection numbers, serial numbers, locations; etc.

(f) List of equipment that has been installed or changed for any reason such as; blown fuses, power outages, upgrades, etc.

9.5 At no time, shall an unsealed installation be used for revenue purposes.

10.0 Installation Modifications

An authorized representative accredited for MCMS installation inspections or the local Measurement Canada district office shall be notified, in advance, of any modifications required to a MCMS system. Any modifications to a MCMS are subject to all requirements of this document including the re-inspection of the installation modifications pursuant to section 7.0.

11.0 Records of installation modifications

11.1 Records or log of events kept by the authorized representative when breaking an installation seal shall include:

(a) Reasons for breaking the installation seal, and description of the work performed.

(b) Name of the accredited organization, including the name of the organization's employee who conducted the work.

(c) Date of breaking the installation seal.

(d) List of equipment that has been installed or changed for any reason such as; meter inspection numbers, serial numbers, locations, blown fuses, power outages, upgrades, etc.

(e) Updated system configuration chart and installation wiring diagrams identifying modifications to the system.

(f) A record that the system has been re-inspected and resealed according to the accredited organization's procedures and this specification.

12.0 Revisions

The purpose of revision 1 is to clarify the requirements for accredited organizations.

The purpose of revision 2 is to:

(a) add in new section addressing responsibilities of accredited organizations.

(b) add in new section addressing measurement circuits and colour coding.

(c) expand and provided additional clarity to inspection requirements.

(d) expand and provide additional clarification of installation seals and breaking installation seals.

(e) reorganize and reformat the document.

(f) included requirements for commissioning.

13.0 Additional Information

For additional information regarding this specification, please contact the Senior Program Officer responsible for electricity measurement. Further information regarding Measurement Canada and its programs can be found on the Measurement Canada web site at http://mc.ic.gc.ca.

for

Alan E. Johnston
President
Measurement Canada

Measurement Canada | Mesures Canada

Specifications

Category: **ELECTRICITY**	Specification: **S-E-05 (rev. 1)**	Page: **1 of 3**
Document(s):	Distribution Date: **2008-05-14**	Effective Date: **2008-07-01**
	Supersedes: **S-E-05**	

Specifications for Approval of Type of Electronic Meters - Net Metering

1.0 Scope

These specifications apply to all electronic energy meters submitted for type approval of net metering.

2.0 Authority

These specifications are issued under the authority of section 12 of the *Electricity and Gas Inspection Regulations.*

3.0 References

3.1 *Electricity and Gas Inspection Act* (R.S. 1985, c. E-4), s. 28(1).

3.2 *Electricity and Gas Inspection Regulations* (SOR/86-131), s. 13, 14.

3.3 Measurement Canada, LMB-EG-07(1986): Specification for the Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices.

3.4 Bulletin E-20, Test Provision for Electronic Meters

4.0 Terminology

Bi-directional Meter
A bi-directional meter is a meter that has the capacity to meter delivered energy or received energy and to record them in separate registers.

Delivered Energy
Delivered energy is the energy measured when current flows through the meter from the electricity grid to the load.

Net Metering
Net metering is the ability to measure delivered and received energy and to register the difference (net) between the two. If received energy exceeds delivered energy the net value is negative. If delivered energy exceeds received energy the net value is positive.

Net Meter
A net meter is a meter that is used to perform net metering.

Net Register
A net register is a register, which records the difference (net) between the value of the delivered and of the received energy quantities measured by the meter.

Received Energy
Received energy is the energy measured when current flows through the meter from the load side of the service back to the electricity grid.

5.0 Technical and Metrological Requirements

5.1 General

5.1.1 Electronic energy meters capable of net metering shall comply will all of the applicable requirements of LMB-EG-07, and the additional requirements contained in this specification.

5.1.2 Performance requirements of LMB-EG-07 are applicable in both forward and reverse directions for net metering.

5.1.3 Electronic meters which sum the total registration of the delivered plus received energy quantities shall not be assessed by Measurement Canada or be deemed to be an approved billing function.

5.2 LMB-EG-07 Section 3: Additional Requirements

5.2.1 Meters approved for net metering shall have a register which increments energy accumulation positively when the energy flow is in a positive direction (delivered energy), and shall also decrement the same register when the direction of energy flow is in a negative direction (received energy).

5.2.2 Where registration is decrementing down to a zero value and the energy flow is in the negative direction, the meter register shall continue to register down to zero and continue decrementing from the meters full count value (99999 for a meter with the minimum five digit display).

5.2.3 For net metering, the direction of energy flow shall indicate when energy is being received or delivered.

5.3 Requirements for Net metering of Legal Units of Measure

5.3 General

5.3.1 Net metering of voltampere hours is not permitted.

5.3.2 The following are the phasing relationships that shall be used for establishing the direction of flow for watthours and varhours:

(a) Watthours delivered: Phase angle between voltage and current is between 0° and 90° (quadrant I), and between 270° and 360°(quadrant IV).

(b) Watthours received: Phase angle between voltage and current is between 90° and 180° (quadrant II), and between 180° and 270° (quadrant III).

(c) Varhour delivered: Phase angle between voltage and current is between 0° and 90° (quadrant I), and between 90° and 180°(quadrant II).

(d) Varhour received: Phase angle between voltage and current is between 180° and 270°(quadrant III), and between 270 to 360°(quadrant IV).

5.4 LMB EG-07 Section 6: General and Additional Requirements

5.4.1 A meter with net metering shall provide provisions for testing the delivered and received energy quantities. (Reference Bulletin E-20 for additional clarification on test provision for electronic meters). (LMB-EG-07 reference; 6-2.2 Testing).

5.4.2 The word "Net" shall be indelibly and distinctly marked or electronically displayed on the meter. (LMB-EG-07 reference 6-3 Marking).

6.0 Administrative Requirement - Notice of Approval

A notice of approval established for a meter with a net metering function shall state that the net metering function has been approved for the purpose of net metering, and indicate any applicable conditions or limitations.

7.0 Revision

The purpose of this revisions is to clarify the type approval display requirements for received energy in section 5.2 and 5.3, and to establish that MC does not approve net energy voltampere hour quantity. Approval of net metering for voltampere hour is not being permitted at this time since there is no industry standard which clearly defines direction for voltampere hour energy.

8.0 Additional Information

For additional information regarding this specification, please contact the Senior Program Officer responsible for electricity measurement. Further information regarding Measurement Canada and its programs can be found on the Measurement Canada web site at http://mc.ic.gc.ca.

Alan E. Johnston
President
Measurement Canada

Information

2008-02-20

Amendments to Measurement Canada Specification LMB-EG-07 and Policies Related to Interpretations of LMB-EG-07

Over the past number of years, Measurement Canada (MC) has made policiy decisions and interpretations related to the application of type approval specifications for electricity meters in MC Specification LMB-EG-07 that have not been previously published by the Agency. The purpose of this notice is to communicate the publication of these amendments and interpretations for the information of MC staff and electricity stakeholders.

The requirements included in MC Specification S-E-06 amend certain sections of LMB-EG-07. These amendments have been previously implemented by the Agency during the evaluation of electricity meters for the purpose of type approval. As these amendments occurred prior to the implementation of the Agency's revised publication process in the 1990's, the changes to some of the requirements of LMB-EG-07 had not yet been published.

The policies included in MC Bulletin E-30 communicate interpretations related to LMB-EG-07 which have been made to the application of MC Specification LMB-EG-07 since the beginning of it's implementation. In addition, it consolidates references to amendments to certain sections of LMB-EG-07 that have previously been established through publication of various MC Provisional Specifications and Bulletins.

As the amendments and interpretations identified within the subject Specification and Bulletin are currently being applied by the MC Approval Services Laboratory, MC will not perform a consultation on these documents with consumer and industry stakeholders.

Any enquiries with respect to this notice should be directed to the following Measurement Canada representative:

Dave Flieler
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Information

2008-10-15

Revisions to the Specification for the Approval of Type of Electricity Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-07 (S-E-06)

This information bulletin is intended to advise electricity sector stakeholders that Measurement Canada (MC), has revised MC Specification S-E-06 to remove requirements identified under the Government of Canada paper burden reduction initiative.

The approval requirements in the Provisional Specifications PS-E-06 and PS-E-07 and the bulletin E-20 have been moved to S-E-06 (rev. 1). PS-E-06, PS-E-07 and E-20 have been revoked.

MC Specification S-E-06 (rev. 1) is effective immediately.

For further information, please contact:

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Specifications

Category: **ELECTRICITY**	Specification: **S-E-06 (rev. 2)**	Page: **1 of 13**
Document(s): **Electricity Specification LMB-EG-07**	Distribution Date: **2009-08-27**	Effective Date: **2009-10-01**
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Specification for the Approval of Type of Electricity Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-07

1.0 Scope

This specification applies to all electricity meters and auxiliary devices submitted for approval pursuant to LMB-EG-07. (Specifications for Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices).

2.0 Authority

These specifications are issued under the authority of section 12 of the *Electricity and Gas Inspection Regulations*.

3.0 References

Specifications for Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices, LMB-EG-07 (1986).

4.0 Background

Since the beginning of the application of Measurement Canada (MC) specification LMB-EG-07 and prior to the implementation of the Agency's revised publication process in the 1990's, the Agency has implemented changes to some of the requirements of the specifications which have not been published. The purpose of this specification is to consolidate and officially communicate the applicable requirements of LMB-EG-07 that have been changed over the years and that are currently being applied during type approval evaluation.

5.0 Amendments to Specific Sections of LMB-EG-07

5.1 Amendments to Section 1 - Scope of LMB-EG-07

Reserved for future revisions to section 1 of LMB-EG-07.

5.2 Amendments to Section 2 - Definitions of LMB-EG-07

5.2.2 Section 2-23 is hereby amended as follows:

Display - A device or other means used to visually present the value of a measured quantity and other relevant information. It may take the form of an integral part of a meter or a separate display module.

5.2.3 Section 2-59 is hereby amended as follows:

Register (Electronic) - A memory location in the meter where the value of a measured quantity is electronically recorded.

Register (Mechanical) - A mechanical device integral to the meter where the value of a measured quantity is recorded and visually presented.

5.3 Amendments to Section 3 - General of LMB-EG-07

5.3.1 Section 3-2.5.1 (a), which requires the word "Line" to be indicated on Single-phase self-contained meters is hereby revoked.

5.3.2 Section 3-2.7.4 is amended as follows:

> **3-2.7.4 Multiplier** - The meter multiplier, if other than unity, shall be marked permanently and prominently, on the register face. *

* **Note:** This requirement may be satisfied through physical marking or via electronic display.

5.3.3 Section 3-2.7.5 has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 3-2.7.5 is hereby amended as follows:

> **3-2.7.5 Clock Registers** - The minimum diameter of clock dial circles shall be 10mm.
>
> Each dial shall be divided into ten equal and clearly numbered divisions. Preferably, the dials shall be distinctly separated from each other. The gearing shall be such that a complete revolution of any pointer shall cause the adjacent pointer on the left to advance one division.
>
> The dial centers shall be located so as to avoid any possibility of ambiguity in reading.

5.3.4 Section 3-2.7.6 has been amended to remove the requirement, identified under the Government of Canada paper burden reduction initiative, that all windows in the register face lie in a straight line and be of the same size. Section 3-2.7.5 is hereby amended as follows:

> **3-2.7.6 Cyclometer Registers** - The test dial, in the case of a cyclometer-type register, may be of either the drum or pointer type.
>
> If the test dial is of the drum type, it shall be divided into ten equal numbered divisions, shall be marked "test dial", and a reference mark shall be provided on the register face for accurate reading.
>
> The arrangement of the cyclometer drums and the cutouts on the register face, shall be such that, with the exception of the fastest moving drum, one and only one digit is one position to another. The duration of this change period shall not exceed the time required for the fastest-moving drum to make one-tenth of a revolution.
>
> The size and shape of any numerals shall be such that they are clearly legible.

5.3.5 Section 3-2.7.7 Multi - rate registers has been revoked effective 2005-01-24 and replaced with PS-E-12 (Provisional Specifications for the Approval of Type of Electricity Meters - Approval Requirements for Electricity Meters with Multiregister Metering Functions).

5.3.6 Section 3-2.7 title is hereby amended as follows: Registers (Mechanical)

5.3.7 Section 3-2.9 is hereby added to section 3-2 to include the requirements for electronic registers.

> **3-2.9 Registers (Electronic)**
>
> Electronic registers shall be non-volatile (they shall be capable of storing the last recorded value of a measured quantity if the meter is subjected to a power failure). Stored values shall not be overwritten and shall be capable of being retrieved upon restoration of power.
>
> Electronic register shall be capable of storing measurement information in a manner which provides for at least 5 digits of resolution at the display.

5.3.8 Section 3-2.10 is hereby added to section 3-2 to include the requirement for a means to indicate the value of any legal unit of measure which is recorded by the meter.

> **3-2.10 Means of Indication**
>
> The meter shall have one (or more) means of indication which is (are) capable of presenting or displaying the numerical value of each legal unit of measure for which the meter is approved. The means of indication shall be either a register (mechanical) or a display.

5.3.9 Section 3-4.1 is amended as follows:

3-4.1 Nameplates

Every meter, instrument or device shall have the following details indelibly and distinctly marked on one or more nameplates attached in such a way as to be clearly visible from the front, with all covers in place:

i) Name or mark of manufacturer
ii) Type or designation
iii) Serial number
iv) Departmental approval number
v) Operating temperature range *

*Note: This requirement shall only apply if the operating range is less than -40°C to +53°C. (i.e. intended for temperature controlled locations). This requirement may be satisfied through physical marking or via electronic display.

3-4.1.1 Space shall be provided for affixing the inspection number.

3-4.1.2 Additional marking requirements applicable to various types of meters and devices are set forth in subsequent sections specific thereto.

5.4 Amendments to Section 4 - Induction Type Watt Hour Meters of LMB-EG-07

5.4.1 Section 4-2.1.1 has been amended to remove the requirement that the direction of rotation be indicated by an arrow. Section 4-2.1.1 is hereby amended as follows:

4-2.1.1 Direction of Rotation - Viewed from above, the direction of rotation of the disc shall be counterclockwise.

5.4.2 Section 4-2.1.2.2 has been amended to remove the requirement that every fifth division be longer than the others. Section 4-2.1.2.2 is hereby amended as follows:

4-2.1.2.2 - On self-contained single-phase meters, the disc shall carry the following markings, in black:

On the upper periphery, one hundred divisions, with every tenth division identified consecutively by the figures 10, 20, ... 90.

5.4.3 Section 4-2.2.3 has been amended to remove the requirement that the test dial be located out of line with other dials or be distinctly different in appearance. These requirements are redundant given the other requirements stipulated in this section. Section 4-2.2.3 is hereby amended as follows:

4-2.2.3 Test Dials - With the exception of meters with a multi-rate register, all single phase meters shall be provided with a special test dial for testing the register. In the case of polyphase meters, if the lowest reading dial or drum requires more than one hour to make one complete revolution when the meter under single phase conditions specified in 3-5.1 (vi), is running on maximum load or 100 A whichever is lesser, a test dial shall be provided.

The pointer of the test dial shall rotate at ten times the speed of the lowest reading dial or drum. There shall be no figures on the test dial but it shall be divided into ten equal divisions. The direction of rotation shall be indicated by means of an arrow.

5.4.4 Section 4.3.2 Test Links, has been revoked. Advances in technology have made it possible to facilitate the safe, effective and accurate testing of electricity meters without the use of test links. Electricity meters submitted to Measurement Canada for Approval of Type pursuant to Specification LMB-EG-07 are not required to make use of test links.

5.4.5 Section 4-4 is amended as follows:

4-4.1 Nameplates

In addition to the requirements of subsection 3-4, every meter shall have the following details indelibly and distinctly marked on one or more nameplates attached in such a way as to be clearly legible from the front, with all covers in place.

i) Rated Frequency *
ii) Rated voltage or voltages
iii) Minimum and maximum rated currents
iv) Disc constant *
v) One of the following configuration notations
  1-phase, 2-wire
  1-phase, 3-wire
  2-element
  2½-element wye
  2½-element delta
  3-element wye
  Auto Detect
vi) For single phase transformer type meters, the word "Transformer Type"
vii) For transformer rated meters, also
  1) Primary disc constant
  2) Current transformer rating, e.g. 1000-5A *
  3) Voltage transformer rating, e.g. 2400-120V *

***Note:** These requirements may be satisfied through physical marking or via electronic display.

Note 2: Accepted symbols are θ, EL, Y, Δ.

Note 3: For 2½ element wye and 3 element meters, rated voltage is phase to neutral voltage.

4-4.1.1 If the meter is fitted with accessories such as a reverse running detent, re-transmitting contacts, etc., this shall be specified on the nameplate or on an auxiliary plate, and a diagram of connections shall be provided.

5.5 Amendments to Section 5 - Induction Type Var Hour and Q-Hours Meters of LMB-EG-07

Reserved for future revisions to section 5 of LMB-EG-07.

5.6 Amendments to Section 6 - Static Integrating Meters of LMB-EG-07

5.6.1 Section 6-2.2 has been amended to clarify the requirements to facilitate efficient testing using conventional testing methodologies. Section 6-2.2 is hereby amended as follows:

6-2.2 Testing

6-2.2.1 Each meter shall provide testing means analogous to counting the disc revolutions of an induction watt hour meter. A means of testing shall be provided for each energy quantity measured (e.g. W·h, var·h, etc.).

6-2.2.2 Each meter shall provide pulses or some other form of discrete indication (e.g. light, KYZ, LCD, etc.) of energy accumulation registered by the meter. Each pulse or indication shall represent the same finite amount of energy.

6-2.2.3 Each meter shall provide discrete energy accumulation indications, including pulses, in sufficient numbers and frequency to ensure that the time required to test the meter is comparable to the time required to test an electromechanical energy meter of the same load rating and configuration.

6-2.2.4 Access to the means for testing shall be available with the meter cover in place, without the need to break the verification seal at either the operational location or at another location.

6-2.2.5 Specialized test equipment that may be required to test devices which have unique testing means and are compliant with the above requirements, shall be provided free of charge by the contractor as prescribed under section 19 of the *Electricity and Gas Inspection Act.* The specialized equipment shall also be provided during the approval process by the approval applicant.

5.6.2 Section 6.2.3 is hereby added to section 6.2 to include the requirements for approval of test mode for use during inspections of meters as follows:

Section 6.2.3 Test Mode

6.2.3.1 Electronic meters submitted to Measurement Canada for approval of the test mode for use during inspections shall have the test mode evaluated to determine the extent to which it is suitable for meter verification testing.

6.2.3.2 The meter design schematics, operational block diagrams, or other engineering and technical data shall be evaluated to confirm that there are no internal or external factors which can influence a difference between the resultant measured values obtained in the test and normal operating modes.

6.2.3.3 Each legal unit of measurement requested to be evaluated for approval shall be evaluated in accordance with the requirements of clause 6.2.3.4 and 6.2.3.5, as applicable, for each mode of operation.

6.2.3.4 The accuracy of the energy quantities shall be evaluated, as a minimum, in accordance with the test points and tolerance limits for each voltage, current, and power factor specified in Table 1. For the purposes of evaluation, the voltage circuits shall be connected in parallel and current circuits connected in series, single phase configuration.

Table 1

Reference Value of Voltage (V), Current (I), Power Factor (P.F.)	**Error Tolerance Limit of the difference between the test results in Test Mode and Normal Mode**
V maximum, 25% I maximum, 50% P.F.	0.2
V maximum, 2.5% I maximum, 50 % P.F.	0.2

6.2.3.5 The accuracy of the demand quantities shall be evaluated, as a minimum, in accordance with the test points and tolerance limits for each voltage, current, and power factor specified in Table 2. For the purpose of evaluation, the voltage circuits shall be connected in parallel and current circuits connected in series, single phase configuration.

Table 2

Reference Value of Voltage (V), Current (I), Power Factor (P.F.)	**Error Tolerance Limit of the difference between the test results in Test Mode and Normal Mode**
V maximum, 50% I maximum, 50 % P.F.	0.2

6.2.3.6 Where the test mode is found to comply with 6.2.3.4 and 6.2.3.5 the Notice of Approval shall clearly indicate one of the following as applicable:

(a) the test mode is approved for the purpose of verifying the performance and accuracy of energy measurement functions which have been approved as legal units of measurement in this notice of approval.

(b) the test mode is approved for the purpose of verifying the performance and accuracy of demand measurement functions which have been approved as legal units of measurement in this notice of approval.

(c) the test mode is approved for the purpose of verifying the performance and accuracy of energy and demand measurement functions which have been approved as legal units of measurement in this notice of approval.

5.6.3 Section 6-3.2 is hereby amended to remove the requirement that the information must be indicated in the colour red. The information shall be permanently and prominently indicated irrespective of colour.

5.6.4 Section 6-3.3 is hereby added to section 6.3 to include the requirement that firmware versions be identified as follows:

6-3.3 Firmware Versions

Meter firmware versions shall be prominently indicated either on the meter nameplate or via the electronic display.

5.7 Amendments to Section 7 - Demand Meters of LMB-EG-07

5.7.1 Section 7-2.1.2.1 has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 7-2.1.2.1 is hereby amended as follows:

7-2.1.2.1 General

All clock-type indicators shall have at least three dials.

The minimum diameter of clock dial circles shall be 10 mm.

Each dial shall be divided into ten equal and clearly numbered divisions. The gearing shall be such that a complete revolution of any pointer shall cause the adjacent pointer to the left to advance one division.

5.7.2 Section 7-2.1.3.1 has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 7-2.1.3.1 is hereby amended as follows:

7-2.1.3.1 General

All cyclometer-type demand indicators shall have at least three digits.

The size and shape of the numerals shall be such that they are clearly legible.

The arrangement of the cyclometer drums and the cutouts in the demand-indicator face shall be such that, with the exception of the fastest moving drum, one and only one digit is in full view at all times except when the drum is advancing from one position to the next.

5.7.3 Section 7-3.3 Test Links, has been revoked. Advances in technology have made it possible to facilitate the safe, effective and accurate testing of electricity meters without the use of test links. Electricity meters submitted to Measurement Canada for Approval of Type pursuant to Specification LMB-EG-07 are not required to make use of test links.

5.7.4 Section 7-4 is amended as follows:

7-4 Markings

7.4.1 Nameplate Marking

In addition to the requirements of subsection 4-4, demand meter nameplates shall bear the following information:

i) Response period or demand interval *
ii) Full-Scale demand rating
iii) Single-Phase test constant (if applicable)
iv) All information essential for determination of the demand from the meter indication.

7-4.1.1 The marking shall be indelible, distinct, and visible from outside the meter with its cover in place.

*Note: This requirement may be satisfied through physical marking or via electronic display.

5.8 Amendments to Section 8 - Induction Type Loss Meters of LMB-EG-07

5.8.1 Section 8-4 Markings has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 8-4 is hereby amended as follows:

8-4 Markings

8.4.1 Nameplate Marking

In addition to the requirements of subsection 4-4, every meter shall bear, as appropriate, the following information:

i) Auxiliary Supply Voltage
ii) For secondary rated meters, the disc constant in $A^2 \cdot h$ per revolution
iii) For primary rated meters
  1) Primary line resistance
  2) Primary disk constant in kW·h per revolution

5.9 Amendments to Section 9 - Static Loss Meters of LMB-EG-07

5.9.1 Section 9-3 Markings has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 9-3 is hereby amended as follows:

9-3 Markings

9.3.1 Nameplate Marking

In addition to the requirements of subsection 8-4 every meter shall bear, as appropriate, the following information:

i) Voltage and frequency of auxiliary supply
ii) For secondary - rated meters, the test constant and pulse constant in $A^2 \cdot h$ per pulse

5.10 Amendments to Section 10 - Transducers of LMB-EG-07

Reserved for future revisions to section 10 of LMB-EG-07.

5.11 Amendments to Section 11 - Null Balancing Instruments of LMB-EG-07

Reserved for future revisions to section 11 of LMB-EG-07.

5.12 Amendments to Section 12 - Pulse Devices of LMB-EG-07

5.12.1 Section 12-4 Markings has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 12-4 is hereby amended as follows:

12-4 Markings

12-4.1 Nameplate Marking

In addition to the requirements of subsection 3-4.1 every pulse device shall bear, as appropriate, the following information:

12-4.1.1 Pulse Initiators (Information may be on initiator or host meter)

i) Pulse initiator output constant Kp

12-4.1.2 Relays and Pulse Amplifiers

i) Type of input (2 or 3 wire)
ii) Type of output (2 or 3 wire)
iii) Voltage and frequency of auxiliary supply (if applicable)
iv) Rate of maximum voltage and frequency (pulses per unit time) of input pulses
v) Minimum pulse width if critical to operation of the device
vi) Connection diagram

12-4.1.3 Totalizers

i) Input to output pulse ratio, (prescalar unit)
ii) Number of additive and subtractive elements. If both are present, each shall be clearly identified.
iii) Type of input (2 wire or 3 wire)
iv) Type of output (2 wire or 3 wire)
v) Voltage and frequency of the auxiliary power supply
vi) Rated or maximum voltage and frequency (pulses per unit time) of the input pulses
vii) Connection diagram

5.13 Amendments to Section 13 - Programmable Devices and Pulse Recorders of LMB-EG-07

5.13.1 Section 13-4 Markings has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. Section 13-4 is hereby amended as follows:

13-4 Markings

13-4.1 Nameplate Marking

In addition to the requirements of subsection 3-4.1 every programmable device and pulse recorder shall bear, as appropriate, the following information:

i) Demand interval
ii) Up-date interval, and for each channel, input identification, pulse constant and multiplier or prescalar unit
iii) rated voltage and frequency of auxiliary power supply
iv) rated or maximum voltage and frequency (pulses per unit time) of the input pulses
v) connection diagram

Note 1: Where the device is a register included as an integral part of a meter, and not wholly detachable, the above information may be shown on the meter nameplate.

Note 2: i: The demand interval shall be marked on any device which measures or calculates a demand quantity over a specific interval. If no such measurements or calculations are made, then the demand interval is not applicable to the markings required on the nameplate.

Note 3: ii: If a device simply receives pulses, temporarily storing them, and then retransmits them, or a fraction or multiple thereof, then the pulse constant need not be marked on the nameplate since the pulses could come from any source and be sent to any other receiving device.

5.14 Amendments to Section 14 - Instrument Transformers of LMB-EG-07

This section has been revoked (effective 2008-07-01) and replaced with S-E-07 (Specifications for the Approval of Measuring Instrument Transformers).

5.15 Amendments to Section 15 - Static Demand Meters of LMB-EG-07

5.15.1 Section 15-2 is hereby amended to include technical requirements to evaluate maximum demand reset mechanism of static demand meters as follows:

15-2.1 General

The requirements of subsection 3-2 shall apply.

15-2.2 Reset Device

A mechanical reset device shall be such that, in its normal position, it does not affect the values stored and/or displayed in any maximum demand register. Means shall be provided for sealing the reset device in this position. Resetting of any maximum demand register shall only be possible either after breaking the seal or with a special tool.

5.15.2 Section 15-3.1 Test Links, has been revoked. Advances in technology have made it possible to facilitate the safe, effective and accurate testing of electricity meters without the use of test links. Electricity meters submitted to Measurement Canada for Approval of Type pursuant to Specification LMB-EG-07 are not required to make use of test links.

5.15.3 Section 15-3.2 has been revised to remove a repeated sentence. Section 15-3.2 is hereby amended as follows:

15-3.2 Demand Interval

The demand interval shall be not less than 15 minutes. The demand shall be averaged over the demand interval, but it may be recalculated after each update interval.

5.15.4 Section 15-3 is hereby amended to include technical requirements to evaluate electronic means of maximum demand reset as follows:

15-3.4 Reset Device

15-3.4.1
A meter which provides a register for maximum demand values of any legal unit of measurement, and which is not equipped with a mechanical reset mechanism, shall have electronic means by which the maximum demand register may be reset.

15-3.4.2
Resetting may be performed through an on-board device or through a remote mechanism. Actuation of the reset means shall have the effect of resetting demand values stored in any maximum demand registers to zero, or to the current demand value.

5.15.5 Section 15.4 is amended as follows:

15-4 Markings

15-4.1 Nameplates - In addition to the requirements of section 7-4, the nameplate shall bear the following information:

i) Update interval (if applicable)*

ii) Loss Compensated (indelibly marked on the nameplate of meters which are internally compensated for line or transformer losses

iii) Firmware Versions *

*Note: These requirements may be satisfied through physical marking or via electronic display.

5.16 Amendments to Section 16 - Induction Type Voltage-Square Hour Meters of LMB-EG-07

5.16.1 Section 16-4 has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. A reference to section 4.4 for applicable common marking requirements has been added and the marking requirements adequately addressed in section 4.4 have been removed from this section. Section 16.4 is hereby amended to the following:

16-4 Markings

16-4.1 Nameplates - In addition to the applicable requirements of section 4-4, the nameplate shall bear the following information.

i) For secondary-rated meters, the single phase test constant and the pulse constant Kp in V^2.h per pulse

ii) For primary rated meters:

a) Voltage Transformer ratio
b) Pulse constant Kp in V^2.h per pulse

5.17 Amendments to Section 17 - Static Voltage-Square Hour Meters of LMB-EG-07

5.17.1 Section 17-4 has been amended to remove requirements identified under the Government of Canada paper burden reduction initiative. A reference to section 16.4 for applicable common marking requirements has been added and the marking requirements adequately addressed in section 16.4 have been removed from this section. Section 17.4 is hereby amended to the following:

17-4 Markings

17-4.1 Nameplates - In addition to the requirements of clause 16-4, the nameplate shall bear the following information:

i) Firmware Versions (prominently indicated either on the meter nameplate or via the electronic display).

5.18 Amendments to Section 18 - Sub-Metering of LMB-EG-07

Reserved for future revisions to section 18 of LMB-EG-07.

5.19 Amendments to Section 19 - Signal Converters of LMB-EG-07

Reserved for future revisions to section 19 of LMB-EG-07.

6.0 Revisions

The purpose of Revision 1 was to remove requirements identified under the Government of Canada paper burden reduction initiative. The requirements in E-20, PS-E-06 and PS-E-07 were also transferred to this specification to maintain all the LMG-EG-07 changes in one document to facilitate consistent implementation and reduce the number of locations users have to search to find the applicable approval requirements.

The purpose of Revision 2 is: to include requirements for provision of a means of indication pursuant to the policy established in section 3.4 of bulletin E-30 and as recommended by the LUM JWG; to include specifications for electronic registers; to include an allowance for certain marking requirements to be displayed electronically, (sections 5.3.2, 5.3.9, 5.4.5, 5.7.4 and 5.15.5); and to make minor amendments to the English version of section 5.12.

7.0 Additional Information

For additional information regarding this specification, please contact the Senior Program Officer responsible for electricity measurement, or visit our website at http://mc.ic.gc.ca.

Alan E. Johnston
President
Measurement Canada

Specifications for the Approval of Measuring Instrument Transformers

1.0 Scope

This specification applies to instrument transformers which are intended to be used in revenue metering.

2.0 Authority

This specification is issued pursuant to subsection 12 (1) of the *Electricity and Gas Inspection Regulations*.

3.0 References

3.1 *Electricity and Gas Inspection Act* (R.S. 1985, c. E-4), ss. 9(4)

3.2 *Electricity and Gas Inspection Regulations* (SOR/86-131), ss. 12(1).

3.3 CAN/CSA-C60044-1:7 Part 1 - Current Transformers

3.4 CAN/CSA-C60044-2:7 Part 2 – Inductive Voltage Transformers

3.5 CAN/CSA-C60044-3:7 Part 3 – Combined Transformers

3.6 CAN/CSA-C60044-5:7 Part 5 – Capacitor Voltage Transformers

4.0 Definitions

Accuracy Class - A designation assigned to a measuring instrument transformer the errors of which remain within specified limits under prescribed conditions of use.

Accuracy Rating Voltage - The normal operating voltage of a voltage transformer upon which the accuracy performance is based.

Burden - The property of the circuit connected to the secondary winding that determines the active and reactive power at the secondary terminals. The burden is expressed either as total ohms impedance with the effective resistance and reactance components, or as the total volt-amperes and power factor at the specified value of current or voltage, and frequency.

Capacitor Voltage Transformer - A voltage transformer comprising a capacitor divider unit and an electromagnetic unit so designed and connected that the secondary voltage of the electromagnetic unit is substantially proportional to the primary voltage, and differs in phase from it by an angle which is approximately zero for an appropriate direction of connections and rated frequency.

Combined Instrument Transformer - A combination of voltage and current measuring transformers in a single tank or assembly. Also known as a "Metering Outfit".

Continuous Thermal Current Rating Factor (RF) - The number by which the rated primary current of a measuring current transformer is multiplied to obtain the maximum primary current that can be carried continuously without exceeding either the limiting temperature rise from 30°C average ambient air temperature or the rated accuracy. The RF of tapped-secondary or multi-ratio transformers applies to the highest ratio, unless otherwise stated.

Current Transformer(CT) - A measuring instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.

Double-Primary Current Transformer - A current transformer equipped with two primary windings suitable for series or parallel connection and common to all secondary coils and magnetic circuits.

Double-Ratio Current Transformer - A multi-ratio current transformer which has two ratios which are in the ratio of two to one.

Double-Secondary Current Transformer - One CT which has two secondary coils each on a separate magnetic circuit with both magnetic circuits excited by the same primary winding or windings. The secondary coils may be tapped or untapped.

Double-Secondary Voltage Transformer - One which has two secondary windings on the same magnetic circuit insulated from each other and the primary. Either or both of the secondary windings may be used for measurement or control.

Dual-Ratio Current Transformer - A multi-ratio current transformer having two ratios which are not necessarily in the relation of two to one.

Highest Voltage for Equipment - The highest continuous RMS steady-state voltage for which the equipment insulation is designed.

Instrument Transformer - A measuring transformer which is intended to reproduce in its secondary circuit, in a definite and known proportion, the current or voltage of its primary circuit with the phase relations substantially preserved.

Marked Ratio - The ratio of the rated primary value to the rated secondary value as stated on the nameplate.

Multi-Ratio Current Transformer - One from which more than one ratio can be obtained by the use of taps or series-multiple connection.

Multiple Secondary Current Transformer - One which has three or more secondary coils each on a separate magnetic circuit with all magnetic circuits excited by the same primary winding.

Percent Ratio Error of an Instrument Transformer - The difference between the ratio correction factor and unity expressed in per cent.

Phase Angle Correction factor (PACF) - The ratio of the true power factor to the measured power factor. It is a function of both the phase angle of the instrument transformer and the power factor of the primary circuit being measured.

NOTE: The phase angle correction factor is the factor which corrects for the phase displacement of the current or voltage or both, due to the instrument transformer phase angle. The measured watts or watt hours in the secondary circuits of instrument transformers must be multiplied by the phase angle correction factor and the true ratio to obtain the true primary watts or watt hours.

Phase Angle of an Instrument Transformer - The phase displacement, between the primary and secondary values.

NOTE: The phase angle of a current transformer is designated by the Greek letter beta (β)and is positive when the current leaving the identified secondary terminal leads the current entering the identified primary terminal.

For example:

β = 2600 (RCF - TCF), where β approximates the phase angle in minutes; and
β = (RCF-TCF) / 1.333, where β approximates the phase angle in radians.

NOTE: The phase angle of a voltage transformer is designated by the Greek letter gamma (γ) and is positive when the voltage at the identified secondary terminal leads the voltage at the identified primary terminal.

For example:

γ = 2600 (TCF-RCF), where γ approximates the phase angle in minutes; and
γ = (RCF-TCF)/1.333, where γ approximates the phase angle in radians.

Rated Insulation Level - The combination of voltage values which characterize the insulation of an instrument transformer to withstand dielectric stresses.

Rated Output - The value of the apparent power (in volt-ampere at a specific power factor) which the transformer is intended to supply to the secondary circuit at the rated secondary current or voltage and with rated burden connected to it.

Rated Primary Current of a Current Transformer - The current selected for the basis of performance specifications.

Rated Primary Voltage of a Voltage Transformer - The voltage selected for the basis of performance specifications.

Rated Secondary Current - The rated primary current divided by the marked ratio.

Rated Secondary Voltage - The rated primary voltage divided by the marked ratio.

Ratio Correction Factor (RCF) - The ratio of the true ratio to the marked ratio. The primary current or voltage is equal to the secondary current or voltage multiplied by the marked ratio times the ratio correction factor.

Symbols for Current Transformer - Symbols for measuring current transformer ratio designation as per Canadian Designation column of Table 1A of CAN/CSA-60044-1:7 shall be applicable.

Accuracy Designation for Current Transformer - Accuracy designation for current transformers shall be such that the accuracy class is identified, followed by the letter B, followed by the maximum standard burden applicable for the accuracy rating.

Example: 0.15B1.8*

0.15 accuracy class for a burden B1.8.

NOTE: * B1.8 is a standard burden for measuring in accordance with Tables 1 and 2 in section 5.1.2.

Symbols for Voltage Transformer - Voltage transformer symbols for ratio designation as per the CSA column of Table 1A of CAN/CSA-60044-2:7 shall be applicable.

Accuracy Designation for Voltage Transformer - Accuracy designation for voltage transformers shall be such that the accuracy class is identified, followed by all the standard burdens applicable for the accuracy rating.

Accuracy Designation for Voltage Transformer - Accuracy designation for voltage transformers shall be such that the accuracy class is identified, followed by all the standard burdens applicable for the accuracy rating.

Example: 0.3WXYZ *

0.3% accuracy for a burden of 200 VA.

NOTE: * WXYZ are standard burdens in accordance with Table 3 in section 4.3.2.

Three-Wire Current Transformer - A current transformer which has two separate primary windings each completely insulated for the rated insulation level of the transformer. This type of current transformer is for use on a three-wire, single-phase service.

NOTE: These may have two primary windings, one secondary winding and one core assembled as a single unit; or have two primary windings, two secondary windings and two cores assembled as separate units and mounted on one base with the secondaries connected permanently in parallel to a single terminal block. The secondary current in both cases is proportional to the phasor sum of the primary currents.

Transformer Correction Factor (TCF) - The transformer correction factor is the ratio correction factor multiplied by the phase angle correction factor for a specified primary circuit power factor.

True Ratio - The ratio of the root-mean-square (RMS) primary value to the RMS secondary value under specified conditions, with sinusoidal current or voltage in the primary winding.

Type - The manufacturer's designation for transformers having different nominal currents or voltages, but which are similar in:

- Measurement characteristics
- Model and construction

Voltage Classification - The level of power frequency voltage which identifies the system of insulation levels and associated tests applicable to the transformer.

Voltage Transformer(VT) - A measuring instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs from it by an angle which is approximately zero for an appropriate direction of the connections.

5.0 Ratings

5.1 Current Transformer

All current transformers shall meet the following requirements.

5.1.1 Preferred current ratings shall be according to the values in Tables 1C and 1D of CAN/CSA 60044-1:7.

5.1.2 Standards burden of current transformer shall be according to the values in the Tables 1 and 2 below.

Table 1

Standard burden	Characteristics			Characteristics for 60 Hz 5A secondary current	
	Resistance Ω	Inductance mH	Impedance Ω	V•A	Power Factor
E-0.04	0.04	0.0	0.04	1	1.0
E-0.2	0.20	0.0	0.20	5	1.0
B0.1	0.09	0.116	0.1	2.5	0.9
B0.2	0.18	0.232	0.2	5.0	0.9
B0.5	0.45	0.580	0.5	12.5	0.9
B0.9	0.81	1.044	0.9	22.5	0.9
B1.8	1.62	2.088	1.8	45.0	0.9

Table 2 - Standard Burdens for Current Transformers with 1 Ampere Rated Secondary Current

Standard burden	Characteristics			Characteristics for 60 Hz 1A secondary current	
	Resistance Ω	Inductance mH	Impedance Ω	V•A	Power Factor
E-0.01	0.25	0.0	0.25	0.25	1.0
E-0.04	1	0.0	1.0	1	1.0
E-0.2	5	0.0	5.0	5	1.0
B0.1	2.25	2.9	2.5	2.5	0.9
B0.2	4.5	5.8	5.0	5.0	0.9
B0.5	11.25	14.5	12.5	12.5	0.9
B0.9	20.25	26.1	22.5	22.5	0.9
B1.8	40.5	52.2	45.0	45.0	0.9

5.2 Voltage Transformer

All voltage transformers shall meet the following requirements:

5.2.1 Preferred voltage ratings shall be according to the values in Tables 1C and 1D of CAN/CSA 60044-2:7. Only rated secondary voltages of 120 volts and 115 volts shall be approved for measuring applications.

