

STANDARDS



Wholesale Revenue Metering Standard - Hardware

Issue 9.0

This standard provides the principles, accountabilities, and requirements for *metering installations* used for *settlement* in the IESO-administered wholesale market.

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IMP_PRO_0025	Internal Manual 3: Settlements, Part 3.9: Conformance Monitoring
IMP_PRO_0058	Market Manual 3: Metering, Part 3.9: Conformance Monitoring
MDP_GDE_0002	Guide to Documents Published in Baseline 12.1
MDP_PRO_0011	Market Manual 3: Metering, Part 3.5: Site Specific Loss Adjustments
MDP_PRO_0012	Market Manual 3: Metering, Part 3.6: Conceptual Drawing Review
MDP_PRO_0013	Market Manual 3: Metering, Part 3.2: Meter Point Registration and Maintenance
MDP_PRO_0032	Market Manual 5: Settlements, Part 5.2: Metering Data Processing

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Table of Changes

Reference (Section and Paragraph)	Description of Change
Section 6.9.1.b and c	Corrected typographical errors in sections b and c and removed the footnote in 6.9.1.c referencing IEEES C57, 13.6 2005 IEEE Standard for High Accuracy <i>Instrument Transformer</i> .
Section 6.9.1.d	New section describing the selection of current transformer ratios.
Section 6.10.1	Added requirements for current transformers.
Section 6.10.2	Added requirements for voltage transformers.
Section 6.10.3	Added requirements for electronic current transformers.
Section 6.10.4	Added requirements for electronic voltage transformers.
Section 6.10.5	New section regarding monitoring requirements for new electronic <i>instrument transformers</i> .
Section 11.3.2.d	Added reference to s6.9.1 c and d regarding <i>instrument transformers</i> .
Section 16	Added two new terms to the Glossary of Terms: Continuous current rating factor (RF) and High accuracy <i>instrument transformer</i> .
References	Added references to new metering industry standards.

1. Introduction

1.1 General Requirements

1.1.1 Minimum Requirement

This standard sets forth the minimum requirements for wholesale *metering installations*.

1.1.2 Exceeding Minimum Requirement

A *metering installation* of a higher level of accuracy or functionality than that required by this standard may be installed.

1.2 Who Should Use This Document

1.2.1 Applicability

This standard shall be observed by *metered market participants* and by *metering service providers* in the *IESO-administered market*.

1.3 Conventions

The standard conventions followed for this document are as follows:

- The word 'shall' denotes a mandatory requirement;
- Terms and acronyms used in this document that are *italicized* have the meanings ascribed thereto in Chapter 11 of the *market rules*;
- Double quotation marks are used to indicate titles of legislation, publications, forms and other documents.

– End of Section –

2. Scope

2.1 Metering Installations

2.1.1 Applicability to Equipment

This standard applies to the following metering equipment:

- a. *meters*;
- b. *instrument transformers*, cabling, enclosures, test blocks, fuses, conduit and associated *metering installation* accessories;
- c. on-site storage of *metering data*; and
- d. on-site communications equipment and communication protocols.

The equipment is used for the *settlement* of IESO-administered transactions occurring in Ontario's wholesale electricity markets.

2.1.2 Applicability to Installations

This standard applies to *metering installations* in the *IESO-administered market* for:

- a. connection between utility *control areas*;
- b. connection to the *IESO-controlled grid* system;
- c. points of connection between local distribution companies;
- d. connection of *registered market participants* embedded within the local distribution companies;
- e. designated interties with other grid systems; and
- f. any other locations as required by the *IESO* for *settlement* purposes.

2.1.3 New and Existing Metering Installations

This standard applies to new and existing *metering installations* in the *IESO-administered market* for:

- a. new installations constructed after the *Market Rules* come into effect; and
- b. existing installations constructed before the *Market Rules* came into effect where the Alternative Metering Installation Standard is being applied.

– End of Section –

3. Wholesale Meter Points

3.1 Defined Point of Sale

The defined point of sale shall be the point on the boundary of the *IESO-controlled grid* at which *settlement* transactions are deemed to take place.

3.1.1 Connected Market Participants

The *defined meter point* for connected *market participants* shall be the defined point of sale and shall be one of the following:

- a. the point at which a neighbouring *control area* is connected to the *IESO-controlled grid*; or
- b. the point at which a designated¹ radial line is connected to the *IESO-controlled grid*; or
- c. for *generators*, the point at which a *generator* transformer is connected to the *transmission system*; or
- d. for loads, the point at which a load transformer is connected to the *transmission system*; or
- e. for *distributors*, the point at which the *distributor* is connected to the *IESO-controlled grid* or connected to another *distributor*; or
- f. any other *connection point* deemed to be necessary for *settlement* by the *IESO*.

3.1.2 Embedded Market Participants

The *defined meter point* for *embedded market participants* shall be one of the following:

- a. the point at which a *generation facility* or *load facility* is connected to the *distribution system*²; or
- b. any other *connection point* deemed to be necessary for *settlement* by the *IESO*.

Each embedded participant's *meter* shall be associated with one or more defined points of sale. The *metering data* from the embedded participant's *meter* shall be adjusted for the electrical losses between it and the associated defined point(s) of sale.

3.2 Meter Point – New Installations

3.2.1 Location

The actual *meter point* shall be located as close as practicable to the *defined meter point*.

3.2.2 When Meter Point Not Located at Defined Meter Point

Where the actual *meter point* is not located at the *defined meter point*, the following conditions shall apply:

- a. the installation shall be subject to *IESO* approval.

¹ Designated by the *IESO* as not being part of the *IESO-controlled grid*.

² The *defined meter point* shall be at the primary distribution voltage.

- b. *metering data* recorded in the *metering database* shall be adjusted to allow for physical losses between the *meter point* and the *defined meter point*.
- c. consumption of *station service* at a transformation or transmission station shall be separately accounted for if it is not accounted for in the data available from the main metering.
- d. consumption of *station service* at a generating station shall be separately accounted for if supplied from the *transmission system* or the *distribution system*, and is not accounted for in the data available from the main metering.

3.3 Meter Point – Existing Installations

3.3.1 When Meter Point Not Installed at Defined Meter Point

If the actual *meter point* is not at the *defined meter point*, the *metering data* recorded in the *metering database* shall be adjusted to allow for physical losses between the actual *meter point* and the *defined meter point*.

3.3.2 Station Service Supply Included

At transformer stations, where the *station service* supply is included in the revenue *metering data* collected by the *IESO*, there will be no further adjustment to the *metering data* for the *station service* by the *IESO*.

3.3.3 Station Service Supply Not Included

At existing transformer stations where the *station service* supply is not included in the revenue *metering data* collected by the *IESO*, one of the following conditions shall apply:

- a. *metering data* shall be adjusted by a fixed correction factor by completing and submitting form 1311; or
- b. separate revenue metering shall be installed to *meter* the *station service* supply.

– End of Section –

4. Conformance with Blondel's Theorem

4.1 Blondel's Theorem

4.1.1 General Requirements - Blondel's Theorem

Multiconductor or polyphase power measurement is based on Blondel's Theorem as follows. "The total power delivered to a load system by means of n conductors is given by the algebraic sum of the indications of n wattmeters so inserted that each of the n wires contains one wattmeter current-coil, its potential coil being connected between that wire and some point of the system in common with all the other potential coils; if that common junction of all the potential leads is on one of the n wires, the total power is obtainable from the indications of $n-1$ wattmeter elements."

4.2 Blondel's Theorem – New Installations

4.2.1 Elements Required

New *metering installations* in the *IESO-administered market* shall conform to Blondel's Theorem. The table below lists the number of elements required to conform to Blondel's Theorem:

Type of Power Source	Elements Required
Three wire delta	2
Ungrounded wye	2
Solidly grounded wye	3
Wye grounded through impedance	3
Distribution circuit (three phases and a neutral)	3
Three-phase transmission circuit with grounded skywire or counterpoise	3

See Appendix C for illustrations of Blondel conformance.

4.3 Non-Blondel Compliant Metering – Existing Installations

4.3.1 IESO Approval

Existing installations that do not conform to Blondel's Theorem are subject to *IESO* approval.

4.3.2 Compliance with Measurement Canada Rulings

Existing installations shall comply with any future Measurement Canada rulings on two and one-half element *meters* (or two-element *meters* using three delta connected current transformers and two voltage transformers connected phase to ground). As per Measurement Canada Bulletin E-24E (rev.1) dated 2002-11-29, "5.1 Effective April 1, 2003, all new and all reconstruction of existing 3- phase 4-wire wye configured *metering installations* shall use metering that is compliant to Blondel's Theorem such as 3-element metering. An example of a reconstructed *metering installation* may include service upgrades and, or *instrument transformer* replacement. Reconstruction of existing *metering installation*, sites that do not have sufficient physical space to accommodate the additional voltage transformer will not be required to meet 5.1 above".

4.3.3 Considerations for Installations that do not Conform to Blondel's Theorem

Subject to specific site approval by the *IESO*, as detailed in section 4.4, the following Non-Blondel-Compliant installations will be considered for registration:

- a. two and one-half element *metering installations* — using three current transformers, two voltage transformers connected phase to ground and a two and one-half element *meter*;
- b. two and one-half element *metering installations* — using three delta connected current transformers, two voltage transformers connected phase to ground and a two-element *meter*;
- c. delta metering of transmission or distribution circuits — using two current transformers, three voltage transformers connected phase to ground with 69V secondaries and a two-element *meter*; and
- d. two-element *metering installation* located at the transformer station where the power system neutral/ground is available but not used — using two current transformers and two voltage transformers connected phase to phase and a two-element *meter*.
- e. two-element metering of a *generation facility* where a grounded *generation facility* is connected to a grounded winding of the step up power transformer. The *metering installation* is located between the *generation facility* and the step up power transformer. All load connections between the *generation facility* and the *metering installation* are delta connected – using two current transformers and two voltage transformers connected phase to phase and a two-element *meter*.

4.4 Metering that does not Comply with Blondel's Theorem

4.4.1 Registration in the IESO-Administered Market

An existing *metering installation* that does not conform to Blondel's Theorem may be registered in the *IESO-administered market*, subject to Non-Blondel metering requirements by the *IESO*. At seal expiry, a *metering installation* described in 4.3.3b must be modified to meet the specification of section 4.3.3a.

In addition, the new two and one-half element *meter* shall be a main *meter* that:

1. is on the Conforming Meter List;
2. has the capability to calculate the missing voltage; and

3. records the volt square hour (missing voltage) in channel 6 for each interval.

4.4.2 Non-Blondel Metering Requirements

The requirements for registration are:

- a. the magnitude of maximum error shall be determined and submitted to the *IESO* for approval;
- b. where the maximum error can be shown to be less than 0.2% for both active and reactive power, the installation shall be approved the *IESO* without a correction factor; and
- c. where the maximum error exceeds 0.2%, the *IESO* may grant approval to continue to use the existing metering and apply a fixed correction factor to the *metering data*.

4.4.3 Maximum Error Exceeding 3.0%

Where the maximum error exceeds 3.0%, the *metering installation* shall be replaced with a *metering installation* that is Blondel-Compliant.

4.4.4 Application of Fixed Correction Factors

Fixed correction factors shall be applied in the following way:

- a. *energy* flows in the sell direction shall not be increased; and
- b. *energy* flows in the buy direction shall not be decreased.

– End of Section –

5. Meters

5.1 Accuracy Requirements for Main Meters – New Meters

5.1.1 Requirements

Accuracy requirements shall apply to all new main *meters*. The requirements for main *meters* are:

- a. *meters* shall be approved by Measurement Canada prior to deployment in the *IESO-administered market*;
- b. *meters* shall meet or exceed the 0.2 accuracy class of ANSI standard C12.20;
- c. the pulse resolution of the *energy* transferred shall be within $\pm 0.05\%$ (at full load kW) of the *energy* measured by the *meter*;
- d. Measurement Canada test points shall be used;
- e. tolerance for all tests shall be 0.2% at unity power factor and 0.3% at 0.5 power factor; and
- f. *meters* shall be listed on the Conforming Meter List.

