MDP_STD_0004

STANDARDS

Wholesale Revenue Metering Standard - Hardware

Issue 14.0

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

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Related Documents

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IMP_PRO_0058	Market Manual 3: Metering, Part 3.9: Conformance Monitoring
MDP_GDE_0002	Guide to Documents Published in Baseline
MDP_PRO_0010	Market Manual 3: Metering, Part 3.4: Measurement Error Correction
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
MDP_STD_0005	Site-Specific Loss Adjustments

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Reference (Section and Paragraph)	Description of Change
Throughout Document	Added reference to electricity storage participation where required.

1. Introduction

1.1 General Requirements

1.1.1 Minimum Requirement

This standard sets forth the minimum requirements for *metering installations* in the *IESO-administered market*.

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 subject to *IESO* approval.

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:

a. The word 'shall' denotes a mandatory requirement;

b. Terms and acronyms used in this document that are *italicized* have the meanings ascribed thereto in Chapter 11 of the *market rules*;

c. 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 Metering Equipment

This standard applies to the following metering equipment:

a. *meters*;

b. *instrument transformer*s, cabling, enclosures, test blocks, fuses, conduit and other associated *metering installation* components; and

c. on-site communications equipment and communication protocols.

Metering installations conforming to this standard are used for the *settlement* of transactions in the *IESO-administered market*.

2.1.2 Applicability to Metering Installations

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

a. connection between *IESO* and neighbouring *control areas*;

b. connection to the *IESO-controlled grid*;

c. points of connection between local distribution companies;

d. connection of *market participants* embedded within the local distribution companies; and

e. any other locations as required by the *IESO* for the *settlement* of transactions in the *IESO-administered market*.

2.1.3 Declaration of Compliance and Alternative Metering Installation Standards

This standard applies to Declaration of Compliance (DOC) and Alternative Metering Installation Standards (AMIS) *metering installations* in the *IESO-administered market*. These compliance types apply for:

a. *metering installations* for which the major components were ordered or procured after May 17, 2000 and meet DOC requirements outlined in Part I of the wholesale revenue metering hardware standard; and

b. *metering installations*:

- in service on April 17, 2000; or
- that are the subject of an application for registration filed prior to the *market commencement date* and in respect of which the major components were ordered or procured on or before May 17, 2000; and
- meet AMIS requirements outlined in Part II of the wholesale revenue metering hardware standard.

– End of Section –

3. Meter Points

3.1 Defined Meter Point

The *defined meter point* shall be the point of connection to the *IESO-controlled grid* at which all *settlement* transactions are deemed to take place.

3.1.1 Directly Connected Facilities

The point of connection for a directly *connected facility* is the *defined meter point* 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 designated[1] 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 *electricity storage facilities*, the point at which the *facility's* transformer is connected to the *transmission system*; or
f. for *distributors*, the point at which the *distributor* is connected to the *IESO-controlled grid* or connected to another *distributor*; or
g. any other *connection point* deemed to be necessary for *settlement* by the *IESO*.

3.1.2 Embedded Connected Facilities

The point of connection for an embedded *connected facility is* the *embedded connection point*[2]. Each embedded connected *market participant's meter* shall be associated with one *embedded connection point* and shall be one of the following:

a. the point at which a *generation facility*, *load facility*, or *electricity storage facility* is connected to the *distribution system* within which it is *embedded*; or
b. any other *connection point* deemed to be necessary for *settlement* by the *IESO*.

The *embedded market participant's metering data* shall be adjusted for *energy* losses between its *embedded connection point* and the *defined meter point* as approved under the *Ontario Energy Board* decision and rate order.