5.2.2 Standard burdens for voltage transformers shall be according to the values in the Tables 3 below.

Table 3 - Standard burdens for Voltage Transformers

Standard Burden			Characteristics on 120 V Basis		
Designation	**VA**	**PF**	**Resistance Ω**	**Inductance H**	**Impedence Ω**
Q	1.0	1	14400	0	14400
T	2.5	1	5760	0	5760
W	12.5	0.1	115.2	3.042	1152
X	25	0.7	403.2	1.092	576
Y	75	0.85	163.2	0.268	192
Z	200	0.85	61.2	0.101	72
ZZ	400	0.85	30.6	0.0504	36

6.0 Design Requirements

6.1 Temperature Rise

6.1.1 Current Transformer - Temperature rise of current transformers shall meet the requirement of section 4.6 of CAN/CSA 60044-1:7.

6.1.2 Voltage Transformer - Temperature rise of voltage transformers shall meet the requirement of section 5.4.6 of CAN/CSA 60044-2:7.

6.2 Insulation

6.2.1 Current Transformer - Insulation level for current transformers shall meet the requirement of section 5.1 of CAN/CSA 60044-1:7.

6.2.2 Voltage Transformer - Insulation level for voltage transformers shall meet the requirement of section 6.1 of CAN-CSA 60044-2:7.

7.0 Markings

7.1 Terminal Markings

In general, terminal markings shall identify the primary and secondary windings, the winding sections (if any), the relative polarities of windings and winding sections, and the intermediate tappings, (if any).

7.1.1 Current Transformer - Terminal markings of current transformers shall meet Canadian marking requirements of sections 10.1.2 and 10.1.3 of CAN/CSA 60044-1:7.

7.1.2 Voltage Transformer - Terminal markings of inductive voltage transformers shall meet Canadian marking requirements of sections 11.2.2 and 11.2.3 of CAN/CSA 60044-2:7. Terminal markings of capacitor voltage transformers shall meet Canadian marking requirements of sections 13.2 and 13.2A of CAN/CSA 60044-5:7.

7.1.3 Combined Transformer - Terminal markings of combined transformers shall meet Canadian marking requirements of section 10.2 of CAN/CSA 60044-3:7.

7.2 Nameplate

7.2.1 Nameplate Positioning (General) - The nameplate of measuring instrument transformer shall be attached so as to be clearly visible or easily accessible. If the transformer is contained within another device such as a power transformer, metering outfit; the nameplate shall be mounted on the exterior of such device in such a manner as to be readily visible, i.e. on the measuring element or base. Under no circumstances shall the nameplate be mounted on the terminal cover.

7.2.2 Current Transformer - Nameplates of current transformers shall include, as a minimum where applicable, the following:

a. Manufacturer's name or trademark
b. Manufacturer's Type
c. Manufacturer's Serial Number
d. Rated Frequency
e. Rate Primary and Secondary Currents
f. Voltage Classification
g. Continuous Thermal Current Rating Factor
h. Approved Measuring Accuracy Rating
i. Approval Number

7.2.3 Voltage Transformer - Nameplates of voltage transformers shall include, as a minimum where applicable, the following:

a. Manufacturer's name or trademark
b. Manufacturer's Type
c. Manufacturer's Serial Number
d. Rated Frequency
e. Rate Primary and Secondary Voltages
f. Voltage Classification
g. Lightning Impulse Level
h. Rated Voltage Factor and Rated Time
i. Approved Measuring Accuracy Rating
j. Approval Number

8.0 Accuracy

8.1 Current Transformers

8.1.1 Assignment of Accuracy Class - A measuring current transformer shall be given an accuracy class as specified in Table 4 for each standard burden, (Tables 1 and 2), up to the maximum for which it is designed. For multi ratio CTs, if only one accuracy rating is assigned, it shall apply to all ratios.

8.1.2 Basis for Measurement Accuracy Classes - Accuracy classes for measuring current transformers are based on the requirement that the transformer correction factor (TCF) shall be within specified limits for the following conditions:

a. 100% of rated primary current or the corresponding continuous current factor;
b. 10% or 5% of rated primary current
c. power factor (lagging) of metered power load from 0.6 to 1.0
d. burden of a specific standard value and
e. normal service conditions

NOTE: At 5% or 10% of rated primary current, the permissible error is twice the permissible error at 100% rated primary current.

The relationships between the limits of the ratio correction factors (RCFs) and the phase angle for the limiting values of the TCFs specified in Table 4 are shown in the parallelograms in Figure 1 and Figure 2.

Table 4 - Accuracy Classes and Corresponding Limits of Transformer Correction Factors for Measuring Current Transformers

Accuracy Class	100% rated current*	10% rated Current	5% rated current	Limits of power factor (lag) of metered power load
0.15	0.9985–1.0015		0.997–1.003	0.6–1
0.3	0.997–1.003	0.994–1.006		0.6–1
0.6	0.994–1.006	0.988–1.012		0.6–1

NOTE: These limits also apply at the maximum continuous current rating factor (RF)

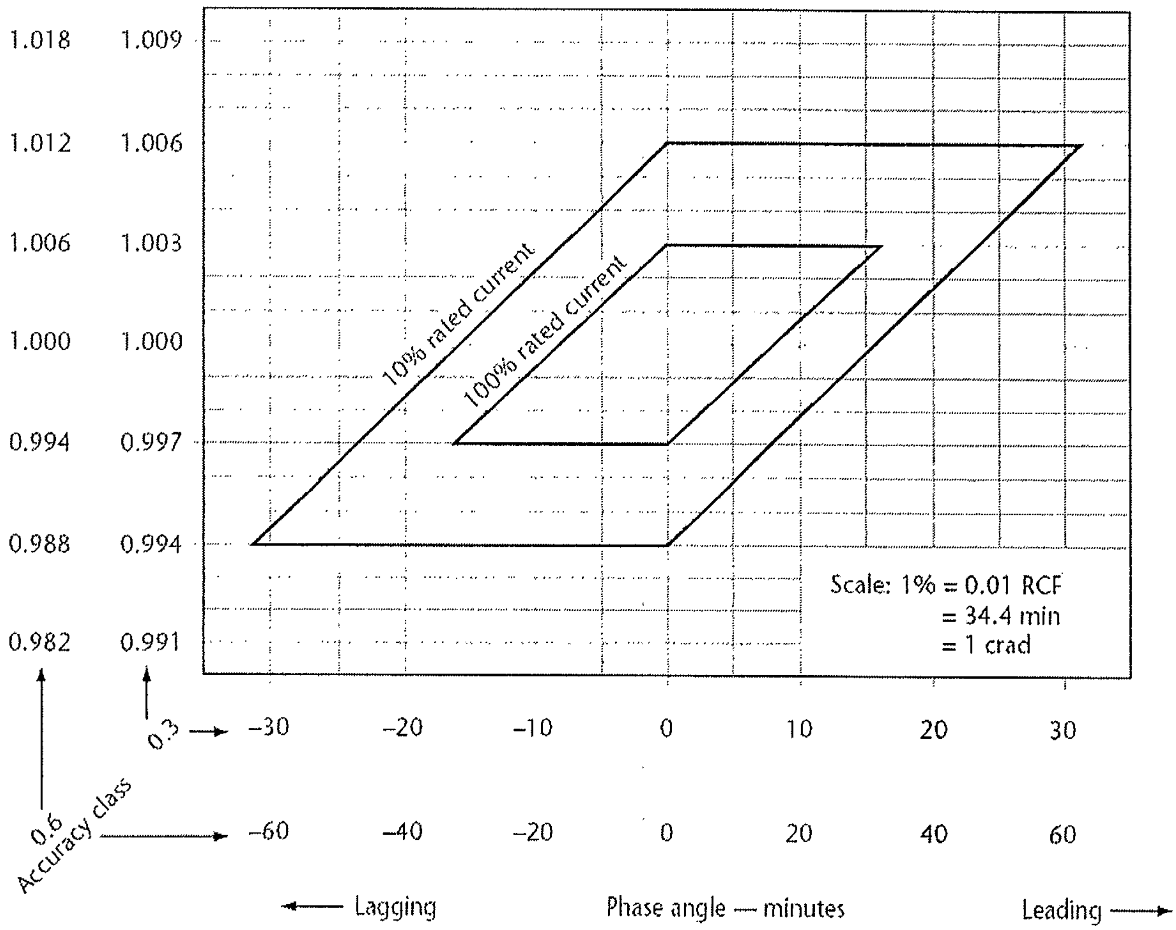

Figure 1 - Limits of 0.3 and 0.6 Accuracy Classes for Measuring Current Transformers

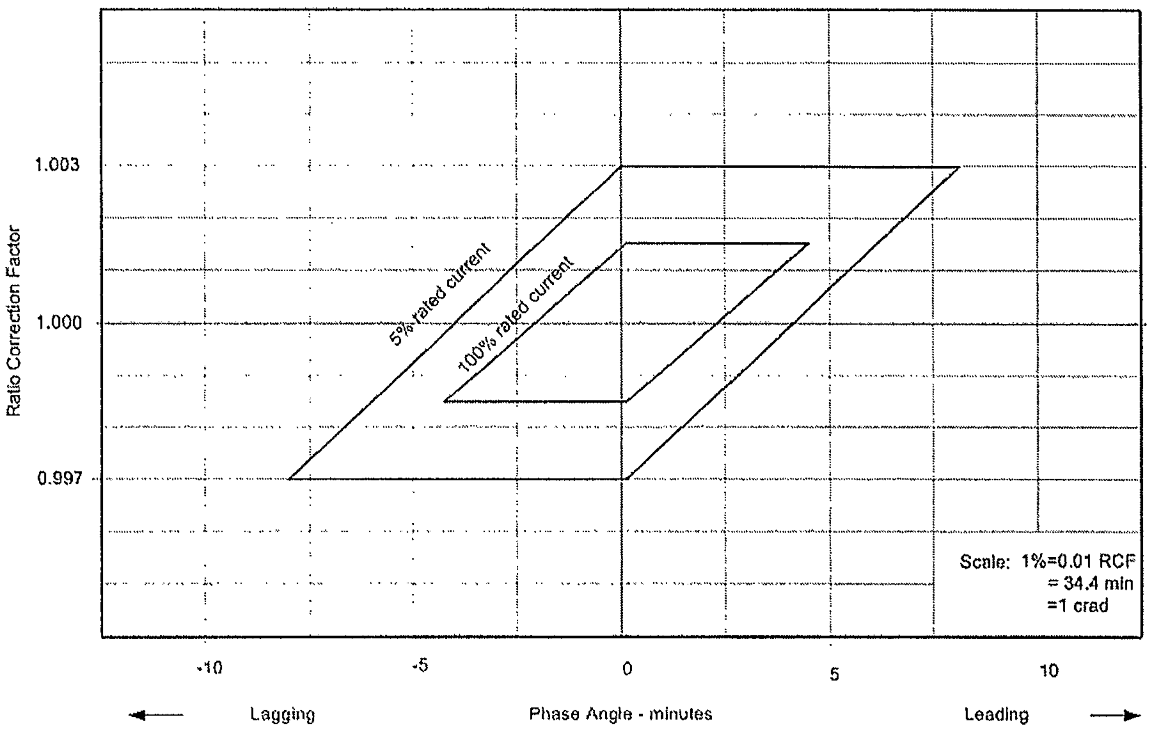

Figure 2 - Limits of 0.15 Accuracy Class for Measuring Current Transformers

8.2 Voltage Transformers

8.2.1 Assignment of Accuracy Class - A measuring voltage transformer shall be given an accuracy class as specified in Table 5 for each standard burden in Table 3, up to the maximum for which it is designed.

8.2.2 Accuracy Class for multi-ratio measuring VT - Where a single accuracy designation is specified for transformers with secondary and tertiary windings (in the form "0.3Z" for example) the accuracy requirement shall only apply to the secondary winding when the tertiary winding is not loaded, to the tertiary winding when the secondary winding is not loaded, and to both windings when the designated burden is divided in any proportion between the two windings. Where a double accuracy designation is specified (in the form "0.6Z-0.6Z" for example) the first designation shall apply to the secondary winding and the other to the tertiary shall apply when the tertiary winding is either not loaded or loaded with its designated burden, and the accuracy requirement for the tertiary winding shall apply when the secondary winding is either not loaded or loaded with its designated burden.

8.2.3 Basis for Measurement Accuracy Classes: Accuracy classes for measuring voltage transformers are based on the requirement that the transformer correction factor (TCF) shall be within specified limits for the following conditions:

a. 90% to 110% of accuracy-rated voltage
b. voltage corresponding to the continuous rating factor as per Table 10B of CAN/CSA 60044-2:07
c. power factor (lagging) of metered power load from 0.6 to 1.0
d. burden of a specified standard value
e. for indicated service conditions

The relationships between the limits of the ratio correction factors and the phase angle for the limiting values of the TCFs specified in Table 5 are shown in the parallelogram in Figure 3.

Table 5 - Accuracy Classes and Corresponding Limits of Transformer Correction Factors for Voltage Transformers for Measuring *

Accuracy Classes	Limits of TCF for 90% to 110% Accuracy-Rating Voltage **		Limits of Power Factor (Lag) of Metered Power Load
	Minimum	Maximum	
0.15	0.9985	1.0015	0.6-1
0.3	0.997	1.003	0.6-1
0.6	0.994	1.006	0.6-1

NOTE:

* See Figure 3

** These limits also apply at the maximum continuous voltage rating factor

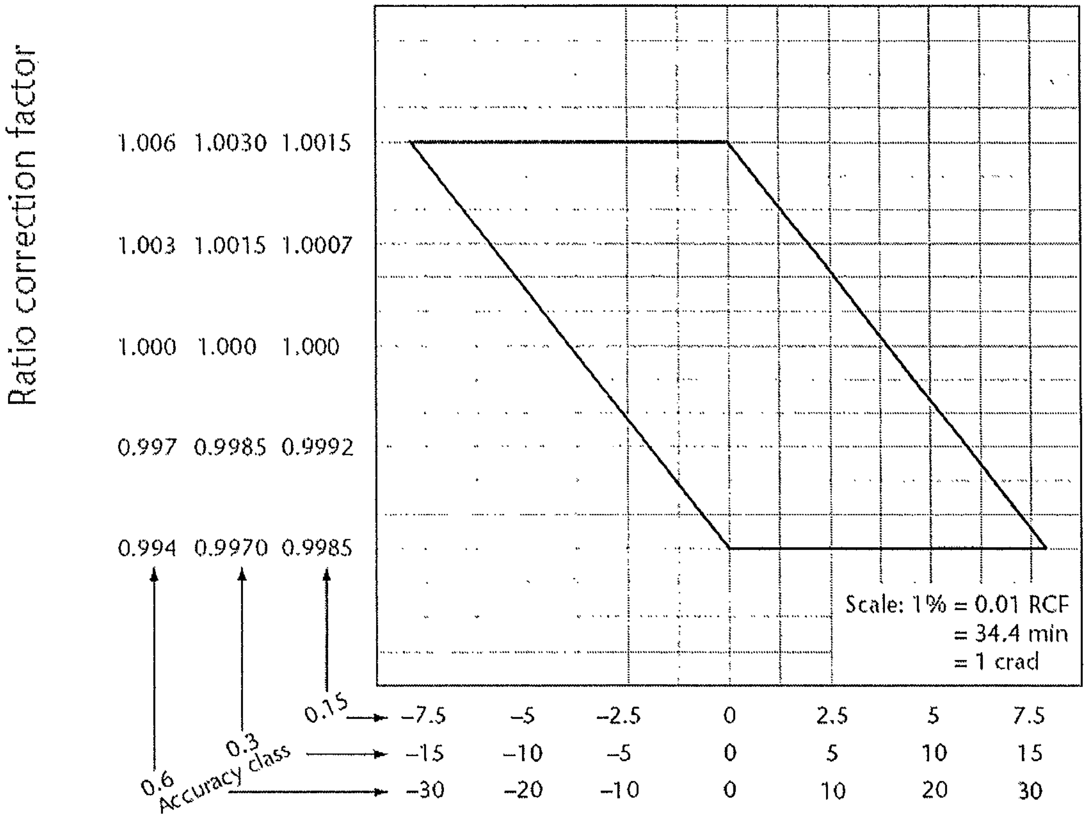

Figure 3 - Limits of 0.15, 0.3 and 0.6 Accuracy Classes for Measuring Voltage Transformers

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Information

2009-03-19

Specifications for the Installation and Use of Electricity Meters

Measurement Canada (MC) is formally issuing "Specifications for the Installation and Use of Electricity Meters - Measurement Canada Standard Drawings for Electricity Metering Installations", which consolidates policies that were formerly established in Agency directives, and which are currently being applied and enforced by MC inspectors.

This specification also updates and consolidates, in an electronic format, Measurement Canada standard drawings (Appendix A) which prescribe how electricity meters must be connected to circuits to ensure accurate measurement. The initial consolidated package of standard drawings which was established by MC in 1975 has been modified and augmented, and subsequently re-drafted in electronic format to facilitate posting on the MC Web site.

Public consultation on a draft version of this specification and standard drawings was performed in November and December 2008. Minor amendments were incorporated into this version of the specification and the standard drawings based on feedback received.

For further information, please contact:

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Specifications

Category: **ELECTRICITY**	Bulletin: **S-E-08**	Page: **1 of 6**
Document(s): **S-E-03, PS-E-08, E-24**	Issue Date: **2009-03-19**	Effective Date: **2009-03-19**
	Supersedes:	

Specifications for the Installation of Electricity Meters - Measurement Canada Standard Drawings for Electricity Metering Installations

1.0 Purpose

The purpose of this specification is to formally establish Measurement Canada (MC) requirements pertaining to the appropriate connection of electricity meters to electrical circuits in which legal units of measurement (LUM) are intended to be measured for establishing the basis of a charge. The initial consolidated package of Standard Drawings which was established by MC in 1975 has been modified and augmented, and subsequently re-drafted in electronic format to facilitate posting on the MC web site.

2.0 Scope

This specification applies to all electricity metering installations (as well as installations of self-contained meters) which are intended to be used in revenue metering with the exception of Multiple Customer Metering Systems (MCMS).

3.0 Authority

This specification is issued under the authority of section 12(2) of the *Electricity and Gas Inspection Regulations* (EGIR).

4.0 Terminology

Electricity Metering Installation means an installation that consists of more than one electricity meter installed at the same location and that is used for the purpose of obtaining the basis of a charge for electricity supplied to a purchaser. *(Electricity and Gas Regulations* (SOR/86-131), s. 2(1))

Self-contained Meter means a meter designed to be connected directly to a power circuit, without the use of external devices such as instrument transformers or shunts.

Canada

5.0 Standard Installations

5.1 Meter Connections

Each meter (including instrument transformers) forming part of an electricity metering Installation shall be connected in accordance with the appropriate diagram established in the Measurement Canada Standard Drawings for Metering Installations. Refer to Appendix A.

5.2 Colour Codes

MC standard wire colour codes are established in Appendix B. Colour coding of wires shall be continuous from end to end.

5.3 Voltage Connection Points

All voltage transformers and/or meter voltage terminals shall be connected to the line side of the circuit being measured, (i.e. between the supply and any current transformers).

5.4 Neutral Conductor

No current transformer or meter current coil shall be connected in the circuit neutral conductor.

6.0 Non-standard Installations

6.1 Meter Connections

Meter connection configurations other than those established in Appendix A may be used subject to the terms established in section 4.2.1 of S-E-03.

6.2 Colour Codes

Colour codes other than standard are acceptable subject to the following requirements:

(a) the difference between current and voltage leads is clearly distinguishable;

(b) the use of green and white is restricted only to purposes which conform to the Canadian Electrical Code; and

(c) the code is consistent in other installations owned by the electricity distributor/contractor.

6.3 Voltage Connection Points

Meter voltage terminals may be connected to the load side of the circuit being measured subject to the following conditions:

(a) a ring or "window" type current transformer is used; and

(b) the installation conforms to standard drawing number 1305 or 1306 in all other aspects.

7.0 Transformer Secondaries

7.1 Current transformer secondary returns may be shared via one wire connected from the meter terminals to the test-block/switch provided that the wire is of sufficient gauge to conduct the load without imparting a burden which exceeds the burden rating of the transformers.

7.2 Voltage transformer secondary returns may be shared via one wire connected from the meter terminals to the test-block/switch provided that the wire is of sufficient gauge so as not to impart a burden which exceeds the burden rating of the transformers.

8.0 Grounding

8.1 The case of each meter (Including instruments transformers) forming part of an electricity metering installation shall be appropriately grounded.

8.2 Instrument transformer secondary wires shall be grounded. Secondary wires which are interconnected shall be interconnected and grounded at only one point.

9.0 Totalizing

9.1 Totalizing (summation) of two or more circuits may be performed in the following manners:

(a) via parallelling of current transformer (CT) secondaries,

(b) through use of a totalizing current transformer, or

(c) through use of a multi-element meter.

9.2 Parallelling CT secondaries is permitted subject to the following conditions:

(a) parallelled circuits are of the same voltage and frequency;

(b) current transformers have identical ratios;

(c) the potential circuits of the meter are supplied from a common bus to which the primary circuits are connected; and

(d) the meter ratings are sufficient for the totalized load.

9.3 A totalizing current transformer may be used subject to the following conditions:

(a) the primary circuits are of the same voltage and frequency;

(b) the potential circuits of the meter are supplied from a common bus to which the primary circuits are connected;

(c) the primary windings of the totalizing transformers are supplied from corresponding phases of the primary lines;

(d) each primary winding of the totalizing transformer in conjunction with its primary current transformer produces the correct proportion of the total secondary current; and

(e) the overall multiplier for the totalizing transformer is the sum of the ratios of all the primary current transformers which supply the totalizing transformer.

9.4 A multi-element meter may be used as a totalizing device provided that each meter section contributes to the totalized value of measurement from its correct proportion of the total load.

9.5 A totalizing meter may consist of two or more complete meter units supplied from separate primary circuits which supply a common meter register subject to the following conditions:

(a) the potential coils of each meter unit is supplied from the primary circuit which supplies the current coils of the corresponding meter unit; and

(b) each meter unit contributes to the totalized value of measurement from its correct proportion of the total load.

9.6 Summation of VA/VA-hour units in totalized circuits shall be performed by vectorial addition only.

10.0 Connection of Ancillary Devices

Relays, instruments, auxiliary transformers and other devices may be connected between the test-block/switch provided that they do not affect measurement accuracy, and do not interfere with testing of the meter and/or installation. In addition, wiring diagrams and all burden details for such devices must be available on-site.

11.0 4-Wire Circuits Metered with 2-Element Meters

11.1 Delta Connection at Test-block/switch

Standard drawings (3400-D series) outlining acceptable delta connections are established in Appendix A.

11.2 VA and VA-hour Measurement

Volt-ampere and Volt-ampere hour measurement is permitted subject to the requirements established in section 6 (b) of PS-E-08.

11.3 New metering installations are subject to the policy established in section 5.1 of Bulletin E-24. This means that new 4-wire installations (as of April 1, 2003) shall not be metered with 2-element meters.

12.0 Polyphase Circuits Metered with Single-phase Meters

The use of two single-phase meters to meter a 3-phase 3-wire circuit and the use of three single-phase meters to meter a 3-phase 4-wire circuit is permitted only where the units of watthour and/or var-hour energy are measured. This form of metering is not permitted for VA-hour measurement nor for demand measurement.

13.0 Additional Information

For additional information regarding this specification, please contact the Senior Program Officer responsible for electricity measurement. For more information regarding Measurement Canada and its programs, visit our Web site located at http://mc.ic.gc.ca.

for

Alan Johnston
President
Measurement Canada

Appendix A

This appendix is available as a separate package due to its large size.

Appendix B - MC Standard Colour Codes for Electricity Metering Installations

Phase	Currents		Potentials		Application
	Line	Load	Line	Load	
A B C N	Red - White Blue - White	Red - Black Blue - Black	Red Blue	Yellow White	3-Phase, 3-Wire, Delta 2-Element Meter 2 CTs 2 PTs
A B C N	Red - White Yellow - White Blue - White	Red - Black Yellow - Black Blue - Black	Red Blue	Yellow White	3-Phase, 4-Wire, Y 2-Element Meter 3 CTs, (delta at test links) 2 PTs
A B C N	Red - White Yellow - White Blue - White	Red - Black Yellow - Black Blue - Black	Red Blue	Yellow White	3-Phase, 4-Wire, Y 2½ -Element Meter 3 CTs 2 PTs
A B C N	Red - White Yellow - White Blue - White	White	Red Blue	White	3-Phase, 4-Wire, Y 2½ -Element Meter 3 CTs, (Y at transformers) Direct potentials
A B C N	Red - White Yellow - White Blue - White	White	Red Yellow Blue	White	3-Phase, 4-Wire, Y 3-Element Meter 3 CTs, (Y at transformers) 3 PTs, (Y at transformers)
A B C N	Red - White Yellow - White Blue - White	White	Red Yellow Blue	White	3-Phase, 4-Wire, Delta 3-Element Meter 3 CTs, (Y at transformers) Direct potentials
A B C N	Red - White Yellow - White Blue - White	White	Red Yellow	White Blue	3-Phase, 4-Wire, Delta 2-Element Meter 3 CTs, (all secondaries to test links) Direct potentials
A B C N	Red - White Yellow - White	Red - Black Yellow - Black	Red Yellow	White Blue	3-Phase, 4-Wire, Delta 2-Element Meter One 3-Wire CT, one 2-wire CT, (all secondaries to test links) Direct potentials
Green is used only for non-current carrying ground conductor					
White is used for current-carrying neutral or common conductor					

Bulletins

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2009-02-19

Revision and Revocation of MC Bulletins and Provisional Specifications

Measurement Canada issued Specification S-E-06 (rev.1) effective 2008-10-15. This Specification consolidated various amendments to Specification LMB-EG-07 and supercedes PS-E-06, PS-E-07, and Bulletin E-20.

Information pertaining to Bulletin E-20 "Test Provisions for Electronic Meters" is found in section 5.6.1 of S-E-06.

Information pertaining to PS-E-06 "Test Links" is found in sections 5.4.4, 5.7.3 and 5.15.2 of S-E-06.

Information pertaining to PS-E-07 "Requirements for Test Mode" is found in section 5.6.2 of S-E-06.

PS-E-06, PS-E-07 and Bulletin E-20 are therefore hereby revoked.

The issuance of S-E-06 (rev.1) necessitated minor housekeeping amendments to sections 4.1, 4.4 and 4.10 of Bulletin E-30 and therefore it has been revised and issued as E-30 (rev. 2).

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~~E-1~~	~~Preconditioning of Electricity and Gas Meters Submitted for Compliance Sampling~~ Revoked 2007-07-23		~~1990-02-23~~
~~E-2~~	~~Defect Information Regarding the Test Mode on *Schlumberger Sangamo KVI* and *SVI* Multifunction Electricity Meters~~ Revoked 2005-04-21		~~1991-06-14~~
~~E-3~~	~~Irregularity in Demand Interval Length on *Schlumberger Sangamo KVI* and *SVI* Meters~~ Revoked 2005-04-21		~~1991-10-02~~
~~E-4~~	~~Temporary Dispensation of Sealing Requirement for Electronic Demand Recorders and Totalizers used in the Measurement of Electricity~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1992-01-17~~
~~E-5~~	~~Temporary Permission for Putting a Meter into Service without Verification and Sealing -- Notice of Approval AE-0393~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1992-01-31~~
~~E-6~~	~~Temporary Permission for Putting a Meter into Service without Verification and Sealing -- Notice of Approval AE-0448~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1992-06-17~~
~~E-7~~	~~Temporary Permission for Putting a Meter into Service without Verification and Sealing -- Notice of Approval AE-0473~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1993-01-19~~
~~E-8~~	~~Temporary Permission for Putting a Meter into Service without Verification and Sealing -- Notice of Approval AE-0521~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1993-12-20~~
~~E-9~~	~~Temporary Permission for Putting a Meter into Service without Verification and Sealing -- Notice of Approval AE-0524~~ Revoked 2005-04-21	~~EGI Act, section 9~~	~~1993-12-20~~

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~~E-21 (rev. 1)~~	~~Policy on the Application of the Specifications for the Calibration, Certification and use of Electricity Calibration Consoles (S-E-01: rev. 1)~~ Revoked 2007-07-23	~~S-E-01 (rev.1) Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles~~	~~2003-10-21~~
~~E-22~~	~~Calibration of Local Radian Standards~~ Revoked 2008-04-29		~~2001-01-11~~
E-23 (rev. 2)	Verification of Electronic Electricity Meters containing a Test Mode Function	S-E-06 section 5.6.2	2009-10-01
E-24 (rev. 1)	Policy on Approval and Use of 2½ Element Metering		2002-11-29
E-25 (rev. 2)	Temporary Permission for Putting a Meter into Service without Verification and Sealing	EGI Act, section 9	2008-09-15
E-26 (rev. 4)	Reverification Periods for Electricity Meters and Metering Installations	See Clause 7.1 and E-26 (rev. 3)	2008-07-18
E-27	Policy on the use of Electricity Meters in Net Metering Applications	Information Bulletin "New Policy for Net Metering".	2007-07-01
E-28 (rev. 2)	Qualification of Electricity Meters for Lenghtened Initial Revirification Period of 10 Years	S-EG-01; S-S-05; E-26	2009-08-19
E-29 (rev. 1)	Electricity Meter Calibration Console Burden Effects	S-E-01, S-E-02 (section 5.2.4)	2010-04-01
E-30 (rev. 2)	Policy Decisions and Interpretations Related to Specification LMB-EG-07	Electricity Specification LMB-EG-07; Electricity Specifications and Provisional Specifications; Bulletins E-20; E-24; GEN-25; and GEN-31	2009-02-19

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Bulletin

Category: **ELECTRICITY**	Bulletin: **E-23 (rev. 2)**	Page: **1 of 3**
Document(s): **S-E-06 section 5.6.2**	Issue Date: **2009-08-27**	Effective Date: **2009-10-01**
	Supersedes: **E-23 (rev. 1)**	

Verification of Electronic Electricity Meters containing a Test Mode Function

1.0 Purpose

The intent of this bulletin is to provide a revised policy for testing energy and demand registers of electronic meters which contain a test mode function.

2.0 Scope

This bulletin applies to electronic electricity meters which contain a test mode function that are submitted for approval or have been approved by Measurement Canada.

3.0 Background

Electronic meters are generally designed with multiple modes of operation such as, normal, alternate and test mode. The normal mode is the mode used by the meter while in service. The alternate and test modes are the modes which can be activated by the user through a switch or other means. The test mode is used for meter testing and is designed to increase resolution of the energy register and/or reduce the time required to test the demand function.

The present policy contained in the Electricity and Gas Inspection Procedures Manual for the verification of the electronic energy and demand functions approved for revenue metering requires all the specified demand tests be performed using the test mode feature, with one final test performed in normal mode. The normal mode test is performed to verify the accuracy of the demand measurement and energy registration of the meter when in the normal operating mode.

Following a review of this policy in consultation with the electricity industry, Measurement Canada has determined that increased evaluation of the test mode at the approval stage could be done to confirm the performance of the test mode function and eligibility for use in meter verification. Consequently, Measurement Canada has decided to remove the normal mode test requirement for meters which have a test mode approved for verification purposes.

4.0 Terminology

For the purposes of this bulletin, the following terminology shall apply:

Register - A memory location in the meter where the value of a measured quantity is electronically recorded.

Register test - The performance test which compares the quantity measured by a certified reference standard against the quantity accumulated and stored in a memory location used in the normal mode of operation.

Verification - All the operations carried out by an inspector or accredited meter verifier having the object of ascertaining and confirming that a meter entirely satisfies specified requirements. Verification includes both inspection and the application of the verification mark. Any reference to verification applies to both the verification and reverification of meters, whether by 100% inspection or through the use of statistical sampling methods authorized by Measurement Canada.

5.0 Policy on the Approval of Test Mode

5.1 Electronic electricity meters containing a test mode shall be evaluated for approval to use the test mode for meter verification. Evaluation shall include an assessment of the meter design to confirm which approved measurement functions can be tested using the test mode.

5.2 Where the test mode is found to comply with the specifications for test mode contained in PS-E-07, the Notice of Approval shall clearly indicate one of the following as applicable:

(a) the test mode is approved for the purpose of verifying the performance and accuracy of energy measurement functions which have been approved as legal units of measurement in this notice of approval.

(b) the test mode is approved for the purpose of verifying the performance and accuracy of demand measurement functions which have been approved as legal units of measurement in this notice of approval.

(c) the test mode is approved for the purpose of verifying the performance and accuracy of energy and demand measurement functions which have been approved as legal units of measurement in this notice of approval.

5.3 The approval applicants for all electronic electricity meters approved prior to the issuance of this bulletin are responsible for applying to Measurement Canada for the approval to use test mode for meter verification.

5.4 Any accredited organization that wishes to use the test mode on specific meters to verify energy and demand functions shall ensure that the approval to use test mode for verification is stated in the Notice of Approval as prescribed in clause 5.2. If not, then the accredited organization will need to contact the approval applicant indicated on the Notice of Approval and request that the applicant obtain approval from Measurement Canada to use the test mode for verification.

6.0 Policy on the Verification of Electronic Electricity Meters Containing Test Mode

6.1 Use of Test Mode

The test mode where approved may be used for meter verification testing to the extent indicated in the Notice of Approval without requiring further testing in the normal mode of operation (as prescribed in the note provided under clause 8.7 of the Electricity and Gas Inspection Procedures Manual July 7, 1998).

6.2 Register Testing

6.2.1 The register values obtained during verification testing shall be determined to a resolution of 0.1%.

6.2.2 The register test may be performed using the following options:

(a) by using the test mode if the test mode permits access to registration to the required resolution indicated in clause 6.2.1; or

(b) by accessing the internal registers via the optical port; or by any other communications port available on the meter, where registration is provided to a resolution of 0.1%

(c) by performing a normal mode energy test with registration accumulated to a resolution of 0.1%.

6.2.3 If meter multipliers are modified during verification tests, then the meter program shall be evaluated to confirm that the correct multipliers have been re-programmed prior to sealing.

7.0 Revisions

The purpose of revision 1 was to include a policy for the approval of test mode on meters approved prior to the issuance of this bulletin and to clarify the requirements for register testing.

The purpose of revision 2 is to remove the definition of "Display" as the term is not used in this bulletin; to modify the definition of "Register" such that it more correctly reflects the definition of "Register (Electronic)" in S-E-06; and to make minor editorial modifications.

8.0 Additional Information

For additional information regarding this bulletin, please contact the Program Officer responsible for electricity measurement. Further information regarding Measurement Canada can be found on our web site located at http://mc.ic.gc.ca.

Gilles Vinet
Vice-President
Program Development Directorate

Bulletin

Category: **ELECTRICITY**	Bulletin: **E-29 (rev. 1)**	Page: **1 of 5**
Document(s): **S-E-01, S-E-02 (section 5.2.4)**	Issue Date: **2010-02-19**	Effective Date: **2010-04-01**
	Supersedes: **E-29**	

Electricity Meter Calibration Console Burden Effects

1.0 Purpose

The purpose of this bulletin is to clarify requirements of section 7.1.5 and 7.2 of S-E-01 as relates to the impact of burden direction, (capacitive or inductive), as well as magnitude, on a calibration console.

2.0 Scope

This Bulletin applies to all electricity meter calibration consoles which are certified in accordance with S-E-01 (*Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles*).

3.0 Background

3.1 Issue

Measurement Canada (MC) has been made aware of a technical situation which can have serious implications on the level of confidence in the accuracy of test results for verified electricity meters. In 2005 MC was informed that some electricity calibration consoles were not able to comply with certain requirements of S-E-01 pertaining to the effects of meter burden when the consoles were burdened with a certain type of meter. At the time this was thought to be an isolated incident and corrective action was implemented to address the situation. Since that time, MC has performed a study and evaluation of additional technical data and information provided by electricity stakeholders. The situation has been determined to be broader in scope than originally thought.

3.2 Effects of Burden

The amount of burden placed on a test console can vary drastically depending on the type and number of meters being tested. The error which a console indicates for any given meter under test will depend on the burden placed on the console by the meter(s), (ie: the effect of burden impacts on the ability of a test console to directly compare the accuracy of a meter under test with that of the certified reference standard). This results in a level of uncertainty in the indicated error of the meter under test. Specification S-E-01 contains requirements pertaining to the effects of various burden conditions which are placed on the console during meter testing. The purpose of those requirements is to ascertain if a console is capable of testing meters under a range of burden conditions while minimizing the level of uncertainty in the indicated error of the meter(s).

3.3 Description of Problem

3.3.1 Section 7.1.5.1 of S-E-01 identifies the test burdens to be used during console certification testing. In general it establishes that the console be tested under conditions of high burden and again under conditions of low burden. This criteria is sufficient under the assumption that meter burden varies in magnitude only. However meter burden does have direction as well as magnitude, and can be either inductive or capacitive, this is evidenced by a growing number of meter types exhibiting capacitive burden characteristics. The result is such that a high inductive burden meter may impact on the console indicated error in a negative direction while a high capacitive burden may impact on the console indicated error in a positive direction. The limits for maximum permissible spread of error due to burden effects may be exceeded between the high inductive and high capacitive burden even if they are complied with between one of the high burdens and low burden. Therefore confidence in the test results which a console indicates for a meter under test is compromised by this significant increase in the level of uncertainty.

3.3.2 Concern regarding the level of confidence in the certainty of established meter errors has been raised to MC by electricity stakeholders. The criterion outlined in this Bulletin are established in order to mitigate the potential for increased measurement uncertainty and ensure confidence in the level of uncertainty pertaining to meter errors indicated by certified calibration consoles. As concern has been raised directly from electricity stakeholders concerning confidence in the level of uncertainty and accuracy of verified meter errors, the expeditious implementation of this Bulletin is of high importance.

4.0 Metrological Considerations

4.1 Section 7.1.5.1 of S-E-01

4.1.1 The intention of section 7.1.5.1 of S-E-01 is to identify the maximum range of burden conditions that a certified calibration console may be subjected to in order to assure that the full expected range of meter burdens is in fact assessed. This section establishes the voltage burdens to be used when performing subsequent metrological tests pursuant to section 7 of S-E-01.

4.1.2 Sections 7.1.5.1 (a)(i), (b)(i), (c)(i) are intended to include the highest inductive voltage burden and the highest capacitive voltage burden. Therefore when assessing a console pursuant to section 7.1.5.1, three tests must be performed: 1) The highest inductive burden, 2) The highest capacitive burden, 3) The lowest burden (which could be zero burden for polyphase meters). See the note under section 4.2.3 (a) below for further information.

4.1.3 The burden which causes the medium error of the three shall be used as the general test burden where applicable in other sections of S-E-01 if the difference between the three is no greater than 0.1%.

4.2 Section 7.2 of S-E-01

4.2.1 The intention of section 7.2 of S-E-01 is to assess the console to determine if it complies with criteria which aims to minimize the level of uncertainty in the indicated errors of meters under test, under the full range of burden conditions that can be imparted by meters which are intended to be verified on the calibration console.

4.2.2 The criteria of section 7.2.1 must be complied with in order for the calibration console to be certified to verify all the meter types which are included within the statement of intended use for the calibration console as required by section 5.2.6 of S-E-01. Given the background information described above, MC will consider the requirements of section 7.2.1 to be met in situations where the difference between the three errors (determined pursuant to section 7.1.5.1), exceeds the criteria of section 7.2.1. This will be accepted only on condition that the calibration console be characterized for the range of burdens (meter types) which are intended to be verified on the calibration console. See the note at the bottom of section 4.2 for further information.