5.1.2 Meters Sealed by Meter Service Organization

The population of *meters* sealed by a *meter* service organization for application in the *IESO-administered market* shall be randomly distributed to *metered market participants*; so as to disperse the error associated with the accuracy of the *meter* calibration.

5.2 Accuracy Requirements for Alternate Meters – New Meters

5.2.1 Requirements

Accuracy requirements shall apply to all new alternate *meters*. The requirements for alternate *meters* are:

- a. *meters* shall be approved by Measurement Canada prior to deployment in the *IESO-administered market*;
- b. *meters* shall meet or exceed the 0.5 accuracy class of ANSI standard C12.20; and
- c. the pulse resolution of the *energy* transferred shall be within $\pm 0.05\%$ (at full load kW) of the *energy* measured by the *meter*.
- d. Measurement Canada test points shall be used;
- e. tolerance for all tests shall be 0.5% at unity power factor and 0.6% at 0.5 power factor; and
- f. the *meters* shall be listed on the Conforming Meter List.

5.2.2 Meters Sealed by Meter Service Organization

The population of *meters* sealed by a *meter* service organization for application in the *IESO-administered market* shall be randomly distributed to *metered market participants*; so as to disperse the error associated with the accuracy of the *meter* calibration.

5.3 Accuracy Requirement for Meters – Existing Meters

5.3.1 Conditions of Use

A *meter* installed before the *Market Rules* came into effect, and that does not comply with the requirement of section 5.1.1.b for main *meters*, and section 5.2.1.b for alternate *meters*, will be permitted by the *IESO* to remain in service subject to the following conditions:

- a. Measurement Canada has granted approval of type for the specific *meter*;
- b. an accredited *meter* service organization or Measurement Canada has verified and sealed the *meter*; and
- c. the seal has not expired.

5.3.2 Replacement

All *meters* shall be replaced at the seal expiration date:

- a. with *meters* conforming to section 5.1 for main *meters* and 5.2 for alternate *meters*; or
- b. with *meters* conforming to section 5.1 for main *meters*.

5.4 Functional Requirements – New Meters

5.4.1 Use of Instrument Transformers

Instrument transformers supplying the main *meter* shall be used solely for the purposes of revenue metering and not for any other purposes, including, but not limited to, the attachment of other devices.

5.4.2 Requirements for Main and Alternate Meters

Meters installed as the main or alternate *meter*, shall meet the minimum requirements listed below and accepted on the Conforming Meter List:

Item	Main Meter	Alternate Meter
Quadrants	4 Quadrant: - Wh/Varh DEL - Wh/Varh REC	4 Quadrant: - Wh/Varh DEL - Wh/Varh REC

Item	Main Meter	Alternate Meter
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Item	Main Meter	Alternate Meter
Interval Data	Wh, Varh for <i>settlement</i> of market transactions. Four channels are required for recording Wh/Varh DEL and Wh/Varh REC. V ² h, I ² h per phase for loss adjustment and data validation ³ .	Wh, Varh for <i>settlement</i> of market transactions. Four channels are required for recording Wh/Varh DEL and Wh/Varh REC.
Time Synchronization	The internal clock shall be capable of being reset set by the data collection software during normal collection operations.	The internal clock shall be capable of being reset set by the data collection software during normal collection operations.
Data Storage	35 days of 5-minute time-stamped interval data. 100 event log readable by MV90.	10 days of 5-minute time-stamped interval data. Flags readable by MV90.
Data Collection Protocol	Compatible with MV90.	Compatible with MV90.
Encoded Registers	Date- and time-stamped readings of the cumulative <i>energy</i> register for each active or reactive <i>energy</i> measured and to be read remotely.	Date- and time-stamped readings of the cumulative <i>energy</i> register for each active or reactive <i>energy</i> measured and to be read remotely.
Password Protection	Two or more levels. One for each: <i>Meter</i> data collection agency: full access to set time functions; read-only access to interval data, event log and meteorological quantities.	Two or more levels. One for each: <i>Meter</i> data collection agency: full access to set time functions; read-only access to interval data, event log and meteorological quantities.
Built-in Battery Backup	In the event of power outage or depressed voltage, the <i>meter</i> maintains the interval data, event log and clock time for 35 days. Clock time shall drift less than 1 minute per month.	In the event of power outage or depressed voltage, the <i>meter</i> maintains the interval data, event log and clock time for 10 days. Clock time shall drift less than 1 minute per month.
Self Power ⁴		Not the same source as the main <i>meter</i> .
Power Switching	From an external source.	Connected to phase power.

³ The time integral of voltage or current squared over a *metering interval* recorded as if it were another energy measurement in a normal data channel, the quantity may be displayed as a *demand* (V² or I²) by MV90.

⁴ In cases where the *facility* is disconnected from the source and kept off potential for an extended period of time, the auxiliary power configuration must be such that both the Main and Alternate meters are powered at all times. Use of an auto transfer scheme for auxiliary power to the Alternate Meter is subject to IESO approval.

Item	Main Meter	Alternate Meter
Self Monitoring	Condition monitoring to record, in the event log or channel status, critical errors such as failure of the measuring system or pulse overrun. The <i>IESO</i> must be able to upload and detect the critical error.	
<i>Instrument Transformer</i> Monitoring	Condition monitoring capable of detecting loss of voltage and/or current and recording of the event, date and time in the event log. The <i>IESO</i> must be able to upload and detect faulty equipment condition.	
Optical Interface	To enable local downloading of metered data.	To enable local downloading of metered data.
Modem	Either internal or external: 9.6 Kb/s minimum.	Either internal or external: 2.4 Kb/s minimum.

5.4.3 Data Channel Assignments for Main and Alternate Meters

Main *meters* will provide the following data channels.

Data from the Main Meter

	Interval Data	Channel
1.	kWh delivered	1
2.	kVARh delivered	2
3.	kWh received	3
4.	kVARh received	4
5.	V ² H per phase	5, 6, 7
6.	I ² h per phase	8, 9, 10

Table 5.1: Data Channels for Main Meters

The channels numbers shown shall be the assignment for the wholesale market.

Meters installed in delta power systems may have two current transformers and two voltage transformers instead of three as shown above. In this case, channel 5 and channel 6 is V²h per phase and channel 7 and channel 8 is I²h per phase.

Since MV90 has the capability to record up to 16 channels, channels 11 to 16 for a three element *meter* or channels 9 to 16 for a two element *meter* shall be set to unconnected (code 42) and flagged to omitted on upload.

Data from the Alternate Meter

Alternate *meters* will provide the following data channels:

	Interval Data	Channel
1.	kWh delivered	1
2.	kVARh delivered	2
3.	kWh received	3
4.	kVARh received	4

Table 5.2: Data Channels for Alternate Meters

Since MV90 has the capability to record up to 16 channels, channel 5 to 16 must be set to unconnected (code 42) and flagged to omit on upload.

5.5 Optional Functional Requirements

5.5.1 Discretion

Optional metering functions are discretionary.

5.5.2 Meter Data Obtained Directly From Meter

Meter data is that obtained directly from the main or alternate *meter*. Any method of accessing the main or alternate *meters* shall not affect the accuracy of the *meter* data.

5.6 Technological Advance

5.6.1 Future Considerations

Additional specifications may be developed and implemented in the wholesale market by the *IESO* as required.

5.7 Functional Requirements – Existing Meters

5.7.1 Before Market Rules Come Into Effect

If the *metering installation* was installed in *facilities* constructed before the *Market Rules* came into effect, *IESO* approval shall be required for continued use of the *meter* in the *IESO-administered markets*.

5.7.2 Requirements for Approval

The requirements for approval are:

- a. Measurement Canada shall have previously granted approval of type for that specific *meter*;
- b. a *meter* service organization or Measurement Canada shall have verified and sealed the *meter*;
- c. the seal shall not have expired;
- d. for all dispatched *generators* and loads, the *meter* shall match the five-minute interval;
- e. for non-dispatched loads and self-scheduled *generators* the *meter* shall collate to five or 15 minute intervals;
- f. the *meter* shall be compatible to the *IESO's* software system; and
- g. the *meter* shall be suitable for time synchronization to EST by the *IESO*.

5.8 Internal Meter Identification Number – New Meters (Device I.D.)

5.8.1 Identification Number

Each *meter* shall have an internal identification number.

5.8.2 Characteristics of Identification Number

The internal identification number shall be unique within the *IESO-administered market* and shall consist of no less than seven alphanumeric characters.

5.8.3 Assigning First Character

The *IESO* shall assign the first character of the identification number to each manufacturer of *meters* approved for use in the *IESO-administered market*.

5.8.4 First Character Specification

The first character shall be alphanumeric: 1 to 9 or A to Z.

5.8.5 Remaining Characters Specification

The remaining six or more characters shall be unique to the manufacturer.

5.9 Internal Meter Identification Number – Existing Meters

5.9.1 Identification Number

Each *meter* shall have an internal identification number.

5.9.2 Characteristics of Identification Number

The internal identification number shall be unique within the *IESO-administered market*.

– End of Section –

6. Instrument Transformers

6.1 General Requirements

6.1.1 Inclusion of Instrument Transformer

Metering installations shall include *instrument transformers*.

6.1.2 Items Requiring IESO Approval

As part of the process of *meter* registration, the following information shall be provided to the *IESO*:

- a. verification that *instrument transformers* conform to the required accuracy class;
- b. verification that *instrument transformers* operate within their rated burden limits;
- c. verification that *instrument transformers* operate within their operating limits; and
- d. error correction factors for *instrument transformers*.

6.2 Security

6.2.1 Security Requirements

Instrument transformers connections to cabling shall be secure and tamper proof.

6.2.2 Seals

Sufficient seals shall be placed to ensure detection of unauthorized access to the *instrument transformer* secondary connections.

6.2.3 Seal Requirements

The requirements for sealing are:

- a. seals shall have unique serial numbers;
- b. seals shall be traceable to the *metering service provider* that installed the seals; and
- c. the *metering service provider* shall maintain a record of the seal serial numbers and log subsequent changes including reasons for the seal change.

6.3 Restoration After Failure

6.3.1 Emergency Instrument Transformer (IT) Restoration Plan

An Emergency Instrument Transformer Restoration Plan (EITRP) shall be in effect and ready to execute in case of *instrument transformer* failure, except in the case of a small or minor embedded

generation facility that meets the requirements of the *market rules*, Chapter 6, section 4.6 - such *facilities* that meet these requirements do not require an EITRP.

6.3.2 Requirements for Emergency Restoration Plan

The *emergency IT* restoration plan shall be subject to *IESO* approval and shall:

- a. include notification to the *IESO* within one *business day* of discovering such a failure;
- b. provide a temporary source for Main/Alternate metering within twelve days of discovering the failure;
- c. in the absence of Main/Alternate metering, provide check metering compatible with automated data collection and processing by the *IESO* within twelve days of discovering the failure;
- d. identify and apply the correction factors required to bring the proposed temporary *metering data* to *IESO*-approved accuracy limits;
- e. provide for temporary replacement *instrument transformers* within twelve days if alternate or check metering is unavailable; and
- f. provide for the permanent replacement or repair of failed *instrument transformers* within twelve weeks of discovery of such failure.

6.3.3 Temporary Replacement Instrument Transformers

Temporary replacement *instrument transformers* shall be pre-approved for use by the *IESO*.

6.4 Primary Connection Point – Loads

6.4.1 Location of Primary Terminals

The primary terminals of each current transformer shall be located as close as practicable to the *defined meter point*.

6.4.2 Alternative Location of Primary Terminals

Where the primary terminals of each current transformer are not located at the *defined meter point*, the installation shall be subject to *IESO* approval.

6.4.3 Requirements for Primary Terminals

The primary terminals of each voltage transformer shall be:

- a. at the same potential as the current transformer; and
- b. as close as practicable to the primary terminals of the current transformer of the same phase.