3.1.3 Delivery Point and Registered Wholesale Meter

The *delivery point* for a given *registered wholesale meter (RWM)* shall be a uniquely identified reference point determined by:

a. adjusting the metering data from that *RWM* in accordance with section 4.2.3 of Chapter 6; and

[1] Designated by the *IESO* as not being part of the *IESO-controlled grid.*
[2] The *embedded connection point* will be as defined in the Local Distribution Company agreement.

b. summing the metering data from that *RWM* with *metering data* from all other applicable *RWMs* in accordance with the relevant *meter point* documentation submitted in respect of that *RWM* pursuant to section 1.3 of Appendix 6.5 of Chapter 6.

3.2 Meter Point

3.2.1 Location

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

a. the *meter point* shall be subject to *IESO* approval;

b. *metering data* in the *metering database* shall be adjusted for *energy* losses between the *meter point* and the *defined meter point*; and

c. consumption of *connection station service* shall be separately accounted for if it is not accounted for in the *metering data* in the *metering installation*.

3.2.3 When Meter Point Not Located at Embedded Connection Point

Where the *meter point* is not located at the *embedded connection point*, the following conditions shall apply:

a. the *meter point* shall be subject to *IESO* approval; and

b. *metering data* recorded in the *metering database* shall be adjusted for *energy* losses between the *meter point* and the *embedded connection point*.

– End of Section –

PART I. DECLARATION OF COMPLIANCE STANDARD

4. Metering Installations – General Requirements

4.1 General Requirements – Revenue Meters

Each Declaration of Compliance (DOC) *metering installation* shall contain *meters* which conform to the wholesale revenue metering hardware standard requirements as follows:

a. *meters* shall be listed on the Conforming Meter List and shall be programmed in accordance with the *IESO* Conforming Meter Framework;

b. comprised of two *revenue meters*, a main *meter* and an alternate *meter* in a *main/alternate metering installation*;

c. comprised of a single *meter* in a standalone *metering installation* for a minor embedded *generation facility*;

d. Main *meters* shall meet or exceed 0.2% accuracy of ANSI C12.20;

e. Alternate *meters* shall meet or exceed 0.5% accuracy of ANSI C12.20; and

f. *meters* must be approved and verified by Measurement Canada.

4.2 General Requirements – Metering Installations

Each Declaration of Compliance (DOC) *metering installation* shall comply with the wholesale revenue metering hardware standard requirements as follows:

a. have *instrument transformers* where the current transformers and voltage transformers meet or exceed 0.3% accuracy of ANSI C57.13 or CAN/CSA C61869;

b. conform with Blondel's Theorem (see **Appendix** C: Blondel Conformance);

c. meet the security requirements established by the *market rules*, and any policy or standard established by the *IESO*; and

d. be commissioned in accordance with the *market rules*, and any policy or standard established by the *IESO*.

4.3 Configurations of Declaration of Compliance Metering Installations

Each Declaration of Compliance (DOC) *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 Blondel's Theorem and section 5.3 – Accuracy Requirements for Instrument Transformers.

   One set of *instrument transformers* is connected to the main *meter* and the second set of *instrument transformers* is connected to the alternate *meter*.

A measurement or control device may optionally be connected to the second set of voltage transformers only, subject to *IESO* approval. See Figure B-1 for a graphical representation.

b. A *main/alternate metering installation* comprised of a single set of *instrument transformers*, which are approved by Measurement Canada, and meet the requirements of Blondel's Theorem and section 5.3 – Accuracy Requirements for Instrument Transformers.

   The single set of *instrument transformers* is connected to both the main and alternate *meters*.

   The voltage transformers have a single secondary winding only. Measurement and control devices shall not be connected to the single voltage transformer secondary winding. See Figure B-2 for a graphical representation.

c. A *main/alternate metering installation* comprised of a single set of *instrument transformers* which are approved by Measurement Canada, and meet the requirements of Blondel's Theorem and section 5.3 – Accuracy Requirements for Instrument Transformers.

   The single set of *instrument transformers* is connected to both the main and alternate *meters*.