4.2.3 The following conditions shall be met in order for the calibration console to be certified to verify all the meter types which are intended to be verified on the calibration console:

(a) All burdens applicable to each meter type which is intended to be verified on the calibration console shall be identified. The burdens shall be assessed in accordance with section 7.1.5.1.

NOTE: MC strongly recommends that calibration console owners perform the assessment of burdens (as outlined in section 7.1.5.1 of S-E–01) for each electronic meter type, plus each electro-mechanical type fitted with an RF transmitter that is expected to be verified on each console. Such assessment would result in a complete evaluation of the meter types which may potentially impart burden effects that cause the console to not comply with specified requirements. The test procedures pursuant to section 7.1.5.1 are relatively short and will secure the needed information with minimal resources required. The added benefit of this approach is that console owners will not have to research meter burden data as the effect of all the assessed burdens will be known. This information may be useful in evaluation of corrective action considerations as identified in section 7.0 below, and determination of necessary console upgrades or modifications. Subsequently, meter owners will be able to group meter types having similar burden effects.

(b) All burdens (meter types) which impart errors of no more than 0.1% difference (spread of error) among them, have met the criteria of section 7.2.1 and can therefore be included within the statement of intended use of the calibration console subsequent to tests required pursuant to section 7.8.2.6 of S-E-01.

(c) A list of every burden (meter type) for which the calibration console is certified to verify shall be established by the console owner.

4.2.4 Calibration console errors, at any test point and under any burden condition, shall not exceed the applicable tolerance set out in section 7.8.

4.2.5 All parameters, restrictions or limitations pertaining to the use of meter burdens for the purposes of calibration console certification shall be documented in the "Remarks" section of the calibration console certificate.

Ex: This console is not certified for the verification, reverification or compliance sampling of any electronic meter type, or any meter which is equipped with a RF transmitting devices, except as listed below:

(1) ABC meter

(2) DEF meter type fitted with the XYZ Automatic Meter Reading Module.

4.3 Example

Meter W error (due to burden effect) = - 0.01%
Meter X error (due to burden effect) = - 0.08%
Meter Y error (due to burden effect) = - 0.10 %
Meter Z error (due to burden effect) = + 0.09 %

In this example meters W, X and Y comply with the requirements of 7.2 of S-E-01, and pursuant to section 7.1.5.1, the meter among the three which imparted the medium error on the console must be used as the test burden for all subsequent metrological requirements of S-E-01. In addition, meter Z is not eligible to be verified on this console as the error imparted by its burden (in relation to that of the meters W, X and Y) exceeds the tolerance of section 7.2.1 of S-E-01. Pursuant to section 7.8.2 of S-E-01, all console calibration errors must be determined once with the burden imparted by meter W, X or Y, (whichever one imparted the medium error on the console), as the test burden.

A listing identifying meter types W, X, and Y as complying with one range of burden shall be created which will facilitate selection of the pertinent test points, (for the meters of that burden range), which are required pursuant to section 7.8 during certification of the console. This will provide meter verifiers with the appropriate error corrections to be applied when verifying various meter types.

5.0 Implementation

5.1 The criterion of this Bulletin have been in effect since 2007-12-13 for all electricity calibration consoles which require certification pursuant to S-E-01.

5.2 The criterion of section 4.0 of this Bulletin has been in effect since April 1, 2008 for all electricity calibration consoles which require recertification (including annual certificate extensions) pursuant to S-E-01.

5.3 All expansions of calibration console scope or intended use, (additional meter types which may be verified on the console) shall be evaluated to ascertain if they include meter types which may have burden characteristics that could cause the console to be non-compliant with section 7.2 of S-E-01. Where expansion of intended use includes such meter types the calibration console shall be assessed in accordance with the Metrological Requirements outlined in this Bulletin.

6.0 Factors Impacting on Effects of Burden

MC has undertaken a study to determine if capacitive burden effects are limited as to the number of meter types and calibration console types which when used together may result in non-compliance with section 7.2 of S-E-01. The study demonstrated that there are a range of meter types and calibration consoles which when used in conjunction may result in non-compliance with the specified requirements for burden effect.

The following factors may result in burden effect errors which exceed the specified limits of error.

(1) Meter design - some meter types (particularly electronic meters) exhibit capacitive burden characteristics which may burden a calibration console significantly in direction and magnitude such that the error spread between it, and that of a meter type which has inductive burden characteristics, exceeds the specified limits of error.

(2) Automatic Meter Reading devices, (particularly Radio-Frequency transmitters) - some meter types which include integrated or ancillary RF transmitters have been discovered to exhibit significant capacitive burden characteristics.

(3) Calibration console design and use - some calibration consoles have been constructed with components specifically designed to compensate for the burden effects of either capacitive meter types or of inductive meter types, but not both. This increases the likelihood that the error spread between the two meter types will exceed the specified limits of error. Other possible calibration console contributing factors include the design and use of components such as: power supply, current transformers and potential transformers.

7.0 Corrective Action Considerations - Compliance with Section 7.2.1 of S-E-01

(1) Console manufacturers and service companies have identified various upgrades which allow certain calibration consoles to comply with specified requirements under a wider range of burden conditions. MC recommends that calibration console owners contact these companies in order to bring non-compliant consoles into compliance with specified requirements.

(2) Console owners may wish to designate specific consoles to be used with specific meters types as opposed to designating every console to be used with every meter type. For example console # 1111 may comply with limits of error for burden effects with meters W, X and Y, while console # 2222 may comply with limits of error for burden effects with meters Z and ZZ.

8.0 Revision

The purpose of this revision is to:

(a) make modifications to the referenced sections of S-E-01 as that document underwent structural changes;

(b) require use of the medium error producing burden (as opposed to the highest) for calibration of the consoles now that there are three tests (sections 4.1.3 and 4.3);

(c) modify section 5.0 to remove implementation requirements that have already occurred.

9.0 Additional Information

For additional information regarding this bulletin, please contact the Senior Program Officer responsible for electricity measurement, or visit our website at http://mc.ic.gc.ca.

Alan Johnston
President
Measurement Canada

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Bulletin

Category: **ELECTRICITY**	Bulletin: **E-30 (rev. 2)**	Page: **1 of 4**
Document(s): **Electricity Specification LMB-EG-07; Electricity Specifications and Provisional Specifications; Bulletins E-20; E-24; GEN-25; and GEN-31**	Issue Date: **2009-02-19**	Effective Date: **2009-02-19**
	Supersedes: **E-30 (rev.1)**	

Policy Decisions and Interpretations Related to Specification LMB-EG-07

1.0 Scope

This Bulletin applies to all electricity meters submitted for approval pursuant to LMB-EG-07 (Specifications for Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices).

2.0 Background

Measurement Canada (MC) has, over the past number of years, made various policy decisions and interpretations related to Specification LMB-EG-07. The purpose of this bulletin is to consolidate and communicate these decisions for the information of Measurement Canada staff and electricity stakeholders.

3.0 Policy Decisions

3.1 Demand Reset for Maximum/Peak Demand Meters - (Relates to sections 7 and 15 of LMB-EG-07)

3.1.1 A meter which is equipped with a dedicated maximum demand register, indicator or display must also be equipped with capabilities to reset the register. Resetting may be performed through an on-board device or through a remote mechanism. Reset will be assessed during approval evaluations to determine if it conforms with technical requirements established for the reset mechanism and to determine if activating the reset has any impact on the metrological characteristics of the meter.

3.1.2 A demand meter which is not equipped with a dedicated maximum demand register, indicator or display shall automatically recalculate the indicated or measured demand value upon completion of the previous demand interval or response period.

3.2 Interval/Load Profile Metering - (Relates to section 13 of LMB-EG-07)

MC does not currently have specifications relative to the approval of interval or load profile functions that extend beyond the traditional electricity metering areas of demand measurement and pulse initiating & recording devices used for the transmittal of energy or demand measurements to a remote location. Pertinent specifications are expected to be established pursuant to recommendations developed by the Joint MC-electricity industry Working Group on the Establishment of Legal Units of Measure Outside an Approved Meter.

3.3 Telemetering Devices and Systems - Automatic Meter Readers (AMR) - (Relates to section 13 of LMB-EG-07)

3.3.1 Pulse based recording and generating telemetering devices are currently clearly defined in LMB-EG-07, and applicable performance tests are established.

3.3.2 MC does not approve retrofit-type (i.e., installed under the meter glass cover with access restricted by a seal) automatic meter reader (AMR) devices per se. The AMR, as a meter component, shall be evaluated to ensure that it functions and does not impair or impact on the operation of the meter as a whole. No specific performance testing of the AMR itself is required. The AMR is to be identified in the host meter's notice of approval (NOA).

3.3.3 MC does not approve stand-alone non-pulse based AMR's which operate outside of any host meter and receive data through the host meter's electronic telecommunication devices (RS-232, powerline carrier, RF, etc). The purpose of these devices is to simply re-transmit legal units of measure (LUM) established by the host meter. No approval for this AMR is required as this does not constitute a "meter" under the definition in the Legislation.

3.3.4 MC currently does require approval of AMR devices which operate outside of any host meter and which modify or create LUM since this does constitute a "meter" as defined by the Legislation. For the most part, at this time, such devices are pulse based and approval performance requirements are established in LMB-EG-07. The NOA for such devices will not make reference to host meters, since they operate outside of the host meter and are designed to connect to the host meter in a manner that does not affect the approved host meter pattern.

3.3.5 Bulletin GEN-26 establishes policies pertaining to the modification of approved meters. Prior to the issuance of bulletin GEN-26, MC had granted approval for some AMR devices that were built within a host meter. The policies of bulletin GEN-26 effectively imply that modification of any existing AMR approvals (which were granted prior to the issuance of bulletin GEN-26) will not be accepted by MC. Where the AMR manufacturer creates a modification MC will inform the manufacturer of the GEN-26 policies which require that such an AMR (as a component of a meter) must be evaluated as part of the host meter pattern, and the request for approval (revision) must therefore be submitted by the manufacturer(s) of the meter(s) with which the AMR is intended to be used. For modifications to existing AMR approvals which MC deems immaterial, the Agency may (as they see fit) issue a modification acceptance letter (MAL) under the host meter NOA which identifies the AMR that may be used as a component of that host meter.

3.4 Meter Display - (Relates to section 3.2 of LMB-EG-07)

All approved meters must have some manner of indicator/display which forms part of the approval. The indicator may be external or ancillary to the main body of the meter, (connected via wires, RF, etc). It is anticipated, though not specifically required, that the indicator/display will be physically located at the meter site.

3.5 Multi-Rate Registers - (Relates to section 3.2 of LMB-EG-07)

The policy pertaining to approval of meters containing multiple rate registers is outlined in bulletin GEN-31 section 5.0. In accordance with this policy, the energy measurement accuracy of each individual multi-rate register which is integral to a meter and intended for use in revenue metering shall be evaluated in order for the meter to be approved. The accuracy of the rate switching mechanism used to switch energy measurement registration from one register to another will not be evaluated.

3.6 Net Metering Registers/Displays and Annunciators - (Relates to section 3.2 of LMB-EG-07 and section 5.2 of S-E-05)

3.6.1 A meter which only performs net metering (ie; result of "forward accumulation minus reverse accumulation) does not require separate delivered and received registers. When energy is supplied in reverse it will be registered and displayed (with the reverse annunciator), and when supplied in forward (as normal) it will simply be registered and displayed as normal. The approvals examiner may exercise some flexibility in regards of the type of annunciator that is used in indicating that energy is being to received on the grid. The type of annunciator used by the meter will be indicated in the NOA.

3.6.2 The intent of requirements pertaining to identification of registers/displays is that registers must indicate the specific electrical quantity they are intended to register/display. In the case of a net meter the intent is such that when the display is displaying W-h negative, it must label this in some manner that distinguishes it from W-h positive, and Var-h negative etc. The approvals examiner may exercise some flexibility in regards of the label appearance, provided that NOA indicates which label refers to which electrical quantity and direction.

4.0 Consolidated Amendments to MC Specification LMB-EG-07 (established prior to date of issue of this Bulletin)

4.1 The following sections of LMB-EG-07 related to requirements for meter "test links" have been previously revoked. (See S-E-06).

(1) 4-3.2
(2) 7-3.3
(3) 15-3.1

4.2 The following sections of LMB-EG-07 related to requirements for "multi-rate registers" have previously been revoked through PS-E-12.

(1) 3-2.7.7

4.3 The following section of LMB-EG-07 related to requirements for "reverse detent" has previously been revoked through a former Agency memorandum issued by the Director on 1992-10-27.

(1) 12-2.1

4.4 Approval requirements pertaining to "Test Mode" have been established in section 5.6.2 of MC specification S-E-06.

4.5 Approval requirements pertaining to Electronic Current Transformers have been established in MC specification PS-E-13.

4.6 Approval requirements pertaining to Electronic Voltage Transformers have been established in MC specification PS-E-16.

4.7 Approval requirements pertaining to "Net Metering" have been established in MC specification S-E-05.

4.8 Approval requirements pertaining to "Prepayment Meters" have been established in MC specification PS-EG-01.

4.9 Approval criteria pertaining to assessment of units of measurement and functions have been established in section 5.3 of MC bulletin GEN-25.

4.10 Approval criteria pertaining to test provisions for electronic meters have been established in section 5.6.1 of MC specification S-E-06.

4.11 Approval policies pertaining to "2 ½ Element Metering" have been established in section 4.0 of MC bulletin E-24.

4.12 Specifications pertaining to approval of Instrument Transformers (IT's) - conventional type, not electronic type - have been established in MC Specification S-E-07. This specification supercedes requirements established in section 14 of LMB-EG-07. Subsequent to the effective date of S-E-07 section **14** of LMB-EG-07 is no longer applicable to approval of IT's and is thereby revoked.

4.13 Specifications for physical sealing provisions for electricity and gas meters have been established in MC Specification S-EG-02. This specification supplements requirements already established in section **3-2** of LMB-EG-07.

5.0 Implementation

This bulletin shall be effective immediately as it simply consolidates and communicates decisions and interpretations which have been previously established, and does not establish any new interpretations or decisions.

6.0 Revision

The purpose of this revision is to make minor housekeeping amendments to sections 4.1, 4.4 and 4.10 above.

The purpose of revision 1 was to include identification of new specifications related to specification LMB-EG-07 as identified in sections 4.12 and 4.13 above.

7.0 Additional Information

For additional information regarding this bulletin, please contact the Senior Program Officer responsible for electricity measurement, or visit our Web site at http://mc.ic.gc.ca.

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P-E-01

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Generic Procedures for Conducting Installation Verifications of Multiple Customer Metering Systems

Measurement Canada　Mesures Canada

Procedures

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Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements of S-E-01 (rev. 3)

P-E-01 (rev. 3) Summary of Amendments

Section	Description
5	Modified numbering/lettering due to modification of S-E–01 section 5
5	Removed references to 5.2 (d)(i) thru (xviii) and reworded to address these removals
6	Modified numbering/lettering due to modification of S-E–01 section 6
6	Removed references to 5.2 (d)(i) thru (xviii) and reworded to address these removals
7	Modified numbering/lettering due to modification of S-E–01 section 6
7	Removed references to 5.2 (d)(i) thru (xviii) and reworded to address these removals

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Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements of S-E-01 (rev. 3)

1.0 Scope

This document is intended to provide support for certification of calibration consoles to the requirements of S-E-01 (Specifications). Detailed descriptions and explanations, as well as test procedures related to specific requirements are provided. Worksheets associated with the test procedures and requirements are appended to this document.

1.1 General

S-E-01 identifies specifications that relate to the certification, calibration, and use of electricity meter calibration consoles. The procedures provided in the following sections describe the processes necessary to test and certify a console for compliance to the requirements of S-E-01.

The procedures have been organized so that they follow the structure and format of the Specifications. Sections 5.0 to 7.0 of this document correspond to section 5.0 to 7.0 of the Specifications. There are worksheets associated with each procedure and they are found attached as an annex to this document.

2.0 References

2.1 Canada Labour Code Part II (Human Resources Development Canada, March 1994).

2.2 CAN/CSA-C22.2 No.231 Series-M89 "CSA Safety Requirements for Electrical and Electronic Measuring and Test Equipment."

2.3 Handbook for Electricity Metering, Ninth edition, 1992, Edison Electric Institute.

2.4 Statistical Sampling Plans for the Verification and Reverification of Electricity and gas Meters (LMB-EG-04, section 3.0 and 4.0, Consumer and Corporate Affairs Canada, Legal Metrology Branch 1986).

2.5 Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles (S-E-01, Measurement Canada).

2.6 *Electricity and Gas Inspection Act.*

2.7 *Electricity and Gas Inspection Regulations.*

2.8 Workplace Health and Safety Agency's Resource Module; Electrical Hazards (Human Resources Development Canada).

2.9 Specifications for Approval of Type of Electricity Meters, Instruments Transformers and Auxiliary Devices, (Consumer and Corporate Affairs, Legal Metrology Branch, 1986).

2.10 IEEE Standard Dictionary of Electronic Terms, 1977, The Institute of Electrical and Electronic Engineers Inc.

3.0 Definitions

Burden
The load usually expressed in VA, which is placed on transformer secondaries by the associated meter coils, leads and other connected devices, at a specified test point and power factor.

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.

Distortion
An undesired change in waveform which will result in a non-sinusoidal waveform.

Electromechanical Demand Meter
An electricity meter which measures demand power using a thermal element, or mechanical gearing from an electro-mechanical rotating energy disk.

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

Floating/Phantom Voltage
A voltage that cannot be measured with a voltmeter having low input impedance, (eg. 20 000 ohms or less); usually a moving coil type voltmeter.

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

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 using input pulses from an electro-mechanical rotating energy disk.

Impedance
The total opposing effect to the flow of current in an AC circuit. Impedance may consist of resistance or resistance and reactance.

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

Live
Energized to be at a potential difference with respect to ground or any other terminal, and/or energized to be carrying electrical current.

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

Recti-Thermal Demand Meter
An electricity meter which measures demand power by the use 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.

Regulator
A device which operates to ensure that an electrical quantity which deviates from a set point or set load is brought back to that set point or set load.

Series/Parallel Testing
This is a method of testing electricity meters such that the voltage is applied in parallel to all voltage coils of the meter from the same voltage source of the calibration console. The current is applied in series to all current coils of the meter from one current source of the calibration console.

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.

Semi-Automatic Console
A console which is capable of setting and resetting loads after initial setting by operator. (eg. Multi-Amp console).

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

Specifications
The Specifications For the Calibration, Certification, and Use of Electricity Calibration Consoles. (S-E-01)

Standard
A certified measuring instrument, having errors traceable to the National Research Council of Canada, that is used to calibrate a Calibration Console.

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

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

4.0 Safety

4.1 Scope

The purpose of this section is to briefly describe the safety requirements and hazards when performing calibrations for the certification and use of Electricity Measuring Apparatus as related to the Specifications.

4.2 Requirements

An inspector is required to be qualified to test and operate calibration consoles pursuant to the specifications. Inspectors will be deemed qualified if they have sufficient knowledge, training and experience of several different types of calibration consoles and electrical theory to perform that duty safely and properly.

A qualified inspector is required to be aware of the following safety documents:

(1) Canada Labour Code Part II.

(2) Regulations respecting Occupational Safety and Health made under Part II of the Canada Labour Code.

(3) Safety and Health Committees and representatives' regulations.

(4) Treasury Board Manuals that outline the National Joint Council Agreements as related to Health and Safety. (Personnel Management Manual Vol. 12).

(5) Departmental Policies.

(6) Safety Policies at the site of the calibration console inspection, which includes Provincial and local Occupational Safety and Health Committee policies.

(7) Workplace Hazardous Material Information System (WHIMS)

4.3 Hazards

(1) The greatest hazard of working with electrical calibration consoles is that of electrical shock. Calibration consoles may be energized to their rated operating voltage and current and be as high as 600 volts, 200 amps. If they are incorrectly used there is a greater hazard of the test consoles exceeding their rated operating ranges.

Current levels as low as 1 to 8 mA the sensation of shock is felt by humans. When current levels exceed 8 mA painful shock will occur and risk of life is eminent.

The resistance of the human body is approximately 100,000 ohms from hand to hand. If the hands are wet or sweaty, the body resistance reduces to 37,000 ohms.

NOTE: The value of resistance of the Human body is referenced from the Workplace Health and Safety Agency's Resource Module, Titled: **Electrical Hazards.**

(2) Fire and Explosions are hazards if a calibration console does not operate within the manufactures requirements and limits.

Inspectors must know and follow the proper operating instruction on all types of consoles. For example there is a hazard simply by shutting down certain calibration consoles. If the correct switches are not turned off in order, equipment will be damaged and an explosion or fire may result.

Transformers, wiring and connections will burn and start an electrical fire if the console limits are exceeded. If a meter or burden is incorrectly connected or current and voltage ratings are exceeded, an explosion or fire may result.

4.4 Safe Operating Procedures

(1) Calibration consoles generally operate at voltages as high as 600 volts and currents up to 200 amps. The inspector performing the calibration console certification tests relating to the Specifications must comply with all the Canada Occupational Safety and Health Procedures and Regulations, Measurement Canada's safety practices and policies, as well as, the safety practices and policies for the location the tests are being performed.

(2) If the inspector is not capable of avoiding the safety hazard at the source, all of the required personal protective safety equipment must be used before performing any tests. The personal protective safety equipment includes safety shoes or boots, safety glasses, proper protective clothing, rubber insulating gloves with leather gloves, proper insulated tools and equipment.

(3) When working on a calibration console make sure the console is de-energized prior to making or changing connections. It is important to make sure that all connections are tight. The wire sizes must be of the proper gauge and insulated to withstand the maximum voltage supplied. The wiring length must be kept to the minimum necessary to hook up the measuring instruments.

(4) The work area must be safe, clean and free from obstructions that could interfere with the safety of testing operations.

(5) Ensure that all equipment whether issued by the department or the Utilities, is checked for broken leads, frayed insulation etc. Consult with Utility personnel, know who is in charge, and also the extent of qualifications of others.

(6) Open secondaries of current transformers (CT's) are a high voltage danger. Always ensure the secondaries of the CT's are shorted when a load has been disconnected.

(7) When performing the grounding and isolation tests a shock hazard is possible from any exposed metal panels if not properly grounded, as well as, voltage and current terminals if not properly isolated. This voltage may be as high as the full operating voltage that the console is set to. Protective equipment should be used and the floor under and around the console should be dry. The use of rubber matting around the console is preferred for added safety protection.

(8) When performing calibration tests the inspector must be protected and aware of the hazard of opening the secondary current circuit of the loading transformer. If the current circuit is inadvertently opened on some types of consoles especially when set at the lowest current tap setting and with the rheostats set to the maximum operating range, an unusually high voltage may be present between the open current circuit terminals. The voltage between the current terminals is dependent on the rating of the loading transformer. In some cases the voltage present, maybe as high as 480 volts or the voltage equivalent to the rating on the loading transformer, typically 110 volts. The amount of leakage current between the open current terminals and ground may be found to exceed 1 mA.

(9) When using a calibration console equipped with a creep switch insure the correct operation of the creep switch is understood before attempting any procedures. In some situations a console that indicates that the 'creep is on' means there is no current flowing to the meter under test positions, it may also mean that the console is live and current is flowing to the meter under test positions. The console should always be treated as live regardless of the status of the creep switch.
There may also be a large voltage on the current circuit when the creep switch is enabled and on some consoles it is highest at the lowest current switch setting. Do not make connection changes using the creep switch to disable the load as an 'on/off' switch.

(10) When performing the calibration tests for demand, energy, burden effects and distortion the console will be energized to an operation voltage and current. All safety precautions will need to be employed. There is a hazard with the potential coil burdens that are placed across the test socket voltage terminals. Care must be maintained to ensure no bare wire is contacted.

There should always be plenty of open space, free of wiring or other possible entanglements, since these tests require moving to different meter-under-test positions, and involves installing and removing meters. Ensure that whenever the equipment is moved the connections remain tight.

These tests will require setting and resetting many different loads. Care should always be taken to ensure that the voltages and currents are within the range of all standards and transformers, and the burdens in the meter-under-test positions.

(11) If the calibration console is equipped with pulse counters they may or may not be able to count live pulses. The specifications of the console's pulse counters and generators, and the test equipment pulse counters and generators must be known if live pulses are to be counted. Do not count live pulses at a voltage which exceeds the rating of the test equipment pulse counters and the pulse counters built into the console.

5.0 Procedures for Assessing Administrative Requirements

5.1 Roles and Responsibilities

5.1.1 Scope

These procedures relate to section 5.2 of the Specifications. This section outlines the roles and responsibilities related to the administration and application of the Specifications.

5.1.2 General

5.1.2.1 Certification process:

(1) The owner of a calibration console which is not authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01 can request certification for a calibration console through any District or Regional office of Measurement Canada.

(2) The owner of the calibration console must be compliant with the requirements as stated in section 5.2.3 and 5.2.4 or 5.2.5 as applicable, of the Specifications. All required information must be provided to Measurement Canada or to the organization authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01. Consoles which have never been certified, or which have not had a valid certificate for the last three years must be fully tested by the owner in accordance with the Specifications and this document. All other consoles demonstrate compliance to the requirements of sections 7.5, 7.6, and 7.8 of the Specifications as applicable, and the associated procedures in this document.

(3) All calibration console certification tests shall be carried out by the local inspection staff of Measurement Canada or by an organization authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01.

(4) One copy of all completed documentation and test results will be sent to the appropriate Regional Office of Measurement Canada. One copy will be retained by local organization who performed the console certification. One copy will be given to the owner of the console.

(5) The Regional Office may review the documentation, and any recommendations for certification of the console by the inspector. If the Regional Office disagrees with the recommendations, they may consult with the Program Development and Engineering/Laboratory Divisions of Measurement Canada to determine appropriate action.

(6) If all documentation and test results satisfy the conditions set out in the Specifications, a certificate of calibration will be generated and issued by the respective Measurement Canada Regional Director or the organization authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01. One copy of the certificate will be sent to the owner of the Calibration console, and one copy to the local organization which performed the certification tests.

(7) The information provided on or with the certificate will include: all calibration console errors as determined pursuant to section 7.8 of the Specifications, all console identification data, date of certification, bias transformer and regulator damping settings (if applicable), and any special provisions, exclusions, or limitations if the console is given a limited certification.

5.1.2.2 Conducting Tests

(1) All certification tests and procedures pursuant to the Specifications and this document are to be conducted by a local Measurement Canada Inspector designated under the *Electricity and Gas Inspection Act* or by an organization authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01.

(2) All setups, pre-testing, calibrating, and troubleshooting that is required prior to the request for certification of a calibration console is the responsibility of the owner of the console.

5.1.2.3 Test Equipment - Refer to Section 5.2.1 of the Specifications

(1) All test equipment and standards that are used pursuant to the Specifications and this Document for the purposes of determining an error must have a valid certificate of calibration issued by the Calibration Services Laboratory or National Research Council of Canada. The person who is performing the certification tests is responsible for ensuring that all measuring equipment has valid certification if required.

5.1.2.4 Pre-Testing - Refer to Section 5.2.5 of the Specifications

(1) The owner of the calibration console is required to pre-test the console, subject to the requirements of section 5.2.4 & 5.2.5 of the Specifications, prior to any certification tests performed by Measurement Canada inspectors.

(2) The Measurement Canada Inspector is responsible for ensuring that all required pre-testing has been performed by the owner of the console. This should be done by examining all the worksheets and test results including daily accuracy check results if applicable.

(3) The inspector must be satisfied that the console will meet the requirements of the Specifications before beginning testing.

5.1.2.5 Information Required - Refer to section 5.2.6 of the Specifications

(1) The owner of the console shall identify all possible testpoints, along with their respective tap and selector switch settings, that the console is to be certified for. (Completed worksheets for pretesting, the organizations scope of accreditation or quality records will serve to identify the test points)

(2) The Measurement Canada inspector or organization authorized to re-certify calibration consoles on behalf of MC pursuant to C-D-01 must use the identified test points, in conjunction with the requirements set out in section 7.8 of the Specifications, to determine the testpoints that will be used to certify the console.

(3) All certification testpoints must be performed using the specific tap and selector switch settings specified for that particular testpoint. The selector switch settings determine the magnitude of voltage and/or current to be used for testing. The tap settings are generally found at the loading transformers. Some consoles require that taps be set manually to coincide with specific test loads. Some consoles automatically select the appropriate taps to coincide with specific test loads. Some consoles use amplifier circuits to create test loads, and therefore do not have loading transformer tap settings.

(4) All electrical quantities that the console is to be certified for must be recorded on the "Calibration Console Usage Summary" table of the worksheets.

(5) If the console will be used to verify electromechanical demand meters, (exponential or block interval), this must be indicated on the "Calibration Console Usage Summary" table of the worksheets.

(6) If the console will be used to verify single phase and/or polyphase meters, this must be indicated on the "Calibration Console Usage Summary" table of the worksheets.

(7) For many of the tests required in the Specifications it is necessary to place test burdens in all or some of the meter-under-test positions of a console. The owner of the console is required to determine which meters have the highest voltage burdens. The meter burden is expressed in VA and is the total additive burden from all voltage coils and associated circuits. The inspector will use this information to determine which meters/burdens to use while performing certification tests. This information should be recorded on the "Meter Burden Data" section of the worksheets.

(8) In order to facilitate testing of any console pulse counters, the inspector must know the maximum pulse rate that meters with pulse outputs will deliver at a specified test load. This information must be provided by the owner of the console. The pulse rate is to be determined based on a meter testpoint at rated voltage and 25% of rated current, with all elements in series. This information must be recorded on the "Calibration Console Usage Summary" table of the worksheets.

Example

360 volt, 200 amp, 3 element meter with Kp=5.0. At a testpoint of 360 volts, 50 amps in series the meter will pulse at a rate of:

$(360 \times 50 \times 3) \div (3600 \times 5) = 3.0$ pulses per second

(9) In order to facilitate testing of console pulse generators, if there are any, the inspector must know the maximum pulse rate that meters or recorders with pulse inputs will accept. This information must be provided by the owner of the console.

(10) The owner of the console must determine the number and type of reference meters that will be used in conjunction with the console at one time. This information must be recorded on the "Calibration Console Usage Summary" table of the worksheets. The console certification tests must be performed with the specified number and type of reference meters connected in the circuit as they would be under normal meter testing.

Example: If the console is normally used for meter testing with two Radian standards connected in series/parallel with the secondary voltage and current circuits, then all certification tests shall be performed with two Radian standards connected in series/parallel with the secondary voltage and current circuits.

(11) The owner of the console must provide the maximum voltage of the highest voltage rated meter, and the minimum current shown on the nameplate of the lowest current rated meter. This information must be recorded on the "Calibration Console Usage Summary" table of the worksheets.

Example: The minimum current shown on the nameplate refers to the lowest level of current in the approved current range of the meter. A transformer meter may have a current range of: 0.1 amps to 10.0 amps. In this case 0.1 amps is used.

(12) The owner of the console must provide the maximum test current of the highest current rated meter.

(13) The owner of the console must provide the largest test load which is used to verify exponential demand meters, or block interval demand meters which require regulators and cannot be verified pursuant to the requirements of section 6.4.9 of the Specifications.

(14) The owner of the console is required to identify all regulators, line conditioners, and other equipment used in conjunction with the console for testing meters. This should include equipment that is integral to the console, such as built-in regulators, as well as external equipment that may influence calibration console accuracy such as line regulators, conditioners or UPS's that may be adjacent to the console or in another area of the premises. This information must be recorded on the "Regulators, Line Conditioners, Other Equipment" table of the worksheets.

5.1.2.6 Test Burdens - Refer to section 5.2.7 of the Specifications

(1) The owner of the console is responsible for ensuring that all meters and burdens required for certification tests are available.

(2) Test burdens will generally include meters in all but one meter-under-test position, as well as a potential coil of the same type used to burden the meter-under test-position that the test socket and standard are in.

(3) Examples of possible burdens required for a typical ten position console might be:

(a) Nine 120 volt, 10 amp, 3 element recti-thermal meters and three similar potential coils.

(b) Nine 360 volt, 200 amp, 3 element recti-thermal meters and three similar potential coils.

(c) Nine 240 volt, 200 amp, 1.5 element single phase meters and one similar potential coil.

(d) Nine 120 volt, 200 amp, 3 element recti-thermal meters and three similar potential coils.

(e) Nine 600 volt, 200 amp, 2 element recti-thermal meters and two similar potential coils.

5.1.2.7 Requirements for Maintaining Certification - Refer to sections 5.2.8 through 5.2.13 of the Specifications

(1) The scope of certification of any calibration console may be limited to certain specific meter types or test methods. It is the responsibility of the owner of the console to inform the local office of Measurement Canada if the console will be required to perform verification tests beyond the scope of it's certification. Measurement Canada will determine what, if any, additional certification tests are required to be performed before the scope of console certification may be expanded. Measurement Canada will perform any such required additional tests, and amend the console certificate in accordance with the certification process, section 5.1.2.1 above.

(2) Any limitations to the scope of use of a certified calibration console will be clearly stated on the console certificate. The console must be used for testing meters in the same manner and methodology in which the certification tests were performed.

(3) Any certificates and certification worksheets must be retained by the owner of the console for the period of certification of the console. This documentation must be readily available whenever the console is being used for verification testing during the course of its certification period.

(4) The owner of the certified console is responsible for maintaining the console in good repair and operating order, both electrically and mechanically.

(5) The owner of the certified console is required to inform the local office of Measurement Canada if any parts or equipment have been replaced, if any repairs or adjustments have been made, and if the console has been relocated. The log book shall be updated to indicate any such activities.

(6) The owner of the certified console shall inform the local office of Measurement Canada, in writing, immediately after any repairs or adjustments are performed. This will include all minor repairs such as soldering wire or connections, replacement of connection pins or binding posts. This also includes changing any of the settings that were established while performing the certification tests. (Eg: Bias transformers, regulator damping, etc.). Measurement Canada will determine if any additional certification tests are required as a result of the repairs or adjustments. This decision may be made by the local office of Measurement Canada, in consultation with the Regional Electrical Specialist and/or Engineering/Laboratory Division if required. The owner of the certified console must also inform the local office of Measurement Canada if any changes are made to the console's identification markings or numbers.

(7) The owner of the certified console shall inform the local office of Measurement Canada, in writing, prior to any modification or relocation of the console. This will include relocation to a different area on the premises or to another premises. This also includes any major repairs or replacement of parts, such as reference meters, transformers, control circuits, regulators, change of power supply, etc. Measurement Canada will determine the extent that the modification will affect the certification of the console and the extent to which additional certification tests must be performed. This decision will generally be made by the local office of Measurement Canada, in consultation with the Regional Electrical Specialist and/or Engineering/Laboratory Division. Measurement Canada may limit the scope of certification of a certified console before allowing the owner to proceed with the stated modification.

Example: A ten position console is certified for testing in all 10 positions using multiple potential transformers. The owner wants to replace the multiple potential transformer in position 7. Measurement Canada will be informed in writing prior to any such replacement. Measurement Canada may now limit the scope of certification to include tests using multiple transformers in positions 1 to 6, and 8 to 10 only, until such time as additional certification tests are performed on the position with the new multiple transformer.

5.2 Procedures for Assessing Markings And Documentation

5.2.1 Nameplate

5.2.1.1 Scope

This procedure relates to section 5.3.1 of the Specifications. It is intended to verify and record the calibration console nameplate information.

5.2.1.2 General

The calibration console nameplate information is to be recorded on the worksheet for identification and reference purposes. This information is recorded on the certificate of calibration.

5.2.1.3 Procedure

(1) Determine if the console is clearly identified with a nameplate which is readily accessible and legible.

(2) Record on the worksheet, Name of the calibration console manufacturer, Model number, Serial number and the supply voltage and configuration.

(3) If the calibration console is not marked accordingly have the owner do so prior to the calibration of the console.

5.2.2 Log Book or File

5.2.2.1 Scope

This procedure relates to section 5.3.2 of the specifications. The purpose of this procedure is to ensure that all calibration console owners maintain a log book or file in reference to the calibration console.

5.2.2.2 General

Calibration console owners are required to keep records of all details regarding the operation and history of the console. The specification outlines the specific details that are to be recorded and kept on file or in the form of a log book. This information is to be readily available and accurate for use by Measurement Canada in evaluating the calibration console. The weekly accuracy tests are to be recorded in the log books.

5.2.2.3 Procedure

(1) Verify the log book or file is correctly maintained by the owner of the calibration console and kept readily available.

(2) Verify that the dates and details are recorded in regards to, weekly accuracy tests, identification of the person or persons performing all accuracy checks, adjustments, maintenance, repairs, and all modifications made to the calibration console.

(3) Record on the worksheet the acceptance of the log book or file.

5.2.3 Operating Manuals and Schematics

5.2.3.1 Scope

This procedure relates to section 5.3.3 of the Specifications. The purpose of this procedure is to ensure calibration consoles have operating manuals and schematic drawings.

5.2.3.2 General

Calibration consoles are required to have an operating manual to establish the correct operation of the console. The schematic drawings are to be available to assist in the calibration of the console.

5.2.3.3 Procedure

A procedure is not required. Record on the worksheet if the operating manual and schematic drawings are available.

5.2.4 Calibration Console Markings

5.2.4.1 Scope

This procedure relates to section 5.3.4 of the Specifications. The purpose of this procedure is to ensure calibration consoles have correct markings.

5.2.4.2 General

Calibration consoles are required to have all controls, displays and switches indelibly identified. The markings are required to ensure correct and safe operation of the console.

5.2.4.3 Procedure

(1) Visually inspect all controls, switches and displays and verify they are accurately marked and identified.

(2) If the controls are not correctly marked the owner is required to take corrective action to do so.

(3) Record on the worksheet the acceptance of all Markings.

6.0 Procedures for Assessing Technique Requirements

6.1 Procedures For Assessing Use Requirements

6.1.1 Accuracy Check

6.1.1.1 Scope

The following procedure relates to section 6.1.2 of the Specifications. This procedure is intended to ensure that a calibration console's accuracy is maintained during its period of certification.

6.1.1.2 General

In order to provide assurance that a calibration console maintains its accuracy, an accuracy check is required every week that a console is used. The accuracy check is conducted by installing a meter with known errors, or a certified standard or reference meter in a meter-under-test position, and comparing the errors determined by the console with the known errors of the device installed in the meter-under-test position. The error should be within the requirements of section 6.1.2.3 of the Specifications.

If a calibration console fails the accuracy check it cannot be used until the cause of the change in error is found and corrected. In addition, any meters that were verified on the console between the time of the accuracy check that failed and the last accuracy check that the console passed, will have to be reverified on another certified console, or on the same console after it has had its fault(s) corrected.

6.1.1.3 Apparatus

1) Meter of known error, or certified standard, or certified reference meter.
2) Shorting bars

6.1.1.4 Setup

1) Install the meter of known error, or certified standard, or certified reference meter in a meter-under-test position.
2) Install shorting bars in all other meter-under-test positions.

6.1.1.5 Procedure

(1) Review the log book and select a test point from the test points used to verify meters that has not been selected in a previous accuracy check. If all test points have been selected already, the selection of test points for the accuracy check may repeat itself.

(2) Energize the console at the test point selected.

(3) Execute a simulated verification test for the set up.

(4) Record the error determined by the console for the device installed in the meter-under-test position.

(5) Calculate the error of the console by subtracting the known error of the device in the meter-under-test position from the error determined by the console.

(6) The result obtained in step 5) above should be within the tolerance specified in section 6.1.2.3 of the Specifications.

(7) Record the results of the accuracy check, as well as, the test point used, in the log book.

6.2 Procedures For Assessing Environmental Requirements

6.2.1 Temperature

6.2.1.1 Scope

This procedure relates to section 6.2.1 of the Specifications. The purpose of this procedure is to ensure that the ambient temperature surrounding the console is within the requirement set out in section 6.2.1.1 of the Specifications while it is being calibrated.

6.2.1.2 General

This procedure involves measuring the ambient temperature surrounding the console.

6.2.1.3 Apparatus

(1) Certified Thermometer

6.2.1.4 Procedure

(1) Place the thermometer within approximately 10 meters of the console.