6.4.4 Connection to Power System

With respect to any physical separation of the points at which the voltage transformer and the current transformer of each phase are connected to the power system, the installation shall:

- a. minimize the voltage drop between the voltage transformer and the current transformer; and
- b. minimize the leakage of current between the voltage transformer and the current transformer.

6.4.5 Connection to Common Solid Bus

Where a *metered market participant* has two supply circuits connected to a common solid bus (i.e. no tie-breaker between the two supply circuits), the *metering installations* for the two supply circuits may utilize a single set of VTs which are connected to the common solid bus.

6.4.6 Constant Correction Factor

Where the maximum error introduced by any physical separation of the primaries of the voltage transformer and current transformer exceeds 0.02%, for either active or reactive power flow, a constant correction factor shall be provided by the *metering service provider*.

6.5 Primary Connection Point – Generators

6.5.1 Location of Voltage Transformer Primary Terminals

The primary terminals of each voltage transformer shall be located as close as practicable to the *defined meter point*.

6.5.2 Alternative Location of Voltage Transformer Primary Terminals

Where the primary terminals of each voltage transformer are not located at the *defined meter point*, the installation shall be subject to *IESO* approval.

6.5.3 Requirements for Current Transformer Primary Terminals

The primary terminals of each current transformer shall be either:

- a. at the same potential as the primary terminals of the corresponding voltage transformer; or
- b. connected to the corresponding phase at the grounded side of the *generation facility*.

6.5.4 Leakage Current

Where the current transformers are located on the grounded side of the *generation facility*, leakage current between the location of the current transformer and the location of the corresponding voltage transformer shall be minimized.

6.5.5 Constant Correction Factors

Where the error introduced by leakage current between the location of the current transformer and the location of the corresponding voltage transformer exceeds 0.02%, for either active or reactive power flow, constant correction factors shall be supplied to the *IESO*.

6.6 Primary Cable

6.6.1 Minimizing Error

Error introduced by the primary cable and terminations connecting the high-voltage terminals of an *instrument transformer* to the *IESO-controlled grid* shall be minimized.

6.6.2 New Installations

For new installations, the error introduced by the primary cable and connections shall not exceed 0.02%.

6.6.3 Existing Installations

For existing installations, where the error introduced by the primary cable and connections exceeds 0.02%, a constant correction factor shall be supplied to the *IESO*.

6.7 Power System Switching – New Installations

6.7.1 Location of Primary Connections

Primary connections of the *instrument transformer* shall be located such that operation of power system equipment does not degrade the following elements:

- a. accuracy of measurement;
- b. data required for validation or *settlement*;
- c. loss adjustment factors; and
- d. monitoring of metering equipment condition.

6.7.2 VT Primary Switching Devices and Rack-Out Mechanisms

Notwithstanding Section 6.7.1, the presence of switching devices on the primary connections of the VT's is permitted only under the following conditions:

- a. the auxiliary power supply to the main *meter* shall be external and supplied from a source that is unaffected by any form of power switching;
- b. the auxiliary power supplied to the alternate *meter* shall be taken from the VT secondary;
- c. sufficient seals shall be placed to ensure detection of unauthorized access to the VT switching device;
- d. the *IESO* shall be notified of the operation of the switching device and of consequences to the metering as per Section 1.3.5 - Power Switching Operations Procedure of “Market Manual 3: Metering, Part 3.9 - Conformance Monitoring”; and
- e. only the switching conditions as outlined in Appendix D are permitted.

6.7.3 Emergency Bypass Switching Device – Pole Mounted Metering Equipment

Notwithstanding Section 6.7.1, the presence of an emergency bypass switching device associated with a pole mounted *metering installation* is permitted only under the following conditions:

- a. the emergency bypass switching device forms part of the EITRP for the *metering installation*; and
- b. the *metering service provider* is required to define a Low Limit on Interval (interval kW *demand*) validation check for the *metering installation*; and
- c. the *IESO* shall be notified of the operation of the emergency bypass switching device and of consequences to the metering as per Section 1.3.5 – Power Switching Operations Procedure of “Market Manual 3: Metering, Part 3.9 – Conformance Monitoring”.

6.8 Power System Switching – Existing Installations

6.8.1 Information Required by IESO

If the operation of an existing power system switching device affects the normal operation of the *metering installation*, or bypasses the metering, or electrically separates the *instrument transformers*, the following information shall be submitted to the *IESO*:

- a. identification of all switching devices that may cause *metering data* to be incorrect;
- b. for each switching device, identification of an alternate source of data; and
- c. a correction factor.

6.8.2 Timing of Notification

The *IESO* shall be notified, within 48 hours, of the date, time, and duration of the planned switching operation.

6.8.3 Method of Notification

Notification to the *IESO* is accomplished by completing and submitting Form 1464-Notification of Power Switching.

6.8.4 Interval Data and Adjustment Factors

At the time of *meter* registration, interval data and adjustment factors for abnormal power system switching with which to edit the *metering data* shall be supplied to the *IESO*.

6.8.5 Notification of Emergency Metering Operation

Within 24 hours of any emergency power system operation affecting normal metering operation, the *IESO* shall be notified of the event and of consequences to the metering by completing and submitting Form 1464-Notification of Power Switching.

6.8.6 Metering Installations

Where power system switching affects the metering more than twice per annum, additional *metering installations* shall be installed to cover this contingency.

6.9 Instrument Transformer Ratios – New Instrument Transformers

6.9.1 Selection of Current Transformer Ratios

Current transformer ratios shall be selected according to the following factors:

- a. the maximum sustained primary current in a current transformer shall not exceed the primary tap multiplied by the continuous current Rating Factor (RF) of the current transformer; and
- b. the minimum sustained primary current during normal operation shall not be less than 10% of the primary tap, for ANSI 0.3 accuracy class; or
- c. the minimum sustained primary current during normal operation shall not be less than 5% of the primary tap, for the defined standard of ANSI 0.15 accuracy class; and
- d. the minimum sustained current during normal operation shall not be less than 1% of primary tap, for the defined standard of ANSI 0.15S accuracy class.

6.9.2 Selection of Voltage Transformer Ratios

Voltage transformer ratios shall be selected such that operation at the minimum or maximum sustained secondary voltage shall not affect *meter* accuracy or *meter* function.

6.10 Accuracy Requirements – New Instrument Transformers

6.10.1 Current Transformers

Current transformers shall conform to the IEEE ANSI C57.13 -2008 for 0.3 metering accuracy class or the Canadian Standards Association CAN/CSA-C60044-1:07 for 0.3 metering accuracy class. High accuracy current transformers shall conform to the IEEE ANSI C57.13.6 for 0.15 and 0.15S metering accuracy class or the Canadian Standards Association CAN/CSA-C60044-1:07 for 0.15 and 0.15S metering accuracy class.

6.10.2 Voltage Transformers

Voltage transformers shall conform to the IEEE ANSI C57.13 - 2008 for 0.3 metering accuracy class or the respective Canadian Standards Association CAN/CSA-C60044-2:07, CAN/CSA-C60044-3:07, or CAN/CSA-C60044-5:07 for 0.3 metering accuracy class.

6.10.3 Electronic Current Transformers

Electronic current transformers shall conform to the respective IEEE ANSI C57.13 – 2008 and IEEE ANSI C57.13.6 for 0.3, 0.15 and 0.15S metering accuracy class or the respective Canadian Standards Association CAN/CSA-C60044-1:07 and CAN/CSA-C60044-8:07 for 0.3, 0.15 and 0.15S metering accuracy class. Electronic current transformers shall have 5 Amp rated secondary output for the *IESO-administered market*.

6.10.4 Electronic Voltage Transformers

Electronic voltage transformers shall conform to the respective IEEE ANSI C57.13 – 2008 and IEEE ANSI C57.13.6 for 0.3 and 0.15 metering accuracy class or the respective Canadian Standards Association CAN/CSA-C60044-1:07 and CAN/CSA-C60044-7:07 for 0.3 and 0.15 metering accuracy class.

6.10.5 Monitoring Requirements – New Electronic Instrument Transformers

Where the installation has an electronic *instrument transformer*, it shall have a mechanism for real-time monitoring of alarm statuses and events associated with optical sensors, transmitting systems and secondary converters. Within 24 hours of any metering alarm affecting the normal metering operation, the *IESO* shall be notified of the alarm event and the consequences to the *revenue* metering. An alarm event log shall be in place and maintained for *IESO* audit purposes. The installation shall be subject to *IESO* approval.

6.11 Safety Requirements – New Instrument Transformers

6.11.1 Requirements

The installation shall conform to the requirements of:

- a. Measurement Canada Standard Drawings;
- b. the Ontario Electrical Safety Code; and
- c. the ANSI/IEEE C57.13-1983 IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

6.12 Instrument Transformers – Existing Installations

6.12.1 Continued Use of Existing Instrument Transformers

Approval of the *IESO* shall be required for continued use of existing *instrument transformers* in the wholesale market.

6.12.2 Approval

Instrument transformers shall be approved for use by Measurement Canada, or shall have special dispensation/temporary permission from Measurement Canada.

6.12.3 Dispensation After Market Rules Come Into Effect

Should further dispensation/temporary permission be required after the *Market Rules* come into effect, the *metered market participant* shall seek dispensation/temporary permission from Measurement Canada, and maintain records of the equipment granted dispensation.

6.12.4 Accuracy

Instrument transformers shall meet the requirements of ANSI 0.3 accuracy, or correction factors shall be applied.

6.12.5 Proof of Accuracy Compliance

Proof of compliance with 0.3 ANSI accuracy class shall be provided as follows:

- a. in the form of factory test cards complete with serial numbers;
- b. provide verifiable nameplate data, where the nameplate contains the required ANSI accuracy information and is affixed to the *instrument transformers*; and
- c. Measurement Canada-type approval information, where such approval contains the required ANSI accuracy information.

6.12.6 Accuracy Requirements

Where accuracy tests are required, they shall comply with the following requirements:

- a. tests shall be carried out by a third-party testing agency using equipment traceable to Canadian national standards;
- b. tests shall be conducted with the existing burden connected to each current transformer;
- c. additional tests shall be conducted at other suitable burdens if the existing burden is expected to change in the future;
- d. tests shall include on-site ratio and phase-angle error tests;
- e. on-site ratio- and phase-angle tests of current transformers shall be measured over a range of secondary current from not more than 0.1 ampere to not less than the rating factor;
- f. where the secondary current is less than 0.1 ampere, an additional test point shall be provided at the minimum load current; and
- g. test results shall provide correction factors to be applied to both active and reactive power at each test point.

6.12.7 Other Identical Units

Where an *instrument transformer* is identical to another unit tested on-site, as described in section 6.12.7, the *instrument transformer* shall be considered as having met the requirements listed there provided that:

- a. copies of manufacturer's records verify that the *instrument transformer* is identical; and
- b. copies of installation records or other documentation certify that the applied burden is either identical to that carried by the tested unit or within the measured ability of the tested unit.

6.12.8 Security

Instrument transformer installations shall conform to the security requirements of section 6.2.

6.12.9 Rated Burden

Instrument transformer installations shall conform to rated burden.

6.12.10 Replacement

Where an *instrument transformer* is replaced, it shall be replaced with units compliant with the requirements of section 6.10.

6.12.11 Upgraded or Refurbished Metering Installation or Metered Facility

Where the *instrument transformers* are substantially upgraded or refurbished, the *instrument transformers* shall comply with sections 6.9 and 6.10 and shall comply with section 4.2.

– End of Section –

7. Secondary Cabling for Instrument Transformers

7.1 Applicability

The requirements in this section apply to all *instrument transformers* used in all *metering installations*.

7.2 New Current Transformers

7.2.1 Size of Secondary Cabling

The secondary cabling between the current transformers and the *meter* enclosures shall be of a sufficient size that the rated burden for the 0.3 ANSI accuracy class is not exceeded when current, equivalent to the rated current, flows in the secondary winding.