   The voltage transformers have double secondary windings where the voltage transformers are connected with:

   - the secondary winding connected to the main *meter* and the tertiary winding connected to the alternate *meter*; or
   - the secondary winding connected to both main and alternate *meters*;

   a measurement or control device may optionally be connected to the tertiary winding only, subject to *IESO* approval. See Figure B-3 for a graphical representation.

d. A minor embedded *generation facility metering installation* comprised of a single set of *instrument transformers* which are approved by Measurement Canada, and meet the requirements of Blondel's Theorem, section 10.1 – Metering Installations for a Minor Embedded Generation Facility and section 5.3 – Accuracy Requirements for Instrument Transformers.

   The single set of *instrument transformers* is connected to a standalone *meter* consisting of either a main *meter* or an alternate *meter* from the Conforming Meter List. See Figure B-4 for a graphical representation.

– End of Section –

5. Instrument Transformers – General Requirements

5.1 Inclusion of Instrument Transformer

Metering installations shall include *instrument transformers*.

5.2 Information Requiring IESO Approval

As part of the *metering installation* registration process, *instrument transformer* information shall be provided to the *IESO* to verify:

a. Measurement Canada approval of type;

b. *instrument transformer* conformance to the applicable ANSI or CAN/CSA accuracy class;

c. *instrument transformer* normal operation is within their rated burden limits;

d. *instrument transformer* normal operation is within their operating limits; and

e. *instrument transformer* ratio and phase angle correction factors for the applicable ANSI or CAN/CSA accuracy class.

5.3 Accuracy Requirements for Instrument Transformers

5.3.1 Current Transformers

Current transformers shall conform to the IEEE C57.13-2016 for 0.3 metering accuracy class, or the Canadian Standards Association CAN/CSA-C61869-2:14 for 0.3 metering accuracy class.

High accuracy current transformers shall conform to the IEEE C57.13.6-2005 for 0.15 and 0.15S metering accuracy class, or the Canadian Standards Association CAN/CSA-C61869-2:14 for 0.15 and 0.15S metering accuracy class.

5.3.2 Voltage Transformers

Voltage transformers shall conform to the IEEE C57.13-2016 for 0.3 metering accuracy class, or the respective Canadian Standards Association CAN/CSA-C61869-3:14, CAN/CSA C61869-4:14, and CAN/CSA-C61869-5:15 for 0.3 metering accuracy class.

High accuracy voltage transformers shall conform to the IEEE C57.13-2016 for 0.15 metering accuracy class, or the respective Canadian Standards Association CAN/CSA-C61869-3:14, CAN/CSA C61869-4:14, and CAN/CSA-C61869-5:15 for 0.15 metering accuracy class.

5.4 Safety Requirements for Instrument Transformers

5.4.1 Requirements

Metering installations shall conform to the requirements of:

a. the "Ontario Electrical Safety Code"; and

b. the IEEE C57.13.3-2014 – "Guide for Grounding of Instrument Transformer Secondary Circuits and Cases".

5.5 Instrument Transformer Ratios

5.5.1 Selection of Current Transformer Ratios

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

a. the maximum sustained primary current during normal operation shall not exceed the primary tap multiplied by the continuous current rating factor 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
- 5% of the primary tap, for ANSI 0.15 accuracy class; or
- 1% of primary tap, for ANSI 0.15S accuracy class.

5.5.2 Selection of Voltage Transformer Ratios

Voltage transformer ratios shall be selected such that operation at the minimum or maximum sustained secondary voltage, specified to be 90% and 110% of accuracy-rated voltage in Measurement Canada S-E-07 specifications, shall not affect *meter* accuracy or *meter* function.

5.6 Instrument Transformer – Primary Connection Point

5.6.1 Requirements for Primary Terminals

5.6.1.1 Primary Terminal for Current Transformer

The primary terminals of each current transformer shall:

a. be at the same potential as the primary terminals of the corresponding voltage transformer; and

b. designate all phase terminals oriented towards the *IESO-controlled grid* as INPUT CT primary terminals;

- The INPUT CT primary terminal will define the INPUT CT secondary terminal. The INPUT CT secondary terminal shall connect to *meter* line side current terminal.
- The INPUT polarity of each current transformer shall remain consistent in the secondary metering circuit through to the *revenue meters*.