(2) Record the temperature reading indicated on the thermometer.

6.2.1.5 Remarks

The procedure above may be repeated during the course of console calibration if it appears that the temperature is fluctuating to the extent that it may be outside the specified limits.

6.3 Procedures For Assessing Mechanical Requirements

6.3.1 Indication of Energization

6.3.1.1 Scope

This procedure relates to section 6.3.1 of the Specifications.

6.3.1.2 General

The purpose of this requirement is to ensure that there is prominent indication whenever the console is energized.

6.3.1.3 Apparatus

No test apparatus is required.

6.3.1.4 Setup

No setup is required.

6.3.1.5 Procedure

(1) Ensure that the console has a master on/off switch for controlling application of power to the console.

(2) Energize the console.

(3) Determine if there is prominent indication of energization. (Illuminated working instruments will serve as indication of energization).

(4) De-energize the console.

(5) Complete the worksheets associated with this procedure.

6.3.2 Circuit Protection

6.3.2.1 Scope

This procedure relates to section 6.3.2 of the Specifications. The purpose of this procedure is to ensure that all circuit protection features of a calibration console are readily available.

6.3.2.2 General

This procedure involves a visual inspection of the calibration console and its circuit protection features.

6.3.2.3 Apparatus

There is no special test apparatus required for this procedure

6.3.2.4 Procedure

(1) Refer to the operating manual for the calibration console if required, and determine the location of all circuit protection features of the console. Ensure that these features are readily accessible

(2) Complete the worksheet related to this procedure.

6.3.3 Grounding

6.3.3.1 Scope

This procedure relates to section 6.3.3 of the Specifications. The procedure is intended to ensure that a console operator is not exposed to shock hazards during normal use of the calibration console.

6.3.3.2 General

Calibration consoles which are grounded shall be tested for proper grounding by taking voltage measurements between ground and all exposed metal panels while the console is energized to full voltage and minimum current. A properly grounded console is one that does not exhibit measured voltages greater than those stated in the Specifications.

For the case of consoles which are not grounded, but protect the operator from a shock hazard by use of a ground fault interrupting (GFI) circuit breaker, a test shall be conducted to determine if the ground fault protection system operates as required.

6.3.3.3 Apparatus

6.3.3.3.1
Consoles without automatic ground fault protection.

(1) Voltmeter with a low input impedance such as an electrodynamometer or moving coil voltmeter capable of measuring the full operating voltage of the console. An electronic voltmeter may be unsuitable for this application as it may register floating/phantom voltages.

(2) Shorting bars for all the meter-under-test positions.

(3) Ohmmeter.

6.3.3.3.2
Consoles with automatic ground fault protection consisting of a ground fault interrupting (GFI) circuit breaker which does not have a test function.

(1) Shorting bars for all the meter-under-test positions.

(2) Fuse holder complete with 0.5 A fuse. (Rated at 600 V rms).

(3) Load resistor selected according to section 6.3.3.5.3.

(4) Test leads to connect the fuse and resistor in series between ground and the console supply conductor.

(5) Ammeter.

6.3.3.4 Setup

(1) Place shorting bars in all the meter-under-test positions.

(2) Plug a long wire with a banana plug at one end into the ground socket of any wall electrical outlet that has the same ground as the outlet that supplies the console. The banana plug may have to be splayed out to ensure it stays in the socket. The other end of the wire should reach the working area at the console.

6.3.3.5 Procedure

6.3.3.5.1
Consoles without automatic ground fault protection.

(1) Ensure the console is de-energized.

(2) Using the ohmmeter, with one lead connected to the system ground, check all the exposed metal panels, including screws, bolts, metal fasteners, switches, etc. All such exposed metal panels should be electrically connected to ground, ie: reading zero resistance.

(3) Energize the console to the highest test voltage and lowest test current used for verifying meters.

(4) Using the voltmeter with one lead connected to the system ground, check all the exposed metal panels, including screws, bolts, metal fasteners, switches, etc.

(5) Ensure that the voltage between the exposed panels and system ground is within the limits stated in section 6.3.3.1 of the Specifications.

(6) Record on the worksheet the maximum voltage measured in step 5) above.

6.3.3.5.2
Consoles with automatic ground fault protection consisting of a CSA approved ground fault interrupting (GFI) circuit breaker which has a test function, shall be tested using the test switch.

(1) Energize the console to the highest test voltage and lowest test current used for verifying meters.

(2) Activate the GFI test switch.

(3) If the GFI circuit breaker does not trip, the console shall not be certified until a functional GFI circuit breaker is installed.

6.3.3.5.3
Consoles with automatic ground fault protection consisting of a ground fault interrupting (GFI) circuit breaker which does not have a CSA approved test function, shall be tested to ensure that the breaker trips if the fault to ground exceeds 10 mA.

(1) Measure the line voltage which supplies the console.

(2) Using the supply voltage to ground as a reference, calculate the size of resistor required to create a line to ground current of 10 mA. For a console with a supply voltage of 120 volts rms, the resistor would be calculated as follows:

$$120\text{ V} \div 0.01\text{A} = 12{,}000 \text{ ohms}$$

Perform a test to demonstrate that the generated current is 10 ±1 mA. Connect a 0.5 A (600 V rated) fuse in series with the resistor during all tests.

(3) Ensure the console is de-energized at the circuit breaker which supplies the console.

(4) Connect the resistor between ground and one of the supply conductors at the console, using a 0.5 A fuse connected in series with the resistor. The fuse and resistor must both be rated for a voltage exceeding the console supply voltage

(5) Switch on the circuit breaker supplying the console.

(6) Energize the console to the highest test voltage and lowest test current used for verifying meters.

(7) If the GFI circuit breaker does not trip during steps 3) or 4), the console shall not be certified until a functional GFI circuit breaker is installed.

(8) Repeat steps 3) to 7) for each supply conductor (excluding ground) which enters the console.

6.3.3.6 Remarks

If any voltage is measured while performing the test of section 6.3.3.5 above, a second test should be performed with a low impedance moving coil type voltmeter to ensure that the voltage measured is not a floating\phantom voltage.

Complete the sections related to Grounding in the worksheets.

6.3.4 Isolation

6.3.4.1 Isolation From Ground

6.3.4.1.1 Scope

This procedure relates to section 6.3.4.1 of the Specifications. This procedure is intended to ensure that all of the live circuits of a calibration console are electrically isolated from ground.

6.3.4.1.2 General

This test is performed by measuring the leakage current between ground and all live terminals on a calibration console. The console is energized to full voltage and current during this test. Conformance of a calibration console to the isolation requirements reduces the risk of shock hazard to an operator during normal use of the console.

6.3.4.1.3 Apparatus

(1) Milliammeter capable of reading from 100 microamps to 1.0 amps.

(2) Voltmeter with a low input impedance such as an electrodynamometer or moving coil voltmeter. If this is device is unavailable, a digital electronic voltmeter may be used.

(3) Resistors as determined by the procedure in 6.3.4.1.5 below.

(4) Ohmmeter.

(5) Shorting bars for all the meter-under-test positions. The shorting bars must be of a type that will allow access to the current and voltage terminals to perform the test.

6.3.4.1.4 Setup

(1) If the console is to be used for testing single phase and polyphase meters then setup the console in the configuration used for polyphase socket meter connections.

(2) If the console is to be used for testing single phase meters only, then setup the console in the configuration used for single phase socket meter connections.

(3) Plug a long wire with a banana plug at one end into the ground socket of any wall electrical outlet that is at the same ground potential as the outlet that supplies the console. The banana plug may have to be splayed out to ensure that it stays in the socket. The other end of the wire should reach the working area at the console.

6.3.4.1.5 Procedure

(1) Ensure the console is de-energized.

(2) Using the ohmmeter, with one lead connected to the system ground, check all possible live voltage and current terminals. All terminals should be electrically isolated from ground, ie: reading infinite resistance.

(3) Place shorting bars in all meter-under test positions.

(4) Energize the console to its full operating voltage and full steady state current.

(5) Using the electromechanical voltmeter, with one lead connected to the system ground, check if there is any voltage between any of the live terminals and ground. The voltage measured between any live terminal and ground should be essentially zero. If this is the case, proceed to step 6). If there is a measurable voltage between any live terminal and ground, then a high leakage current may be present and step 6) must not be carried out: proceed with steps 12) to 17) instead.

(6) Select the highest current range on the milliammeter and connect one lead to the system ground wire. Take measurements at all live terminals to determine if there is any leakage current from the terminal to ground. If there is no measurable current with the milliammeter set to its highest current range, reduce the range until a current measurement can be read.

(7) De-energize the console, record the results in the Isolation section of the worksheets.

(8) Energize the console to it's full operating voltage and the lowest test current used for verifying meters. Where loading transformers are used and manually selected, this test shall be performed using the highest voltage tap for the loading transformer to provide the lowest test current.

(9) Repeat steps 5) to 7).

The following steps are to be performed if the console makes use of multiple potential transformers during normal single phase meter testing.

(10) Energize the console to the highest voltage to be used with the multiple potential transformers.

(11) Repeat steps 5) to 7) for all the multiple potential transformer terminals. If voltage was measured in step 5), perform steps 12) to 17).

(12) Record the voltage measured and determine a value for a test resistor based on the following formula:

$$R_{(\text{test resistor})} = V_{(\text{measured})} \div 0.002$$

(13) Ensure that the resistor is of sufficient wattage by applying the formula:

$$W = I^2 \times R$$

where, $I = 2$ mA, and
R = the test resistor value calculated in step 12) above

(14) De-energize the console, and apply the resistor between ground and the test terminal. Re-energize the console and measure the voltage across the resistor. If the measured voltage is still present, the console is considered to be improperly isolated and no further tests should be performed.

(15) If the voltage has dropped to a lesser value than initially measured, de-energize the console and install the ammeter in series with the resistor.

(16) Measure the current flow through the resistor. If the current is 1 mA or greater, the console is considered to be improperly isolated. If the current is less than 1 mA, and the voltage level is greater than 30 V rms the console is considered to be improperly isolated.

(17) De-energize the console and remove the resistor.

6.3.4.1.6 Remarks

No further testing or calibration shall be performed on a console that fails the requirements of section 6.3.4.1.5.

6.3.4.2 Isolation of Secondary Circuits From Primary Circuits

6.3.4.2.1 Scope

This procedure relates to section 6.3.4.2 of the Specifications. It will determine if the primary supply circuits are isolated from the secondary supply circuits of calibration consoles. This procedure applies to calibration consoles that use transformers to provide phantom loading of voltage and current metering circuits.

6.3.4.2.2 General

This test is performed by measuring the voltage between the voltage supply circuits to the console and the secondary voltage and current circuits of the console. If no voltage is measured, the calibration console is deemed to have the primary supply circuits isolated from the secondary metering circuits and meets the requirements of the specifications.

6.3.4.2.3 Apparatus

(1) Voltmeter with a low input impedance such as an electrodynamometer or moving coil voltmeter. An electronic voltmeter is unsuitable for this application as it will register floating/phantom voltages.

(2) If the console is used for testing single phase and polyphase meters then polyphase meters are required for each meter-under-test-position. If the console is to be used for testing single phase meters only then single phase meters are required for each meter-under-test position.

(3) Long leads need to be used for making connections to the voltmeter from the primary supply to the test console metering circuits.

6.3.4.2.4 Setup

(1) The calibration console schematic drawings should be reviewed prior to attempting this procedure to determine safe access to the appropriate voltage connections and switches.

(2) Panels may need to be removed from the back of the calibration console or the supply switch opened to access the voltage terminals.

(3) If the console is used for testing single phase and polyphase meters then setup the console in the configuration used for polyphase meter connections.

(4) If the console is to be used for testing single phase meters only then setup the console in the configuration used for single phase meter connections.

(5) Set the current selector switch or console configuration to enable current to flow in series with the current coils of the meters installed in the meter-under-test-positions.

6.3.4.2.5 Procedure

(1) Ensure the proper safety equipment is used for performing this test. Rubber gloves and safety glasses need to be used when obtaining any voltage readings.

(2) Set the voltmeter to the highest voltage range setting.

(3) Measure the voltage from each phase to ground and each phase to phase of the calibration supply to determine its correct configuration.

(4) If the calibration console supply configuration is 3 ϕ 3 wire delta verify that each phase is not grounded. If one of the phases is found to be grounded stop any further testing until the safety hazard is corrected.

(5) Place meters in all meter-under-test-positions.

(6) Connect one lead of the electromechanical voltmeter to one phase of either the 3 ϕ 3 wire delta, 3 ϕ 3 wire network, 3 ϕ 4 wire wye or 1 ϕ 3 wire supply voltage (A phase).

(7) Connect the second lead of the electromechanical voltmeter to each of the different voltage and current terminals of the calibration console metering test circuits.

(8) Energize the console to the voltage rating and test current of the meters installed in the meter-under-test-positions.

(9) Verify that no voltage is present between the voltage supply and the live voltage and current terminals of the calibration console.

(10) Repeat the test for the other phases of the calibration console supply voltage.

(11) Repeat the test if the calibration console is equipped with multiple potential transformers. Connect and energize the multiple potential transformers in the metering test circuits and verify no voltage is present between the primary voltage supply and the secondary voltage terminals of the multiple potential transformers.

(12) Indicate on the worksheets if the calibration console primary supply circuits are isolated from the secondary test circuits.

6.3.4.2.6 Remarks

It may be convenient to combine the testing for the isolation from ground at the same time as verifying the primary supply circuits are isolated from the console metering test circuits, if all of the conditions of the isolation from ground procedure can be met.

6.3.5 Meter Mounting Arrangements

6.3.5.1 Scope

This procedure relates to section 6.3.5 of the Specifications which requires meter mounting arrangements to be within ± 3.0° of true level.

6.3.5.2 General

This procedure tests the levelness of a console and then tests the levelness of a meter socket installed on the console.

6.3.5.3 Apparatus

(1) 1.0° angle gauge block.

(2) digital inclinometer.

(3) meter base from any socket based meter (for calibration consoles with sockets only).

6.3.5.4 Inclinometer and Gauge Block

The inclinometer and gauge block will be supplied by the Calibration Services Laboratory of Measurement Canada. The gauge block is certified and serves as a traceable standard. The digital inclinometer serves as an indicator of the degree of levelness.

6.3.5.5 Meter Base from Any Socket Based Meter

From a meter base of any socket based meter, fashion a device which can be inserted into the calibration console sockets and which will present a surface upon which the digital inclinometer can be placed to determine both the side-to-side and the front-to-back level. This resting surface is to be representative of the disc of an intact meter when installed in the socket.

6.3.5.6 Setup

6.3.5.6.1
Locate a level surface. Establish that the surface is level by measuring its incline with the inclinometer. Turn the inclinometer 180° about its vertical axis and measure the incline again. The surface may be considered level if both readings are within ±1.5°.

6.3.5.6.2 Calibration of Inclinometer

(1) Place the 1.0° angle gauge block on the level surface with the inclinometer on top of it.

(2) Record the inclinometer indication.

(3) Rotate the gauge block 180° and place the inclinometer on top of the gauge block again.

(4) Record the inclinometer indication again. The errors of the inclinometer at ± 1.0° have now been established.

6.3.5.7 Procedure

6.3.5.7.1 Calibration of Socket Level

(1) Ensure that the calibration console is de-energized.

(2) Place the device fashioned from the socket based meter base into the socket.

(3) Place the inclinometer on the device and measure the side-to-side and front-to-back slope.

(4) Determine if the socket is compliant with the requirements of the Specifications

(5) Repeat steps 1) through 4) for the other sockets.

6.3.5.7.2 Calibration of Bottom-Connected Meter Mounting Arrangements

Calibration is not required for socket adapters.

6.3.6 Operating Mode

6.3.6.1 Scope

This procedure relates to section 6.3.6 of the Specifications. It is intended to ensure that calibration consoles are capable of testing meters in a manner described in section 6.3.6 of the Specifications.

6.3.6.2 General

The requirement of section 6.3.6 of the Specifications ensures that meters can be verified with their current circuits connected in series and their voltage circuits connected in parallel. Some calibration consoles facilitate this mode of testing with provisions for physically making the appropriate connections. In this case all current circuits are energized from the same source and likewise, voltage circuits energized from the same source. Other consoles operate with independent isolated amplifier circuits to each coil of a meter under test. The independent amplifiers energize the coils of a meter under test, in a simulated "series/parallel" configuration. This procedure checks the proper functioning of both methods.

6.3.6.3 Apparatus

(1) Reference standard (Radian) capable of measuring power, voltage and current.

(2) Shorting bars for all but one of the meter-under-test positions.

(3) Test socket and leads.

6.3.6.4 Setup

No specific set up is required for this procedure since there are no provisions for testing meters in any manner other than series/parallel testing. The test console must operate in this manner, or simulate operation in this manner.

6.3.6.5 Procedure

(1) Review operating manuals or schematics if required, and determine whether,

(a) the console connects meter coils in true "series/parallel" configuration, or

(b) the console simulates "series/parallel" configuration.

(2) If the console connects meter coils in true "series/parallel" configuration no further testing is required.

(3) If the console simulates "series/parallel" configuration follow the steps outlined below to verify this feature.

4) Place shorting bars in all but one of the meter-under-test positions.

5) Place the test socket in one meter-under-test position.

6) Ensure that the console is operating in simulated series/parallel mode by enabling that function.

(7) Set up the console for testing a three-element meter, with the voltage set to the highest test voltage used for testing meters, and the current set to the highest test current used for testing meters. (If the highest test current used for testing meters is greater than 50 amps, then use 50 amps for this test.) If the console does not use all three elements for meter testing, then the unused elements need not be tested here. ie: A console used only for testing single phase meters need only have the left and right elements tested, the middle element may be excluded from this test.

(8) Using the appropriate leads, connect the Radian standard to the "Left" current circuit of the test console, and to the "Left" voltage circuit of the test console. Ensure that all of the other current circuits are shorted at the test socket.

(9) Set the Radian standard to measure voltage, and energize the meter-under-test position. Record the voltage. Set the Radian standard to measure current and record the current.

(10) Repeat step 9) for each of the voltage circuits and each of the current circuits. This step can easily be combined with the following steps.

(11) Set the Radian standard to measure "watts". Set the console for a "Series, 0.5 Power factor" test and energize the meter-under-test position. Record the watt reading, and then de-energize the meter-under-test position.

(12) Leaving the current circuit as it is, connect the Radian standard to the "Middle" voltage circuit of the calibration console and repeat step 11).

(13) Leaving the current circuit as it is, connect the Radian standard to the "Right" voltage circuit of the test console and repeat step 11).

(14) Connect the Radian Standard to the "Middle" current circuit of the test console, and to the "Left" voltage circuit of the test console. Ensure all of the other current circuits are shorted at the test socket.

(15) Repeat steps 11) to 13).

(16) Connect the Radian Standard to the "Right" current circuit of the test console, and to the "Left" voltage circuit of the test console. Ensure that all of the other current circuits are shorted at the test socket.

(17) Repeat steps 11) to 13).

6.3.6.6 Remarks

The watt, voltage, and current readings must be within the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

The spread of the watt, voltage, and current readings between the elements must also be within the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

In the Operating Mode section of the worksheets record if the console is capable of series-parallel testing, or if it simulates series-parallel testing, or if it does not satisfy the requirements of series-parallel testing in either manner.

6.3.7 Individual Elements

6.3.7.1 Scope

This procedure relates to section 6.3.7 of the Specifications. The purpose of this procedure is to ensure that all calibration consoles are capable of testing individual elements of meters.

6.3.7.2 General

Calibration consoles are required to be able to test individual elements of meters. This test is performed on meters in order to determine if there is a balance between the errors of individual elements.

When evaluating a console for individual element test capabilities, it is important that the test load applied to each element from the console be the same. In the case of manual consoles, this is not an issue since the operator sets all loads. Manual consoles that have all of the individual elements marked on control switches will be assessed for their correct identification and use. A semi-automatic or fully automatic console, however, must be evaluated to ensure that loads are applied consistently. A console is evaluated by setting the load to the highest current test point or 50 amps whichever is lower, and the lowest current test point used for verifying meters.

6.3.7.3 Apparatus

(1) Three ammeters, (or one Radian standard) each with accuracies of ±0.5%, which are capable measuring the highest current test point or 50 amps whichever is lower, and the lowest current test point used for verifying meters.

(2) Socket adaptor and leads to be used in the meter-under-test position.

6.3.7.4 Setup

(1) Connect the test socket adaptor in the meter-under-test position.

(2) If a clip-on ammeter is used, connect the current leads in the test socket from the top current connections to the bottom current connections. This will ensure series operation and facilitate insertion of the clip-on ammeter.

(3) If a clip-on ammeter is not used, proceed to the next step.

(4) Connect the current leads from the "Left, Right and Middle" current circuits of the test socket to the ammeters or Radian standard ammeter

(5) If the console is to be certified for meters which do not use the middle current circuit, the ammeter does not have to be connected in this position.

(6) Place shorting bars in the remaining meter-under-test-positions to allow testing in series.

6.3.7.5 Procedure

6.3.7.5.1 Non-manual operating consoles

(1) Connect the ammeters as described in the test setup section 6.3.7.4 above.

(2) Energize the console and set the current to operate on the "Left" current element at the highest current test point used for verifying meters or to a maximum of 50 amps whichever is lower. This initial setting will be set by the operator and cannot be changed or adjusted for semiautomatic consoles.

(3) Record the value of the current in the worksheet for the "Left" current element. If using a clip on ammeter, clip on the left current element and record the value on the worksheet. Clip on the other elements to ensure there is no current flowing in the other elements.

(4) Switch the highest current as established in step 2) to the "Right" current element using the correct switching operation procedures for the test console.

(5) Record the value of the current in the worksheet for the "Right" current element. If using a clip on ammeter, clip on the right current element and record the value on the worksheet. Clip on the other current elements to ensure there is no current flowing in the other elements.

(6) Switch the highest current as established in step 2) to the "Middle" current element if this element is used for verifying meters.

(7) Record the value of the current in the worksheet for the "Middle" current element. If using a clip on ammeter, clip on the middle current element and record the value on the worksheet. Clip on the other current elements to ensure there is no current flowing in the other elements.

(8) Switch the highest current as established in step 2) for series operation using the correct switching operation procedures for the test console.

NOTE: If using a Radian standard ammeter with the inner, outer and middle connected to each tap, do not apply a current that will exceed the rating of the standard when all three taps are used.

(9) Record the value of the current in the worksheet for the total series current divided by the number of elements measured. If using a clip on ammeter, clip on each current element and record, the average of the elements measured on the worksheet.

(10) Repeat steps 2) to 9) substituting the lowest current test point used for verifying meters, for the highest current test point and record these values on the worksheet.

(11) Record on the worksheets whether regulators were "on" or "off" during this test.

6.3.7.5.2 Manual Operating Consoles

(1) Connect the ammeters as described in the test setup section 6.3.7.4 above.

(2) Energize the console and set the current to operate on the "Left" current element at a convenient current test point used for verifying meters.

(3) If using a clip on ammeter, clip on the left current element. Clip on the other elements to ensure there is no current flowing in the other elements.

(4) Switch the current as established in step 2) to all of the other appropriate current elements using the correct switching operation procedures for the test console. When switching the current to the other elements determine that the switches are correctly labelled and the console is capable of individual element testing.

6.3.7.6 Remarks

The difference between the values of the current recorded on the individual current elements and the series current element values measured are not to be greater than 2.0 percent of the nominal current setting. If this tolerance is not met then the console may be certified to be used as a manual console only.

6.4 Procedures For Assessing Electrical Requirements

6.4.1 Creep Switch

6.4.1.1 Scope

This procedure relates to section 6.4.1 of the Specifications. It is intended to verify conformance of creep switches to the tolerances set out in the Specifications.

6.4.1.2 General

Most calibration consoles are equipped with a creep switch in order to reduce the current supplied to the meter-under-test (MUT) positions to zero. In some circumstances the current is not entirely reduced to zero. This procedure determines if there is an unacceptable amount of current passing through the MUT positions while the creep switch is engaged. If the switch does not function to the requirements of the specification, the console certificate will indicate that the creep switch is not to be used. An alternate method to determine if a meter creeps may be established.

A watt hour standard is used to determine if any energy can be registered while the creep switch is engaged. Registration outside of the limits established in the Specifications indicates that the creep switch is not functioning as required.

The calibration consoles shall have some sort of indication when the creep switch or other such device is activated.

6.4.1.3 Apparatus

(1) Certified watt hour standard.

(2) Shorting bars for use with multi-position calibration consoles

(3) Socket adaptor and leads to be used in the meter-under-test position.

6.4.1.4 Setup

(1) Connect the voltage and current inputs of the watt hour standard to a meter-under-test position on a console. Use a socket adapter if necessary.

(2) Install shorting bars in all other meter-under-test positions.

(3) Apply the test voltage to each meter-under-test-position.

6.4.1.5 Procedure

(1) Connect the watt hour standard as described in the test setup above.

(2) Set the console for series current operation and connect the load voltage as described in the test setup above.

(3) Energize the console and set the voltage to the highest voltage used for verifying meters.

(4) Set the current to the lowest current value used for verifying meters.

(5) Enable the creep switch to reduce the current supplied to the meter-under-test position to zero.

(6) Verify that a status indicator of an acceptable type (eg. indicating light, on-screen indication, or current working instument reduces to zero, etc.) shows that the creep switch is active.

(7) Record any watt hour energy registration indicated on the standard during a fifteen minute interval.

(8) Calculate the allowable energy registration using the formula provided in 6.4.1.7.1 below.

(9) Complete the worksheets related to this procedure.

6.4.1.6 Remarks

If the watt hour standard reads zero energy after 5 minutes the creep switch will be deemed to have met the requirements of the specification and this can be entered on the worksheets.

6.4.1.7.1 Formulae

$W.h_{max} = 0.1\% \cdot (volt_{max}) \cdot (current_{min}) \cdot 15 \div 60$

Where:
$W.h_{max}$ is the maximum allowable energy that can be recorded by the watt hour standard in a fifteen minute period with the creep switch enabled.

$volt_{max}$ is the maximum voltage used for verifying meters.

$current_{min}$ is the minimum current used for verifying meters.

Example:

Let, $volt_{max}$ = 600 volts
$Current_{min}$ = 0.1 amps

Then $W.h_{max} = 0.001 \cdot 600 \cdot 0.10 \cdot 15 \div 60$
$= 0.015$ watt hours

6.4.2 Maximum Test Voltages and Currents

6.4.2.1 Scope

This procedure relates to section 6.4.2 of the Specifications. It determines whether a calibration console is capable of continuously supplying voltages and currents required to verify the meters.

6.4.2.2 General

This test involves energizing the console at required voltages and current for a period of time and monitoring the condition of the console during the test period.

6.4.2.3 Apparatus

(1) Shorting bars for all meter-under-test positions.

(2) Meters and/or coils having burdens equivalent to the meter having the highest rated voltage burden.

(3) Meters and/or coils having burdens equivalent to the meter having the highest rated current burden.

6.4.2.4 Setup

(1) Install meters and/or coils having burdens equivalent to the meter having the highest rated voltage in each meter-under-test position.

6.4.2.5 Procedure

(1) Energize the console at the maximum voltage used for verifying meters.

(2) Set the load current to the maximum value that would be used to verify the highest voltage rated meter.

(3) Monitor the voltage and current levels for a period equivalent to the maximum time required to perform a verification test on a meter being verified at the set load.

(4) De-energize the console and remove the meters and or coils.

(5) Install meters and/or coils having burdens equivalent to the meter having the highest rated current.

(6) Energize the console at the largest load current used for verifying meters. Set the voltage at the voltage rating of the meter that has the largest current rating.

(7) Monitor the voltage and current levels for a period equivalent to the maximum time required to perform a verification test on a meter being verified at the set load.

6.4.2.6 Remarks

If the loads being monitored in steps 3) and 7) are not maintained or if the console shows signs of overheating or undue stress, it can be considered to have not met the requirements of section 6.4.2 of the specifications.

6.4.3 Indicating instruments

6.4.3.1 Scope

This procedure relates to sections 6.4.3 of the Specifications. The purpose of this procedure is to verify that the indicating instruments of a calibration console have a precision that is within the limits indicated in section 6.4.3.2, Table 1, of the Specifications. The indicating instruments are required to indicate all voltages, currents, phase angles and loads necessary to verify all meters to be calibrated on the console.

6.4.3.2 General

This test is conducted by measuring voltages, currents, phase angles and loads at a meter-under-test position with a standard and, comparing with the results of the calibration console indicating instruments. The console shall be equipped with a voltmeter, ammeter, and phase angle or power factor indicating meter. Consoles used for watt or watthour testing shall be equipped with a wattmeter. Consoles used for va or va hour testing shall be equipped with a volt ampere power meter (rms or average as required). Consoles used for var meter testing shall be equipped with a var power meter. Indicating instruments that require a multiplier to be applied to their reading in order to obtain a true value, are acceptable. If a console is equipped with two instruments which can measure the same quantity, both instruments shall be tested for precision within their maximum range. The requirements for indicating instruments may be satisfied by calibration console reference meters as stated in 6.4.3.5 of the specifications. All indicating instruments should be readily accessible and easily viewed by the operator while setting loads.

6.4.3.3 Apparatus

(1) Two standards each capable of measuring wh, vah, varh, voltage rms, current rms, and any other quantities required to be monitored while testing meters the console is used to verify.

(2) A test socket adapter.

(3) Wires of proper size, insulation, and length.

(4) Two coaxial cables with BNC connectors and a T connector.

(5) A stop/start switch for the standards.

(6) Voltage or current transformers of appropriate ratio if needed.

6.4.3.4 Setup

6.4.3.4.1 Voltmeter, Ammeter, and Power Meter Setup

(1) Plug the test socket adapter in a meter-under-test position. Using two leads, connect the voltage input of a standard to the test socket binding posts. (see remark: 6.4.3.6.1)

(2) In the same meter-under test position, connect the current circuit of the standard in series with the test socket. (see remark: 6.4.3.6.2)

(3) Install jumpers or meters of appropriate current rating in the remaining meter-under-test positions.

6.4.3.4.2 Phase Angle Meter Setup

(1) Plug the test socket adapter in a meter-under-test position and connect the current coils of two standards in series with the test socket.

(2) Connect the voltages coils of the two standards in parallel with the voltage output at the test socket.

(3) Using the coaxial cables, connect the input resets of the two standards in parallel with a T-adapter, and connect the stop/start switch. (see remarks: 6.4.3.6.1 and 6.4.3.6.2)

6.4.3.5 Procedure

A list of target test points for this procedure is provided under section 6.4.3.7. Any target test points that exceed the range of test points used for verifying meters, are not required to be evaluated.

Tolerances for indicating instruments may be found in Table 1 of section 6.4.3.2 of the Specifications.

Test results shall be recorded with two digits of resolution after the decimal point, unless this is not practical (regulators may be enabled to obtain stable readings).

When testing a manual or semi-automatic consoles, the operator sets the loads using the normal operating procedure for the console. With fully automatic consoles, the operator inputs the required load values and the console sets the load automatically.

All consoles are required to be verified for volts, amps, and phase angle. Tests for power meters are required for each power quantity that is used for verifying meters on the console.

Before performing the tests calculate the target quantities using the information provided in sections 6.4.3.7.2 to 6.4.3.7.5 and record the target values on worksheets.

6.4.3.5.1 Voltmeter test

(1) Select 'volts (rms)' on the console and the standard

(2) Energize the voltage circuit of the console.

(3) Set the target test voltage on the console pursuant to Table 2, in section 6.4.3.8.

(4) Read the true voltage on the standard and record readings of the standard and the console on the voltmeter calibration worksheet.

(5) Repeat steps 3) & 4) for all required test voltages pursuant to Table 2, in section 6.4.3.8.

6.4.3.5.2 Ammeter Test

(1) Select 'amps (rms)' on the console and the standard

(2) Energize the current circuit of the console.

(3) Set the target test current on the console pursuant to Table 3, in section 6.4.3.9

(4) Read the true current on the standard and record readings of the standard and the console on the ammeter calibration worksheet.

(5) Repeat steps 3) & 4) for all required test currents pursuant to Table 3, in section 6.4.3.9.

6.4.3.5.3 Power Meter Test. (Watt meter) (N/A where power standard is used to setup loads)

(1) Select 'watt' on the console and the standard.

(2) Energize current and voltage circuits.

(3) Set the test current, voltage, phase angle, and target power on the console as determined from Table 4 in section 6.4.3.10.

(4) Read the true power on the standard and record readings of the standard and the console on the wattmeter calibration worksheet.

(5) Repeat steps 3) & 4) for all required loads as determined from Table 4 in section 6.4.3.10.

6.4.3.5.4 Power Meter Test (Var meter) (N/A where power standard is used to setup loads)

(1) Select 'var' on the console and the standard

(2) Energize current and voltage circuits

(3) Set the current, voltage, phase angle, and target power on the console as determined from Table 4 in section 6.4.3.10.

(4) Read the true power on the standard and record readings of the standard and the console on the varmeter calibration worksheet.

(5) Repeat steps 3) & 4) for all required loads as determined from Table 4 in section 6.4.3.10.

6.4.3.5.5 Power Meter Test (VA(rms) meter) (N/A where power standard is used to setup loads)

1) Select 'VA(rms)' on the console and the standard.

2) Energize current and voltage circuits.

(3) Set the current, voltage, phase angle, and the target power on the console as determined from Table 4 in section 6.4.3.10.

(4) Read the true power on the standard and record readings of the standard and the console on the va meter calibration worksheet.

(5) Repeat steps 3) & 4) for all required loads as determined from Table 4 in section 6.4.3.10.

6.4.3.5.6 Power Meter Test (VA(average) meter) (N/A where power standard is used to setup loads)

(1) Select 'VA(average)' on the console and the standard.

(2) Energize current and voltage circuits.

(3) Set the first current, voltage, phase angle, and target power as determined from Table 4 in section 6.4.3.10.

(4) Read the true power on the standard and record readings of the standard and the console on the va meter calibration worksheet.

(5) Repeat steps 3) & 4) for all required loads as determined from Table 4 in section 6.4.3.10.

6.4.3.5.7 Phase Angle Meter (Refer to 8.2 for test set up)

NOTE: When testing with current lagging by 0°, - 30°, or - 60°, set the display of one standard to wh and the other to vah.

(1) Energize current and voltage circuits

(2) Set the first current, voltage, phase angle, and power meter as determined from Table 5 in section 6.4.3.11

(3) Start both standards and let them register for 10 seconds.

(4) Read the standards displays and the phase angle meter or the power factor indicator of the console.

(5) To calculate the angle, refer to section 6.4.3.7 and record the results on the phase angle worksheet.

(6) Repeat steps (3) & (4) for all required phase angles as determined from Table 5 in section 6.4.3.11.

6.4.3.6 Remarks

6.4.3.6.1
The preferred location for connecting the voltage leads is at the test socket voltage binding posts. An alternative to this is to connect the voltage leads to the voltage binding posts of this position on the console panel. Late model consoles may not have voltage binding posts on the console panel in which case a test socket with voltage binding posts must be used.

6.4.3.6.2
If the test current exceeds the maximum rated input of a single current standard current coil, the input and output current leads can be connected to two or three parallelled input current coils on the standard (e.g. Radian standards). This will allow the standard to measure higher currents without the use of external current transformers.

6.4.3.7 Formulae

(1) Calculate the true phase angle from the readings of the two Standards with current lagging voltage by 0°, - 30°, or - 60° as follows:

Phase angle = $\cos^{-1}$ (Wh/VAh)

(2) Examples of Phase Angle Error Calculations

Example 1:

The target phase angle is 60 degrees
The Pf indicated on the console is 0.49242
The calculated (true) Pf using reference standards is 0.49546

% error = (Indicated - True) / True · 100
= ((cos A - cos B) / cos B) · 100
% error = ((0.49242 - 0.49546) / 0.49546) · 100
= 0.61 %

Example 2:

The target phase angle is 60 degrees
The phase angle indicated on the console is 60.5 degrees
The calculated (true) phase angle using reference standards is 60.3 degrees

Angular error = Indicated - True = 60.5° - 60.3° = 0.2°

6.4.3.8 Target Test Points for Voltmeter Tests

Table 2 below, identifies the test points for evaluating console volt meters.

Table 2

Volts (rms)	
Parallel	Multiple
120	120
240	240
360	
480	
600	

6.4.3.9 Target Test Points for Ammeter Tests

Table 3 below, identifies the test points for evaluating console ammeters.

Table 3

Current (rms)
0.25
0.5
2.5
5.0
10.0
25.0
50.0
100.0
150.0

6.4.3.10 Target Test Points for Watt, Volt Ampere, and Vvar Meter Tests (N/A where power standard is used to setup loads)

Table 4 below, identifies the test points for evaluating console watt, volt ampere, and var meters.

Table 4

Watt, Volt ampere, and Var meter Test Points					
Current (amps)	**Voltage** (volts)				
	120	240	360	480	600
0.25	a	a	a	a	a
0.5	a	a	n/a	n/a	n/a
2.5	b	ab	b	b	b
5.0	b	a	n/a	n/a	n/a
25.0	b	a	n/a	n/a	n/a
50.0	b	a	n/a	n/a	n/a
100.0	b	ab	b	b	b
Watt meters	a: 1.0Pf b: 0.5Pf n/a: not applicable				
Volt ampere meters	a: 1.0 Pf b: 0.5 Pf n/a: not applicable				
Var meters	a: 0.5 Pf b: 0.866 Pf n/a: not applicable				

6.4.3.11 Target Test Points for Phase Angle Meter Tests

Table 5

Phase angle meter test points		
Current(amps)	**Voltage** (volts)	
	120	600
2.5	abcd	abcd
50	abcd	abcd
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: 0.866Pf d: 0.0 Pf	

6.4.4 Accuracy and Repeatability of Calibration Consoles

6.4.4.1 Scope

This procedure relates to section 6.4.4 of the Specifications. The test conducted in this procedure applies to fully automatic and semi-automatic calibration consoles. The intent of this test is to ensure that such consoles set and reset loads within the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

6.4.4.2 General

In order to ensure consistency in electricity meter testing, fully automatic and semi-automatic consoles are required to be tested to ensure that they can set and reset loads with accuracy and repeatability.

In this procedure the console is energized to the test load determined pursuant to the requirements of section 7.1.4 of the Specifications. The voltage, current, power and phase angle are measured at a meter-under-test position and compared to the values set in the console testpoints.

The console is then set and reset, without adjusting the load, three successive times and the resulting voltage, current, power, and phase angle is measured after each resetting of the load.

6.4.4.3 Apparatus

(1) One reference standard (Radian) capable of measuring voltage, current and power, (watts).

(2) One reference standard (Radian) capable of measuring apparent power, (VA rms)

(3) Shorting bars for all but one of the meter-under-test positions.

(4) Test socket and leads

6.4.4.4 Setup

(1) Place Shorting bars in all but one of the meter-under-test positions.

(2) Place the test socket in one meter-under-test position.

(3) Using the appropriate leads, connect the Radian standards in series with the "Left" current circuit of the test console, and in parallel with the "Left" voltage circuit of the test console. Ensure that each of the other two current circuits are shorted at the test socket.

6.4.4.5 Procedure

(1) Energize the console to the test load determined pursuant to section 7.1.4 of the Specifications.

(2) For semi-automatic consoles, manually adjust any variacs or rheostats to obtain as close as possible, the expected voltage, current, power and phase angle.

(3) For fully automatic consoles, record the resulting voltage, current, power and phase angle on the Repeatability of Load Setting section of the worksheets. The measured values should not differ from the expected results by more than the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

NOTE: Do not make any manual adjustments while conducting procedural steps 4) to 6) below.

(4) De-energize the console according to the normal operating procedure for the console; (ie. Activate the "stop" or "reset" switches).

(5) Re-energize the console according to the normal operating procedure for the console; (ie. Activate the "start" or "test" switches). Record the resulting voltage, current, power and phase angle on the Repeatability of Load Setting section of the worksheets.

(6) Repeat steps 4) and 5) two more times.