7.3 New Voltage Transformers

7.3.1 Minimizing Error

The error introduced by the secondary cable and terminations shall be minimized.

7.3.2 Correction Factor

Where the error introduced by the secondary cable and connections exceeds 0.02%, a correction factor shall be submitted to the *IESO*.

7.3.3 Error Limit

The error introduced by the secondary cable and connections shall not exceed 1.0%.

7.4 Additional Requirements – New Instrument Transformers

7.4.1 Codes and Conditions

Instrument transformer secondary cabling and cabling accessories shall comply with the following codes and conditions:

- a. the Ontario Electrical Safety Code;
- b. Measurement Canada colour coding (where appropriate, permanent tagging/labelling may be used);

- c. the current transformers shall be dedicated to the *main/alternate metering installation* and used for no other purpose;
- d. voltage transformers with one secondary winding shall be dedicated to the *main/alternate metering installation* and used for no other purpose;
- e. voltage transformers with two secondary windings may be used for purposes other than wholesale metering. The *metering installation* shall comply with the following:
 - the main *meter* is connected to one dedicated winding
 - the alternate *meter* and all other devices are connected to the other winding.
 - the voltage transformers operate within the rated burden limits for the 0.3 ANSI accuracy class and meets all other requirements such as VEE.
 - all devices connected to the voltage transformers shall be installed inside the *meter* enclosure
- f. for a dual *main/alternate metering installation*, the alternate *instrument transformers* may be used for purposes other than wholesale metering. The *metering installation* shall comply with the following:
 - the alternate *instrument transformers* operate within the rated burden limits for the 0.3 ANSI accuracy class and meets all other requirements such as VEE
 - all devices connected to the alternate *instrument transformers* shall be installed inside the *meter* enclosure
- g. electrical connection to the *instrument transformer* secondary terminals shall not be permitted outside of the *meter* enclosure;
- h. cabling from the *instrument transformers* to the *meter* enclosure shall be routed in dedicated conduit or have protective qualities such as Teck 90 cabling;
- i. the route shall be visually traceable, where buried cable is unavoidable such as underneath a roadway, Form 1509 must be completed and submitted to the *IESO*; and
- j. all in-use secondary terminals of each *instrument transformer* shall be brought to the test block on a separate conductor. For the case of the voltage transformer, a single conductor may be used as a common return to the test block.

7.5 Secondary Cabling – Existing Installations

7.5.1 Installations Prior to Market Rules

The use of existing cabling installed in *facilities* constructed before the *Market Rules* come into effect, shall be subject to the approval of the *IESO*.

7.5.2 Requirements

Existing secondary cabling shall comply with the following requirements:

- a. *meter(s)* shall be connected to the *instrument transformers* as registered;
- b. fixtures (such as AC outlets and voltage test points) that may allow unauthorized access to the *instrument transformer* secondaries shall be removed, disabled, or made inaccessible by a sealed cover;

- c. any remaining devices connected to the *instrument transformer* secondary cables shall be sealed;
- d. as many of the requirements listed in section 7.4 as practicable;
- e. all non-conformance with *IESO* approval requirements shall be listed; and
- f. where the requirements of section 7.4 are not met, error correction factors shall be submitted to the *IESO*.

7.5.3 Constant Correction Factor

For existing voltage transformer installations where the error introduced by the secondary cable and connections exceeds 0.02%, a constant correction factor shall be submitted to the *IESO*.

7.5.4 Replacement

Where the cabling is subsequently replaced after the *Market Rules* come into effect, it shall conform to the requirements of sections 7.3 and 7.4.

7.5.5 Upgraded or Refurbished Metering Installation or Metered Facility

Where the secondary cabling is substantially upgraded or refurbished, the secondary cabling shall comply with sections 7.3 and 7.4.

– End of Section –

8. Instrument Transformer Burdens – All Installations

8.1 General

8.1.1 IESO Approval

Devices connected to the *meter's instrument transformers* shall be subject to *IESO* approval.

8.1.2 Review Requirements

Burden approval shall include a review of:

- a. every device connected to every *instrument transformer*;
- b. the burden imposed by each device; and
- c. the size of the conductors in the secondary cabling and the length of the path followed by the cabling.

8.1.3 Alter Secondary Connections or Burden

Secondary connections or burdens of registered *metering installations* shall not be altered without prior approval of the *IESO*.

8.2 Verification of Connections – All Installations

8.2.1 Tracing and Verification – Circuits

The *meter's instrument transformer* secondary circuits shall be traced and the connected burden verified.

8.2.2 Tracing and Verification – Connection of Terminals

Connection of the *instrument transformer* terminals to the *meter* enclosure shall be visually verified and electrically traced.

8.3 Verification of Burden – All Installations

8.3.1 Measurement or Calculation

The burden on each main and alternate *instrument transformer* shall be either measured at the secondary terminals of the *instrument transformer* or calculated from the connected devices.

8.3.2 On-site Testing

Where the nameplate data required for the burden calculation is not available for any device connected to an *instrument transformer*, the burden shall be established by on-site testing.

8.3.3 Not to Exceed Nameplate Ratings

The measurement or calculation shall verify that actual burdens in service do not exceed the nameplate ratings of any *instrument transformer*.

8.4 Burden Calculation – All Current Transformers

8.4.1 General Requirements

The burden calculation for a current transformer shall include:

- a. the impedance of the secondary wiring;
- b. the impedance of all devices connected to the current transformer;
- c. the apparent impedance associated with the *connection* of current transformer secondaries;
- d. the apparent impedance associated with the sharing of a common current path through a measuring device with another current transformer;
- e. the apparent impedance associated with the sharing of an *IESO*-approved common-return conductor;
- f. the apparent impedance associated with the impedance of any other current transformer(s) connected in parallel with subject *instrument transformer*;
- g. burden under balanced power system conditions; and
- h. worst-case unbalance, including single-phase power.

8.4.2 Establishing the Burden

The calculation shall establish the burden as the ratio of the voltage and current at the secondary terminals of the current transformer.

8.4.3 Rated Burden Limit

The calculated burden:

- a. for new installations, shall not exceed the rated burden limit for the 0.3 ANSI accuracy class; and
- b. for existing installations, shall not exceed the rated burden limit of its own accuracy class.

8.5 Burden Calculations – All Voltage Transformers

8.5.1 General Requirements

The burden calculation for a voltage transformer shall include the apparent power and power factor at the secondary terminals of the *instrument transformer*.

8.5.2 Allowance for Worst-Case Unbalance

If the secondary cabling uses a common return, allowance must be made for worst-case unbalance including loss of secondary fusing or single-phase power on the power system.

8.5.3 Rated Burden Limit

The calculated burden:

- a. for new installations, shall not exceed the rated burden limit for the 0.3 ANSI accuracy class; and
- b. for existing installations, shall not exceed the rated burden limit of its own accuracy class.

– End of Section –

9. Parallel Connected Current Transformer Secondaries

9.1 New Installations

9.1.1 Prohibition in New Installation

Parallel connected current transformer secondaries are not permitted in new installations.

9.2 Existing Installations

9.2.1 IESO Approval

Where parallel connected current transformer secondaries existed within *facilities* constructed before the *Market Rules* come into effect, approval shall be obtained from the *IESO* to continue use within the *IESO-administered market*.

9.2.2 Requirements for Approval

The requirements for approval are:

- a. current transformers shall have the same nominal ratio and the same secondary ampere rating;
- b. paralleled secondaries shall be connected to the same phase;
- c. phasing shall be consistent on both primary and secondary circuits;
- d. paralleling of secondaries shall be done at the test links directly connected to the *meter*;
- e. each *meter point* shall have its own current test links;
- f. paralleled secondaries shall be used to sum currents from no more than two *meter points*;
- g. a common point shall exist at the primary voltage to which each of the measured flows is connected;
- h. the primaries of the voltage transformers for the paralleled installation must be connected to the common point;
- i. the burden on any current transformer shall not exceed the rated burden;
- j. the burden shall be kept as low as practicable and shall take into account the effects of common secondary leads and worst-case unbalance;
- k. worst-case unbalance shall include operation of secondary fusing or single phase primary power;
- l. the *meter* shall be rated at twice the secondary rating of one current transformer;
- m. current transformers shall not operate below 10% of the secondary ampere rating under normal operating conditions;
- n. the primaries of the current transformers shall not be paralleled;

- o. where a switching device exists between the primary *connection point* of the current transformers, the *IESO* shall be notified whenever the paralleled current transformers are operated with the switching device open; and
- p. notification shall identify the date, time and duration, and current and voltage readings for both *meter points* before, after, and at regular intervals during the period of disconnection. Notification must also provide a correction factor calculated from the readings that the *IESO* shall use to edit the *metering data* collected.

9.2.3 Elimination

Current transformer parallel connected secondaries shall be eliminated at the next opportunity when major work or upgrading is carried out at the *meter points*.

– End of Section –

10. Metering Installation Enclosure

10.1 New Installations

10.1.1 Meter Enclosure

All *meters*, test links, and fuses shall be contained within a *meter* enclosure. The communication equipment, such as an external modem or a telephone line switcher, may be located in a separate locked enclosure under strict control of the *metered market participant* provided that the equipment is supplied from an external power source; otherwise the communication equipment shall be contained in the *meter* enclosure.

10.1.2 Meter Enclosure Requirements

The *meter* enclosure shall comply with the following requirements:

- a. the *meter* enclosure shall be secured by the *metering service provider*, in a manner approved by the *IESO*;
- b. the *metering service provider* shall have access to the *meter* enclosure at all times;
- c. persons other than the *metering service provider* shall not be given access to the *meter* enclosure;
- d. the *meter* enclosure shall be sealed as far as practicable in a manner approved by the *IESO*;
- e. seals shall be placed to ensure the detection of unauthorized access to the *instrument transformer* connections, *meter*, test links, test-link cover and fuses;
- f. seals shall be individually numbered; and
- g. seals shall be traceable to the *metering service provider*.

10.1.3 Maintenance and On-site Audit

The time, date, serial number, and *meter point* name for each seal removed and replaced during maintenance and on-site audit shall be recorded for inspection by the *IESO*.

10.1.4 Test Blocks

Test blocks shall be installed inside the *meter* enclosure to allow the current and voltage from each *instrument transformer* and each *meter* to be individually determined.

10.2 Existing Installations

10.2.1 IESO Approval

Existing *metering installations* installed before May 17, 2000 shall be accepted into the *IESO-administered market*, subject to *IESO* approval.

10.2.2 Requirements for Approval

The requirements for security approval are:

- a. the *metering installation* shall be secure;
- b. the *metering installation* shall comply with as many requirements of section 10.1 as practicable; and
- c. where the existing *metering installation* does not meet the requirements of section 10.1, variances shall be listed and submitted to the *IESO* for approval.

– End of Section –

11. Metering Installations

11.1 Configurations of New Metering Installations

Each new *metering installation* shall have one of the following configurations:

- a. A dual *main/alternate metering installation* comprised of two independent sets of *instrument transformers* which are approved by Measurement Canada, and meet the requirements of section 4.2 and section 6.10. The *main instrument transformers* are connected to the main *meter* and *alternate instrument transformers* are connected to the alternate *meter*. See Figure B-1 for a graphical representation.
- b. A *main/alternate metering installation* comprised of a single set of *instrument transformers* (where the voltage transformers have dual secondary windings,) which are approved by Measurement Canada, and meet the requirements of section 4.2 and section 6.10. The single set of *instrument transformers* are connected to both the main and alternate *meters*. See Figure B-3 for a graphical representation.
- c. A *main/alternate metering installation* comprised of a single set of *instrument transformers* connected to both the main and alternate *meters*, which are approved by Measurement Canada, and meet the requirements of section 4.2 and section 6.10. See Figure B-2 for a graphical representation.
- d. A small or minor embedded *generation facility metering installation* may use a standalone *meter* consisting of either a main *meter* or an alternate *meter* from the conforming *meter* list. This *metering installation* shall be comprised of a single set of *instrument transformers* approved by Measurement Canada and connected to the *meter*.