- The INPUT polarity configuration will determine the delivered and received power flow as measured at the *IESO-controlled grid*. Four quadrant power flow definitions and conventions are derived from the "Handbook for Electricity Metering". The registration of four quadrant real and reactive energy shall comply with the *IESO* Conforming Meter List functional requirements for main *meter* and alternate *meter* in respect of the *defined meter point*.

5.6.1.2 Primary Terminal for Voltage Transformers

The primary terminals of each voltage transformer shall be:

a. connected as close as practicable to either line side or load side of the current transformer primary terminal;

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

c. at the same potential as the primary terminals of the corresponding current transformer.

5.6.2 Instrument Transformer Connections and Separation

With respect to the physical separation of the points at which the voltage transformer and the current transformer of each phase are primary connected, 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.

Where the maximum error introduced by any physical separation of the primary terminals of the voltage transformer and current transformer exceeds 0.02% for active power flow, a Measurement Error Correction (MEC) correction factor shall be provided by the *metering service provider* for *IESO* approval.

5.6.3 Connection to Common Solid Bus

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

5.6.3.1 VT Single Secondary Winding

The two *main/alternate metering installations* are comprised from a single set of voltage transformers which have a single secondary winding only. The single secondary winding is connected to both of the main *meters* and the alternate *meters* from each *metering installation*. Measurement and control devices shall not be connected to the single secondary winding. See Figure B-5 for a graphical representation.

5.6.3.2 VT Double Secondary Winding

The two *main/alternate metering installations* are comprised from a single set of voltage transformers which have double secondary windings configured with:

- the main *meters* from each *metering installation* connected to the secondary winding;
- the alternate *meters* from each *metering installation* connected to the tertiary winding; and
- a measurement or control device optionally connected to the tertiary winding only.

Alternatively, the voltage transformers with double secondary windings may configure:

- both sets of main *meters* and alternate *meters* from each *metering installation* connected to the secondary winding; and
- a measurement or control device optionally connected to the tertiary winding only.

See Figure B-6 for a graphical representation.

5.6.4 Primary Cable and Terminations Error

Maximum error introduced by the primary cable and terminations connecting the primary terminals of an *instrument transformer* to the *IESO-controlled grid* shall not exceed 0.02%.

5.7 Instrument Transformer – Secondary Cabling and Connections

5.7.1 Instrument Transformer – Secondary Cabling and Terminal Connections

The secondary cabling and terminal connections of each instrument transformer shall conform to Measurement Canada S-E-08 standard drawings for three-phase wye and delta connected *metering installations*.

5.7.2 Current Transformers

5.7.2.1 Size of Secondary Cabling

The secondary cabling between the current transformers and the *meter* shall be of a sufficient size that the rated burden for the 0.3 or 0.15 ANSI accuracy class as applicable, is not exceeded when current, equivalent to rated current, flows in the secondary winding.

5.7.3 Voltage Transformers

5.7.3.1 Secondary Terminal Connections

The secondary terminal connection of each voltage transformer shall:

a. connect to the common node when creating the reference neutral point; and

b. make the ground connection for the common or neutral secondary wires of the voltage transformer at a single point of ground only.

5.7.3.2 Maximum Error – Secondary Cabling and Connections

Maximum error introduced by the secondary cabling and connections shall comply with the following limits:

a. where the maximum error is less than 0.02% the *metering installation* shall be approved without a MEC correction factor applied to *metering data;*

b. where the maximum error exceeds 0.02% a MEC correction factor shall be provided for *IESO* approval*; and*

c. the maximum error limit shall not exceed 1.0%.