All of the measured values should be within the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

6.4.4.6 Remarks

Calibration consoles that do not meet the requirements of this test may be certified for use as a manual console only. Manual consoles are also required to be able to set voltages, currents, and phase angles within the tolerances specified in Table 1 of section 6.4.3.2 of the Specifications.

6.4.4.7 Formulae

Phase angle = cosine $^{-1}$ (watts / va (rms)).

6.4.5 Calibration Console Energy and Demand Reference Meters

6.4.5.1 Scope

This procedure relates to sections 6.4.5, 6.4.6 and 6.4.7 of the Specifications. The purpose of this procedure is to ensure that calibration console reference meters, (Demand and Energy) meet the requirements of the Specifications as outlined in section 6.4.5, 6.4.6 and 6.4.7.

6.4.5.2 General

In order to reduce uncertainties when verifying energy meters, calibration console energy reference meters are calibrated by counting pulses ten times greater than pulses counted when verifying meters. Calibration consoles that automatically calculate and display errors are required to display the errors to a resolution of two significant digits to the right of the decimal point when the console is being calibrated. When the console is used for verifying meters only one significant digit to the right of the decimal is required.

A demand reference meter is required for verification of electromechanical demand meters and electronic block interval meters which cannot be verified using energy test methods. The demand reference meter can be a high accuracy power meter. This demand/power meter is required to display a minimum number of significant digits as specified in section 6.4.7.1 of the Specifications.

It is recommended that all available information relating to the reference meters be reviewed in order to determine the correct use of the reference meters on the console. The reference meters required for use with a console can be determined by reviewing the meters the console is used for verifying.

6.4.5.3 Procedure

(1) Review the electrical quantities used for verifying meters and determine the electrical quantities the energy reference meter(s) and demand reference meter(s) will be required to measure for use on the console.

(2) Enter the information in the required worksheet indicating the type of energy reference meter(s) required. (e.g. watthour, volt ampere hour (rms), volt ampere hour (average), var hour or other).

(3) Enter the information in the required worksheet indicating the type of demand reference meter(s) required. (e.g. watt, volt ampere (rms), volt ampere (average), var or other).

NOTE: If the console is used for testing block interval demand meters only and a control circuit is used for testing the demand meters, then demand reference meters are not required as per section 6.4.9 of the specification.

(4) Enter in the required worksheet the pulse output value for the energy reference meter(s) and also indicate on the worksheet if this meets the specifications.

(5) Enter in the required worksheet the number of significant digits of the test errors displayed by the console if the console automatically displays test errors. Note on the worksheet if the console will not automatically display the meter-under-test errors.

(6) Enter in the required worksheet the significant digits of the demand reference meter(s) and also indicate on the worksheet if this meets the specifications.

(7) Enter in the worksheets the number of meter-under-test positions that are equipped with the control circuits for verifying demand meters using energy test methods.

6.4.6 Control Circuits for Energy and Demand Meters

6.4.6.1 Scope

This procedure relates to sections 6.4.8 and 6.4.9 of the Specifications. The purpose of this procedure is to ensure that calibration console energy and demand control circuits meet the requirements of sections 6.4.8 and 6.4.9 of the specifications.

6.4.6.2 General

Calibration consoles are required to have at least one meter-under-test position that has a control circuit which will automatically count successive disk revolutions of an electromechanical meter or, pulses emitted by an electronic meter, without error If a console does not have at least one such meter-under-test-position, it must automatically determine and display the meter-under-test errors. If a console does not have provision for either test method, it cannot be certified for testing these types of meters.

If a calibration console is equipped with a demand control circuit (eg. GE VIM Controller) for testing block interval demand meters. The system must be capable of starting and stopping the accumulation of energy by the energy reference meter simultaneously with the starting and stopping of the demand interval of the meter under test.

The control circuit for demand testing allows electronic and hybrid block interval demand meters to be verified without the console meeting the regulation requirements of section 7.6 of the Specifications.

6.4.6.3 Apparatus

(1) Energy meters of similar ratings, required for every position equipped with optical light sensors.

6.4.6.4 Setup

Install energy meters in all the meter-under-test-positions to be certified that are equipped with optical light sensors designed to operate on the black mark of the meter disc, and/or creep holes, and/or LED pulses, and/or infra red pulses.

6.4.6.5 Procedure

(1) Energize the console to the full load test point of the meters installed.

(2) Set the optical light sensors to count.

(3) Count 10 revolutions of the meter disc or 10 pulses from an electronic type meter.

(4) Set the load to the light load test point and reset the optical light sensors if necessary and count two (2) revolutions or pulses as the case may be.

(5) Verify that the light sensors successfully counted the disc revolutions or pulses without error.

(6) Enter on the worksheet, whether the console automatically displays the meter-under-test errors and how many significant digits are displayed.

(7) Enter on the worksheet, the number of positions required to be certified, that are equipped with optical light sensors designed to operate on the black mark of an induction meter disc, and/or creep holes, and/or LED pulses, and/or infra red pulses.

(8) Enter on the worksheet, the number of positions to be certified for energy testing using control circuits.

(9) Enter on the worksheet, the number of positions equipped for counting meter pulses and displaying meter under test errors.

(10) Enter on the worksheet whether the console is equipped for counting reference meter pulses.

(11) Enter on the worksheet whether the console is to be certified for use with a demand control circuit using energy reference meter(s) and the number of positions to be certified.

(12) Enter on the worksheet the electrical energy units to be certified which make use of a demand control circuit.

6.4.6.6 Remarks

It may be convenient to combine the testing of steps 1) to 5) with the procedures for assessing the Statistical Calculation performed by the calibration console.

6.4.7 Statistical Calculations

6.4.7.1 Scope

This procedure relates to section 6.4.10 of the Specifications. The purpose of this procedure is to determine if the statistical formulae used by the console or associated computer, provide results for statistical calculations (standard deviation and average error) that are consistent with the applicable requirements of Measurement Canada approved sampling plans.

6.4.7.2 General

This procedure consists of testing a sample of meters on the console and then comparing the results of statistical calculation by the console with results calculated manually or by other means pursuant to the requirements of the approved statistical sampling plan for the verification or reverification of meters.

NOTE: If the statistical sampling program of the console or its associated computer fails to meet therequirements of an approved statistical sampling plan, the console can still be evaluated for certification for meter testing, however, it will not be certified for statistical calculation.

6.4.7.3 Apparatus

(1) A lot of at least 15 meters which can form a sample.

(2) A meter with a known error of more than 3%, to be part of the sample when testing the compliance sampling program.

6.4.7.4 Setup

Install meters of the sample on the console and energize them.

6.4.7.5 Procedure

6.4.7.5.1 Acceptance Sampling

(1) Set the console to a test load that would be used to test the installed meters.

(2) Initiate the routine to test the meters for acceptance sampling.

(3) Record on worksheets, the errors determined by the console for each meter installed in a meter-under-test position.

(4) Calculate the values for mean and standard deviation in accordance with the applicable acceptance sampling plan (eg. LMB-EG-04 Part 1 sect. 3.0).

(5) Compare the results of the statistical calculations from the console computer program with those calculated manually. The results should be identical.

6.4.7.5.2 Compliance sampling

(1) Put the meter which has an error of more than 3% in the sample.

(2) Set the console to a test load that would be used to test the installed meters.

(3) Initiate the routine to test the meters for compliance sampling.

(4) Record on worksheets, the errors determined by the console for each meter installed in a meter-under-test position.

(5) Calculate the values for mean and standard deviation in accordance with the applicable compliance sampling plan (eg. LMB-EG-04 Part 1 sect. 4.0).

(6) Compare the results of the statistical calculations from the console computer program with those calculated manually. The results should be identical.

6.4.7.6 Remarks

Some consoles do not display or print all error values, but only the final statistical results. If this is the case it may be necessary to evaluate the software program to ensure that appropriate formulae are used. The console owner may be requested to provide assistance when evaluating program software.

7.0 Procedures for Assessing Metrological Requirements

7.1 General Procedures For Assessing Metrological Requirements

7.1.1 General Test Setup

7.1.1.1 Scope

This procedure is not related to one specific section in the Specifications. It is intended to provide setup and procedural information that is common to most of the tests and procedures related to Metrological Requirements. Descriptions of physical connections are also provided.

7.1.1.2 General

The majority of the connections and test setups for the procedures related to metrological requirements have common elements. This section will describe the various connections to be made depending on test conditions, console type, and specified use.

7.1.1.2.1 Test Socket Connections

A test socket which provides terminals to take all applicable current and voltage measurements at the meter socket shall be used. Refer to Figure 1 below.

7.1.1.2.1.1

1:1 isolation CT's in Circuit

When 1:1 isolation transformers are used in the test circuit it is important that both current elements are connected to the standard in the meter-under-test position. The left current element must be measured on one tap of the standard and the right current element must be measured on another tap of the same standard. The middle current element is not used since 1:1 CT's are only used with single phase, self contained meters. When this setup is used it is important to note that the Kh setting or expected number of pulses, (which are calculated according to the Basic Procedure for Accuracy Tests (section 7.1.2)), must be doubled since the standard is measuring two times the test current.

The test may also be performed using two standards, with the left current element measured on one standard, and the right current element measured on the other standard. The test voltage is applied to both standards. One standard output is connected to one of the standard inputs on the RM-109, and the other standard output is connected to one of the other standard inputs on the RM-109. In this case the expected pulse count or Kh setting on the RM-109 remains as is calculated, however the RM-109 is set to "**AVERAGE**" both the inputs.

7.1.1.2.1.2

1:1 isolation CT's out of Circuit

If a console operates in true series-parallel testing and no 1:1 isolation CT's are in the test circuit, then only one current element connection to the standard is required. Since all the tests are performed with current elements in "series", any one current element must be connected to a tap of the standard in the meter-under-test position. The other two current elements must be shorted at the test socket.

Since 1:1 isolation CT's are not being used, the length of leads for the current connections is not restricted. However, they should not be any longer than is necessary to perform the test. Refer to Figures 2 and 3 below.

7.1.1.2.2 Burden Connections

For all tests the burden of the standard's current elements and associated connections are considered to approximate burden exhibited by a meter current coil. Therefore no additional burden is required for the current elements of the standard in the meter-under-test position. Refer to Figures 2, 4, and 6 below.

7.1.1.2.2.1 Single Phase Voltage Burdens and Connections

For all single phase tests that require a voltage burden to be connected in parallel with the test voltage, the burden (usually a potential coil) should be connected in parallel across the terminals of the test socket which are also supplying the test voltage to the standard in the meter-under-test position. Generally for single phase test points this will mean that the voltage is supplied across the top left and top right current terminals at the test socket. In this case the leads connecting the burden to the terminals should be as short as practicably possible.

7.1.1.2.2.2 Polyphase Voltage and Burden Connections

For all polyphase tests that require a voltage burden to be connected in parallel with the test voltage the burden, (usually two or three potential coils) should be connected in parallel across the terminals of the test socket which are also supplying the test voltage to the standard in the meter-under-test position. Generally for polyphase test points this will mean that the voltage is supplied across a set of potential pins in the socket. The length of the leads to the test burden is not restricted but should not be any longer than is necessary to perform the test.

7.1.1.2.3 Voltage Connections

All voltage connections for calibration testpoints should be made exactly as they would for a meter that may be installed and verified on the console at that test point. Generally when a polyphase testpoint is being performed the parallel voltage transformer, (if there is one) is used to supply voltage to the meter-under-test positions. Connections are made to supply voltage to the appropriate voltage pins at the socket. Generally when a single phase self contained meter testpoint is being performed, the multiple voltage transformers, (if there are any), are used to supply voltage to the meter-under-test positions. Connections are made to supply voltage to the appropriate pins, (or current lugs when 1:1 isolation transformers are used), at the socket.

Voltage connections to the standard in the meter-under-test position should be made from the applicable voltage terminal at the test socket.

7.1.1.2.4 Shorting Bars

In all instances where shorting bars are used in the meter-under-test positions, they must be connected so that the test current is applied to all the terminals of the meter-under-test positions.

7.1.1.2.5 Consoles which Operate in Simulated Series-parallel Mode

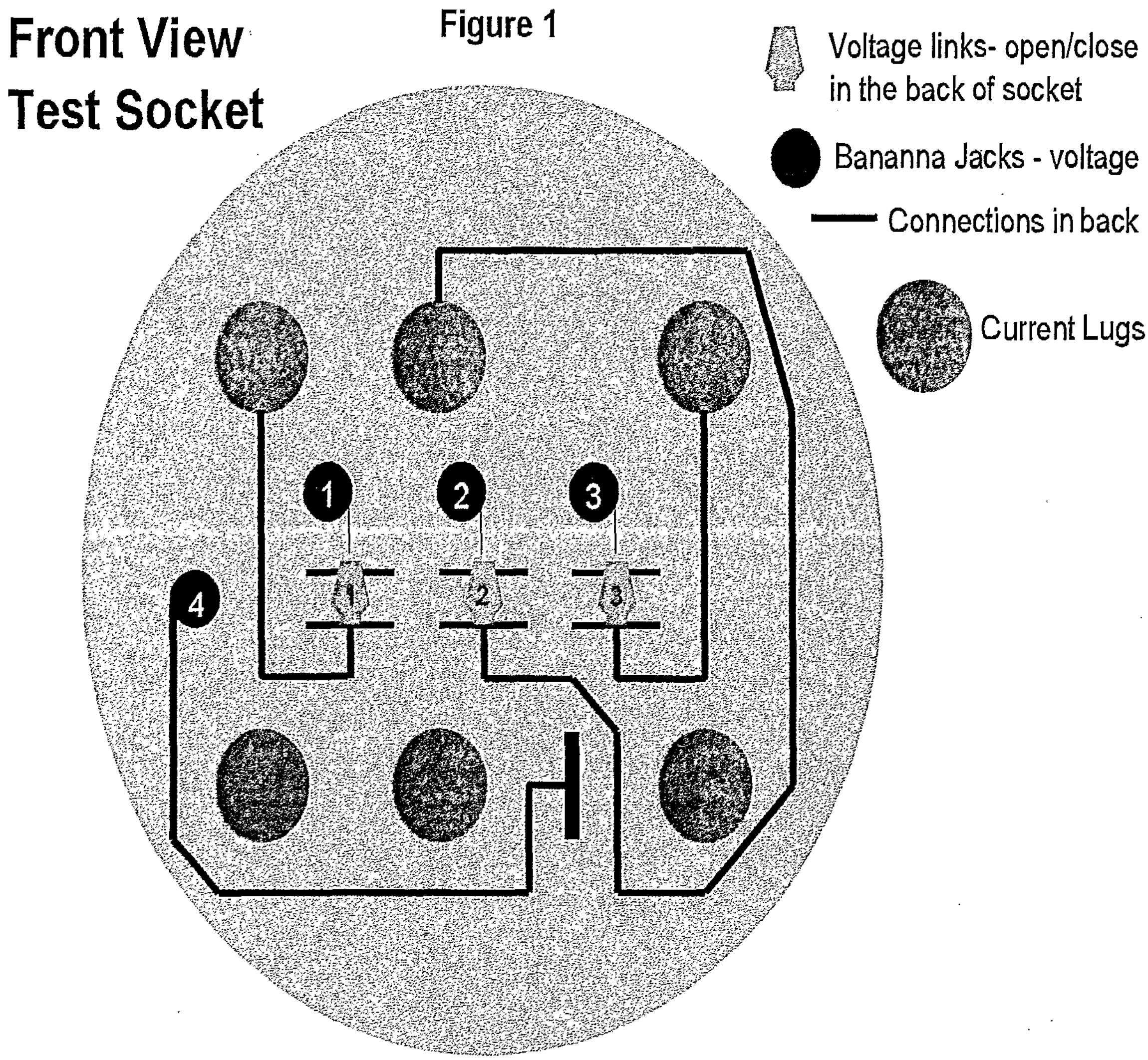
Consoles which operate in simulated series-parallel testing may not have exactly the same voltages, currents and phase angles on each phase. Therefore, if performing tests in "series" and using only one element for voltage and current, (as described in section 7.1.1.2.1.2), an inaccurate error may be displayed.

For single phase testpoints on this type of console, use the test setup described in section 7.1.1.2.1.1.

For polyphase testpoints on this type of console the number of standards required is the same as the number of elements being tested in "series". When performing a testpoint associated with a three element meter, three standards must be used. Each current element and it's associated voltage element will be connected in series-parallel with a standard. The outputs from the three standards in the meter-under-test position should be connected to the three standard inputs on the RM-109. Depending on the calculation used in the Basic Procedure for Accuracy Tests (section 7.1.2), the RM-109 will be set to "**AVERAGE**" or "**SUM**" the three inputs. Refer to Figures 6 and 7 below.

7.1.1.3 Figures (see next 7 pages)

Figure 1



Front View
Test Socket
Voltage links- open/close in the back of socket
Bananna Jacks - voltage
Connections in back
Current Lugs
1
2
3
4

Figure 2

Test socket connections for true series/parallel with no 1:1 CT's or multiple PT's

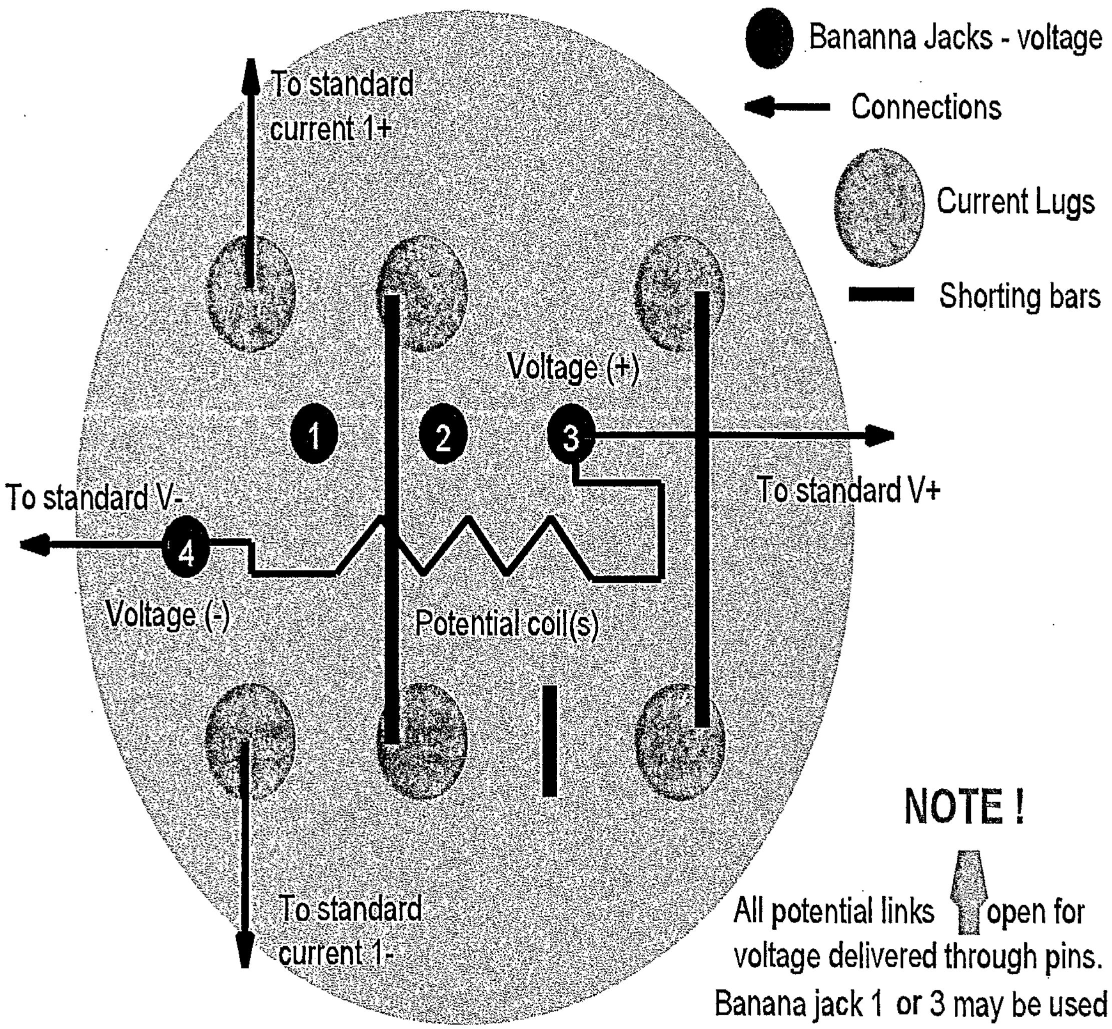


Figure 3

Standard connection for true series/parallel with no 1:1 CT's or multiple PT's

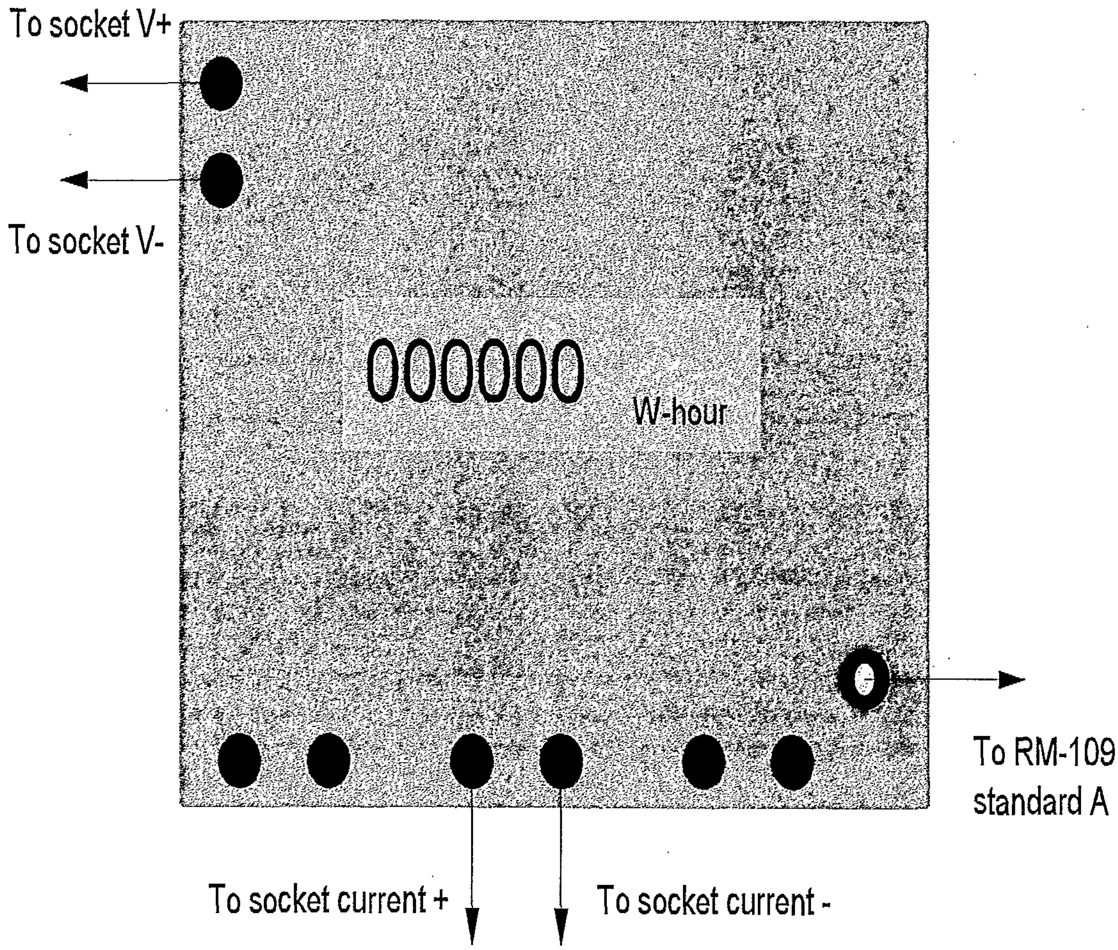


Figure 4

Test socket connections for true series/parallel using 1:1 CT's and/or multiple PT's

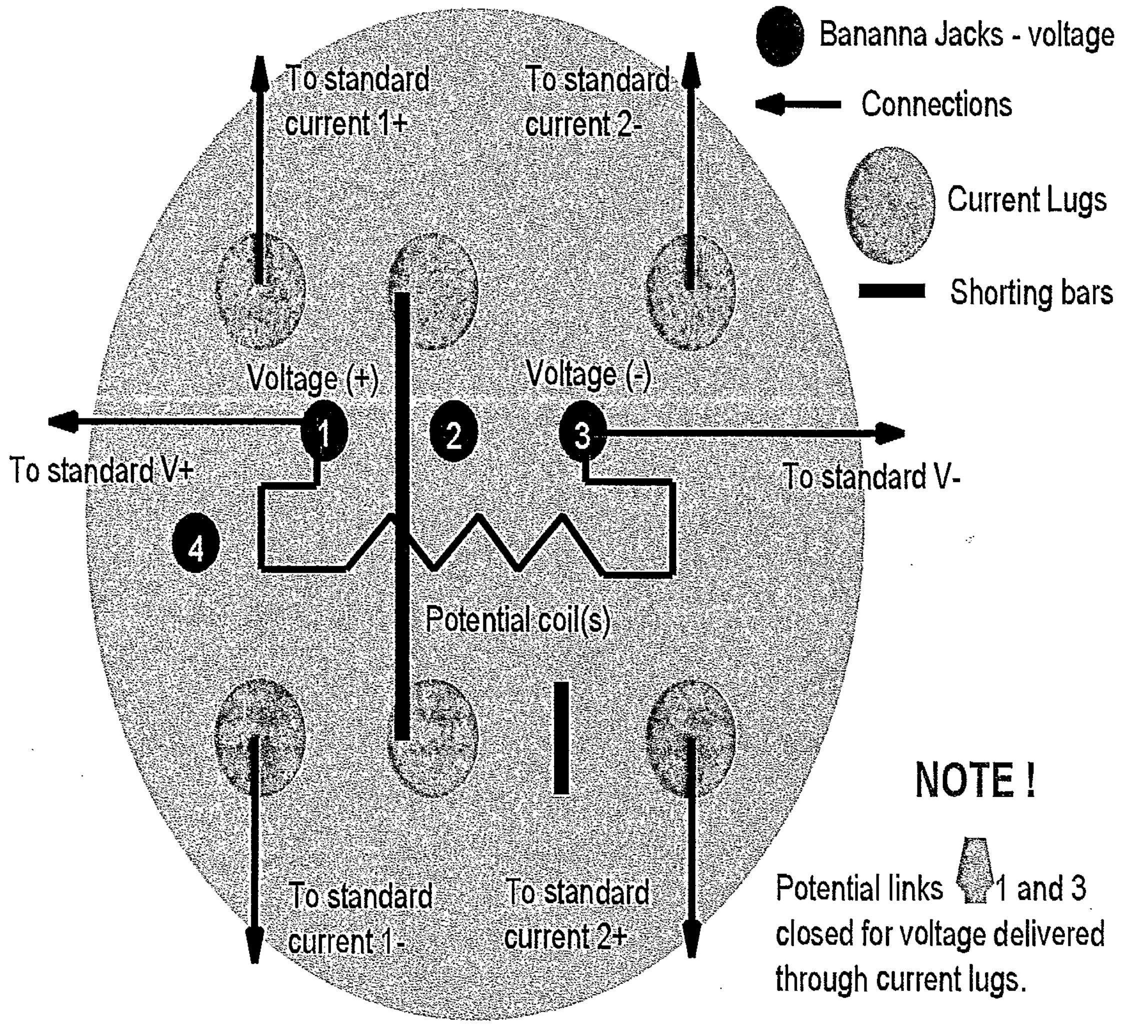


Figure 5

Standard connections for true series/parallel using 1:1 CT's and/or multiple PT's

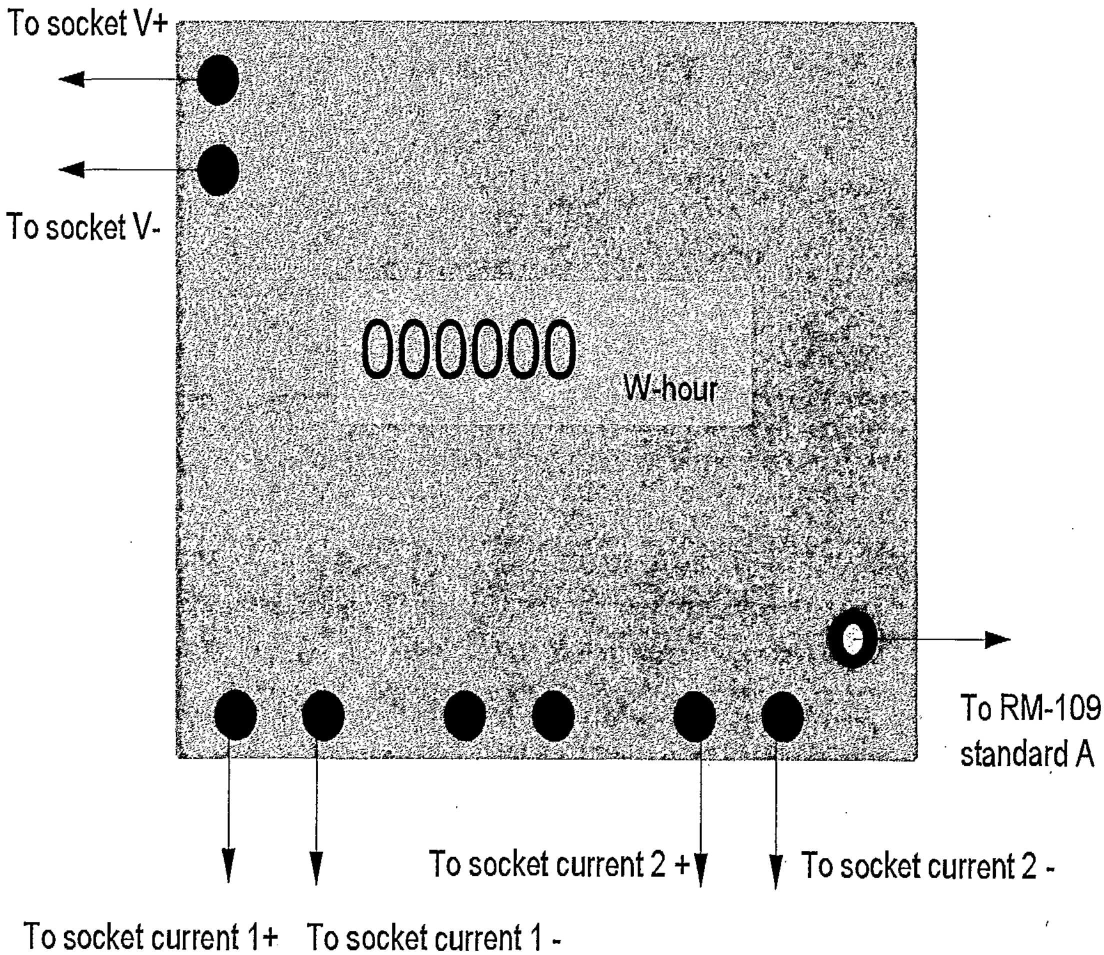


Figure 6
Test socket connections for simulated series/parallel test

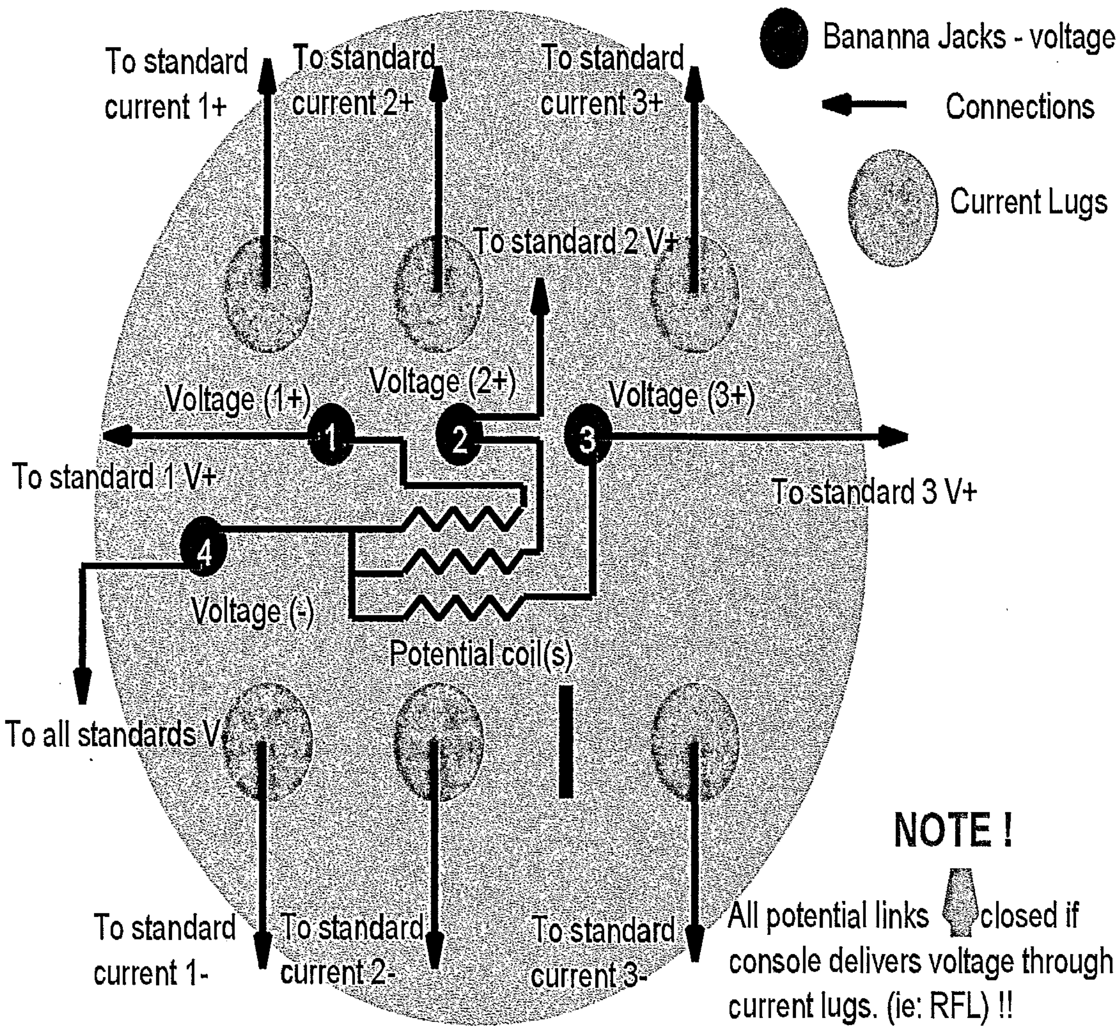
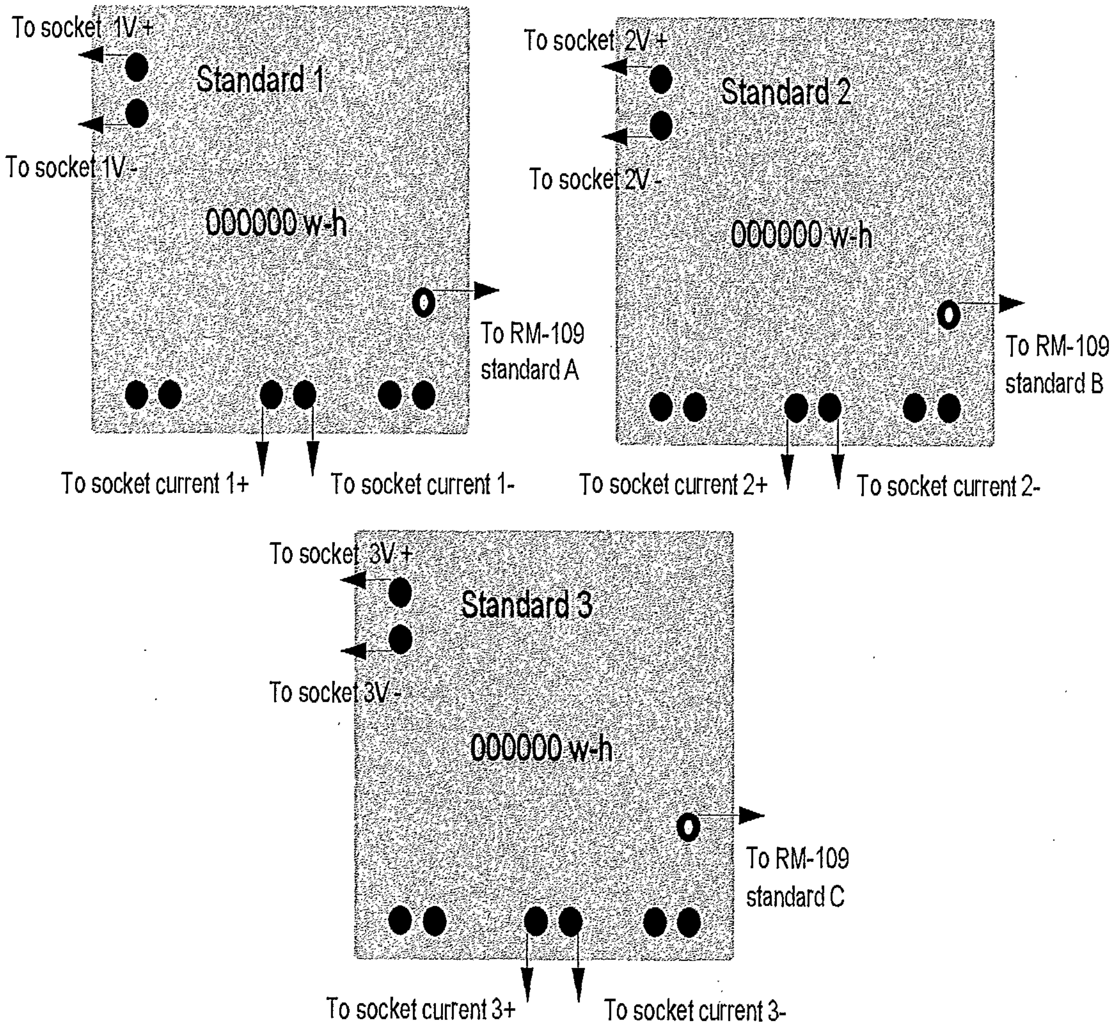


Figure 7
Test socket connections for simulated series/parallel test



7.1.2 Basic Procedure for Conducting Accuracy Tests

7.1.2.1 Scope

The procedures described in this section are intended to be used to conduct the accuracy tests set out in section 7.0 of the Specifications. There are two basic procedures described in this section. The first procedure applies to calibration consoles used for verifying energy meters. The second procedure applies to consoles used for verifying demand meters.

7.1.2.2 Basic Procedure for Conducting Energy Accuracy Tests

7.1.2.2.1 General

The basic procedure for measuring the errors of a calibration console is to connect an appropriate energy standard and any necessary instrument transformers at a calibration console meter-under-test position using an appropriate socket adaptor and to calibrate the standard (and transformer combination) as if it were a meter being verified.

Measurement Canada has developed a light pulser (infrared probe) which can be used to trigger the optical pick-up on the calibration console in the "direct mode". Radian Research has developed a light valve which can be used for the same purpose and which can also operate in the reflective mode and can be used with modulated light sources. Either device is controlled by a Radian RM-109 comparator which can be configured to trigger the probe or valve after receiving a preset number of pulses from a Radian watt hour standard. This arrangement looks to the calibration console exactly like a meter under test as the triggering of the optical pick-up is analogous to the passing of an anti-creep hole in a meter disc. The calibration console control circuit is set up as it would be for normal verification work. In summary, this process will assess the accuracy of the electrical components and reference meter of the calibration console as well as the accuracy of the calibration console control circuit and any associated calculations performed by the console.

7.1.2.2.2 Apparatus

(1) Radian watt hour standard model RM-10, RM-11, or RM-15

(2) Radian comparator model RM-109

(3) Infrared probe OP-01 or Radian light valve RM-1P (see Figures 8 and 9)

(4) Coaxial cables

(5) Tripod, three-pronged clamp, and clamp holder to provide free-standing support for the infrared probe or light valve.