11.1.1 Definition

The *meters* are termed main and alternate; and the main *meter* is used for *settlement*.

11.1.2 Unavailability of Main Meter

When the main *meter* is unavailable, the alternate *meter*'s data shall replace the main *meter*'s original data, in accordance with "Market Manual 5: Settlements, Part 5.2: Metering Data Processing".

11.2 Configurations of Existing Metering Installations

Each existing *metering installation* shall have one of the following configurations:

- a. A standalone main *metering installation* comprised of a single set of *instrument transformers* which are approved by Measurement Canada, and meet the requirements of section 6.10 or section 6.12.7. The single set of *instrument transformers* are connected to the main *meter* only. See Figure B-4 for a graphical representation.
- b. A non-conforming standalone *metering installation* comprised of a non-conforming *meter* will no longer be accepted by the IESO after seal expiry. See Figure B-5 for a graphical representation.

11.2.1 Definition

The *meter* is termed main; the main *meter* is used for *settlement*. The Alternate *meter* is not installed

11.2.2 Unavailability of Main Meter

When the main *meter* is unavailable estimated data shall be used for *settlement*, in accordance with “Market Manual 5: Settlements, Part 5.2: Metering Data Processing”.

11.3 Metering Installations for a Small or Minor Embedded Generation Facility

- a. Each new *metering installation* for a small or minor embedded *generation facility* that meets the requirements of the *market rules*, Chapter 6, section 4.6.1 shall comply with all the requirements of this standard except where specifically noted otherwise. Any *generation facility* with a nameplate rating of less than 2 MVA or less than 17 GWh per annum can take advantage of this simpler revenue metering standard.
- b. The *IESO* will provide notice in writing whenever the small or minor embedded *generation facility* exceeds 17 GWh in any calendar year. The *IESO* will calculate the 17 GWh based on the *IESO's meter* reading data without the application of losses or measurement error correction. Upon receipt of such notice the *metered market participant* shall ensure that the *metering installation* is upgraded so that it is fully compliant with the *market rules* in Chapter 6.
- c. Whether or not there are multiple *generation facilities* under the *metering installation* is not relevant for purposes of measuring the application of the 17 GWh limit. The *IESO* will apply the 17 GWh limit at the *metering installation* irrespective of the number of *generation facilities* or the nature of the generation within the *generation facility*.

11.3.1 Registration

- a. *Metering installations* for small or minor embedded *generation facilities* shall have all delivered and received channels registered in the *IESO-administered markets*. *Metering installations* that have the received channels registered in the wholesale market and the delivered channels not in the wholesale market will not be approved.
- b. An Emergency Instrument Transformer Restoration Plan (EITRP) is not required as part of the registration process.
- c. For the duration of any outage of the *metering installation* or at any time when the *IESO* is unable to retrieve the *metering data* from the *metering installation*, the *metering data* will be estimated as zero in the received channels and at the maximum estimate in the delivered channels. This *metering data* will not be replaced by files received from the *metering service provider (MSP)* or the *metered market participant (MMP)* containing estimated data. Correction factors will be applied as per *Market Manual 3.2, Appendix D, section 5* on the failure of an *instrument transformer* provided the *IESO* can continue to communicate with the *meter*, but *MSP-* or *MMP-*supplied estimated data will not be used.

11.3.2 Instrument Transformers

- a. In accordance with Chapter 6, section 4.1.7.4 additional loads, such as control and protection devices, can be supplied from the revenue metering *instrument transformers*, subject to approval by the *IESO*.
- b. Approval by the *IESO* under subsection (a) above will be subject to the following conditions being met:
 - The burden limit of the *instrument transformers* must not be exceeded. See section 8.3 of this Standard for details.
 - Security and sealing requirements shall comply with section 6.2 of this Standard.
- c. To ensure that the meter multiplier on a registered *metering installation* is not inadvertently changed without notification of the *IESO*, the *metered market participant* shall have in place either a satisfactory system to manage access to the *instrument transformer* taps or it will check the *meter* multiplier on a regular basis. As part of the *IESO* site audit, the *metered market participant* may be requested to prove that such management systems exist or prove that the *meter* multipliers have been checked periodically.
- d. Consideration should be given by the *metered market participant* in section 6.9.1 to using high accuracy current transformers meeting the defined 0.15 or 0.15S ANSI standard. Many small *generation facilities* like windmills often operate at low loads and the high accuracy current transformers may allow accurate measurement at these low loads. Current transformers that comply with the 0.3 ANSI accuracy class and can also meet 0.15 or 0.15S, and have a continuous current rating factor (up to 4.0) should be considered.

– End of Section –

12. Check Metering Installation

12.1 Overview

12.1.1 Separation from the Main Metering Installation

The *check meter* installation shall be separate from the main *metering installation*.

12.1.2 Audit by IESO

Except for the mathematical correlation to the main metering, the *check metering installation* shall not be subject to audit by the *IESO*.

12.1.3 General Requirements for the Main/Check Metering Installation

The *Main/Check metering installation* shall consist of a Main metering and one of the following for the check metering:

- a. a *meter* approved by Measurement Canada, which may be unverified and connected to non-Measurement Canada approved *instrument transformers*; or
- b. a non-Measurement Canada approved *meter* connected to non-Measurement Canada approved *instrument transformers* or cabling; or
- c. data from a SCADA or *energy management system*, subject to the requirements listed in section 12.2.

12.1.4 Validation

Check metering may be used to serve the validation process.

12.1.5 Pricing and Settlement

Should valid data from the main metering be unavailable, *check metering data* adjusted by the mathematical correlation, may be used in the pricing and *settlement processes*.

12.1.6 Flagging of Check Metering Data

The use of *check metering data* in place of main *metering data* will be flagged on *settlement statements*, logged, and monitored by the *IESO*.

12.1.7 Reference

See Figure B-6 for a graphical representation of check metering.

12.2 Requirements for Check Metering Installations

12.2.1 General

Check metering shall comply with the following requirements:

- a. check metering shall be located in a position that achieves a linear correlation with the *metering data* per five-minute interval;
- b. the correlation shall be subject to approval by the *IESO*;
- c. a revised correlation shall be subsequently submitted and approved whenever the check metering is altered;
- d. watt and var channels shall match the main *meter* as a minimum;
- e. check metering must not be connected to the *instrument transformers* used for the main *meter*;
- f. check *metering data* shall be suitable for automated delivery to the *IESO* and automated processing in a format compatible with *IESO MV90* software. The software may be revised and updated at the discretion of the *IESO*;
- g. check *metering data* shall match the interval length of the main metering and shall be time synchronized;
- h. check *metering data* shall be directly comparable to data obtained from the main *meter*; and
- i. where the *IESO's* Energy Management System is the source of the check data, the *IESO* shall not sum flows from more than one *check meter point* during preparation of the check *metering data*.

– End of Section –

13. Hardware Support for the Validation Process

13.1 Validation Requirements – New Metering Installations

13.1.1 Compliance with IESO Procedure

The validation process shall comply with the *IESO* “Market Manual 5: Settlements, Part 5.2: Metering Data Processing”.

13.1.2 Unadjusted Active and Reactive Interval Data

The revenue *metering installation* shall provide the *IESO* with the unadjusted active and reactive interval data for use in the validation process.

– End of Section –

14. Communications for Metering

14.1 Communications Hardware

14.1.1 Compliance with IESO Policy

The communications system shall comply with the *IESO* policy “Meter Data Communications”.

14.1.2 Compatibility with IESO Software

The communications equipment installed shall be compatible with the *IESO*'s MV90 data collection software.

14.1.3 Data Availability

Data communication shall be available to the *IESO*.

14.1.4 Testing

Communication, units of measure, and other site-specific details shall be proven using a live, end-to-end test before the commencement of trading at each *metering installation*.

14.1.5 Main/Alternate Communications

Main/Alternate communications systems and paths are discretionary.

– End of Section –

15. Site-Specific Loss Adjustments

15.1 Requirement for Site-Specific Loss Adjustment Data

15.1.1 Compliance with IESO Procedure

Loss adjustment shall comply with the *IESO* procedure “Market Manual 3: Metering Part 3.5: Site-specific Loss Adjustment” and IESO’s standard “Site-specific Loss Adjustment”.

15.1.2 Calculation of Losses

Losses shall be calculated in software by the *IESO* based on information and calculations provided to the *IESO*.

– End of Section –

16. Glossary of Terms

In addition to the terms listed here, refer to the definitions included in the *Market Rules*.

The following terms were used in this standard:

Actual meter point: In the case of *loads*, the physical location of the current transformers. In the case of *generation facilities* (with the current transformers on the output side of the unit), the physical location of the current transformers. In the case of *generation facilities* (with the current transformers on the grounded side of the unit), the output bushings of the *generation facilities*.

Alternate meter: A *meter* which meets the requirements of Section 5.2 and is on the Conforming Meter List. In a *Main/Alternate metering installation*, the alternate is used for validation of data from the main *meter*. Alternate data may be substituted when valid data from the main *meter* is unavailable.

Apparent impedance: The complex number (ratio) resulting from the division of the phasor voltage by the phasor current measured at the secondary terminals of an *instrument transformer*.

Apparent power: The complex number resulting from the multiplication of the phasor voltage by the phasor current at the secondary terminals on an *instrument transformer*.

Blondel's Theorem: The principle of electricity metering that states that the minimum number of elements required to measure power flowing past any point in a power system is one less than the number of conductors in the circuit. Conformance to Blondel's Theorem ensures accurate measurement when current or voltage is unbalanced.

Burden: For a voltage transformer, the total volt-ampere load, with specified power factor, applied to the secondary terminals. For a current transformer, the total apparent impedance, expressed in ohms, connected to the secondary terminals.

Buy direction: A reference direction for *settlement* purposes. Flow of active or reactive power from the transmission or *distribution system* into a *generation facility* or *load facility*.

Conforming Meter List (CML): *Meters* which have been accepted for use in the *IESO-administered market*. The *meters* are referenced as a Main or an Alternate *meter*. All main *meters* may be used as an alternate *meter*. For new *metering installations*, only *meters* on CML shall be used. The CML is found on the *IESO's* Web site.

Continuous current rating factor (RF): The number by which the rated primary current of a current transformer is multiplied to obtain the maximum primary current that can be carried continuously without exceeding the limiting temperature rise from 30 °C above average ambient air temperature. The RF of tapped-secondary or multi-ratio transformers applies to the highest ratio, unless otherwise stated.

Current summation: A method for deriving the combined power flow at two distinct *defined meter points*. A single main *meter* is supplied by the voltage transformers from one of the *meter points* and the paralleled secondaries of the current transformers at both *meter points*.

Current transformer: An *instrument transformer* designed for the measurement or control of current. Its primary winding, which may be a single turn or bus bar, is connected in series with the load. It is normally used to reduce primary current by a known ratio within the range of a connected measuring device.

Defined meter point: A physical location either at the boundary of the *IESO-controlled grid*, or embedded within the *distribution system*, at which electrical quantities are either actually, or deemed to be, measured.

Defined point of sale: A physical location on the boundary of the *IESO-controlled grid* at which *settlement* transactions are deemed to take place.

Electronic current transformer: An *electronic instrument transformer* in which the output of the secondary converter in normal conditions of use is substantially proportional to the primary current and differs in phase from it by a known angle for an appropriate direction of the connections.

Electronic instrument transformer: An arrangement consisting of one or more current or voltage sensor(s) which may be connected to transmitting systems and secondary converters, all intended to transmit a measuring quantity in a proportional quantity to supply measuring instruments, meters and protective or control devices.

Electronic voltage transformer: An *electronic instrument transformer* in which the secondary voltage in normal conditions of use 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 the connections.

Element: A single-phase device for measuring the active or reactive power associated with the applied voltage and current. On a three-phase power system, a *meter* may comprise two or three elements, the outputs of which are summed to display total three-phase active or reactive power.

High accuracy instrument transformer: References to ANSI 0.15 and 0.15S (superior) accuracy class for current transformer type.