5.8 Instrument Transformer Burdens

5.8.1 General

5.8.1.1 IESO Approval

Meters and any measurement or control devices connected to the *instrument transformers* shall be subject to *IESO* approval. *Revenue meters* shall be approved from the Conforming Meter List. Measurement or control devices may include transducers, control instrumentation, protection and control relays, and any telecommunication equipment.

5.8.1.2 Review Requirements

A review of the burden imposed on *instrument transformers* shall include a review of:

a. the burden imposed by each *revenue meter* and all measurement or control device; and

b. the size of the conductors in the secondary cabling and the length of the path followed by the cabling.

5.8.1.3 Secondary Connections or Burden

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

5.8.2 Verification of Connections

5.8.2.1 Tracing and Verification – Cabling

The *metering installation's instrument transformer* secondary cabling shall be visually verified and electrically traced.

5.8.3 Verification of Burden

5.8.3.1 Calculation of Burden

The burden calculation for an *instrument transformer* shall comply with the following requirements:

a. burden on each *instrument transformer* shall be calculated from all the connected devices;

b. where device nameplate data is not available, on-site measurement tests shall determine value of device burdens to be used in the *instrument transformer* burden calculation; and

c. calculation of burden with all the connected devices shall verify that actual burdens in service do not exceed nameplate burden ratings of any *instrument transformer*.

5.8.4 Burden Calculation – Current Transformers

5.8.4.1 General Requirements

The burden calculation for a current transformer shall include:

a. the impedance of the secondary cabling; and

b. the impedance of all *revenue meters*.

5.8.4.2 Determining the Burden

The calculation shall determine the burden imposed at the secondary terminals of the current transformer.

5.8.4.3 Rated Burden Limit

The calculated burden for DOC installations shall not exceed the rated burden limit of the CT for the 0.3, 0.15 and 0.15S ANSI accuracy class.

5.8.5 Burden Calculation – Voltage Transformers

5.8.5.1 General Requirements

The burden calculation for a voltage transformer shall include the impedance of all *revenue meters*, all secondary cabling, and the equivalent impedance of all connected devices at the secondary terminals of the voltage transformer.

5.8.5.2 Allowance for Cable Sizing

If the secondary cabling uses a common return, cable sizing for the neutral conductor must allow for loss of a secondary fusing event, or a single-phase power event on the power system.

5.8.5.3 Rated Burden Limit

The calculated burden for DOC installations shall not exceed the rated burden limit of the VT for the 0.3 and 0.15 ANSI accuracy class.

5.9 Operation of Switching Devices – DOC Installations

5.9.1 Location of Primary Connections – Instrument Transformers

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

5.9.2 Power Systems Operations Switching

Notwithstanding section 5.9.1, power systems operations switching is managed by r*evenue meter* connections as follows:

a. the auxiliary power supply to the main and alternate *meters* shall conform to the power systems operations switching requirements of section 6.4.2.

5.9.3 VT Primary Switching Devices

Notwithstanding section 5.9.1, the operation of VT primary switching devices is managed by *revenue meter* connections as follows:

a. the auxiliary power supply to the main and alternate *meters* shall conform to the VT primary switching requirements of section 6.4.2;

b. sufficient seals shall be placed to ensure detection of unauthorized access to the VT switching device; and

c. only the switching conditions as outlined in Appendix D are permitted.

5.9.4 Emergency Bypass Switching Device – Pole Mounted Metering Equipment

Notwithstanding section 5.9.1 the operation 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 Emergency Instrument Transformer Restoration Plan 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*.