(6) Test burdens as determined pursuant to section 7.1.5 of the Specifications.

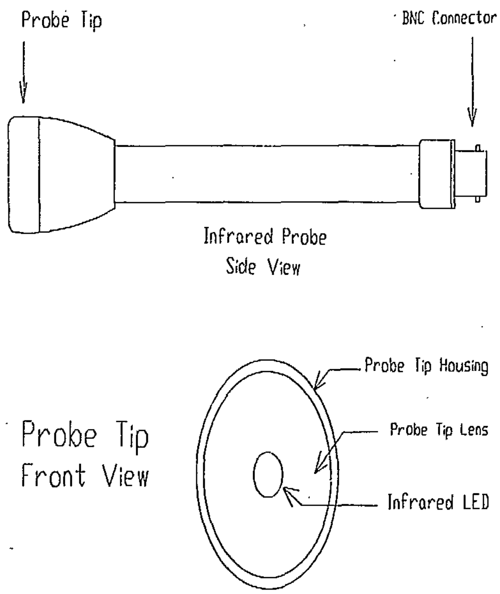


Figure 8:- Infrared Optaic Probe PO-01

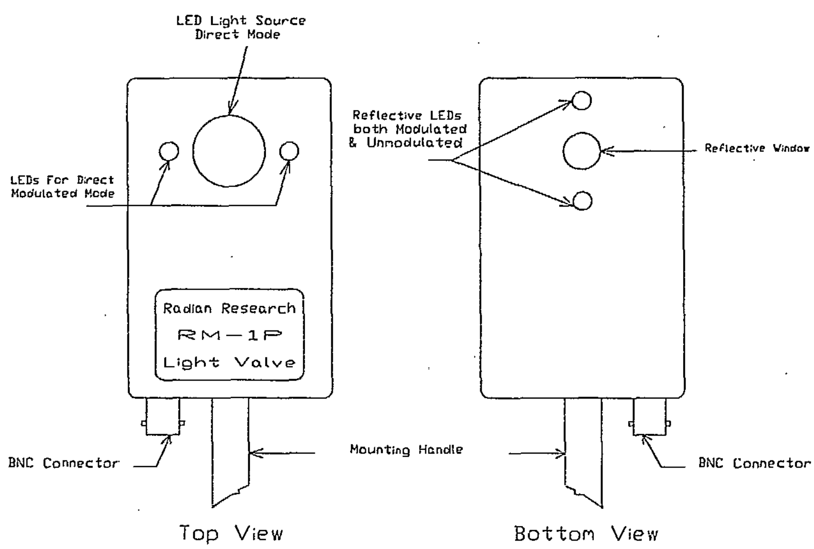


Figure 9 : Radian Research Light Valve RM-1P

7.1.2.2.3 Setup

(1) Ensure the console is de-energized. Install a socket adaptor in the meter-under-test position on the calibration console. Install burdens as determined in Section 7.1.5 of the Specifications.

(2) Connect the potential and current cables from the socket adaptor to the potential and current circuits of the Radian standard.

NOTES:

For a single-phase calibration console, only one Radian standard is required.

To improve stability and repeatability, three Radian standards connected in series/parallel can be used. For such an application, the outputs of the standards are connected to **STANDARD** inputs A, B, and C of the RM-109 and its output set to **AVG** mode.

If one Radian standard is used, as will normally be the case, the **SUM** mode of the RM-109 must be used.

For a true polyphase calibration console, one Radian standard would be required per phase and would be connected to **STANDARD** inputs A, B, and C of the RM-109. The **SUM** mode would be used for this application.

(3) Connect **AUXILIARY POWER** of the Radian standard to an appropriate power source.

(4) Connect **INPUT** of the Radian standard to **RM** on the RM-109 with a short coaxial cable.

(5) Connect the Radian standard **OUTPUT** to the **STANDARD** input on the RM-109.

(6) Connect the infrared probe, or the Radian light valve to the **LED** output of the RM-109.

(7) Verify that all connections are correctly made as illustrated in Figure 10.

(8) Turn on the calibration console, the calibration console accessory instruments, the Radian standard and the RM-109.

(9) Turn on the applicable **STANDARD** input on the RM-109 by pressing the appropriate **ON/OFF** button. Ensure that the appropriate **ON** annunciator is illuminated.

(10) Set the toggle switch **AVG/SUM** on the RM-109 as explained in the notes contained in step 2) above, and ensure that the **SUM** annunciator is illuminated. Set the **GATE/PULSE** switch to **PULSE** and ensure that the **PULSE** annunciator is illuminated.

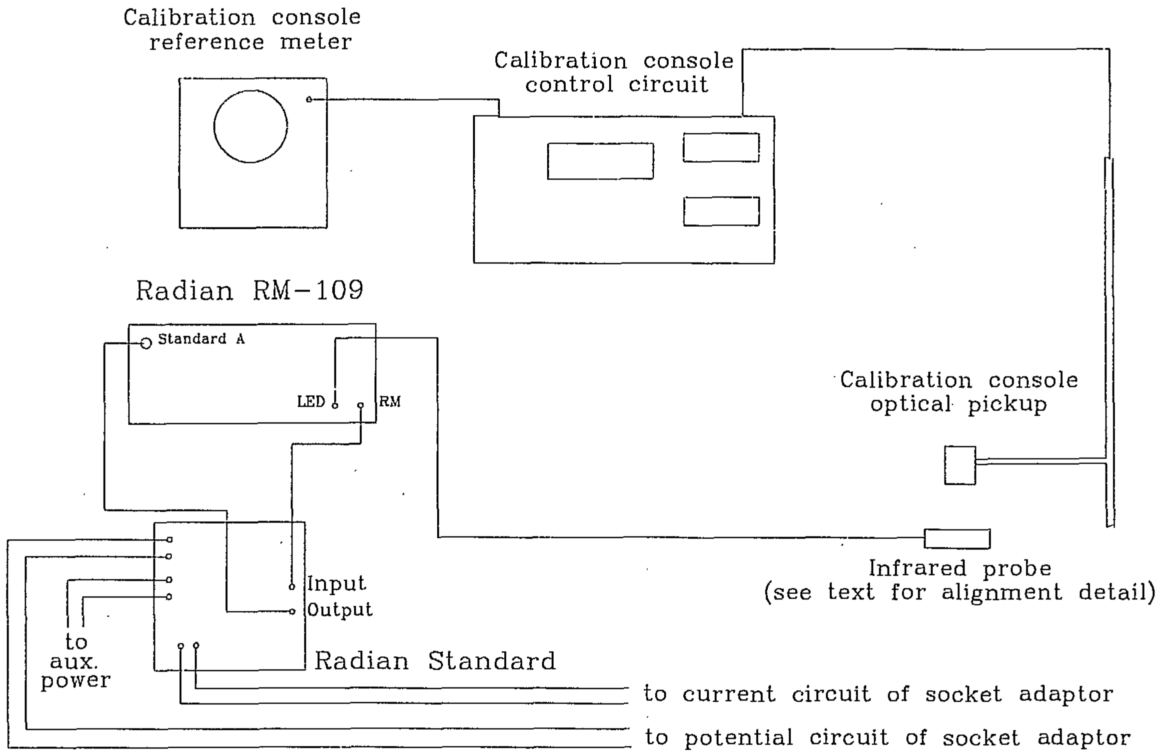


Figure 10: Connections for Testing a Calibration Console

(11) Set the thumb wheel switches on the RM-109 and the number of revolutions of the calibration console control circuit to the values determined from the following relationship:

$$TWS_c \cdot R = 10\,000 \cdot (V_s/V_r) \cdot (I_s/I_r) \cdot k_r$$

where:

TWS_c = thumb wheel switch setting on RM-109

R = number of revolutions set on the calibration console control unit

V_s = voltage applied to the Radian standard

I_s = current applied to the Radian standard

V_r = voltage applied to the calibration console energy reference meter

I_r = current applied to the calibration console energy reference meter

k_r = pulse constant of the calibration console energy reference meter in watt hours per pulse.

This formula allows R and TWS_c to be chosen so that TWS_c is within its maximum range of 999.99999 watt hours. The factor of 10 000 in the formula is to ensure that 10 000 pulses are emitted by the calibration console reference meter. If the control circuit on the console has a setting for expected pulses from the energy reference meter, this should be set to 10 000.

Examples:

A Sangamo J6 calibration console reference meter at a test load of 120 volts, 5 amperes has a pulse constant of k_r = 0.0015 watt hours per pulse. The Radian standard at the meter-under-test position experiences a test load of 120 volts and 5 amperes.

$TWS_c \cdot R = 10\,000 \cdot (120 / 120) \cdot (5 / 5) \cdot 0.0015$

$TWS_c \cdot R = 15$

Set R to 1 and TWS to 15.000

For the same calibration console J6 reference meter, but with the Radian standard now experiencing a test load of 240 volts and 10 amperes, the relationship becomes:

$TWS_c \cdot R = 10\,000 \cdot (240 / 120) \cdot (10 / 5) \cdot 0.0015$

$TWS_c \cdot R = 60$

Set R to 1 and TWS to 60.000

(12) Set the calibration console to any load. The **INPUT** annunciator on the RM-109 will illuminate, indicating a valid input is being fed to the RM-109. If this annunciator does not illuminate, reverify for proper connections of the Radian standard.

(13) Press the **RM-10 RESET** button on the RM-109 to stop and reset the LCD display of the Radian standard. Press **RESET** button on the RM-109 to reset the RM-109 to a new value of TWS.

(14) Press the **START** button on the RM-109. The **TEST** annunciator should illuminate, indicating that the RM-109 is receiving pulses from the Radian standard. The LCD display of the Radian standard should be recording watt hours.

Each time pulses corresponding to the value set on the thumb wheel switches of the RM-109 are received, an output pulse is sent to both the **LED** and the **RM** outputs of the RM-109.

The output pulses to **LED** drive either the infrared probe or the light valve to mimic the passage of a hole or a dark spot on the rotating disc of an induction-type meter. The light source excites the calibration console optical sensor and increments (or decrements) by one the disc revolution count on the calibration console control circuit. See section 7.1.2.2.3.1 for aligning the light source.

The output pulses to **RM** provide a series of control signals to the Radian standard: STOP, RESET and START. The first pulse from **RM** freezes the Radian standard display, the next pulse resets the display to zero and the following pulse restarts the display. The sequence continuously repeats while the test is running. With this mode of operation, the Radian standard delivers pulses continuously although its display only runs every third interval.

(15) The procedure given above can also be modified to apply to:

(i) calibration consoles which automatically determine and display meter-under-test errors, (eg: RFL5800) and

(ii) consoles which emit a pulse train from a reference meter, but the test length is set in the test parameters, not determined by an operator setting the number of expected reference meter pulses, (eg: Multi-Amp)

In these types of consoles, the test parameters are setup in the computer for a specific meter type. Set up the console as if you are testing a three-element meter, (if the console is used for testing polyphase and single phase meters), or a single phase three-wire meter, (if the console is used for testing single phase meters only).

The voltage, current and Kh are preset in the setup selection chosen. Ensure that the values set are correct for the test point being performed.

The thumb wheel setting (TWS) on the RM-109 should be chosen as follows:

$$TWS = Kh_C \times (El_S / El_C) \times (V_S/V_C) \times (I_S/I_C)$$

Where:

Kh_C = the Kh set in the console setup

El_S = the number of test socket elements that the Radian standard is connected to (generally one)

Ei_C = the number of elements that the console is set to test (three for polyphase if the test is performed in series; one for single phase, or if the polyphase test is performed with a single element)

V_S = the voltage applied to the Radian standard

V_C = the voltage that the console sets

I_S = the current applied to the Radian standard

I_C = the current that the console sets

Ensure that the minimum time limits as specified in the procedure of section 7.1.3 are adhered to.

7.1.2.2.3.1 Aligning the Probe or Valve

Infrared Probe OP-01:

Mount the infrared probe on a free-standing tripod with a three-pronged clamp such that its LED end points upward or horizontally. This position facilitates the alignment of the probe with the photocell of the optical pick-up on the calibration console.

Swing the calibration console photocell in front of the infrared probe and align the photocell with the probe. The distance between the lenses should be ½ to 1 cm, except if the photocell is an Infrascan L31 the distance should be 1 to 2 cm. If required, use another three-pronged clamp to hold an odd shaped photocell in alignment with the infrared probe. If the infrared probe or the light valve fails to operate, and the optical pick-up has adjustable sensitivity, reduce the optical pick-up sensitivity. Otherwise, move the probe away from the optical pick-up by a few centimetres.

Set the calibration console control circuit to **DIRECT** (or **HOLES**) mode. Align the probe with the optical pick-up photocell by using the sensitivity indicator on the control circuit or equivalent instrument. The sensitivity meter should read high when the probe and the photocell are aligned.

Radian Light Valve RM-1P:

Same steps as in (1) above, except:

For direct mode, select **DIRECT** (or **HOLES**) on the calibration console control circuit and align the large transparent LED source with the photocell in the calibration console optical pick-up.

For reflective mode, select **REFLECTIVE** (or **EDGE**) mode on the calibration console control circuit and align the round dark flat window (on the opposite side of the valve from the large transparent LED) with the light source and photocell assembly of the calibration console. The two small dark LEDs at the sides of the window generate light pulses.

For a calibration console with a modulated light source, all four small dark LEDs generate light pulses. The two at the sides of the large transparent LED are used as light sources for direct mode; the other two are used for reflective mode.

7.1.2.2.4 Procedure

Set the calibration console to the desired test load and adjust the settings of TWS and R (step 11) of section 7.1.2.2.3) if necessary.

Press the **RESET** button on the Radian standard and the **RESET** and **START** buttons on the RM-109.

Press the **START** button on the calibration console control circuit to start a test.

The control circuit starts to count pulses from the calibration console reference meter when the first pulse from the infrared probe or the light valve strikes the photocell.

Each subsequent pulse from the probe or valve increments (or decrements) the preset number of revolutions on the calibration console control circuit.

When the preset number of revolutions is reached, the control circuit stops accepting pulses from the calibration console reference meter and displays the number of pulses received or calculates an error.

7.1.2.2.5 Calibration Console Error Calculation

The error of the calibration console is the difference between the apparent error determined pursuant to the above procedure and the certified error of the standard (and transformer combination) at the meter-under-test position.

$E_{CC} = E_{SM} - E_C$

where:

E_{CC} = calibration console error in percent

E_{SM} = measured error of the standard (and transformer combination) in percent

E_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_C is determined as follows:

$$\mathbf{Ec = [\,((Es/100)+1)\cos\Theta \,/\, (RCF_E * RCF_I * \cos(\Theta+\beta+\tau)) - 1] * 100}$$

where:

E_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
RCF_E =	certified ratio correction factor for the voltage transformer at the ratio and burden used
RCF_I =	certified ratio correction factor for the current transformer at the ratio and burden used
ß =	certified phase angle error of current transformer at the ratio and burden used in degrees
τ =	certified phase angle error of voltage transformer at the ratio and burden used in degrees
Θ =	phase angle between voltage and current in degrees

The Radian standard used in the test can automatically accommodate most of the range of test loads required for various types of meters without instrument transformers. In this case, RCF_E, RCF_I, ß, and τ will all be unity or zero and the formula reduces to:

$E_C = E_S$

Example:

The test load applied to the Radian standard is 120 volts, 5 amperes at 0.5 power factor with E_S = 0.01 percent.

$E_C = 0.01\%$

Suppose the apparent error measured by the calibration console is

$E_{SM} = -0.07\%$.

The calibration console error is determined as:

$E_{CC} = E_{SM} - E_C$

$= (-0.07\%) - 0.01\%$

$= -0.08\%$

Conduct the tests and calculations at the various test loads and at the various meter-under-test positions as required by S-E-01.

7.1.2.3 Basic Procedure for Conducting Demand Accuracy Tests

7.1.2.3.1 General

A console demand reference meter can be classified either as external or as internal. A reference meter is designated as external if it is not an integral part of the console such as one that is connected to the secondary terminals of the standard position. It also directly displays the required power functions. A reference meter is designated as internal if the reference meter is built-in or integral to the console. In this case the power measurement is usually read on one of the console indicating instruments.

7.1.2.3.1.1 Consoles Having an Internal Reference Meter and an Indicating Instrument.

An accuracy test for consoles with an internal reference meter and an indicating instrument is conducted simply by making a visual comparison between readings on the reference meter, and the readings on the certified standard in the meter-under-test position. The test procedure is outlined in section 7.1.2.3.4.1.

7.1.2.3.1.2 Consoles Having an External Reference Meter

There are two methods available for performing this test. In both cases the test is performed by calibrating a certified standard (and transformer combination) in a meter-under-test position, as if it were an energy meter being verified by the console reference meter.

7.1.2.3.1.2.1
If the console has an input connection for the pulse output of an "external watt-hour standard", then the tests may be performed using the method in section 7.1.2.3.4.2. This is the preferred method, as it is simple to perform, easy to set up, and error calculations are performed automatically. In this case pulses are being counted and compared from the reference meter, to the certified standard in the meter-under-test position.

7.1.2.3.1.2.2
If the console does not have an input connection as stated above, then the method in section 7.1.2.3.4.3 must be used. This test is a comparison between readings on the reference meter, and the readings on the certified standard in the meter-under-test position. The test is performed by comparing the accumulation of energy on the reference meter with that of the certified standard. The two devices will be set to the associated energy function of the demand function that is being tested.

Example

When testing for kVA demand, the reference meter and the certified standard will both be set to read kVA hours.

7.1.2.3.2 Apparatus

7.1.2.3.2.1
For the tests pertaining to section 7.1.2.3.1.1

(1) Reference standard (Radian).

(2) Test socket and leads.

(3) Appropriate test burden's (meters and potential coils) which meet the voltage and current rating requirements of the tests being performed.

7.1.2.3.2.2
For the tests pertaining to section 7.1.2.3.1.2.1

(1) Reference standard (Radian).

(2) Test socket and leads.

(3) Appropriate test burden's (meters and potential coils) which meet the voltage and current rating requirements of the tests being performed.

(4) RM-109, light valve and associated cables as required in section 7.1.2.2 of the Basic Procedure for conducting accuracy tests.

7.1.2.3.2.3
For the tests pertaining to section 7.1.2.3.1.2.2

(1) Reference standard (Radian).

(2) Test socket and leads.

(3) Appropriate test burden's (meters and potential coils) which meet the voltage and current rating requirements of the tests being performed.

(4) One snap switch with BNC connection.

(5) One BNC "T" connector.

7.1.2.3.3 Setup

(1) Install the meters in all but one meter-under-test position

(2) Install the test socket in one meter-under-test position and connect the certified standard to the voltage and current circuit using the appropriate leads. Ensure that the standard is connected appropriately for the type of test being performed, (eg: Single-phase or polyphase).

(3) Install a potential coil (or coils) across the voltage terminals of the test socket. The potential coil(s) must be the same as those in the meters being used as test burdens.

7.1.2.3.3.1
Consoles using an internal demand reference meter and indicating instrument.

(1) Set the certified standard to measure the applicable power function that the console internal reference meter is measuring, (watts, vars, VA avg., VA rms).

(2) Regulators must be in the circuit and switched on while performing these tests.

7.1.2.3.3.2
Consoles that use an external dedicated demand reference meter, and that have an input connection that will accept output pulses from an external reference meter.

(1) Set both the dedicated reference meter, and the certified standard in the meter-under-test position, to measure the applicable power function for the testpoints, (watts, vars, VA avg., VA rms).

(2) Using a coaxial cable, connect the "output" of the reference meter to the "external watt-hour standard" input on the console.

(3) Set up the console to accept pulses from an external reference meter, the internal reference meter is now bypassed. This may need to be done by the Utility technician if it is in a password protected parameter database.

(4) Set up the RM-109 as described in section 7.1.2.2.

(5) Regulators shall be used while performing these tests. Ensure that regulators are in the circuit, and switched on.

7.1.2.3.3.3
Consoles that use an external dedicated demand reference meter, and that do not have an input connection that will accept output pulses from an external standard.

(1) Set both the dedicated demand reference meter, and the certified standard in the meter-under-test position, to measure the associated energy function for the applicable power function that is being tested, (watt-hour for watt demand, var-hour for var demand, etc.).

(2) Connect the "input" from the reference meter to one end of the BNC "T" connector.

(3) Connect the "input" from the certified standard in the meter-under-test position to the other end of the BNC "T" connector.

(4) Connect the snap switch to the input end of the BNC "T" connector.

7.1.2.3.4 Procedure

7.1.2.3.4.1
Consoles using an internal demand reference meter and indicating instrument. See setup section 7.1.2.3.3.1

(1) Set the console to one of the demand testpoints determined pursuant to section 7.8 of the Specifications.

(2) Energize the console, and allow the load to stabilize. Switch on the Regulators.

(3) Monitor both the indicating instrument, (demand reference meter), and the certified standard in the meter-under-test position.

(4) During a period where the load is holding very stable, record the reading on the indicating instrument, (Reading $_{(REF)}$), and the reading on the standard, (Reading $_{(S)}$).

(5) Multiply the reading from the indicating instrument by the appropriate voltage and current ratio.

Reading ($_{MUT}$) = Reading ($_{REF}$) x (V_S/V_{REF}) x (I_S/I_{REF})

Where:

Reading ($_{MUT}$) = the power measured by internal reference meter as shown on indicating instrument, and corrected for transformation factors due to PT's and CT's between internal reference meter and MUT.

Reading ($_{REF}$) = the power reading as measured by internal reference meter as shown on indicating instrument.

V_S = the nominal voltage at the certified standard in the meter-under-test position.

V_{REF} = the nominal voltage at the internal reference meter and indicating instrument.

I_S = the nominal current at the certified standard in the meter-under-test position.

I_{REF} = the nominal current at the internal reference meter and indicating instrument.

(6) The "apparent error" of the certified standard in the meter-under-test position is determined by the following formula:

Error (S) = 100 x (Reading ($_S$) - Reading ($_{MUT}$)) ÷ Reading ($_{MUT}$)

Where: Error ($_S$) = the apparent error of the standard in the meter-under-test position

Reading ($_S$) = the power reading on the standard in the meter-under-test position.

(7) Repeat steps 3) to 6) two more times to ensure consistent results. The three resultant "Error ($_S$)" shall not differ by more than 0.05% in spread. If there is a spread of more than 0.05% then the resulting error is not conclusive due to the lack of repeatability. The three "Error ($_S$)" shall be averaged to determine the final Error (S) at that particular demand testpoint. Record the error and test point on the Console Calibration section of the worksheets.

(8) De-energize the console and switch regulators off.

(9) Repeat steps 1) to 8), with appropriate burdens in the meter-under-test positions, for all applicable test points and meter-under-test positions as determined pursuant to section 7.8 of the Specifications.

7.1.2.3.4.2

Consoles using an external dedicated demand reference meter, and with input connections for counting pulses from external reference meter. See setup section 7.1.2.3.3.2.

(1) Set the console to one of the demand testpoints determined pursuant to section 7.8 of the Specifications.

(2) Energize the console and allow the load to stabilize. Switch on the regulators, then press the "start" button on the RM-109.

(3) Record the error and test point on the Console Calibration section of the worksheets. De-energize the console and switch regulators off.

(4) Repeat steps 1) to 3), with appropriate burdens in the meter-under-test positions, for all applicable test points and meter-under-test positions as determined pursuant to section 7.8 of the Specifications.

7.1.2.3.4.3
Consoles using an external dedicated demand reference meter, but that have no input connections to count pulses from an external reference meter. See setup section 7.1.2.3.3.3.

(1) Set the console to one of the demand testpoints determined pursuant to section 7.8 of the Specifications.

(2) Reset both the dedicated reference meter, and the certified standard in the meter-under-test position to read zero.

(3) Energize the console, and allow the load to stabilize. Switch on the Regulators.

(4) Press the snap switch to start accumulation of energy on both the reference meter and the certified standard.

(5) After five (5) to ten (10) seconds has passed, press the snap switch again to stop the accumulation of energy on both the reference meter and the standard. De-energize the console and switch regulators off.

(6) The "apparent error" of the standard in the meter-under-test position is calculated by the following formula:

$$\text{Error}_{(S)} = 100 \times (\text{Reading}_{(S)} - \text{Reading}_{(REF)}) \div \text{Reading}_{(REF)})$$

Where: $\text{Error}_{(S)}$ = the apparent error of the standard in the meter-under-test position.

$\text{Reading}_{(S)}$ = the energy reading on the standard in the meter-under-test position.

$\text{Reading}_{(REF)}$ = the energy reading on the dedicated demand reference meter

(7) Record the error and test point on the Console Calibration section of the worksheets.

(8) Repeat steps 1) to 7), with appropriate burdens in the meter-under-test positions, for all applicable test points and meter-under-test positions as determined pursuant to section 7.8 of the Specifications.

7.1.2.3.5 Formula

The error of the console at any of the demand test points is as defined in section 7.1.2 of the Specifications.

Portable measuring apparatus error =
[Apparent error of standard(and transformers)]-[Certified (or calculated) error of standard (and transformers)]

7.1.3 Minimum Duration of Accuracy Tests

7.1.3.1 Scope

Refer to section 7.1.3 of the Specifications. This section describes the requirements for minimum test time when performing accuracy tests.

7.1.3.2 General

The requirement of section 7.1.3 of the specifications has been set out to ensure calibration console accuracy test results have a minimum resolution of 0.01%. Some calibration consoles automatically determine and display meter-under-test errors. These consoles do not emit pulses from a reference meter and therefore a minimum time limit is used to ensure the resolution is adequate.

(1) For the case of consoles that emit pulses from a reference meter, the minimum 10 000 pulse resolution is attained by applying the formula as specified in the Basic Procedure for Accuracy tests .

NOTE: The factor of 10 000, in the formula of step 11) of section 7.1.2.2.3 of the Basic Procedure for Accuracy tests, is a minimum. It could be any integer value greater than 10 000. If a larger number is used, than that number must also be used as the set number of pulses expected from the console reference meter.

(2) Some consoles emit pulses from a reference meter, but the operator does not determine the test length by setting the appropriate number of pulses expected by the reference meter. The test length is determined in the test setup for any particular type of meter, based on the meter Kh and the number of disk revolutions required. A minimum of five (5) seconds per pulse interval of the light valve, and a minimum ten (10) seconds total test time, is required. Therefore if the test is set up to do only one pulse interval of the light valve, (one disk revolution), instead of two, then a minimum of ten (10) seconds is required between the start pulse and the stop pulse.

A quick calculation should be performed to ensure that a minimum of 10 000 pulses are emitted from the reference meter.

Example:

A console emits 14 500 pulses/second with 600 watts applied to the internal reference meter connected in the 120 volt, 5 amp secondary circuit. If a calibration test point is performed at 277 volts using the 360 volt tap, and 50 amps using the 100 amp selector switch, then the internal reference meter will be pulsing at a rate of: 14 500 x 277/360 x 50/100 = 5578 pulses/second.

(3) For the case of consoles which automatically determine and display meter-under-test errors, a minimum of five (5) seconds per pulse interval of the light valve, and a minimum ten (10) seconds total test time, is required. Therefore if the test is set up to do only one pulse interval of the light valve, (one disk revolution), instead of two, then a minimum of ten (10) seconds is required between the start pulse and the stop pulse.

7.1.3.3 Remarks

An example of consoles that fall under the category of step 2) of section 7.1.3.2 above is the Multi-Amp.

An example of a console that falls under the category of step 3) of section 7.1.3.2 above is the RFL 5800.

It is important that the minimum time is followed since a shorter measurement period will result in poor repeatability.

7.1.4 Test Positions, Test Loads and Test Burdens

7.1.4.1 Scope

These procedures relate to section 7.1.4 and 7.1.5 of the Specifications. Using the information provided in section 7.1.4 and 7.1.5 of the Specifications, these procedures establish which loads and burdens are required for performing the certifications tests of section 7.0, Metrological Requirements, of the Specifications.

The purpose of the procedures in this section is to determine which burden causes the greatest error.

7.1.4.2 General

7.1.4.2.1
Section 7.1.4.1 of the Specifications sets out the test loads for consoles. The test load is dependant upon whether a console is used for verifying single phase meters, or polyphase meters or both.

7.1.4.2.2 Test Position

Section 7.1.4.1 of the Specifications states that tests shall be conducted with all current elements connected in series. Consoles with an element selector switch shall have that switch set to the "series" position. Some consoles do not have switches, however the test must still be performed with "series" as the selected configuration. All tests must be performed at a minimum of one test load in any one meter-under-test position.

7.1.4.2.3 Test Loads

(1) For consoles intended to verify single-phase meters only, the test load is the highest verification testpoint used to verify meters. This will generally be 240 volts and 50 amps, since that is the verification testpoint for single-phase self-contained, (200 amp), meters.

(2) For consoles intended to verify polyphase transformer type meters, in addition to any other meter types, the test load is 120 volts, 2.5 amps, 0.5 pf.

(3) For consoles intended to verify self contained meters only, the test load shall be the rated voltage of the meter which will be used as the burden determined pursuant to section 7.1.5.1(c) of the Specifications, and 25% of the rated meter current, 0.5 power factor.

(4) If a console is used for verifying meters using 0.5 power factor loads then the test load used for evaluating the console should also be at 0.5 power factor. For consoles that are not used to verify meters at 0.5 power factor, the applicable test load can be set to unity power factor.

(5) Set the voltage selector switch, if there is one, to multiple for all single-phase test loads that use multiple voltage. Set the voltage selector switch, if there is one, to parallel for all single phase test loads, (such as meters with potential test links), that require parallel voltage.

(6) Set the voltage selector switch, if there is one, to parallel for all polyphase test loads that use parallel voltage.

7.1.4.2.4
The burden required while performing single phase tests, is determined using the information provided in section 7.1.5.1(a) of the Specifications. The procedure for determining the single phase burden is provided in section 7.1.4.5.1 below.

7.1.4.2.5
The burden required while performing polyphase tests, is determined using the information provided in section 7.1.5.1(b) of the Specifications for transformer-type meters and using the information provided in section 7.1.5.1(c) of the Specifications for self-contained meters. The procedure for determining the polyphase burden is provided in sections 7.1.4.5.2 and 7.1.4.5.3 below.

7.1.4.2.6
The burdens and test loads for evaluating 1:1 transformers are specified in sections 7.1.5.2 and 7.1.5.3 of the Specifications. A single phase burden must be used when 1:1 isolation transformers are in the test circuit. The test load must be a single-phase test load and it is determined by the information provided in section 7.1.4.2.3 item 1) above.

When 1:1 isolation transformers are out of the test circuit, the test burden must be the polyphase burden. The test load must be a polyphase test load and it is determined by the information provided in section 7.1.4.2.3 item 2) above.

When 1:1 isolation transformers are in the test circuit, the standard in the meter-under-test position must be connected so that both sides (left and right element) of the current circuit are being measured by the standard. Refer to the section 7.1.2 "Basic Procedure for Accuracy Tests" and section 7.1.1, "General Test Setup" for the connections and pulse count or Kh determination.

7.1.4.3 Apparatus

For the purposes of determining the meters to be used as test burdens, the following equipment is required:

(1) Reference standard (Radian).

(2) Test socket and leads.

(3) RM-109, light valve and associated cables as required in the Procedure for conducting accuracy tests.

(4) Appropriate test burden's (meters and/or potential coils) as determined pursuant to the information provided in section 5.2.6 of the Specifications.

(5) Shorting bars for all other meter-under-test positions.

7.1.4.4 Setup

7.1.4.4.1 Single Phase Test Burdens

(1) Refer to the information provided pursuant to section 5.2.6 of the Specifications, to identify the meter types to be used.

(2) Refer to The Basic Procedure for Accuracy Tests for the setup, connections and pulse count determination.

(3) Place a potential coil that represents the meters with the highest voltage burden in any one of the console meter-under-test positions. The potential coil is physically connected across the terminals of the test socket to simulate a meter in the test position.

(4) Place shorting bars in all the other meter-under-test positions.

7.1.4.4.2 Polyphase Transformer-type Test Burdens

(1) Refer to the information provided pursuant to section 5.2.6 of the Specifications, to identify the meter types to be used.

(2) Refer to section 7.1.2, The Basic Procedure for Accuracy Tests for the setup, connections and pulse count determination.

(3) Place potential coils that represent the polyphase transformer-type meters with the highest voltage burden in any one of the console meter-under-test positions. The potential coils are physically connected across the terminals of the test socket to simulate a meter in the test position. (There will normally be three potential coils since the burden of a three element polyphase meter is being simulated).

(4) Place shorting bars in all the other meter-under-test positions.

7.1.4.4.3 Self-contained Test Burdens

(1) Refer to the information provided pursuant to section 5.2.6 of the Specifications, to identify the meter types to be used.

(2) Refer to section 7.1.2, The Basic Procedure for Accuracy Tests for the setup, connections and pulse count determination.

(3) Place potential coils that represent the polyphase self-contained meters with the highest voltage burden in any one of the console meter-under-test positions. The potential coils are physically connected across the terminals of the test socket to simulate a meter in the test position. (There will normally be three potential coils since the burden of a three element polyphase meter is being simulated).

(4) Place shorting bars in all the other meter-under-test positions.

7.1.4.5 Procedure

7.1.4.5.1 Single-phase Test Burden

(1) Set the single phase load to that specified in section 7.1.4.2.3 item 1)

(2) Energize the console and record the resulting error. De-energize the console.

(3) Remove the potential coil and install a potential coil that represents the meters with the lowest voltage burden in the meter-under-test position.

(4) Repeat steps 1) and 2).

(5) The potential coil that represents the meter type which causes the larger error is the type which is to be used for all tests which require a single phase burden. If there is no difference in error, than either type may be used.

7.1.4.5.2 Polyphase Transformer-type Test Burdens

(1) Set the polyphase load to that specified in section 7.1.4.2.3 item 2).

(2) Energize the console and record the resulting error. De-energize the console.

(3) Remove the potential coils and install potential coils that represent the meters with the lowest voltage burden in the meter-under-test position. The lowest voltage burden may be represented by using zero burden. (ie: Shorting bars and no additional potential burden.)

(4) Repeat steps 1) and 2).

(5) The potential coils that represent the meter type which causes the larger error is the type which is to be used for all tests which require a polyphase transformer type burden. If there is no difference in error, than either type may be used.

7.1.4.5.3 Self-contained Test Burdens

(1) Set the polyphase load to that specified in section 7.1.4.2.3 item 3).

(2) Energize the console and record the resulting error. De-energize the console.

(3) Remove the potential coils and install potential coils that represent the meters with the lowest voltage burden in the meter-under-test position. The lowest voltage burden may be represented by using zero burden. (ie: Shorting bars and no additional potential burden.)

(4) Repeat steps 1) and 2).

(5) The potential coils that represent the meter type which causes the larger error is the type which is to be used for all tests which require a polyphase self-contained type burden. If there is no difference in error, than either type may be used.

7.1.4.6 Remarks

It is advantageous to use zero burden, (shorting bars and no pot. coils), for the "low burden" tests if possible. The resulting error differences, when determined in this manner, may allow for the Console Calibration accuracy tests of section 7.8 of the Specifications to be performed with no additional potential burden on the meter-under-test position containing the certified standard.

7.2 Burden Effects

7.2.1 Scope

This procedure relates to section 7.2 of the Specifications. The purpose of this test is to ensure that calibration consoles maintain their accuracy under a range of burden conditions.

This test applies to all calibration consoles.

7.2.2 General

When meters are installed on a test console they burden transformers in the electrical circuits. Different meters introduce different levels of burden. This test is performed by measuring the error at a meter-under-test position while a high voltage burden is in the test circuit. The test is then repeated with a low voltage burden in the circuit. The difference between the two resulting errors is recorded.

This test is performed in conjunction with the procedure for determining Test Burdens, section 7.1.4 above.

7.2.3 Apparatus

See section 7.1.4 above.

7.2.4 Setup

See section 7.1.4 above.

7.2.5 Procedure

7.2.5.1
Tests for consoles when 1:1 Isolation CT's and Multiple PT's are not in the circuit.

(1) Perform the procedures of section 7.1.4.5.2 or 7.1.4.5.3 above, whichever is applicable, with the appropriate test setup and test equipment. This step does not need to be performed if it has already been done for the purposes of determining the polyphase burden required.

7.2.5.2
Tests for consoles when 1:1 Isolation CT's and/or Multiple PT's are in the circuit.

(1) Perform the procedures of section 7.1.4.5.1 above, with the appropriate test setup and test equipment.

(2) Repeat step 1) on all meter-under-test-positions that are equipped with isolation transformers and/or multiple potential transformers. Place shorting bars in the meter-under-test position that was previously tested. Move the test socket to the next position to be tested.

7.2.6 Remarks

The difference in measured errors between the test with the high burden potential coil(s), and the test with the low burden potential coil(s), is required to be within the tolerance specified in section 7.2.1 of the Specifications.

If the difference in errors measured between the test with the high burden potential coil(s), and the test with the low burden potential coil(s), is not more than 0.05%, then it is possible to use either the high voltage burden or the low voltage burden across the certified standard while performing the Console Calibration accuracy tests of section 7.8 of the Specifications.

7.3 Sensitivity to Number of Meters under Test

7.3.1 Scope

This procedure relates to section 7.3 of the Specifications. This test applies only to consoles with more than one meter-under-test position. The test will ensure that the console accuracy is not affected by the number of meters installed.

7.3.2 General

In this procedure the console error is determined for any one meter-under-test position with all other positions empty. This error is compared to the error determined when meters are connected in all the other positions. The difference between the two measured errors is required to be within the tolerance specified in section 7.3.1 of the Specifications.

7.3.3 Apparatus

(1) Reference standard (Radian).

(2) Shorting bars for all but one of the meter-under-test positions.

(3) Test socket and leads.

(4) RM-109, light valve and associated cables as required in the Procedure for conducting accuracy tests.

(5) Meters for all additional meter-under-test positions.

7.3.4 Setup

Refer to the General Test Setup, and Basic Procedure for Accuracy Tests, sections 7.1.1 and 7.1.2 of this document.

7.3.5 Procedure

(1) Place shorting bars in all but one of the meter-under-test positions. Place the test socket in one meter-under-test position. Set up the console as if you are testing a three-element meter, (if the console is used for testing polyphase and single phase meters), or a single phase three-wire meter, (if the console is used for testing single phase meters only). Set the load to the value determined by the procedure for section 7.1.4 of the Specifications.

(2) Using the appropriate leads, connect the Radian standard to one of the current circuits of a meter-under-test position, and to it's associated voltage circuit. Ensure that each of the other two current circuits are shorted at the test socket.

(3) Energize the console and record the measured error in the appropriate box of the Sensitivity to Number of Meters section of the worksheets. De-energize the console.

(4) Remove all the shorting bars from all the other meter-under-test positions and install meters with the burdens determined in section 7.1.5 of the Specifications. Connect the meters exactly as they would be under normal test conditions; voltage, current, etc.

(5) Repeat step 3)

7.3.6 Remarks

The difference between the errors measured in step 3) and step 5) should not exceed the tolerance specified in section 7.3.1 of the Specifications.

If the difference between the errors measured in step 3) and step 5) is not more than 0.05% then it is possible to use shorting bars and no additional potential burdens in all the other meter-under-test positions when performing the Console Calibration accuracy tests of section 7.8 of the Specifications.

7.4 Variation From Position to Position

7.4.1 Scope

This procedure relates to section 7.4 of the Specifications. The purpose of this test is to ensure that the spread of errors between meter-under-test positions of a console does not exceed the tolerance specified in section 7.4 of the specifications. The errors should also comply with requirements of sections 7.8.1, 7.8.2, or 7.8.3 as applicable.

7.4.2 General

In this test, an error is established for each meter under test position. The basic procedure for this is as described in section 7.1.2.2 of this document. A standard is calibrated in each meter under test position in turn while a burden determined pursuant to section 7.1.5 of the Specifications is connected in each other test position of the console.

7.4.3 Apparatus

(1) Test socket adapter

(2) A watt hour standard

(3) A comparator (e.g. Radian RM-109)

(4) A light valve or infrared probe and holder to fix them.