IESO: *Independent Electricity System Operator.*

Main meter: A *meter* which meets the requirements of Section 5.1 and is on the Conforming Meter List. The main *meter* is always used for *settlement* where possible.

Measurement Canada: The federal agency administering and enforcing the *Electricity and Gas Inspection Act*.

Meter point documentation: A package of documents comprising a map or electrical one-line showing the location of the *defined meter point*, a totalization table, and documentation supporting site-specific loss adjustment and error-correction factors. Other information required in the package includes details needed for the collection of data, such as telephone number, password, and translation interface module (TIM). A copy of any analysis or power flow studies used to develop loss adjustments shall also be included. Other required details include supply point details, such as operating designation, voltage, *instrument transformer* ratios, multipliers, length of data storage and format, existence of Main/Alternate or check metering, and names and telephone numbers to facilitate problem resolution.

Meter service organization: An organization accredited by Measurement Canada to verify and seal *meters* for its own organization and other organizations.

Metering maintenance: Activities carried out to verify correct operation of the *meter* and *instrument transformers* installed at a *meter point*. Includes installation repairs, and replacement and preparation of *meter point* documentation.

Non-Conforming Standalone Meter: A *meter* not on the Conforming Meter List but is Measurement Canada approved, capable of collating interval data, compatible with the *IESO's* software system and capable of time synchronization. Normally these *meters* were installed before the *Market Rules* came in effect.

Registration: The entry of metering information into the *IESO data collection system* databases. Registration is conducted after comprehensive on-site and end-to-end testing is conducted to verify remote access to metered data and accurate replication of *meter* parameters and measured quantities at the *IESO*.

Sell direction: A reference direction for *settlement* purposes. The flow of active or reactive power from a *generation facility* or *load facility*, into the *transmission* or *distribution system*.

Site-specific loss adjustment: If the actual *meter point* is not at the *defined meter point*, the *meter* readings shall be adjusted to account for the difference. Application of the loss adjustment results in readings that would have been obtained if the *meter* had been installed at the *defined meter point*.

Totalization table: A list of *defined meter points*, the flows of which are to be algebraically summed when calculating the total transaction of a *metered market participant*. A totalization table also provides additional details for each data channel to be summed.

Voltage transformer: An *instrument transformer* intended for measurement of control purposes which is designed to have its primary winding connected in parallel with a circuit, the voltage of which is to be measured or controlled.

Wholesale metering: All equipment installed to measure and record physical transactions at *defined meter point* in the *IESO-administered markets*.

– End of Section –

Appendix A: Forms

This appendix contains a list of forms used in the Wholesale Revenue Metering Standard-Hardware, which are available on the *IESO* Web site (www.ieso.ca). The forms included are listed in the table below.

Form Name	Form Number
Witness of Buried Section Instrument Transformer Secondary Cables	IMO-FORM-1509
Notification of Power Switching	IMO-FORM-1464
Connection Facility Station Service-Not Metered by a RWM	IMO-FORM-1311

– End of Section –

Appendix B: Metering Installation Figures

The following figures are provided in this appendix:

- a. Figure B.1: Dual Main/Alternate Metering Installation
- b. Figure B.2: Main/Alternate Metering Installation
- c. Figure B.3: Main/Alternate Metering Installation- Dual Secondary Windings
- d. Figure B.4: Standalone Main Metering Installation
- e. Figure B.5: Standalone Non-Conforming Metering Installation
- f. Figure B.6: Main/Check Metering Installation