5.10 Additional Requirements – Instrument Transformers

5.10.1 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 S-E-08 standard drawings for colour coding and permanent tagging/labelling shall be used);

c. voltage transformers with double secondary windings may be used for purposes other than metering. The *metering installation* shall comply with the following:

- all measurement or control devices connected to the voltage transformers shall be installed inside the *meter* enclosure;

d. for a dual *main/alternate metering installation*, the second set of *instrument transformers* may be used for purposes other than metering. The *metering installation* shall comply with the following:

- all measurement or control devices connected to the *instrument transformers* shall be installed inside the *meter* enclosure;

e. electrical connection to the *instrument transformer* secondary terminals shall not be permitted outside of the *meter* enclosure;

f. cabling from the *instrument transformers* to the *meter* enclosure shall be routed in conduit, or have mechanical protective qualities such as Teck 90 armoured cabling;

g. the route shall be visually traceable, except where buried cable is unavoidable such as underneath a roadway, a "Witness of Buried Section Instrument Transformer Secondary Cables" form must be completed and submitted to the *IESO* in Online IESO; and

h. 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.

– End of Section –

6. Meters

6.1 Requirement for Main Meters and Alternate Meters

Main *meters* and alternate *meters* shall be listed on the Conforming Meter List and shall be programmed in accordance with the *IESO* Conforming Meter Framework. See PART III – CONFORMING METERS for accuracy and functional requirements for main and alternate *meters*.

6.2 Requirement for Standalone Meters

Standalone *metering installations* comprised of single main or alternate *meters* shall be listed on the Conforming Meter List and shall be programmed in accordance with the *IESO* Conforming Meter Framework. See PART III – CONFORMING METERS for accuracy and functional requirements for main and alternate *meters*.

6.3 Verified and Sealed Meters

Meters are verified and sealed by an accredited *meter* service organization or Measurement Canada.

Meters shall have a Measurement Canada certificate of inspection attesting the *meter* accuracy and the *meter* verification period.

6.4 Auxiliary Power Supply for Main and Alternate Meters

6.4.1 Auxiliary Power Supply Sources

Under normal *meter* operating conditions, the auxiliary power supply to the main and alternate *meters* shall be powered from:

a. Independent power sources which may include, but are not limited to:
   - *Station service* supply;
   - Distribution secondary service supply;
   - DC battery bank; or
   - Uninterruptible power supply powered from *station service* supply or distribution secondary service supply; or

b. Dependent power sources which may include, but are not limited to:
   - VT phase power; or
   - Uninterruptible power supply powered from VT phase power.

6.4.2 Auxiliary Power Supply Configuration – Minimum Requirements

The *metering data* validation process must be able to differentiate between an actual measurement circuit outage versus a loss connection to the *meter* auxiliary power supply. The *IESO's* Meter Data Acquisition System (MDAS) must be able to communicate with the main *meter* under all operating conditions to ascertain any measurement circuit outage event.

To allow for each *meter* operating condition described, the auxiliary power supply connection configurations to the main and alternate *meters* shall conform with the following minimum requirements to enable validation processing.

Table 6.1: Power Source Connections – Minimum Requirements

Metering Service Mode	Main Meter	Alternate Meter
Normal operating conditions[3]	Dependent power source	Dependent power source different VT phase than main *meter*
VT Primary Switching – Metering Outage[4]	Independent power source	Dependent power source
Power Systems Operations Switching – Extended Power System Outage[5]	Independent power source	Independent power source

6.4.2.1 Normal Operating Conditions

Under normal operating conditions where the metering installation sustains a loss of an input VT phase, at minimum, the main *meter* auxiliary power supply must be connected to a dependent power source and the alternate *meter* auxiliary power supply must be connected to a dependent power supply from a different source of VT phase power.

Power supply connections configured for either of:

- Independent power source to main *meter* and dependent power source to alternate *meter*; or
- Independent power source to main *meter* and independent power source to alternate *meter*,

will both meet and exceed minimum power supply requirements.

6.4.2.2 VT Primary Switching – Metering Outage

Where VT primary switching results in a *meter* outage to the *metering installation*, at minimum, the main *meter* auxiliary power supply must be connected to an independent power source, and the alternate *meter* auxiliary power supply must be connected to a dependent power source.

Power supply connections configured for:

- Independent power source to main *meter* and independent power source to alternate *meter*,

will meet and exceed minimum power supply requirements.