(5) Short wires of suitable size and insulation to hook up current and voltage

(6) Coaxial cables

(7) Meters to burden the console pursuant to section 7.1.5 of the Specifications

7.4.4 Setup

(1) Install burdens (meters) in all but one position.

(2) Install the test socket in the empty position.

(3) Connect the certified standard, the comparator, and align the light valve following the test set up procedures in sections 7.1.2.2 of this document.

7.4.5 Procedure

7.4.5.1
Procedure For Console Intended To Test Single-phase Meters Only

(1) Connect the single-phase test burden as determined by the requirements of section 7.1.5.1(a) of the Specifications.

(2) Set the single-phase test load as determined by the requirements of section 7.1.4.1 of the Specifications.

(3) Begin testing by following the test procedure in section 7.1.2 of this document.

(4) Read the apparent error of the standard at the meter under test position on the console display, and record on the calibration worksheet.

(5) Repeat steps 1) to 4) for each meter-under-test position.

7.4.5.2 Procedure For Console Intended To Test Single-phase And Polyphase Meters Or Polyphase Meters Only

(1) Connect the polyphase test burden as determined by the requirements of section 7.1.5.1(b) of the Specifications.

(2) Set the polyphase test load as determined by the requirements of section 7.1.4.1 of the Specifications.

(3) Begin testing by following the test procedure in section 7.1.2 of this document.

(4) Read the apparent error of the standard at the meter under test position on the console display, and record on the calibration worksheet.

(5) Repeat steps 3) and 4) above for each meter-under-test position.

7.4.6 Remarks

The tolerance for the spread of errors determined in the procedures above is specified in section 7.4.1 of the Specifications. All measured errors in the procedures above are also required to be within the tolerances of applicable sections of section 7.8 of the Specifications.

7.5 Distortion

7.5.1 Scope

The following procedure relates to section 7.5 of the Specifications. In this procedure the level of distortion under specified test conditions is measured. The measured distortion level is also evaluated against the tolerances set in section 7.5 of the Specifications.

7.5.2 General

The tests of this procedure are conducted with current and voltage circuits simultaneously energized, and the appropriate burdens installed in each of the meter-under-test positions. These tests are conducted first with regulators and line conditioners switched out of the circuit, (if normal metering tests are performed without regulators or line conditioners), and then repeated with regulators and line conditioners switched into the circuit (if those devices are required when verifying meters). Using a distortion analyser, the current distortion will be measured then the voltage distortion will be measured.

7.5.3 Apparatus Required

(1) Distortion analyser that uses the correct formula, as stated in section 7.5.7, to calculate distortion.

(2) Appropriate test socket, leads and connections to connect the distortion analyser to a meter-under-test position.

(3) Appropriate burdens (meters and potential coils) for all the meter-under-test positions.

(4) Shorting bars for all the meter-under-test positions.

7.5.4 Setup

7.5.4.1

Setup for Tests Pursuant to Section 7.5.2.3 of the Specifications: Recti-thermal Demand meters.

(1) Install recti-thermal demand meters as they would be under normal testing, in all but one meter-under-test position. Self-contained meters which have a high voltage and current rating should be used for all high voltage and current tests. Appropriately rated transformer meters (eg. 120 volt, 10 amp.), must be used for all low voltage and current test points.

(2) Install the test socket in the empty meter-under-test position.

(3) Set the console for the type of meters that are installed in the meter-under-test positions.

7.5.4.2 Setup for Tests Pursuant to Section 7.5.2.4 of the Specifications: 1:1 CT's and/or multiple PT's

(1) Install single phase meters, simulating the burden requirements as specified in section 7.5.2.4.1 of the Specifications, in all but one meter-under-test position. Install the meters as they would be under normal testing using 1:1 isolation transformers and multiple potential transformers.

(2) Install the test socket in the empty meter-under-test position.

(3) Set the console for the type of meters that are installed in the meter-under-test positions.

7.5.4.3 Setup for Tests Pursuant to Section 7.5.2.5 of the Specifications: Consoles not included in 7.5.2.3 or 7.5.2.4 of the specifications

(1) Install meters, simulating the burden requirements as specified in section 7.5.2.5.1 of the Specifications, in all but one meter-under-test position. Install the meters as they would be under normal testing.

(2) Install the test socket in the empty meter-under-test position.

(3) Set up the console for the type of meters that are installed in the meter-under-test positions.

7.5.5 Procedures

7.5.5.1
Refer to the recti-thermal demand meters setup in section 7.5.4.1 above

(1) Ensure that any regulators or line conditioners that are always in the circuit during normal meter testing remain in the circuit for all the following distortion tests.

(2) If any regulators or line conditioners may be switched out of the circuit, switch them out of the circuit.

(3) Follow the operating instructions for the distortion analyser used, and connect the current terminals of the analyser in series with one of the current elements at the test socket. Do not connect the voltage terminals of the analyser to the test voltage. Ensure that the other two current circuits are shorted at the socket.

(4) Set the load to 120 volts and 2.5 amps.

(5) Energize the console to the specified test point and record the measured value of distortion in the first table of the Distortion section of the worksheets. De-energize the console.

(6) Disconnect the analyser from the current circuit, and short out that circuit at the socket.

(7) Connect the voltage terminals of the analyser in parallel with the test voltage at the socket.

(8) Energize the console to the specified test point and record the measured value of distortion in the first table of the Distortion section of the worksheets. De-energize the console.

(9) Set the load to the lesser of: (i) the maximum verification test current for the installed meters, or (ii) the maximum current rating of the distortion analyser used, and the lesser of: (iii) the maximum voltage rating of the installed meters, or (iv) the maximum voltage rating of the distortion analyser used.

(10) Repeat steps 5) to 8).

(11) If any regulators or line conditioners were switched out of the circuit in step 2), turn them on and repeat all of the distortion measurements at the test loads previously used by following steps 4) to 10).

(12) Remove all meters from all the meter-under-test positions, and install shorting bars

(13) Repeat steps 1) to 11), with the following change:

For step 9), set the load to be the lesser of: (i) the maximum test current used for verifying meters or (ii) the maximum current rating of the distortion analyser used, and the lesser of: (iii) the maximum test voltage used for verifying meters or (iv) the maximum voltage rating of the distortion analyser used.

7.5.5.2

Refer to the Setup of 7.5.4.2: 1:1 CT's and/or multiple PT's

(1) Any regulators or line conditioners that are always in the circuit during normal meter testing shall remain in the circuit for all the following distortion tests.

(2) If any regulators or line conditioners may be switched out of the circuit, switch them out of the circuit.

(3) Follow the operating instructions for the distortion analyser used, and connect the current terminals of the analyser in series with the current elements at the test socket. Do not connect the voltage terminals of the analyser to the test voltage. Ensure that the other two current circuits are shorted at the socket.

(4) Set the load to 120 volts and 2.5 amps.

(5) Energize the console to the specified test point and record the measured value of distortion in the second table of the Distortion section of the worksheets. De-energize the console.

(6) Disconnect the analyser from the current circuit, and short out that circuit at the socket.

(7) Connect the voltage terminals of the analyser in parallel with the test voltage at the socket.

(8) Energize the console to the specified test point and record the measured value of distortion in the second table of the Distortion section of the worksheets. De-energize the console.

(9) Set the load to the lesser of: (i) the maximum test current used for verifying meters that require the use of 1:1 transformers and /or multiple transformers, or (ii) the maximum current rating of the distortion analyser used, and the lesser of: (iii) the maximum test voltage used for verifying meters that require the use of multiple transformers (typically 240 volts), or (iv) the maximum voltage rating of the distortion analyser used.

(10) Repeat steps 5) to 8).

(11) If any regulators or line conditioners were switched out of the circuit in step 2), turn them on and repeat all of the distortion measurements at the test loads previously used by following steps 4) to 10).

7.5.5.3
Refer to Setup 7.5.4.3: Consoles not included in 7.5.2.3 or 7.5.2.4 of the specifications.

(1) Any regulators or line conditioners that are always in the circuit during normal meter testing shall remain in the circuit for all the following distortion tests.

(2) If any regulators or line conditioners may be switched out of the circuit, switch them out of the circuit.

(3) Follow the operating instructions for the distortion analyser used, and connect the current terminals of the analyser in series with the current elements at the test socket. Do not connect the voltage terminals of the analyser to the test voltage. Ensure that the other two current circuits are shorted at the socket.

(4) Set the load to 120 volts and 2.5 amps.

(5) Energize the console to the specified test point and record the measured value of distortion in the second table of the Distortion section of the worksheets. De-energize the console.

(6) Disconnect the analyser from the current circuit, and short out that circuit at the socket.

(7) Connect the voltage terminals of the analyser in parallel with the test voltage at the socket.

(8) Energize the console to the specified test point and record the measured value of distortion in the second table of the Distortion section of the worksheets. De-energize the console.

(9) Set the load to the lesser of: (i) the maximum test current used for verifying meters having the burden determined pursuant to section 7.1.5.1(b) of the specifications, or (ii) the maximum current rating of the distortion analyser used, and the lesser of: (iii) the maximum test voltage used for verifying meters having the burden determined pursuant to section 7.1.5.1(b) of the specifications, or (iv) the maximum voltage rating of the distortion analyser used.

(10) Repeat steps 5) to 8).

(11) If any regulators or line conditioners were switched out of the circuit in step 2), turn them on and repeat all of the distortion measurements at the test loads previously used by following steps 4) to 10).

7.5.6 Remarks

Refer to sections 7.5.1.1 and 7.5.1.2 of the Specifications for the allowable distortion tolerances.

7.5.7 Formulae

The distortion analyser must calculate distortion according to the formula:

% Distortion = [rms of harmonics / rms of fundamental and harmonics] * 100

7.6 Regulation

7.6.1 Scope

This procedure relates to section 7.6 of the Specifications. The procedure is intended to be used to conduct regulation tests required to determine the compliance of a calibration console to the requirements for regulation set out in section 7.6 of the Specifications.

7.6.2 General

This procedure involves two tests that are conducted simultaneously. A PC controlled test has been developed that monitors console loads by recording energy over one minute intervals for sixty minutes. The total energy over the sixty minute test period is also recorded. The PC compares the recorded one minute energy values and determines if they are within the tolerances specified in section 7.6.1.2 of the Specifications. The PC also determines if the energy recorded over the sixty minute period is within the requirements of section 7.6.1.1 of the Specifications.

7.6.3 Apparatus

(1) IBM PC (486DX33 or higher) compatible laptop computer with Windows 3.1 or higher.

(2) Radian RM-15-14 portable multifunction standard.

(3) National Instruments GPIB-1284CT parallel to IEEE 488.2 controller.

(4) Hewlett Packard 53131A universal counter with GPIB interface.

(5) GPIB cable.

(6) PS-E-03 regulation test interface unit (RTIU).

(7) GPIB-1284CT Windows installation diskettes (2 diskettes).

(8) Regulation test software (1 diskette).

(9) Meters to burden the console, as determined pursuant to section 7.1.5.

7.6.4 Setup

7.6.4.1 Software Installation

The following steps are required to install the software on the laptop computer if the software has not already been installed.

The regulation test software is contained in a self-extracting ZIP file. To extract the software follow these steps:

(1) Go to a DOS prompt.

(2) Create a directory for file storage. (eg: **md c:\regtest**)

(3) Change directories to the created directory. (eg: **cd regtest**)

(4) Insert the regulation test diskette in the floppy disk drive and type the command **a:\regzip**.

The GPIB-1284CT software comes on two floppy disks although only disk #1 is the only disk necessary to install the needed software to run the test. Disk #2 contains programs to facilitate troubleshooting of the GPIB interface. To run the installation program, follow these steps:

(1) From Windows Program Manager, select **File/Run...**, and type **a:\setup**.

(2) Follow the online instructions.

Select the option to perform a **custom** setup and remove the options to install the **C Language Interface, Visual Basic Language Interface,** and **Application Examples**.

Important!

For the regulation test software and hardware to work correctly, the **Language** setting in **Main/Control Panel/International** must be set to either United States or Canada (English). The comma in the French style numbers causes software errors.

7.6.4.2 Equipment Connections and Setup

The required equipment is connected as follows:

(1) Connect the parallel port of the laptop computer to the port labelled **computer** on the GPIB-1284CT controller.

(2) Connect the GPIB interface cable from the HP 53131A counter to the port labelled **GPIB** on the GPIB-1284CT.

(3) Connect the serial line from the RTIU to COM port #1 on the laptop.

(4) Using the coaxial cables, connect the RTIU to the input connector on the Radian. Refer to the connection map on the RTIU.

(5) Connect the output connector on the Radian to the RTIU.

(6) Connect the channel 1 input on the HP 53131A counter to the RTIU.

(7) Connect the potential and current inputs to the Radian.

(8) Plug in all the instruments to an auxiliary power supply. The RTIU has its own 9 volt adapter.

(9) Turn on the instruments.

7.6.4.3 Configuration of the GPIB Controller

Configuration of the GPIB controller is normally required only once. This is usually done when the GPIB software is first installed and the GPIB controller has been connected to the laptop computer. If the GPIB controller has already been configured for use with the laptop the remainder of this section can be ignored and regulation tests can be performed as directed in section 7.6.5 below.

Configure the GPIB unit to the connections that were made by running the program **wibconf** from the program group *GPIB* created in Windows Program Manager. A prompt will appear enabling parameter inputs. The parameter inputs should not require to be changed; press **Enter** to skip this step. Edit the configuration information for the connector by pressing **Enter** on the device shown as **"GPIB0"**. A listing of the possible configuration options that can be altered will appear. Note the parallel port number, type of parallel port, and interrupt level settings. Set the type of parallel port setting to **Auto**. Upon completion of the configuration steps above, press the **Esc** key twice. Select **Yes** to save the new settings and press **Enter**.

The configuration information on the current settings of the GPIB-1284CT maybe obtained at any time by running the program **GPIBinf** in the GPIB program group.

If the configuration settings are correct, the equipment is ready to run. To run an equipment diagnostics test, double-click the program icon **ibdiag** in the *GPIB* program group. Select the appropriate parallel port settings and wait while the software checks the device. It will either say that the GPIB passed the test or it will give error conditions and sometimes some possible problems that might have caused the errors. The most common error is forgetting to turn on the GPIB.

The GPIB software also performs a software diagnostics test. This is done by running the program **Wibtest** in the GPIB program group. After opening the program, click on the **Software Diagnostics/Test GPIB0**. For this test, make sure the **GPIB** cable is disconnected from the counter. When the program finishes, it will say whether or not the test was successfully completed.

7.6.5 Procedure

(1) Ensure that all equipment is installed and connected as described in section 7.6.4.

(2) Install the burdens determined pursuant to section 7.1.5 in each meter under test position except the position having the Radian reference meter. Set the calibration console load to the test load determined pursuant to section 7.1.4 of the Specifications.

(3) The calibration console may be allowed to warm-up for a period of up to one hour, if required.

(4) From Windows **File Manager**, double click on the **regtest.exe** file from the directory in which it was installed. (eg: **c:\regtest\regtest.exe**).

(5) At the opening screen click **OK** to continue.

(6) On the **Test Setup Screen** select the total test time (60 minutes) and the count interval time (60 seconds). The default test is a one hour test with a one minute count interval. Click on the **OK** button when finished.

(7) Enter the Radian pulse factor and the test load value on the next screen. The Radian pulse factor can be read on the nameplate on the Radian. If the recorded value is not a standard value, click the button called **Standard**. The name of the button will change to **Custom** and an appropriate pulse factor value can be entered. Click the **OK** button when finished.

(8) The next screen will allow resetting of the Radian from the laptop by clicking on the button marked **Radian Reset**. This button will *start/stop/reset* the Radian unit. Before the test is started, the Radian readout should be reset to zero. Make sure that **watt hours** are selected on the Radian. When the Radian has been reset, click on the **Done** button. The laptop will begin to communicate with the counter and record one minute energy test results automatically in the software.

(9) A five minute test will run to determine the average load that will be used for the regulation test. Upon completion of the five minute test the program will prompt for the start of the one hour regulation test.

(10) After one hour of one minute energy counts, the program will stop the Radian from recording any more energy and will prompt for the Radian energy reading recorded during the one hour test. Enter the actual Radian reading shown on the display at this time. The software will automatically calculate the percent error. When these results are recorded, click on the **OK** button on the bottom of the screen.

(11) De-energize the console. If the meter burdens are not rated for the test load remove the burdens and install burdens that are rated for the test load. Re-energize the console and set the load to the largest test load at 0.5PF (1.0 PF if 0.5 PF is not applied) used to verify exponential or block interval demand meters which can not be verified pursuant to the requirements of section 6.4.9 of the Specifications.

(12) Repeat steps 3) to 10).

7.6.6 Remarks

If the test must be stopped, either double-click the top left corner of the screen or press **Alt + F4**. The software will return to the EG-12 Regulation Test control panel. Click on the icon marked **STOP**.

A new test can be started by clicking on the icon shown in the left margin marked **Go**.

If problems are encountered in the communications between the laptop and the counter, check to see that all the cables are connected tightly and correctly. Make sure that all the equipment has been turned on and set to the right operation mode. If nothing happens when the test runs, make sure that the GPIB software is configured correctly. Running one of the diagnostics tests explained earlier can help in determining the problem.

7.7 Current Switching Effects

7.7.1 Scope

This procedure relates to section 7.7 of Specifications. The procedure is used to determine if semi-automatic and automatic console errors change when automatically switching currents from high loads to low loads.

7.7.2 General

Consoles that have transformers installed between the reference meter and the meter under test position, are most prone to exhibiting error changes from this test. The errors are usually introduced by the phenomenon known as remanence.

In order to detect the effects of remanence, tests are carried out by connecting a standard in a meter under test position, setting a load current, and then switching the current to 10% of its original setting. The load is then returned to the original setting and the apparent errors before and after the switch to light load are compared.

7.7.3 Apparatus

(1) Meters or burdens determined pursuant to section 7.1.5 of the Specifications.

(2) A comparator (eg. Radian RM-109).

(3) A light valve (eg. Radian RM-1P) or infrared probe and support to fix it.

(4) A watt hour standard with pulse output capability.

(5) Coaxial cables

7.7.4 Setup

7.7.4.1 Setup For Consoles Intended To Verify Single Phase Meters

(1) Install single phase meters or burdens determined pursuant to section 7.1.5 of the Specifications in all but one meter-under-test position.

(2) Install the test socket in the remaining test position .

(3) Connect the standard as described in section 7.1.2 of these procedures.

(4) Make connections to put 1:1 isolation transformers in circuit.

(5) When testing with 1:1 transformer in circuit use the multiple voltage transformer.

7.7.4.2 Setup For Consoles Intended To Verify Single Phase and Polyphase Meters

(1) Install polyphase meters or burdens determined pursuant to section 7.1.5 of the Specifications in all but one meter-under-test position.

(2) Install the test socket in the remaining test position .

(3) Connect the standard as described in section 7.1.2 of these procedures.

7.7.5 Procedure

7.7.5.1 Procedure For Consoles Intended To Verify Single Phase Meters

(1) Set the load determined pursuant to 7.1.4 of the Specifications.

(2) Using the normal operating mode of the console, calibrate the console.

(3) Record the error of the standard on the calibration worksheet.

(4) Switch the current to 10 percent, then back to its original value

NOTE: Follow normal operating procedures for the console when conducting these tests. If normal operation requires that the load be set to zero before switching to a new load then do so.

(5) Recalibrate the console and record the results on the calibration worksheet.

(6) Repeat the process four times and record each result on the calibration worksheets.

7.7.5.2 Procedure For Consoles Intended To Test Single Phase And Polyphase Meters

(1) Set the load determined pursuant to section 7.1.4 of the Specifications.

(2) Using the normal operating mode of the console, calibrate the console.

(3) Record the error of the standard on the calibration worksheet.

(4) Switch the current to 10 percent, then back to its original value.

NOTE: Follow normal operating procedures for the console when conducting these tests. If normal operation requires that the load be set to zero before switching to a new load then do so.

(5) Recalibrate the console and record the results on the calibration worksheet.

(6) Repeat the process four times and record each result on the calibration worksheets.

7.7.6 Remarks

The tolerance for the errors determined by this procedure is specified in section 7.7.1 of the Specifications.

Spread of error = (E_{max})- (E_{min})

Where:
E_{max} = maximum apparent error
E_{min} = minimum apparent error

Example:

Five errors recorded as: 0 .08%, 0.08%, -0.05%, 0.09%, 0.07%

Spread = (0.09%)-(-0.05%)
= 0.14%

7.8 Console Calibration

7.8.1 Scope

This procedure relates to section 7.8 of the Specifications. It is used to determine errors of calibration consoles.

7.8.2 General

The extent to which a console is calibrated is dependant on the manner in which it is used. Section 7.8 of the Specifications defines various criteria for use. The calibration procedures associated with various criteria are described below.

(1) A calibration console that is equipped with 1:1 isolation transformers is required to be tested at each position equipped with a 1:1 transformer, at each test point used for testing meters for which 1:1 transformers are required.

(2) Calibration consoles that have position to position errors that have a spread of between 0.1% and 0.2% are required to be calibrated at each meter under test position for the tests described in 3) and 4) below. If the position to position errors are less than 0.1% the console is required to be calibrated at one position only.

(3) A calibration console that is used without 1:1 transformers but has current and/or potential transformers connected between the reference meter(s) and the meter-under-test position(s), is calibrated at combinations of voltage and current tap, and selector switch settings. Calibration is performed at the maximum and minimum test loads for each combination of voltage and current tap, and selector switch combination used to verify meters. The calibration at these test loads is conducted at all power factors used to verify meters.

(4) A calibration console that has reference meters connected in the same circuit as the meter-under-test positions, without any intervening current or potential transformers or isolation transformers, between the reference meters and the meter-under-test positions, is required to be calibrated at any one meter-under-test position. If the console has reference meters that have certificates of calibration that are traceable to the National Research Council of Canada (NRC), it is calibrated at the minimum, median and maximum test loads of the range of loads at unity power factor as well as at all other power factors to be used to verify meters. The maximum, median, and minimum loads are determined as follows:

Maximum load	=	meter test voltage x meter test current (that creates the maximum load)
Median load	=	meter test voltage x meter test current (that creates the middle load of range of meter test loads)
Minimum load	=	meter test voltage x meter test current (that creates the minimum meter test load.)

The NRC traceable reference meter must be calibrated at unity power factor at the minimum and maximum currents at each voltage used to verify meters as well as all test loads not at unity power factor.

A console that has been calibrated using the above maximum, minimum, and median test loads has its errors determined by averaging the errors determined at these three loads. This average value is then added to the known errors of the NRC traceable reference meter.

(5) If a console does not have a reference meter traceable to the NRC, or if after calculating errors by summing the average error above with the reference meter error, there are errors that are greater than ±0.1% or are not within 0.05% of each other, the console is required to be calibrated at the minimum, median, and maximum currents at each voltage used to verify meters, and at all power factors used to verify meters.

7.8.3 Apparatus

Test apparatus required for conducting these tests are identified in the procedure for conducting accuracy tests, provided in section 7.1.2 of this document as well as section 7.1.1.

7.8.4 Setup

The test setup required for these tests is identified in the procedure for conducting accuracy tests, provided in section 7.1.2 of this document, as well as section 7.1.1.

7.8.5 Procedure

For all tests below, use the procedures described in section 7.1.2 of this document to calibrate the console. Also, use the procedure in section 7.1.4 to install the appropriate burden in each meter-under-test position as determined pursuant to section 7.1.4 of the Specifications

(1) Calibrate each meter-under-test position equipped with 1:1 isolation transformers and/or multiple transformers, at every test point that is used with 1:1 transformers in circuit. Install the single phase test burden for this calibration.

(2) For the calibrations below install the burden determined pursuant to section 7.1.5 of the Specifications in each meter-under-test position. If the errors determined in any of the tests pursuant to the applicable subsections of section 7.2 (Burden Effects) differ by 0.05 percent or less, then the meter-under-test position with the standard does not require a burden.

(3) Determine if the console has intervening transformers, other than isolation transformers, between the reference meter(s) and the meter-under-test positions.

(4) If step 3) above is true, determine all combinations of voltage and current tap, and selector switch settings used for verifying meters. Calibrate the console at the maximum, and minimum test loads for each combination of voltage and current tap, and selector switch combination used to verify meters. Also calibrate the console at these test loads at all power factors used to verify meters.

(5) If step 3) above was not true then determine if the console has reference meters that are in the same circuit as the meter-under-test positions.

(6) If step 5) above is true then determine if the console reference meter has a valid certificate of calibration traceable to the NRC as defined in section 7.8.2.4 of the Specifications.

(7) The calibrations of steps 8) and 9) below shall be conducted at each meter-under-test position for consoles that have position to position errors that are between 0.1% and 0.2% as determined in procedure 7.4.

(8) If step 6) above is true then calibrate the console at any one meter-under-test position, at the maximum, median, and minimum test loads of the range of test loads used to verify meters (see 7.8.2 (4) above for an explanation of maximum, minimum, and median).

(9) Calculate the average of the errors determined in step 8) above and add this error value to each error available for the console reference meter.

(10) If step 6) above is false or if any error determined in step 9) above is greater than $\pm$0.1% or not within 0.05% of each other then calibrate the console at the maximum and minimum currents at each voltage used to verify meters and at each power factor used to verify meters.

(11) Repeat steps 1) - 10) as applicable for all electrical quantities used for verifying meters.

7.8.6 Remarks

For the purpose of developing the certificate of errors, for calibration consoles which have position to position errors pursuant to section 7.4 of the Specifications, less than 0.1%, the errors determined in steps (8) and (9) above shall be applicable for each meter-under-test position.

7.8.7 Formulae

The error of the console at any of the test points is as defined in section 7.1.2 of the Specifications.

Portable measuring apparatus error =
[Apparent error of standard(and transformers)]-[Certified (or calculated) error of standard (and transformers)]

7.9 Procedure for Establishing Errors for Consoles with Interchangeable Reference Meters

7.9.1 Scope

This procedure relates to section 7.9 of the Specifications. It is used to determine errors of calibration consoles which will be used with interchangeable reference meters.

7.9.2 General

Once a console has been calibrated with one make, type, or model of a reference meter simple formulae are used to establish errors for the console with other reference meters of the same type, make, and model. An interchangeable reference meter must have certified errors traceable to the National Research Council (NRC) for each test point which would be used to calibrate the console pursuant to the applicable portions of section 7.8 of the Specifications.

7.9.3 Apparatus

There is no apparatus required for this procedure.

7.9.4 Procedure

(1) Ensure that the reference meters that are to be interchanged meet the criteria set out in section 7.9.1 of the Specifications.

(2) Establish the errors of the console at each calibration point by using the formulae specified in S-E-01.

7.10 Pulse Counters and Generators

7.10.1 Scope

This procedure relates to section 7.10 of the Specifications. It is intended to ensure that all calibration consoles which utilize internal or external pulse counters and generators for verification testing meet the requirements of the specifications as referred to in section 7.10.

7.10.2 General

The pulse counters used with calibration consoles are verified by supplying 1000 pulses into them and checking that 1000 pulses were counted by the counter.

Pulse generators used with calibration consoles are verified by counting 1000 pulses output by the generators. The pulse generators are also verified at the maximum frequency or input pulse rate required to verify pulse recorder inputs.

If a console utilizes both pulse counters and pulse generators, the pulse counters can be verified first and if accepted they can be used to verify the pulse generators.

7.10.3 Apparatus

(1) Pulse generator(s) capable of generating Form A and Form C pulse outputs at rates that meet or exceed the maximum pulse rate of the meters with pulse outputs, the console is used to verify.

(2) Pulse counter(s) capable of counting Form A and Form C pulses at rates which meet or exceed the maximum input pulse rate required to verify meters (pulse recorders) equipped with pulse inputs.

7.10.4 Setup

7.10.4.1 Pulse Counter Test Setup

(1) Connect the pulse generator(s) to supply the same pulse to all pulse counters to be certified with the console.

(2) If one generator cannot control all of the counters to be certified at one time connect it to the maximum number of counters the generator can control.

(3) If another generator is available connect it to the remaining counters to be certified.

(4) If there is only one pulse generator available the test must be repeated for the remaining pulse counters to be certified.

7.10.4.2 Pulse Generator Test Setup

(1) Connect the appropriate pulse counter(s) to each position that operates as a pulse generator.

7.10.5 Procedure

(1) Connect the console as described in Pulse Counter Test Setup.

(2) Supply a minimum of 1000 pulses into the pulse counter(s) under test, at a rate equal to the maximum pulse rate, the console is used to verify.

(3) If all the counter positions/channels cannot be tested at one time, repeat (1) & (2) for the remaining pulse counters.

(4) The expected number of pulses counted by the pulse counters must be within ± 1 pulse. Any pulse counter that does not meet this tolerance will not be certified to be used for testing of pulse meters.

(5) Enter the position and number of pulse counters to be certified on the worksheet.

(6) Connect the console as described in Pulse Generator Test Setup.

(7) Set the generators to supply a minimum of 1000 pulses into the pulse counters at the maximum rate the generator is to be certified for. This rate is not to be less than the maximum pulse rate of the meters with pulse outputs, the console is used to verify.

(8) The number of generated pulses at each position/channel to be certified must be within ± 1 pulse. Any pulse generator that does not meet this tolerance will not be certified for testing pulse recorders or any other device that operates from a generated pulse and used for revenue billing.

(9) Enter device identification "Device ID" (assigned in first part of worksheet) for the position and/or channel being tested on the worksheet.

(10) On the worksheet indicate if the console is to be certified for counting or generating live, dry, or both types of pulses, and also indicate if the pulse counters and generators are capable of counting and generating two wire, three wire, or both types of pulses.

7.11 Rangeability

7.11.1 Scope

This procedure relates to section 7.11 of the Specifications. It is used to determine compliance to the rangeability requirements set out in section 7.11 of the Specifications.

7.11.2 General

In this procedure a Radian RM-109 is used to simulate maximum detectable postive and negative meter errors and the console is checked to see if it is capable of determining the simulated error.

7.11.3 Apparatus

Refer to the procedure entitled "Basic Procedure for Conducting Accuracy Tests" in section 7.1.2 of this document.

7.11.4 Setup

Setup the test as outlined in the "Basic Procedure for Conducting Accuracy Tests" as referenced in 7.1.2 above.

7.11.5 Procedure

(1) Simulate the maximum detectable positive error by setting the thumb wheel switches on the RM-109 according to the following formula:

$$\mathbf{TWS_e = TWS_c * [100/(100+e)]}$$

where:
TWS_e = thumb wheel setting to simulate error
TWS_c = thumb wheel setting with no deliberate error
e = desired error in percent.

(2) Using the formula above and the following example conduct a basic accuracy test.

Example:

TWS_c is set at 15.0000 for the basic accuracy test. To introduce an error of e = +3 percent (i.e., to emulate a meter under test which is 3 percent fast) the thumb wheels should be set to:

(3) In the worksheet enter the console reading under the "true error" column and enter maximum detectable postive error under the "calculated error" column.

(4) The console is capable of determining the simulated error if the error difference is within the applicable tolerance (0.2% for energy meters).

(5) Repeat steps 1-3 for the maximum detectable negative error and enter the maximum detectable negative error in the "calculated error" column of the worksheet.

P-E-01 Annex

Measurement Canada | Mesures Canada

Procedures - Worksheets

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	Supersedes: **P-E-01 (rev. 2)**	

Workwheets for Calibrating and Certifying Electricity Calibration Consoles

P-E-01-E (rev.3) ANNEX Summary of Amendments

Section	Description
General	Various minor editorial revisions have been made the tables to reflect the revisions to S-E-01 and P-E-01.
6.3.8	Table removed as this section has been removed from S-E-01.
7.11	Table revised to remove errors less than the maximum detectable.

Console Number:_____________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

1.0 General

Calibration Console Summary Information					
Owner:			**Owner's No:**		
			District:		
Manufacturer:			**Location:**		
Model:			**Number of Positions**	Energy	
Serial No.:				Demand	
Owner has verified compliance to applicable requirements.				Yes	No
Recommended for Certification	Yes	No	**Accredited**	Yes	No
Date of last certification (if applicable): ____________________					
Software/Firmware Version:					
Bias Transformer Settings: (if applicable)					
Regulator Damping Settings: (if applicable)					
Date tests completed:					
Tests performed by (Inspector): **Signature:**			Date:		
Approved by (District Manager): **Signature:**			Date:		

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

1.0 General (Continued)

Reference Meter Data	
Energy Reference Meters	**Demand Reference Meters**
Type (W•h, va•h, var•h):	Type (W, va, var):
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Pulses rate:	Response type:
Type (W•h, va•h, var•h):	Type (W, va, var):
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Pulses rate:	Response type:
Type (W•h, va•h, var•h):	Type (W, va, var):
Manufacturer:	Manufacturer:
Model:	Model:
Serial No:	Serial No:
Pulses rate:	Response type:

Console Number:______________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

Calibration Console Usage Summary			
Enter a checkmark when applicable	✔	Enter a checkmark when applicable	✔
watt hour		watt	
volt ampere hour (average)		volt ampere (average)	
volt ampere hour (RMS)		volt ampere (rms)	
var hour		var	
Q - hour			
Verification		Reverification	
Single phase testing		Polyphase testing	
Test meters without test links		At how many positions?	
Provisions for testing block interval demand using energy test methods		At how many positions?	
Exponential Demand (Electro-mechanical)		Exponential Demand (Electronic)	
Block Interval Demand (Electro-mechanical)		Block Interval Demand (Electronic)	
Number and type of Reference meters to be used at one time			
Maximum pulse rate (Hz) required to be verified for meters having pulse outputs			
Maximum input pulse rate (Hz) required to verified meters (pulse recorders) equipped with pluse input			
Maximum voltage of the highest voltage rated meter: ____________Volts			
Minimum nameplate current of the lowest current rated meter: __________ Amps			
Maximum test current of the meter having the highest current rating: __________ Amps			
The largest test load to be used: _______________ Watts, vars, va, (as applicable)			
Owner has provided test points of all meters console used to verify:			
Owner has provided burdens pursuant to section 5.2.7 of the Specifications:			

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

Meter Burden Data

		Meter Manufacturer	Model	Voltage Rating	Current Range
Single Phase	High Voltage Burden				
	Low Voltage Burden				
Polyphase Self-Contained	High Voltage Burden				
	Low Voltage Burden				
Polyphase Transformer Type	High Voltage Burden				
	Low Voltage Burden				

Regulators, Line Conditioners, Other Equipment

Type of device	Location	Manufacturer	Model	Serial number

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

5.2 Markings and Documentation

5.2.1 Nameplate Information	
Name of Calibration Console Manufacturer	
Model Number	
Serial Number	
Supply Voltage and Configuration	

	Yes	No
5.2.1 Nameplate Acceptable		
5.2.2 Log book Acceptable?		
Maintained?		
Readily Available?		
Weekly Accuracy test results available?		
Persons performing Accuracy tests Identified?		
Adjustments Recorded?		
Maintenance and Repairs Recorded?		
Modifications Recorded?		
5.2.3 Operating Manuals Available?		
Schematic Drawings Available?		
5.2.4 Calibration Consoles Markings Are markings for controls and displays acceptable?		

Console Number:____________	Date of tests:___________	Wksht Pg. _____ of _____

6.0 Technical Requirements

6.2 Environmental Requirements

6.2.1 **Temperature** (ambient)	**Yes**	**No**
Within 23°C ± 5°C?		

6.3 Mechanical Requirements

6.3.1 Indication of Energization	**Yes**	**No**
Master ON/OFF control clearly marked?		
6.3.2 Circuit Protection	**Yes**	**No**
Circuit protection features readily accessible?		
6.3.3 Grounding	**Yes**	**No**
Maximum voltage measured between ground and exposed panels		
Voltage exceeds 30 Vrms		
Voltage exceeds 60 Vdc		
Console equipped with automatic detection system		
Detection system operates correctly		

6.3.4.1 Isolation from Ground		
	High test current	**Low test current**
Maximum voltage between any terminal and ground		
Maximum leakage current between any terminal and ground		
Maximum leakage current after resistor installed		
Maximum voltage measured after resistor installed		

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

6.3.4.2 Isolation of Secondary Circuits From Primary Circuit			
Supply Voltage Configuration Data			
Polyphase Supply Voltages			
3 Phase 4 wire Y		**3 Phase 3 wire delta or network**	
Eab =	Ean =	Eab =	Ea-gnd =
Ebc =	Ebn =	Ebc =	Eb-gnd =
Eca =	Ecn =	Ecb =	Ec-gnd =
En-gnd =			

Single Phase Supply Voltages	
Eline1-line2 =	Eline1-neutral =
	Eline2-neutral =

	Yes	**No**
Are primary circuits isolated from secondary circuits?		

6.3.5 Meter Mounting Arrangements	**Yes**	**No**
Provisions to adjust socket based meters?		

Position	**Angle**		Within Tolerance ($\pm 3°$)	
	Side to side	Front to back	**Yes**	**No**

Console Number:____________ Date of tests:___________ Wksht Pg. _____ of _____

6.3.6 Operating mode	**Yes**	**No**
Console capable of true series-parallel testing. If "Yes" then no further testing is required.		
Console capable of simulated series-parallel testing within tolerances specified in Table 1 of section 6.4.3 of the Specifications Refer to results from tables below		

Voltage and current readings per coil	Phase A (left coil)	Phase B (middle coil)	Phase C (right coil)
Voltage			
Current			

Power reading in Watts		Voltage applied to:		
		Phase A (left coil)	Phase B (middle coil)	Phase C (right coil)
Current applied to:	Phase A (left coil)			
	Phase B (middle coil)			
	Phase C (right coil)			

Standard used:	
Meter-under-test position used:	
Test load used:	
Burden used:	

6.3.7 Individual Elements (Tolerance: 2% Spread)	**Yes**	**No**
Console capable of testing individual elements		
Automatic console		
Semi-Automatic console		

Selector Switch						Tolerance requirements met	
Test Current	Series Current ÷ number of elements	Inner Current	Outer Current	Middle Current	Largest % error of Spread	**Yes**	**No**

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

6.4 Electrical Requirements

6.4.1 Creep switch	**Yes**	**No**
Is console equipped with a creep switch?		
A) Minimum current shown on the nameplate of the lowest current rated meter to be verified on the console.		
B) Maximum voltage of the highest voltage rated meter to be verified on the console.		
C) Maximum allowable energy calculated using formula in section 6.4.1.7.1 of the Procedures		
Is the measured energy less than the maximum allowable energy? (Tolerance is 0.1% of energy expected in 15 minutes at A amps and B volts)		

6.4.2 Maximum Test Voltages and Currents	**Required**	**Measured**
Highest test current used to verify the meters.		
Largest test voltage used to verify the meters.		

6.4.3 Indicating Instruments

Ammeter (amps)				Tolerance: $\pm 2\%$ **Within Tolerance**	
Target Test Current	Indicated Current	True Current	% Error	**Yes**	**No**
0.25					
0.5					
2.5					
5					
10					
25					
50					
100					
150					

Console Number:____________ Date of tests:__________ Wksht Pg. _____ of _____

6.4.3 Indicating Instruments

Volt Meter (volts rms)				Tolerance: ±2% Within Tolerance	
Target Test Voltage	Indicated Voltage	True Voltage	% Error	**Yes**	**No**
Parallel					
120					
240					
360					
480					
600					
Multiple					
120					
240					

Console Number:____________ Date of tests:___________ Wksht Pg. _____ of _____

NOTE: Use the table below as a template for each quantity to be evaluated for power indicating instruments. Check (✓) the appropriate quantity being evaluated.

Power indicating instruments table is not applicable if standard is used to set load.