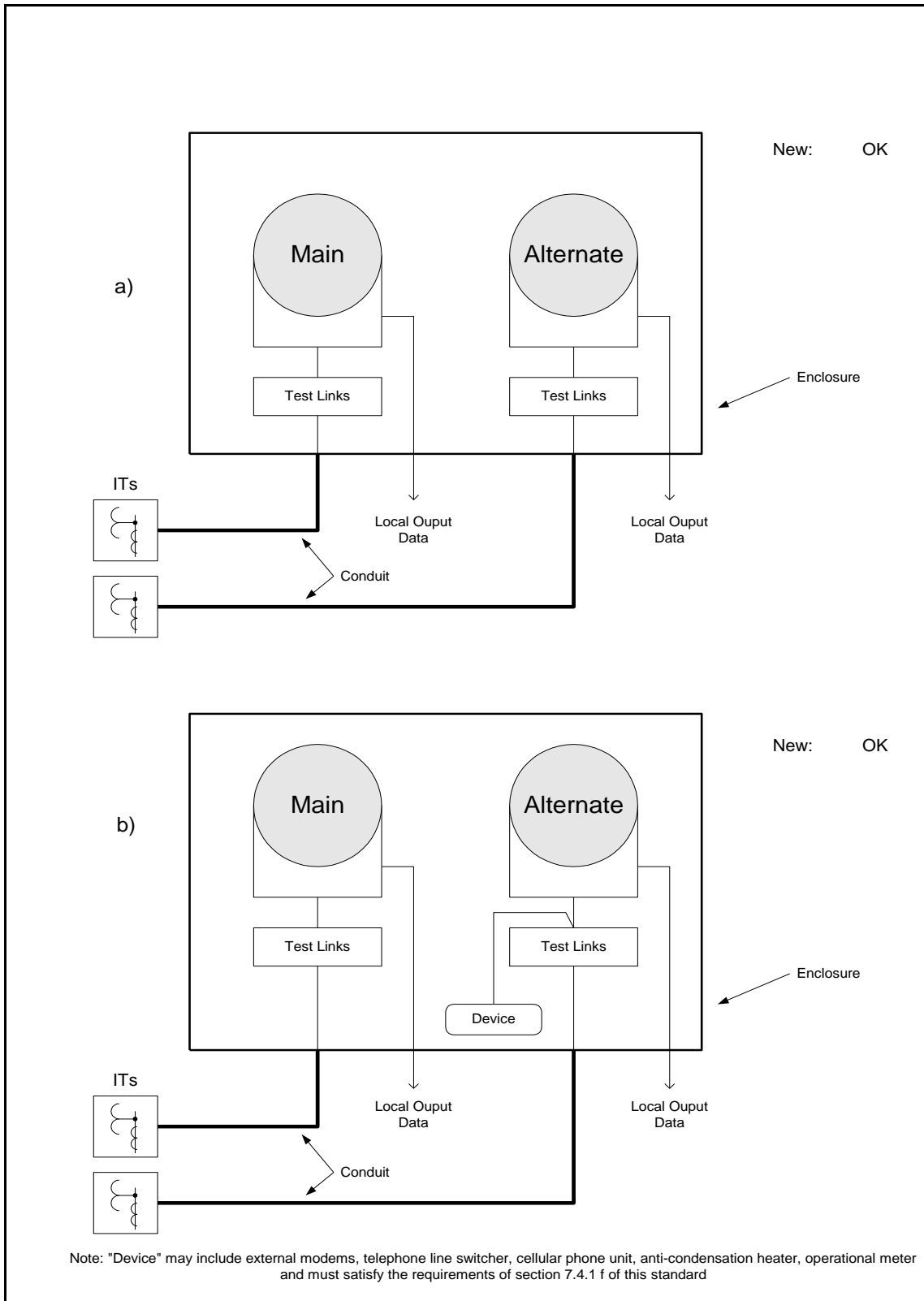


Figure B-1: Dual Main/Alternate Metering Installation

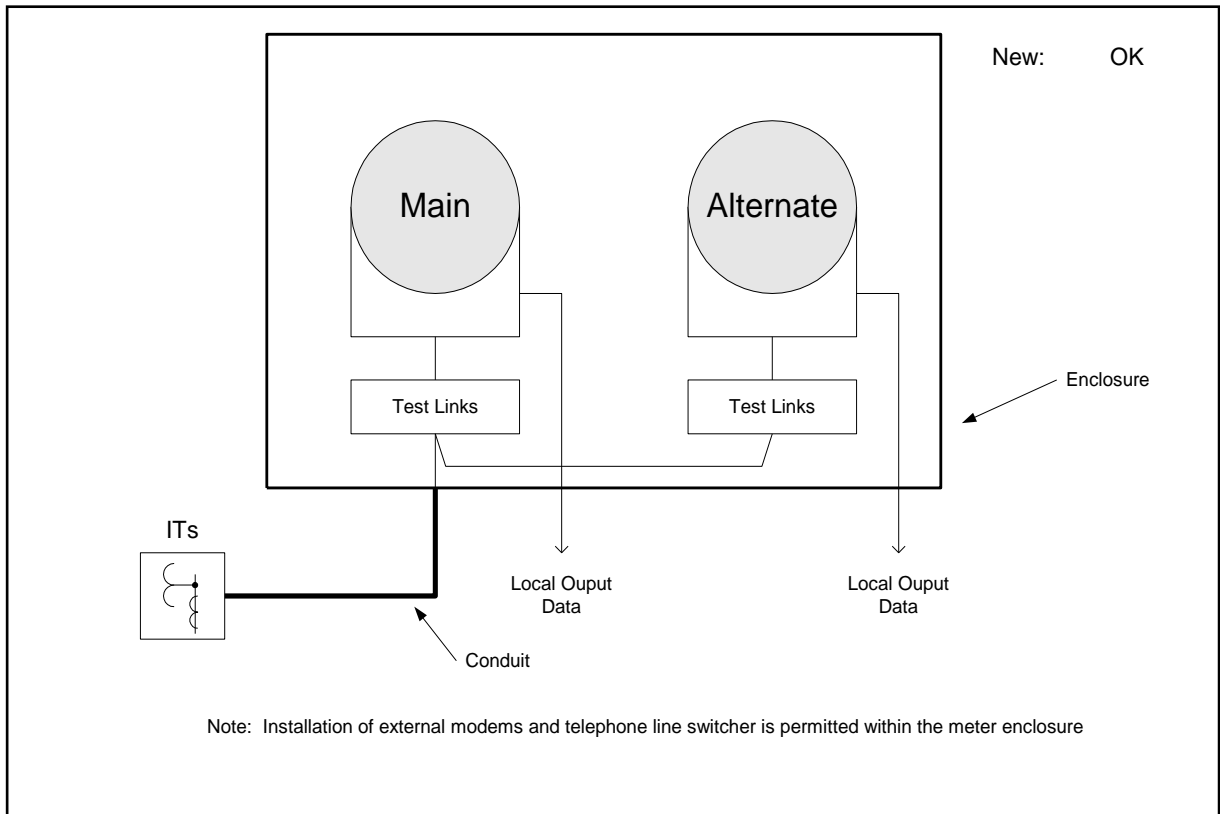


Figure B-2: Main/Alternate Metering Installation

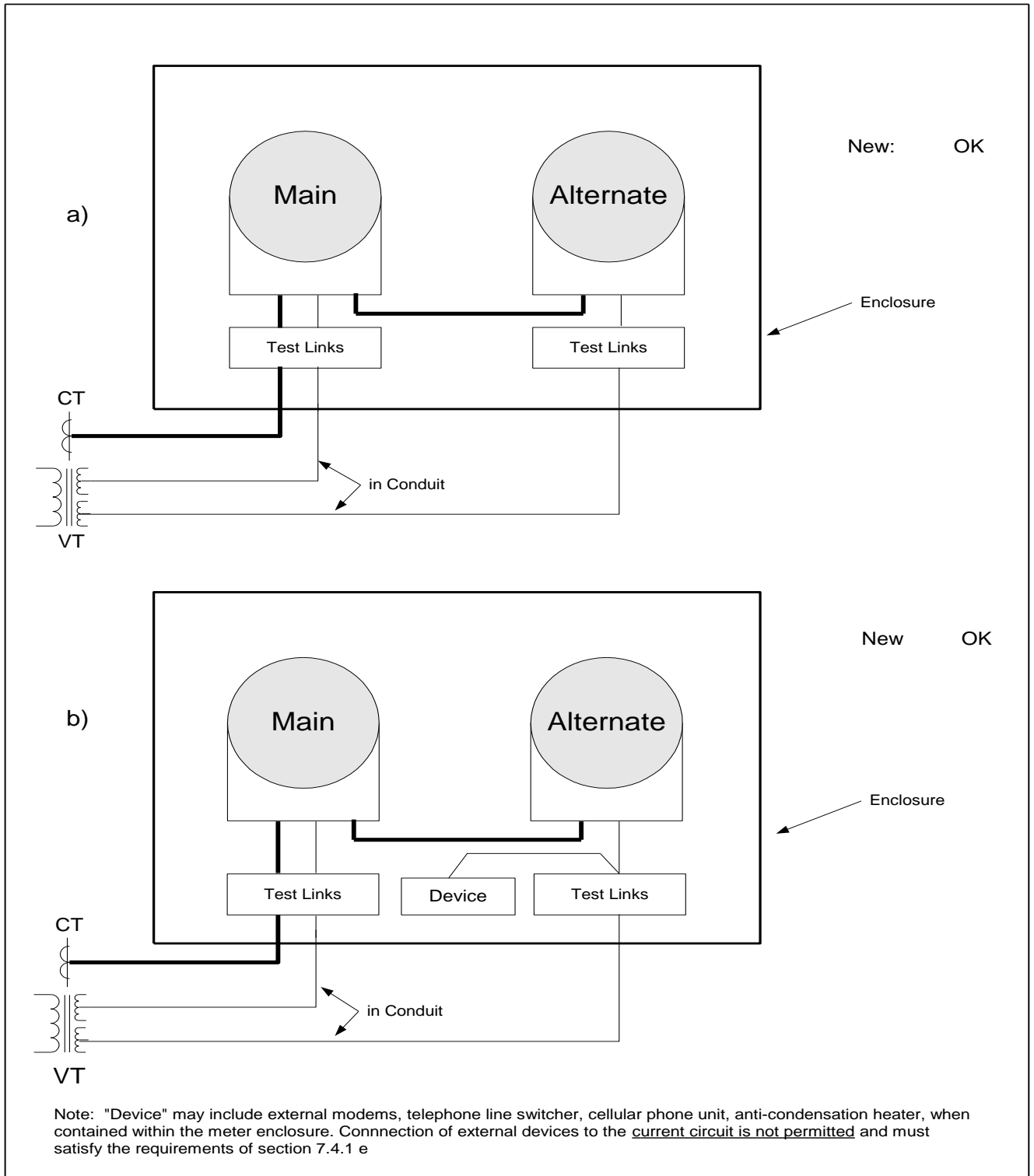


Figure B-3: Main/Alternate Metering Installation - Dual Secondary Windings

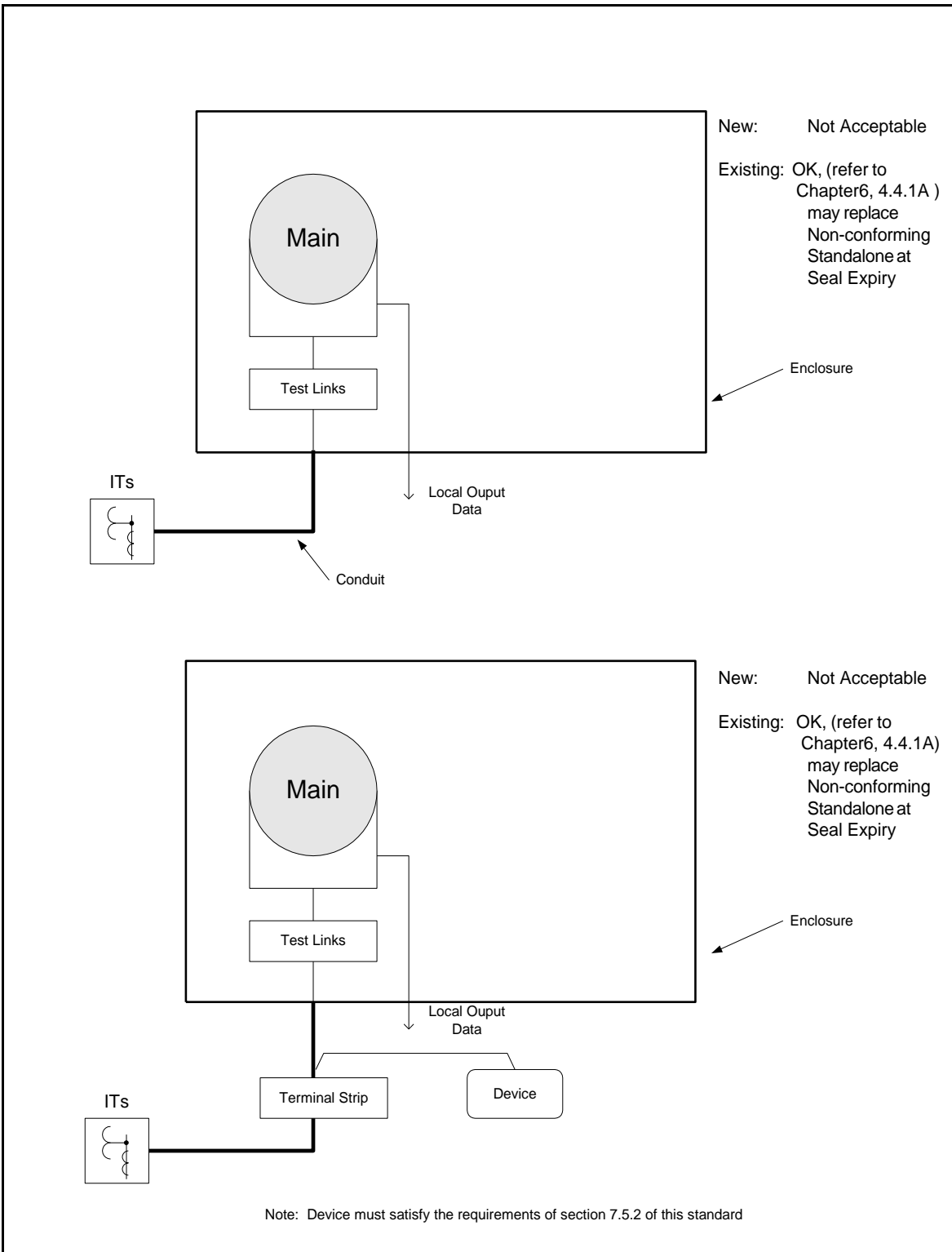


Figure B-4: Standalone Main Metering Installation

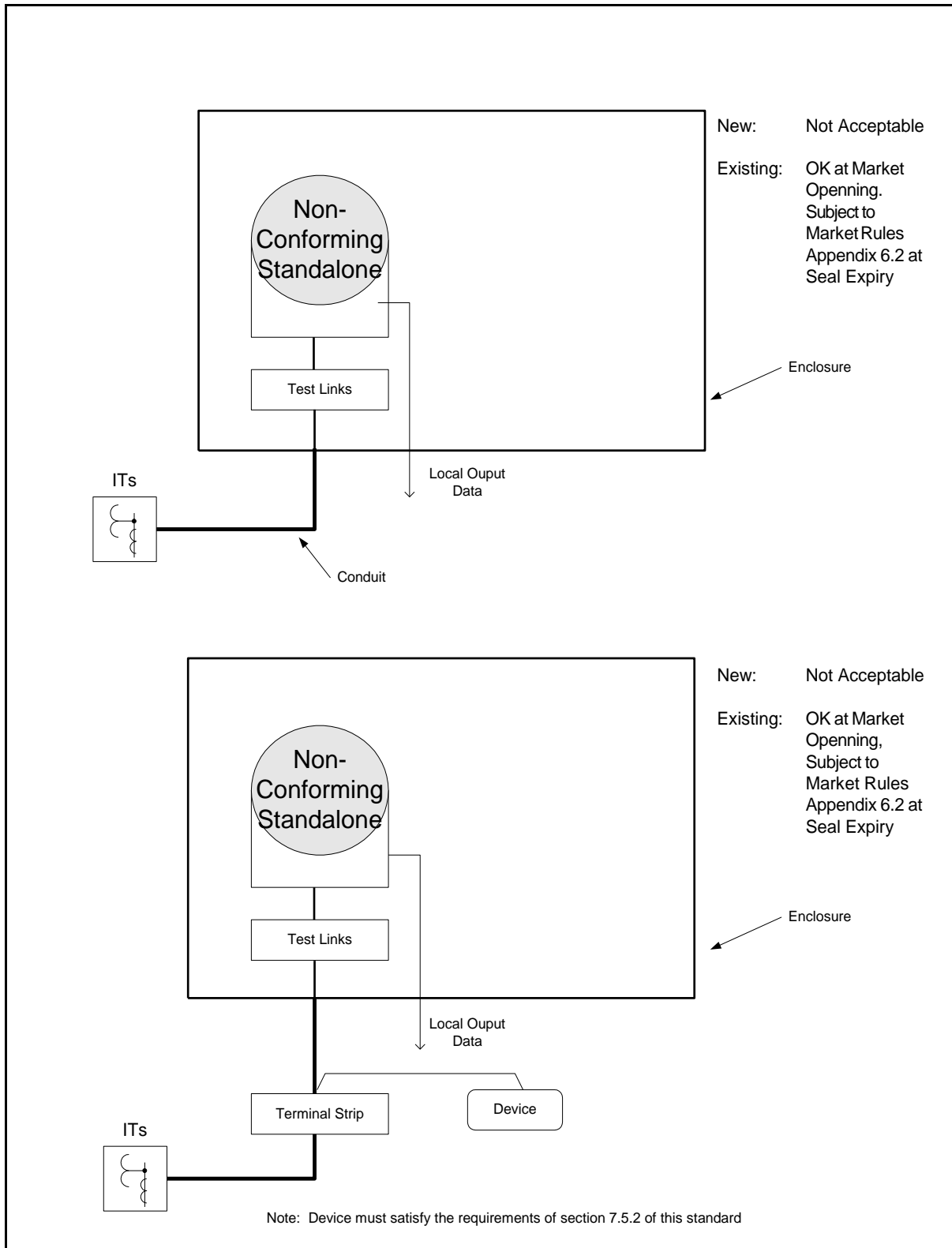


Figure B-5: Standalone Non-Conforming Metering Installation

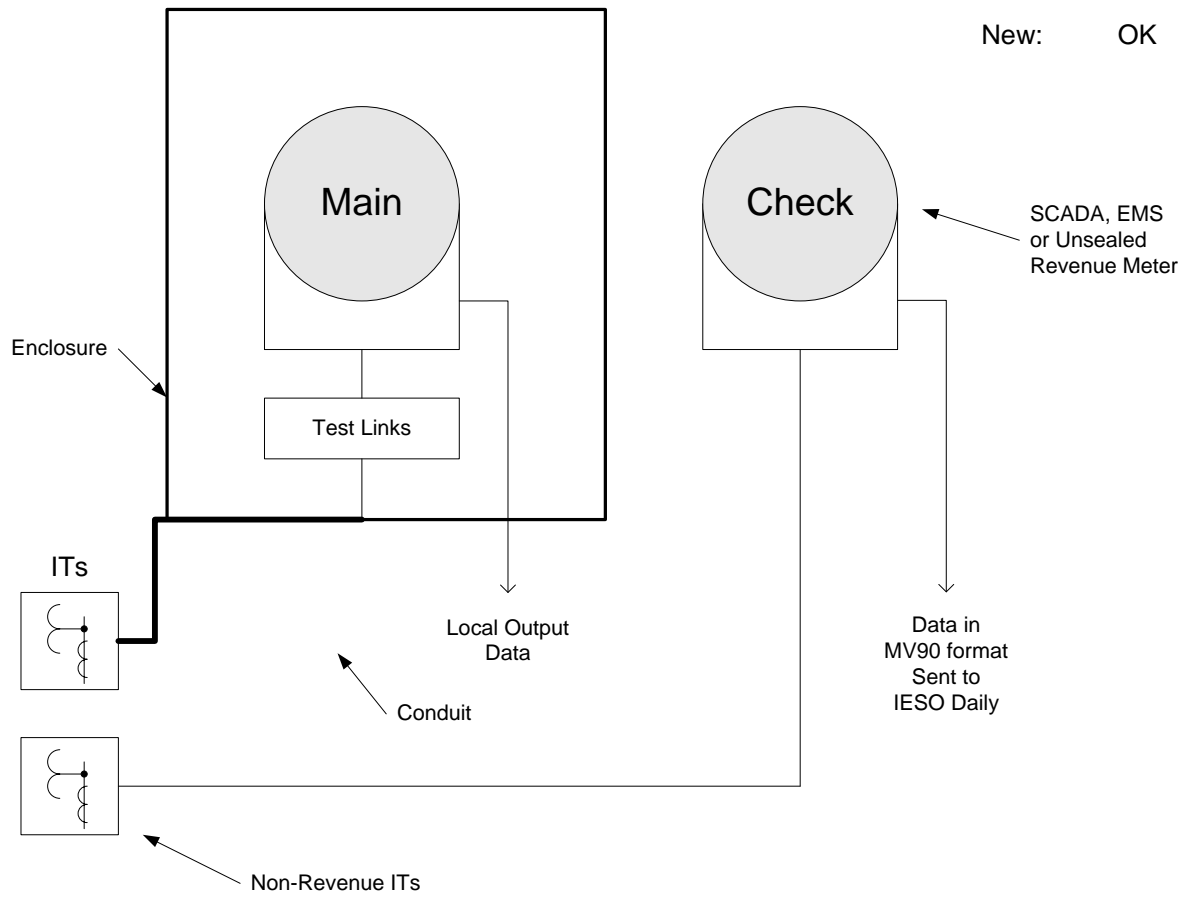


Figure B-6: Main/Check Metering Installation

– End of Section –

Appendix C: Blondel Conformance

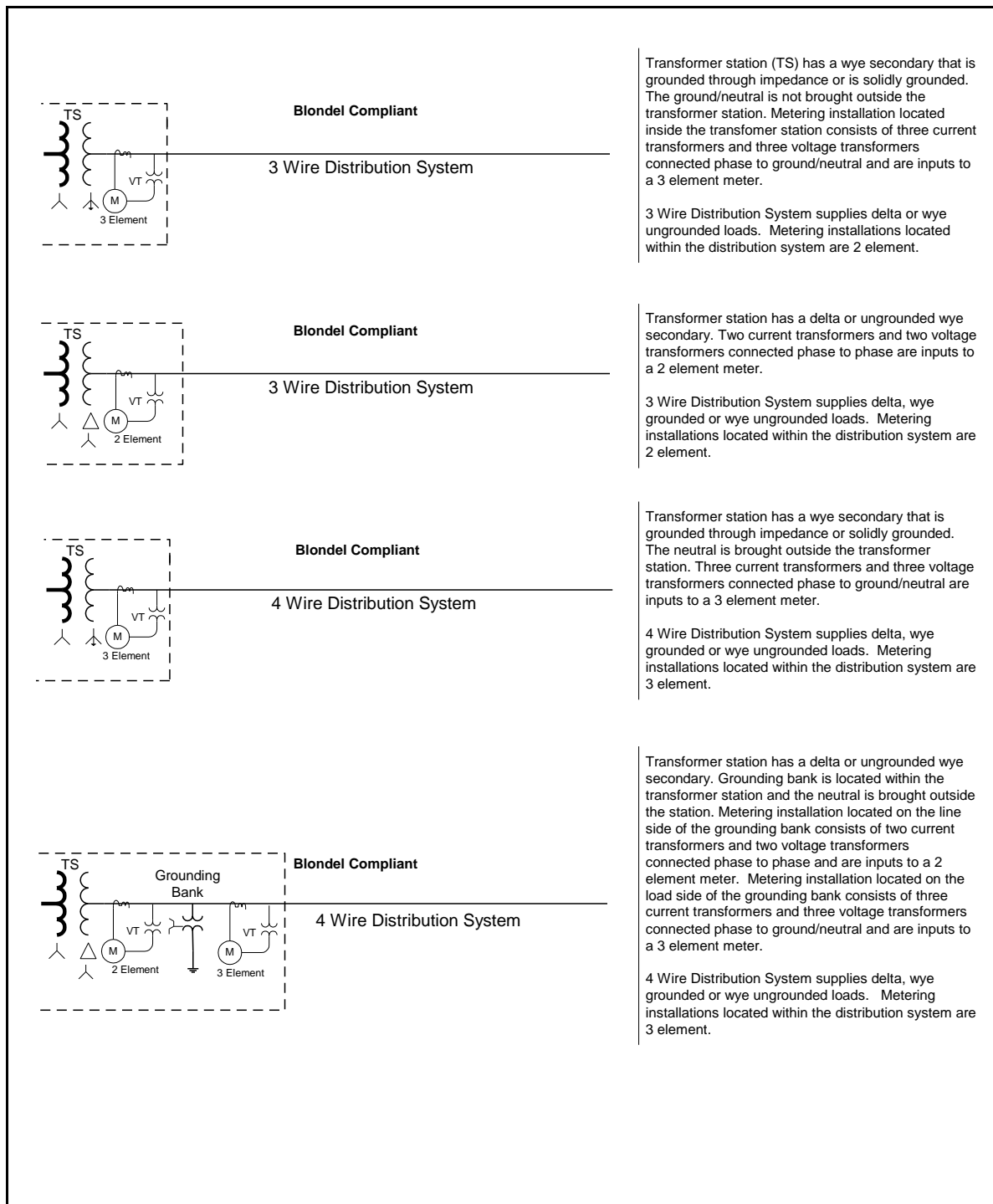


Figure C-1: Illustrations of Blondel Conformance

– End of Section –

Appendix D: VT Primary Switching

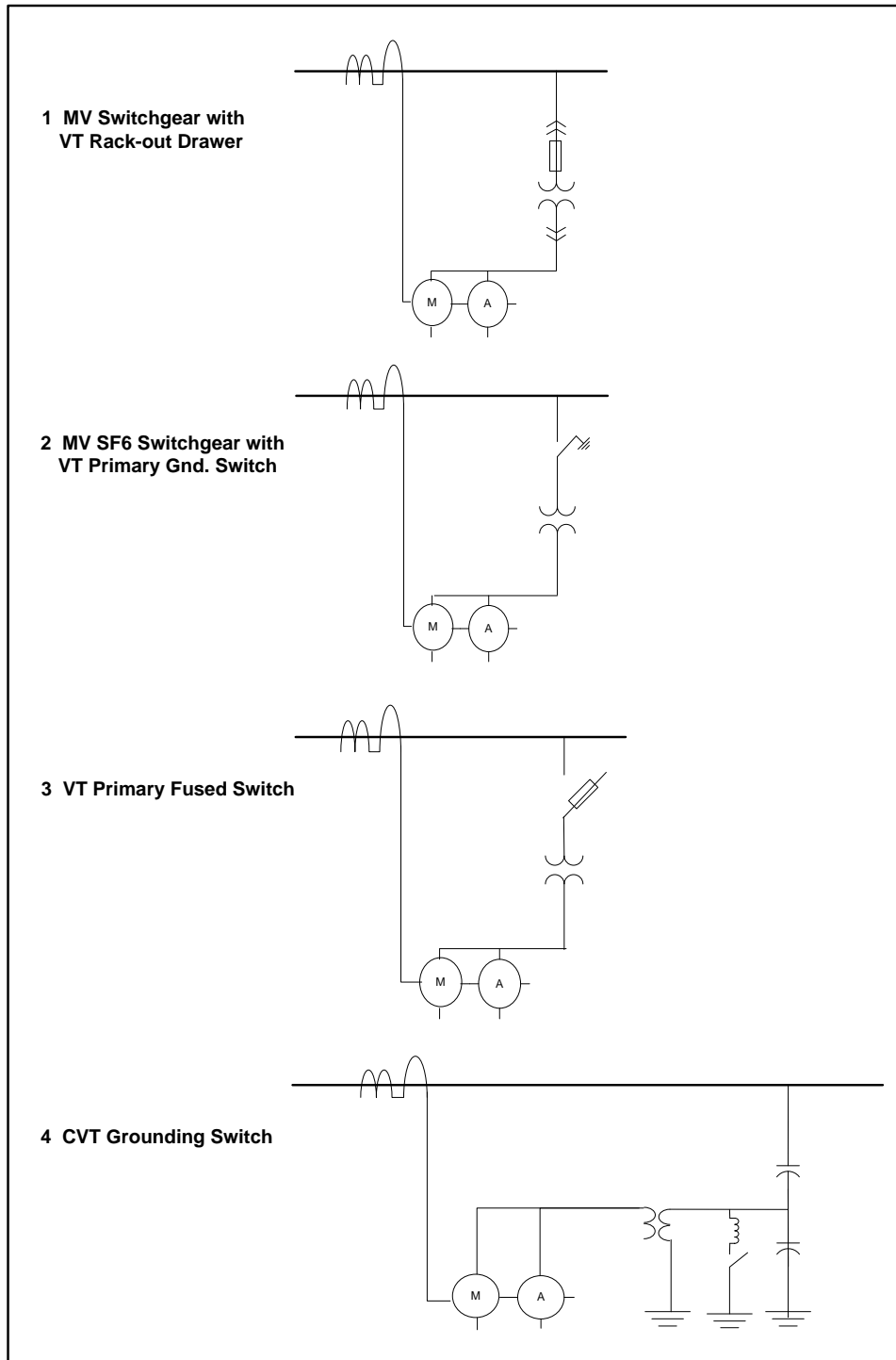


Figure D-1: VT Primary Switching Devices and Rack-out Mechanisms

– End of Section –

References

Document Name	Document ID
Market Rules for the Ontario Electricity Market	MDP_RUL_0002
Market Manual 5: Settlements, Part 5.2: Metering Data Processing	MDP_PRO_0032
Market Manual 3: Metering Part 3.5: Site-Specific Loss Adjustments	MDP_PRO_0011
Site-Specific Loss Adjustments	MDP_STD_0005
IMO Policy on Security of Meter Data	
Canadian Standards Association C13 “Instrument Transformers” CAN3-C13-M83	
ANSI/IEEE C57.13-1983 “IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases”	
Ontario Electrical Safety Code	
ANSI C12.16, “Solid State Electricity Meters”	
IMO policy “IMO Policy on Security of Registered Wholesale Meters, Metering Installations and Metering Data”	
ANSI C12.20-1998 for “Electricity Meters 0.2 and 0.5 Accuracy Classes”	
CAN 3-C17-M84: Canadian specification for approval of type of electricity meters	
CAN 3-Z234.4-79: Canadian specification for all-numeric dates and times.	
Industry Canada “Consolidation of the Electricity and Gas Inspection Act” LMB-EG-01	
Industry Canada “Specifications for Approval of Type of Electricity Meters, Instrument Transformers and Auxiliary Devices”	
ANSI/IEEE C57.13-1978 (Reaffirmed 1986) “Standard Requirements for Instrument Transformers”	
IEEE C57.13.6-2005 “IEEE Standard for High-Accuracy Instrument Transformers”	
IEEE C57.13-2008 IEEE Standard Requirements for Instrument Transformers	
CAN/CSA-C60044-1:07 “Instrument transformers – Part 1: Current transformers	
CAN/CSA-C60044-2:07 “Instrument transformers – Part 2: Inductive voltage transformers	
CAN/CSA-C60044-3:07 “Instrument transformers – Part 3: Combined transformers	

Document Name	Document ID
CAN/CSA-C60044-5:07 “Instrument transformers – Part 5: Capacitor voltage transformers	
CAN/CSA-C60044-8:07 “Instrument transformers – Part 8: Electronic current transformers	
CAN/CSA-C60044-7:07 “Instrument transformers – Part 7: Electronic voltage transformers	
Handbook for Electricity Metering, 10 th Edition	

– End of Document –