6.4.3 Indicating Instruments				Tolerance: ±2%	
Watt Meter ___, Volt ampere (rms) Meter ___, Volt ampere (avg) Meter ____, Var Meter ____					
Target value	Indicated value	True value	% Error	**Within Tolerance**	
				Yes	**No**

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** ____ **of** ____

6.4.3 Indicating Instruments					
Phase Angle Meter				Within tolerance (Tolerance varies)	
Target voltage, current, and phase angle	Indicated phase angle or Pf	True phase angle or Pf	Angular Error or % Error	**Yes**	**No**
For consoles used to test watt and volt ampere meters					
120v, 2.5a, 0°					
120v, 2.5a, -60°					
120v, 50a, 0°					
120v, 50a, -60°					
600v, 2.5a, 0°					
600v, 2.5a, -60°					
600v, 50a, 0°					
600v, 50a, -60°					
Consoles used to test var meters					
120v, 2.5a, -30°					
120v, 2.5a, -90°					
120v, 50a, -30°					
120v, 50a, -90°					
600v, 2.5a, -30°					
600v, 2.5a, -90°					
600v, 50a, -30°					
600v, 50a, -90°					

Console Number:____________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

6.4.4 Accuracy and Repeatability of Load Setting				**Yes**	**No**
Calibration console capable of setting loads automatically					
	Current	Voltage	Phase Angle	Power	
Target					
1st setting					
2nd setting					
3rd setting					
Spread					

Tolerances are specified in Table 1 of the Specifications.	**Yes**	**No**
Are test results within tolerances specified?		
Is the console required to be certified for use in manual mode only?		
Can voltages, currents, and phase angles be manually set to tolerances specified in Table 1 of the Specifications		

Standard used:	
Meter-under-test position used:	

Console Number:____________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

6.4.5 to 6.4.7 Calibration Console Energy and Demand Reference Meters

	Energy Reference Meter		**Pulse Rate Within Tolerance**		**Number of Significant Digits of error displayed**
	Energy Reference Meter		**Pulse Rate Within Tolerance**		**Number of Significant Digits of error displayed**
	Yes	**No**	**Yes**	**No**	
watt hour					
volt ampere hour (rms)					
volt ampere hour (avg.)					
var hour					

	Yes	**No**
Are additional reference meters to be used with the console?		
Are certificate of errors for additional reference meter(s) attached		

Tolerance: Pulse rate of one pulse for every 0.00300 watt hours, volt ampere hours or var hours, display the errors to a resolution of one significant digits to right of decimal point when used for verification tests.

	Electromechanical Meter Testing		**Electronic Meter Testing**		**No. of Significant Digits within tolerance**	
Demand Reference Meters	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
watt						
volt ampere (rms)						
volt ampere (avg)						
var						

Tolerance: 4 digits of resolution displayed for Electromechanical meter testing and 5 digits for Electronic meter testing.

Console Number:_____________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

6.4.8 & 6.4.9 Control Circuits for Energy and Demand Meters			**Yes**	**No**
Console automatically displays meter under test error				
Provision for counting reference meter pulses				
No. of significant digits of error displayed				
No. of positions equipped with optical light sensors				
Type of Control Circuit	**Yes**	**No**	**# of Test Positions**	
Triggers on a black mark of an induction meter disc				
Triggers on a creep hole of an induction meter				
Triggers on LED pulses				
Triggers on Infrared pulses				
Provision for counting meter pulses				

Tolerance: Calibration consoles equipped with devices that automatically detect the disk revolutions of electromechanical energy meters or the test energy pulses provided by an electronic meter, shall be capable of detecting successive revolutions without error.

Control Circuits for Demand Meters	**Yes**	**No**
Provisions for synchronizing energy reference meter start/stop with demand interval start/stop.		
Electrical units used with control circuit for Demand Meters		
watt hour		
volt ampere hour (rms)		
volt ampere hour (average)		
var hour		

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

6.4.10 Statistical calculations

Acceptance Sampling			**Compliance Sampling**	
MUT Position		**Error**	**MUT Position**	**Error**
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
	Console Calculated	**Manually Calculated**	**Console Calculated**	**Manually Calculated**
$\overline{X}$				
S				

	Yes	**No**
Console performs statistical calculations in accordance with the requirements of Measurement Canada approved sampling plans?		
Console software formulae conform to Measurement Canada approved statistical methods?		

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

7.0 Metrological Requirements

7.1.4 Test Loads	**Yes**	**No**
Console intended to be used to verify single-phase self-contained meters only?		
Console intended to be used to verify polyphase transformer type meters in addition to any and all other meter types?		
Consoles intended to be used to verify single phase and/or polyphase, self contained meters only?		
Consoles intended to be used to verify meters at 50% power factor loads?		
Console equipped with 1:1 isolation transformers?		
Test load to be used for all Metrological Requirement Tests (see section 7.1.4.2.3 of the Procedure):		

Test Burdens	**Yes**	**No**
A) Console intended to be used to verify single-phase self-contained meters only.		
B) Console intended to be used to verify polyphase transformer type meters in addition to any and all other meter types.		
C) Consoles intended to be used to verify single phase and/or polyphase, self contained meters only.		

	High Burden	Error	Low Burden	Error
A) For consoles used with single-phase self contained meters.				
B) For consoles used for polyphase transformer type meters.				
C) For consoles used for single phase and/or polyphase self contained meters				

Test burden to be used in conjunction with the test loads specified above:		Meter-under-test position # used to perform above tests	

Console Number:____________ **Date of tests:**___________ **Wksht Pg.** _____ **of** _____

7.2 Burden Effects	**Tolerance:** **Maximum Allowable Error:**		0.1% change in error Section 7.8 of Specifications	
	Burden			Within tolerances	
	High	Low	Spread	Yes	No
7.2.5.1 Position # _____					
7.2.5.2 Position # 1					
7.2.5.2 Position # 2					
7.2.5.2 Position # 3					
7.2.5.2 Position # 4					
7.2.5.2 Position # 5					
7.2.5.2 Position # 6					
7.2.5.2 Position # 7					
7.2.5.2 Position # 8					
7.2.5.2 Position # 9					
7.2.5.2 Position # 10					

7.3 Sensitivity to Number of Meters Under Test	
Tolerance: ± 0.1 % difference	
Error with reference standard only	
Error with reference standard and meters in all other positions	

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

7.4 Variation from position to position

Position on the Console

	1	2	3	4	5	6	7	8	9	10
Error										
	11	12	13	14	15	16	17	18	19	20
Error										

Maximum permissible spread: 0.2%

Maximum spread:		
Maximum spread within tolerances?	**Yes**	**No**
All tolerances within requirements of Section 7.8 of the Specifications?		

Console Number:____________ **Date of tests:**____________ **Wksht Pg.** _____ **of** _____

7.5 Distortion				
Tolerance for thermal meters: 3%			**Yes**	**No**
Console to be used with recti-thermal meters?				
Distortion tests conducted at console position #: ____________				
Burden used:				
Output	Test Load	Recti-thermal meters in circuit. (Y/N)	Regulators in circuit. (Y/N)	Distortion %
Current	2.5 amps	Y	N	
Current		Y	N	
Current	2.5 amps	N	N	
Current		N	N	
Voltage	120 volts	Y	N	
Voltage		Y	N	
Voltage	120 volts	N	N	
Voltage		N	N	
Current	2.5 amps	Y	Y	
Current		Y	Y	
Current	2.5 amps	N	Y	
Current		N	Y	
Voltage	120 volts	Y	Y	
Voltage		Y	Y	
Voltage	120 volts	N	Y	
Voltage		N	Y	

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

7.5 Distortion (contd.)				
Tolerance for any other meter types: 5% THD				
Meter-under-test position used:				
Burden Used:				
Output	Test Load	Specified meters in circuit? (Y/N)	Regulators in circuit? (Y/N)	Distortion %
Current	2.5 amps	Y	N	
Current		Y	N	
Voltage	120 volts	Y	N	
Voltage		Y	N	
Current	2.5 amps	Y	Y	
Current		Y	Y	
Voltage	120 volts	Y	Y	
Voltage		Y	Y	

Console has 1:1 CT's or multiple secondary tap PT's?	**Yes**	**No**

7.6 Regulation	**Automated test results**
Tests conducted at position number:	
Applied test load (low load)	
A) Hour Test (±0.25% tolerance)	
B) Maximum variation between 1 minute energy tests (±0.3% maximum deviation from the expected energy for electromechanical meters) (±0.2% maximum deviation from expected energy for all others).	
Applied test load. (high load)	
A) 1 Hour Test (±0.25% tolerance)	
B) Maximum variation between 1 minute energy tests (±0.3% maximum deviation from the expected energy for electromechanical meters) (±0.2% maximum deviation from the expected energy for all others).	

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

7.7 Current Switching Effects	**Yes**	**No**
Transformer(s) connected between reference meter and meter-under-test position(s)?		
Console used to test single phase meter only?		
Console used to test transformer type meters in addition to all other types?		
Console used to test self-contained single-phase and polyphase meter only?		
Test load and test burden		

	Test 1	**Test 2**	**Test 3**	**Test 4**	**Test 5**	**Max error spread**
Error						

Max allowable error spread: 0.2% Max allowable error tolerance: see section 7.8 of Specifications	**Yes**	**No**
Error spread within tolerance?		
Errors within allowable tolerance?		

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

NOTE: Use this table as a template for each quantity or reference meter that the console is being certified for.

7.8 Console Calibration

Quantity being measured (W, Wh, VA, Vah, etc)			**Reference Meter (Serial or Model or Owner's) Number**		
	Yes	**No**	Position Number		
Parallel Transformer connections				**Yes**	**No**
Multiple Transformer Connections			1:1 Transformers in circuit		
Position to position errors < 0.1%?			Intervening transformers in test circuit		

Voltage	**Current**	**Phase Angle**	**Voltage tap**	**Current Tap**	**Selector switch setting**	**E_{meas} (Measured Error)**	**E_{std} (Certified Error)**	**$E_{cons+ref}$ (E_{meas}-E_{std})**

Console Number:____________ Date of tests:__________ Wksht Pg. _____ of _____

NOTE: Use this table as a template for each quantity or reference meter that the console is being certified for.

7.9 Interchangeable Console Reference Meters							
Quantity being measured (W, Wh, VA, Vah, etc)				**Interchangeable Reference Meter (Serial or Model or Owner's) Number**			
Voltage	**Current**	**Phase Angle**	$E_{cons+ref}$ (From 7.8)	E_{ref} (NRC traceable errors of reference used in Sec. 7.8: calibration)	$E_{cons} = E_{cons+ref} - E_{ref}$ (Equation (1))	E_{ref} (Interchangeable standard)	$E_{cons+ref} = E_{cons} + E_{ref}$ (Equation (2))

Console Number:____________ Date of tests:___________ Wksht Pg. _____ of _____

7.10 Pulse Counters and Generators

				Type of pulses to be certified							
Device I.D.	Built-in/ External	If External: Make: Serial#:		Count./ Gen.	# Pos. / Chan.	Live	Dry	Both	2 wire	3 wire	2&3 wire
A											
B											
C											
D											

7.10 Pulse Counters (Tolerance ± 1 Pulse)

Device I.D.	Position / Channel #	Frequency	Pulse Counter Reading	Reading of Standard	Difference

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

7.10 Pulse Generators (Tolerance ± 1 Pulse)

Device I.D.	Position / Channel #	Frequency	Pulse Generator Reading	Reading of Standard	Difference

7.11 Rangeability **Tolerance:** see section 7.8 of Specifications (0.2% for energy meters)

	Yes	No
Console used for acceptance sampling?		
Console used for compliance sampling?		

Applied Load: Current: __________ amps Voltage: __________volts

Nominal Error	True Error	Calculated Error	Difference
enter maximum detectable postive error. Must be representative of those expected for console use.			
enter maximum detectable negative error. Must be representative of those expected for console use.			

Console Number:____________ **Date of tests:**__________ **Wksht Pg.** _____ **of** _____

Comments

General and/or specific comments respecting the operation/use/limitations of the calibration console:

Console Number:____________ Date of tests:__________ Wksht Pg. _____ of _____

Test Equipment Used for Console Calibration Tests

Item	Make & Model No.	E-number or Serial number	Calibration Expiry Date
Energy Standard(s)			
Demand Standard(s)			
Voltage Standard			
Current Standard			
Level / Inclinometer			
Phase Standard			
Distortion Analyzer			
Thermometer			
Calibration Controller (RM-109)			
Regulation Test Equipment			
Pulse Counter			
Pulse Generator			
Current Transformer			
Multi-meter			
Other Equipment			

P-E-02

Mesures Canada

La mesure juste pour tous

Measurement Canada

Fair Measure For All

November 2, 1998

Subject: **P-E-02: Procedure for Generating and Issuing a Certificate of Calibration for Consoles Compliant with the Requirements of S-E-01**

This document is a companion document to S-E-01: Specifications for the Calibration, Certification, and Use of Electricity Calibration Consoles and P-E-01:Procedures for Calibrating and Certifying Electricity Calibration Consoles Pursuant to the Requirements of S-E-01. It sets out the procedure for generating, issuing, and maintaining certificates of calibration for consoles that meet the requirements of S-E-01, and for issuing extension certificates.

Section 5.1.2.1 of P-E-01 describes the certification process for calibration consoles, however the detailed procedure for issuing a certificate is not provided. This document fills the void. It is intended to be used by Measurement Canada staff as an aid to generating calibration console certificates. Sample certificates, and cover letters are appended to the procedure.

Effective December 1, 1998, all certificates for calibration consoles will be issued under the authority of the Regional Director. This also applies to extension certificates for consoles certified under specifications LMB-EG-12 or PS-E-03. The Director, Marketing and Business Operations, will continue to issue certificates until December 1, 1998. In addition, effective December 1, 1998, the quality control role performed by the Engineering Division of Measurement Canada will be discontinued. It is recommended that this quality control role be performed by the Regional Electricity Specialist prior to signature of the certificate by the Regional Director.

Please note that the delegated authority for the certification of electricity measuring apparatus, pursuant to subsection 8(1) of the *Electricity and Gas Inspection Regulations,* has been limited to the Regional Directors and is not extended, at this point, to the District Managers or the Regional Specialists.

Additional copies of this document are available through:

Measurement Canada - Program Development Division
11 Holland Avenue
Tower A
5th Floor, Suite 513
Ottawa, Ontario
K1A 0C9

Once translated, this procedure will also be posted on Measurement Canada's Website which can be found on the Internet at http://mc.ic.gc.ca.

For any enquiries, please contact the Program Development Division at (613) 952-0657, and ask for the Program Officer responsible for Electricity.

Gilles Vinet
Vice-President, Program Development

Un organisme d'Industrie Canada

An Agency of Industry Canada

Canada

P-E-02

PROCEDURE FOR GENERATING AND ISSUING A CERTIFICATE OF CALIBRATION FOR CONSOLES COMPLIANT WITH THE REQUIREMENTS OF S-E-01

Table of Contents

1.0 SCOPE

This document describes the procedures for generating and issuing a certificate of calibration for consoles that have been tested and found compliant to the requirements of S-E-01: Specifications for the Calibration, Certification, and Use of Electricity Calibration Consoles.

1.1 General

S-E-01 identifies, in section 5.2 Roles and Responsibilities, that Measurement Canada is responsible for issuing any certificate ensuing from the calibration of a console.

This document provides procedures, notes, and templates that will aid in the generation of a certificate. It also identifies requirements for maintaining and updating certificates.

2.0 REFERENCES

1) Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles (S-E-01, Measurement Canada, 1998-07-08).

2) Procedures for Calibrating and Certifying Electricity Calibration Consoles pursuant to the Requirements of S-E-01 (P-E-01, Measurement Canada, 1998-07-08)

3.0 PROCEDURE FOR GENERATING CERTIFICATES OF CALIBRATION

3.1 New Certificates

1) Ensure that all applicable information has been provided in the worksheets.

2) Ensure that the worksheets have been signed and dated.

3) Enter all data as required on the first page of the certificate using the sample certificate found in the appendix, as a template.

4) Assign a unique certificate number in accordance with the following numbering scheme:

EG-XXX-YY-ZZZ

Where:	XXX:	-->	PAC for Prairie Region
			PRA for Prairie Region
			GOR for Greater Ontario Region
			COR for Central Ontario Region
			QUE for Quebec Region
			ATL for Atlantic Region
	YY:	-->	Issue year of certificate eg. 98 for 1998
	ZZZ:	-->	Sequential number assignment (001-999)

5) Assign an expiry date that is one year from the date the tests were completed.

6) The last paragraph of the sample certificate may be modified so that it reflects only those quantities that the console is being certified for.

7) In the note on the second page, a file number can be obtained from the records office at headquarters. The file number usually identifies the owner of the console.

8) Following the note, enter any bias transformer settings that may be applicable to the console.

9) If the console uses has any software or firmware, enter the appropriate revision number(s).

10) Enter all reference meter information as applicable.

11) Enter any restrictions or other notes concerning the certification or use of the console.

12) Complete the tables of errors for each quantity that the console is being certified for.

13) Ensure that table header information is included on each new page that contains table data.

14) If the console does not have tap settings or selector switch settings then these columns may be removed from the table of errors.

15) Under the column for console errors, include the "+" sign for positive errors and the "-" sign for negative errors.

16) If the console is to be used with interchangeable reference meters, include a list of all interchangeable reference meters on the Notes page.

17) For each interchangeable reference meter, include a table of errors similar to the table of errors completed in step 12 above.

18) Ensure that each page is numbered indicating the total number of pages in the certificate. The certificate number should be placed on each page of the certificate.

19) Generate a cover letter using the sample in the appendix, as a template.

20) Have the certificate and cover letter signed by the regional director and send to the owner of the console.

21) Send a copy of the signed certificate, cover letter, and worksheets to the records office at headquarters in Ottawa, to be filed under the file number obtained in step 7) above.

22) Send a copy of the signed certificate and cover letter to the Vice-President, Intervention Strategies.

3.1 Extension Certificates

1) Ensure that the console meets the criteria for automatic renewal of certificates as outlined in bulletin E-17.

2) Issue an extension certificate similar to the original certificate, however, revise the certificate number to include the suffix identifying the renewal year.

   e.g. **EG-XXX-YY-ZZZ-A**

EG-XXX-YY-ZZZ	->	Original certificate number
A	->	Numerical identifier for year of automatic renewal (1 or 2, see Bulletin E-17)

3) The new expiry date should also be revised to reflect the one year extension.

4) Send the extension certificate to the owner of the console with an attached cover letter. A sample cover letter is also provided in the appendix.

3.2 Amendments

Calibration console certificates that require corrections, additions, or other amendments may be reissued under the original certificate number, however, a revision number shall be included with the certificate number.

e.g. **EG-XXX-YY-ZZZ-A Rev. xx**

EG-XXX-YY-ZZZ	->	Original certificate number
A	->	Numerical identifier for year of automatic renewal (1 or 2 see Bulletin E-17)
Rev. xx	->	Revision number xx, where "xx" is sequentially ordered starting with 01.

APPENDIX

Sample Certificate

Sample Cover Letter

Sample Extension Certificate Cover Letter

Measurement Canada

Mesures Canada

Certificate No.:	EG-XXX-YYY
Issue Date:	YY/MM/DD
Expiry Date:	YY/MM/DD

CERTIFICATE FOR CALIBRATION CONSOLE

Owner: A.B.C. Public Utility
Manufacturer: Console Makers Ltd
Serial No.: 123456
Owner's No: 7890

Model: 0001
 # Of Positions: 10 Energy, 10 Demand
Location: Anywhere, Anyprovince

This is to certify that the above stated calibration console was examined, duly calibrated with respect to reference standards, and found to comply with all applicable requirements outlined in sections 7 and 8 of the ***Electricity And Gas Inspection Regulations*** and S-E-01. A statement of the calibration console errors is attached.

The calibration console is certified to be used as a measuring apparatus for the purpose of testing electricity meters as specified hereunder.

This calibration console is hereby certified to be used for the verification, reverification and sample testing of single-phase and polyphase watt hour, volt ampere hour, and var hour energy meters and watt, volt ampere, and var demand meters.

Regional Director

Date

Note: Refer to the test/calibration report dated 23 April 1997 on file: abcd-efgh (*List file number obtained in step7 of Procedure for Generating certificates of Calibration.)*

Bias Transformer Settings

	Internal	**External**	**1:1**
F.L.			
P.F.			
L.L.			

Software/Firmware Version ______________________________

Console Reference Meters

Energy Reference Meters	**Demand Reference Meters**	
Type (W•h, va•h, var•h):	Type (W, va, var):	
Manufacturer:	Manufacturer:	
Model:	Model:	
Serial No:	Serial No:	Owners No.:
Owners No.:	Response Type:	
Type (W•h, va•h, var•h):	Type (W, va, var):	
Manufacturer:	Manufacturer:	
Model:	Model:	
Serial No:	Serial No:	Owners No.:
Owners No.:	Response type:	
Type (W•h, va•h, var•h):	Type (W, va, var):	
Manufacturer:	Manufacturer:	
Model:	Model:	
Serial No:	Serial No:	Owners No.:
Owners No.:	Response type:	

Additional Notes, Comments, Restrictions

Official Console Errors			
*Quantity being measured (**Watt, Watt hours, Volt ampere, Volt ampere hour**, etc.)*			
Position Number		**Reference Meter** *(Serial or Model or Owner's)* **Number**	
		Yes	**No**
Parallel Transformer in circuit			x
Multiple Transformer in circuit		x	
1:1 Transformers in circuit		x	

Voltage (Volts)	Current (Amps)	Phase Angle	Voltage tap	Current Tap	Selector switch setting	Error %
120	*2.5*	*0 °*	*120*	*5*	*2.5*	*0.03*
120	*2.5*	*60 °*	*120*	*5*	*2.5*	*-0.04*
120	*50*	*0 °*	*120*	*100*	*50*	*0.00*
120	*50*	*60 °*	*120*	*100*	*50*	*-0.01*
240	*2.5*	*0 °*	*240*	*5*	*2.5*	*-0.11*
240	*2.5*	*60 °*	*240*	*5*	*2.5*	*0.09*
240	*50*	*0 °*	*240*	*100*	*50*	*0.08*
240	*50*	*60 °*	*240*	*100*	*50*	*0.00*
...	...	...	...	...	...	...
...	...	...	...	...	...	...
...	...	...	...	...	...	...
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...	...	...	...	...	...	...

Measurement Canada
11 Holland Avenue
5th Floor, Suite 513
Ottawa, Ontario
K1A 0C9

Mesures Canada
11, avenue Holland
5e étage, Bureau 513
Ottawa (Ontario)
K1A 0C9

Your file Votre référence

Our file Notre référence
026572-S2

March 30, 1998

A Console Owner
234 Main Street
Mississauga Ontario A1B 2C3

Attention Mr. Tom Smith

Dear Sir:

Re: Certificate for Calibration Console

Please find enclosed certificate EG-COR-98-001 for your calibration console #E1234.

Sincerely,

Regional Director,

cc Vice-President, Intervention Strategies
District Manager, Mississauga

Enclosure

Measurement Canada / Mesures Canada

11 Holland Avenue / 11, avenue Holland

5th Floor, Suite 513 / 5e étage, Bureau 513
Ottawa, Ontario / Ottawa (Ontario)
K1A 0C9 / K1A 0C9

Your file / Votre référence

Our file / Notre référence
026572-S2

March 30, 1998

A Console Owner
234 Main Street
Mississauga Ontario A1B 2C3

Attention Mr. Tom Smith

Dear Mr Smith:

Re: Certificate for Calibration Console

Please find enclosed certificate EG-COR-98-001-1 for your calibration console #E1234. The certificate has been extended to 1999-04-23.

At the term of the second extension, the calibration console must be calibrated against the full range of tests currently specified in S-E-01 dated 98-07-08. If the measuring apparatus meets all of the applicable requirements, it shall be certified by the Regional Director for a period of one year.

For more information please contact the local District Manager of Measurement Canada.

Sincerely,

Regional Director,

cc Vice-President, Intervention Strategies
District Manager, Mississauga

Enclosure

November 2, 1998

Subject: **P-E-02: Procedure for Generating and Issuing a Certificate of Calibration for Consoles Compliant with the Requirements of S-E-01**

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For any enquiries, please contact the Program Development Division at (613) 952-0657, and ask for the Program Officer responsible for Electricity.

Gilles Vinet
Vice-President, Program Development

P-E-04

Table of Contents

Procedures

Category: ELECTRICITY	Procedure: P-E-04	Page: 1 of 13
Document(s): S-E-04	Distribution Date: 2008-06-27	Effective Date: 2008-06-27
	Supersedes:	

Generic procedures for conducting installation verifications of Multiple Customer Metering Systems

1.0 Background

The initial installation verification of all multiple customer metering systems (MCMS) are required to be inspected concurrent with the commissioning process where possible, but no later than one year from the date that the system is activated, in accordance with section 7.2 of S-E-04.

2.0 Purpose

This document is intended to provide generic procedures for Measurement Canada Inspectors to perform inspection of MCMS, where device specific procedures are not available.

3.0 Scope

These procedures apply to all MCMS, including those which use separately approved instrument transformers and are being used for the purpose of obtaining the basis of a charge for electricity in Canada.

4.0 Definitions

Commissioning
The process or procedure used during installation of MCMS prior to activation to ensure the system is operating correctly. (For example, the process for assessing that current sensors or instrument transformers are connected to the correct load and associated with the applicable voltage connections).

Contractor
Any person or body that has undertaken to supply electricity or gas to any purchaser.

Metering Point
An individual meter, found in a multiple customer metering system.

Multiple Customer Metering Systems (MCMS) or Device
Metering systems which fulfill one or both of the following criteria:

(a) systems which require on site central processing of meterological information for more than one metering point.

(b) systems which employ external sensors which are integral to the meter. These systems generally are used in multi customer applications, however they can operate as stand alone, single point meters.

5.0 Responsibilities

5.1 The contractor is responsible to provide the original Inspection Certificates and Configuration Charts for the system in question, in addition to a wiring chart of the system showing the physical location of all metering components within the complex, when required.

5.2 The contractor is also responsible to provide a representative with authority to access all metering points.

5.3 The Inspector or Accredited Organization is responsible to verify that the Contractor has fulfilled all general, administrative and technical requirements of S-E-04.

6.0 Guidelines

6.1 Preliminary

Prior to conducting any field inspections, the Inspection Certificates generated from the initial verification of the system and the applicable Configuration Charts are required. These documents should be supplied by the contractor and will show how the system was configured during the initial verification (in a meter shop), indicating number of metering points per unit, type of metering (1, 2 or 3 elements) association between voltage and current sensors and /or instrument transformers, along with the appropriate connection points for each (where applicable).

6.2 Visual Examination

6.2.1 A preliminary visual examination should be conducted on the components of the system required to be inspected to confirm the location of all metering points, terminal interfaces and host meter(s).

6.2.2 Under ideal circumstances, all metering components (host meter, current sensors, voltage sensors, instrument transformers, main disconnects, etc.) will be located in one central location or electrical room, however in situations where this is not the case, it is important to establish the number of metering points and there individual locations in relation to the host meter prior to beginning inspections.

6.2.3 Example worksheets (Appendix A, B and C) are provided, which address the General, Administrative, and Technical Requirements of S-E-04. Appendix A and portions of appendix B worksheets should be completed prior to carrying out inspections. Appendix C worksheet, which relates to technical information may be completed during on-site inspection work. Record any characteristics which are not in compliance with sections 5.0, 6.0 and 7.0 of S-E-04.

6.3 Installation Verification

6.3.1 This section is in reference to section 7.0 of S-E-04 and is to confirm that the installation of the system is consistent with the systems configuration at the time of it's initial verification in the meter shop. This is accomplished by verifying that all voltage and current sensors and /or instrument transformers are properly identified, properly associated with correct phase and connected to the correct point on the host meter.

6.3.2 The systems configuration chart will be required in determining that the system is properly connected. The most effective and efficient means of conducting this work is by visual inspection, whenever possible.

6.3.3 However, if visual inspection is not possible or does not provide conclusive evidence of correctness of the installation, other options may be used, such as taking voltage readings, de-energizing circuits, using circuit tracers or taking cross phase readings.

6.4 Voltage Sensors

6.4.1 Verify that all associated phases and neutral are connected to the appropriate terminals at the voltage disconnect switch and the appropriate meter connection points according to meter wiring diagrams.

6.4.2 For example, if voltage connections are colour coded, verify Red, Yellow, Blue, and White wires are connected to A,B,C, and N phase connection points at the meter.

6.4.3 In systems which utilize external voltage sensors or transducers, you will need to verify correct connection from supply source to primary side of voltage sensor / transducer and then from the secondary side of voltage sensor / transducer to voltage connection points on metering unit.

6.4.4 The configuration chart in this case will show the voltage sensor's serial number, which phase it should be associated with and which connection points on the metering unit it should be connected to. If local codes or labeling is used, the metering equipments manufacturer should be consulted to determine standardized wire coding for both current and voltage sensors.

6.4.5 For example, in referring to the configuration chart in Appendix E, it show's that voltage sensor number A150 should be associated with A phase, and connected to meter connection points 1 and 2. The chart also shows this sensor to be rated for 120 volts.

6.4.6 If visual inspection is not possible or conclusive, then verification may be completed by use of voltage measurements, between initial supply connection point to meter voltage input connections. A reading of "zero volts" will confirm that, for example, A phase meter input is connected to A phase supply.

6.5 Current Sensors / Terminal Interface Connections

6.5.1 If current sensors are directional they need to be verified for correct polarity. Typically, current sensors have a white dot which indicates the line side.

6.5.2 Verify that each current sensor is connected to it's appropriate connection point on the host meter and that each sensor is connected to the proper phase, according to the configuration chart supplied.

6.5.3 This verification requires the inspector to verify that each current sensor has appropriate markings and serial numbers, in addition to verifying that each current sensor is associated with the appropriate meter and appropriate phase for that specific meter.

6.5.4 For example, in referring to the configuration chart in Appendix E, it show's that current sensor, serial number A9950 is a 100 amp sensor associated with meter number 1 and should be connected to A-phase on the customers service. The chart also shows that this sensor is to be connected to points 47 (common) and 48 at the host meter, and also that the host meter is programmed to associate meter 1 with the 120 volt pt's. (Refer to pt association column)

6.5.5 If visual tracing of wiring is not possible or conclusive, then the inspection can be completed using a circuit tracer. Typically a signal will be injected into the current sensor wire at the connection point of the host meter. The configuration chart will identify a specific current sensor being connected to this point, as mentioned above. Using the receiving portion of the circuit tracing unit, identify which current sensor is receiving a signal and then confirm it's correctness according to the chart.

6.5.5.1
Depending on the system being inspected, it may be necessary to isolate the circuit to be checked, to prevent the signal from the circuit tracer simultaneously traveling along more than one set of ct sensor wires.

6.6 Approved Instrument Transformers

6.6.1 Systems which utilize separately approved instrument transformers are also required to conform to the applicable Measurement Canada Standard Drawings. Additional inspection requirements would therefore include.

6.6.1.1
Verifying that all instrument transformers are approved.

6.6.1.2
Verifying that standardize wire coding is in effect. This could be the use of Measurement Canada's color code, a local color code or use of standardized labeling for wiring. In either case, each transformers secondary wiring should be identifiable for each phase, supply and return.

6.6.1.3
Verifying that all secondaries of transformers are tied to a single ground point, to ensure secondary current is not bypassing metering sensors.

6.6.1.4
Verifying that polarity of transformers are correct. Typically a white dot will indicate the line side of the transformer.

6.6.1.5 Verifying that Instrument Transformers are appropriately marked as per their respective approval. Ratio check's may be necessary in order to verify that marked ratio's are correct.

6.7 Phasing

6.7.1 Verify correct phasing between the meters voltage connections and the associated current sensors and /or instrument transformers, according to the wiring configuration chart.

6.7.2 Inspections completed under 6.4, 6.5 and/or 6.6 of this document, may have been sufficient to ensure correct phasing between voltage and current connections, however if this is not the case, then it will be necessary to verify that all A , B and C phase current sensor's are actually connected to the same phase in which the voltages for A, B and C are connected.

6.7.3 Typically this can be accomplished by visual inspection or by taking voltage readings from the voltage connection point at the meter to the phase in which the associated current sensors are connected. A zero volts reading will confirm that these two points are associated with the same phase. This process should be repeated for each phase.

7.0 Sealing

Apply installation seals in accordance with section 8.0 of S-E-04.

8.0 Inspection Certificates

Issue an inspection certificate in accordance with section 21 of the regulations, including a summary of findings. Clearly state on the certificate that this inspection has been carried out under the requirements of S-E-04.

9.0 Fees

Charge the hourly rate for inspectors time and expenses as per Part VI, section 47 of the Regulations.

10.0 Written Report

Summarize your findings in a written report to the contractor describing any action required on the part of the contractor to bring the system into compliance with S-E-04, or any other applicable Measurement Canada requirements. Ensure all potential inequities found during this inspection are properly addressed through appropriate channels.

Appendices

Worksheets for Conducting Installation Verifications of Multiple Customer Metering Systems

Appendix A - General

Date:	District:	Inspector:

General

Contractors Legal Name: Mailing Address :
Name of Firm or Contracting Company Responsible for Installation:

Installation Address:	MCMS Manufacturer:
Date of Activation:	Model:
Number of Host Meters :	Number of Metering Points :

General Comments Relating to the Installation:

Appendix B - Administrative Requirements

5.0 Administrative Requirements

5.1.1 Is the contractor registered to sell power in accordance with the Act?	Registration Number:
5.1.2 Is the device approved for billing purposes?	Approval Number:
5.1.3 Has the system been initially verified in-shop?	Seal Year: Expiry Year :
5.1.4 Have all installation requirements listed in the approval been adhered to? (i.e. - service type, voltage ratings, etc.)	
5.1.5 Has auxiliary equipment been installed in accordance with MC guidelines?	
5.2 Has the contractor supplied notification to MC in accordance with requirements?	
5.3 Has the contractor supplied a representative in accordance with requirements? Name of Representative:	
5.4 Has the required documentation been provided by the contractor?	
5.5 Have you been provided appropriate access to all installation components?	

Comments:

Appendix C - Technical Requirements

6.0 Technical Requirements

6.2 Are all hardware components safely and securely mounted?
6.3 Is there provision for connecting test equipment to all current sensors?
6.4.1 Is the voltage being taken from the same source as the currents? **6.4.2** Is the voltage differential ensure that the measurement error does not exceed the tolerances prescribed by section 31 of the EGIR? **6.4.3** Are the voltage and current circuits separate and distinct?
6.5 Has the installation been wired to facilitate on site testing?
6.6 Has a voltage test block or disconnect been installed? Is the block or disconnect switch rated between 120 v and 600 v?
6.7 Does the system utilize instrument transformers ? If so, does the installation have a current test block ?
6.8 Is all primary and secondary current and voltage wiring visibly traceable and properly identified?
6.9 Are all sensor serial numbers visible, legible and permanently affixed?
6.10 Can the phase relationship between the voltage and current circuit for any given meter be verified?

Comments:

Appendix D - Work Sheet - Installation Inspection

7.0 Installation Inspection

NOTE: This chart should be copied for additional meters.

Host Meter	Meter Number	All voltage sensor and/or voltage connections correct? (Section 7.3.1)	All current sensor and/or transformer connections Correct? (Section 7.3.2)	Is phasing between voltage and current correct? (Section 7.3.3)	Correct Unit or Customer Connected (section 7.4.4)

NOTE: Additional inspection requirements for systems utilizing separately approved Instrument transformers can be found on following page.

Appendix D - Continued - 6.0 Installation Inspections

7.4 Systems Utilizing Separately Approved Instrument Transformers

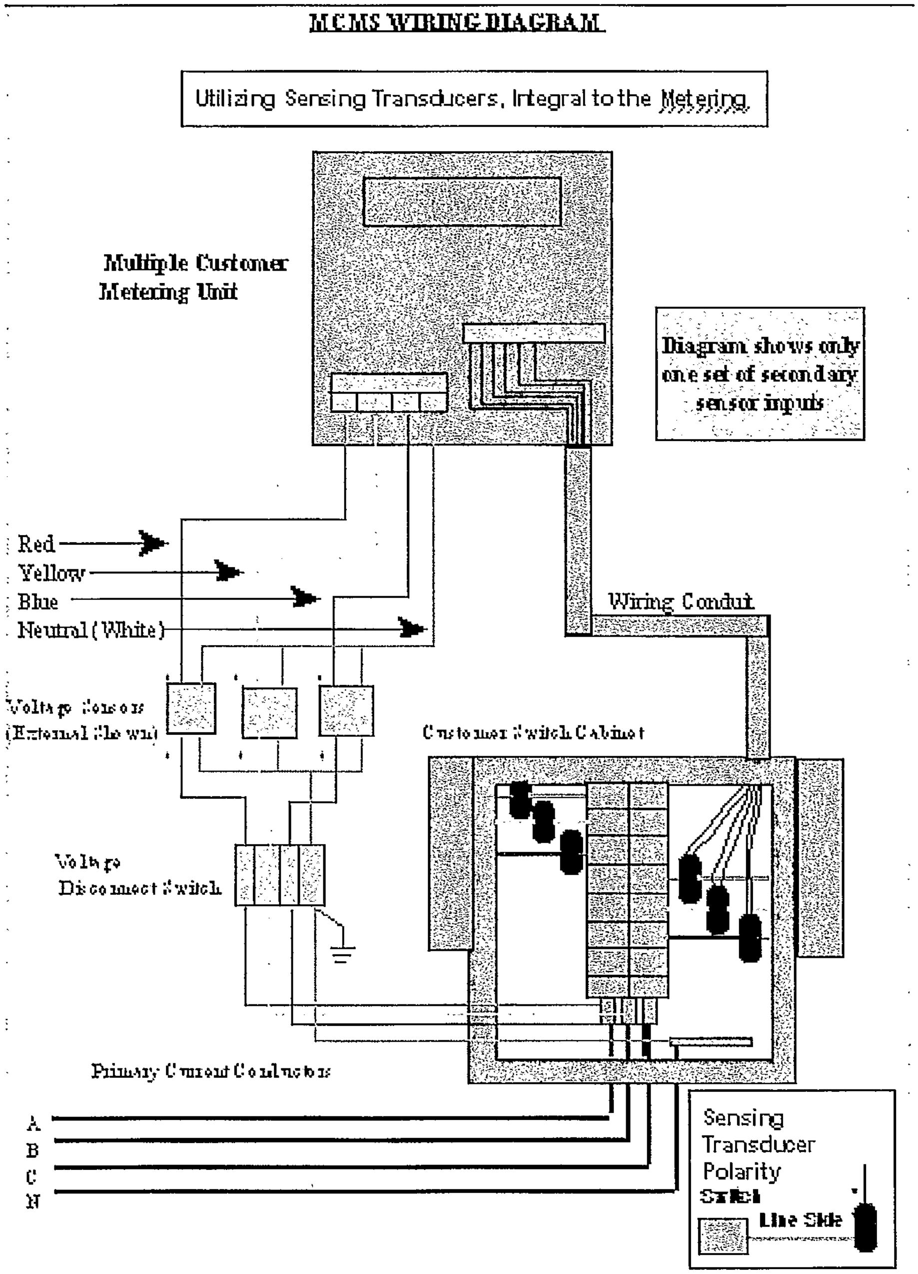
Standard Drawing Associated with Service Type:
7.4.1 Is the system using a standard wire code? Identify Code Used?
7.4.2 Is grounding of secondary wires for instrument transformers correct?
7.4.3 Are the instrument transformers installed according to polarity markings?
7.4.4 Do all instrument transformers have nameplates and appropriate markings? Type of transformers used? Nameplate marked Ratio of transformers? Ratio's confirmed via Dynamic check?
Comments :

Appendix E - Configuration Chart - Example

	Phase	PT #	Host Meter Connection Point	PT Rating	PT Grouping
	A - Red	A150	2 1	120 V	
	B - Yellow	A151	4 3	120 V	"A"
	C - Blue	A152	6 5	120 V	
	A - Red	B250	8 7	347 V	
	B - Yellow	B251	10 9	347 V	"B"
	C - Blue	B252	12 11	347 V	
Meter #	**Phase**	**CT #**	**Connection point**	**CT Rating**	**PT Association**
1	Red	A9950	48 47	100 A	
	Yellow	A9951	50 49	100 A	"A"
	Blue	A9952	52 51	100 A	
2	Red	A7770	54 53	200 A	
	Yellow	A7771	56 55	200 A	"B"
	Blue	A7772	58 57	200 A	

Appendix F

Wiring Diagram - Examples



MCMU STANDARD WIRING DIAGRAM