[3] *Metering installation* that is not subject to VT primary switching or power systems operations switching.
[4] See Appendix D for valid VT Primary Switching.
[5] In cases where the *facility* is disconnected from the source and kept off potential for an extended period of time (e.g. greater than one week), the auxiliary power supply 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 m*eter* is subject to *IESO* approval.

6.4.2.3 Power Systems Operations Switching – Extended Power Systems Outage

Where the VT primary connections of the *metering installation* is subject to extended outages due to power system operations switching, the main *meter* auxiliary power supply must be connected to an independent power source, and the alternate *meter* auxiliary power supply must be connected to an independent power source.

– End of Section –

7. Communications

7.1 Communication System Requirements

7.1.1 Compliance with IESO Standard

The *meter's* communication system shall comply with the *IESO* communication interface of the *metering database*.

a. TCP/IP (Transmission Control Protocol/Internet Protocol) communications shall be used for *metering data* communications. The TCP/IP communications shall comply with the *IESO* TCP/IP model for site-to-site VPN (Virtual Private Network);
b. Modem port numbers must be verified with the *IESO* for port accessibility;
c. Network addresses shall be assigned by the *IESO* to the *market participant's* network or the host *metering service provider's* network;
d. Conforming *meter* port numbers must be acceptable to the *IESO* for TCP/IP communications;
e. TCP/IP communication compliance shall be implemented at time of *metering installation* registration; and
f. *Meters* used for TCP/IP communications must be on the Conforming Meter List.

7.1.2 Compatibility with IESO Communications Interface

The communication equipment installed shall be compatible with:

a. *IESO's* Meter Data Acquisition System (MDAS); and
b. The *IESO* and the *metered market participant* shall be responsible for its own equipment to connect to the communication interface.

7.1.3 Metering Data Availability

Data communications shall be available to the *IESO* during the *IESO* call period. All *metering installation* communication failures shall be restored to meet *metering data* requirements in accordance with Chapter 6 of the *Market Rules*.

7.1.4 Main/Alternate Meter TCP/IP Communications

Main/alternate *meter* communication systems and paths shall comply as follows:

a. *Metering installation* registration shall implement TCP/IP communications;
b. *Metering installation* registration resulting from:
   - a *meter* seal expiry;
   - substantial upgrade or refurbishment of a *metering installation* or *facility*;
   - *metering installation* re-supply from a different *facility*;
   - *metering installation* re-termination from a different feeder; and
   - *metering installation* relocation with reference to the *defined meter point*,

   shall make provision for TCP/IP communications;

c. TCP/IP communication configuration shall support concurrent communication sessions to the *meters*;
d. TCP/IP communications shall be limited to a maximum of four *meters* per TCP/IP connection where concurrent connections are not supported; and
e. *Metered market participant* shall be responsible for the VPN connection, informing the *IESO* of VPN outages, and all *metering data* traffic incurred.

7.1.5 TCP/IP Communications Restriction

The *IESO* recognizes that TCP/IP communications could be restricted or unavailable at some *facility* locations. Supporting documentation of the steps taken must provide proof of best efforts to establish a TCP/IP connection.

a. Identify the service provider coverage in the vicinity (e.g. Government of Canada website https://www.ic.gc.ca/app/sitt/bbmap/hm.html);
b. Identify technical or security reasons why a service cannot be obtained from any applicable service provider indicated; and
c. Identify the communications test process for attempting to acquire a service signal. The classification and model of modems and boosters used, as well as placement and mounting of the boosters, must be described.

Registration of a *metering installation* with an alternative communication technology shall be subject to *IESO* approval.

– End of Section –

8. Enclosure

8.1 Meter Enclosure

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

a. The cabinet must be locked, sealed and accessible only by the *metering service provider*.

b. Conditions of acceptance for cabinet or enclosure are:
   - must be clearly identified;
   - must be under strict control of the *metering service provider;* and
   - cannot be used for any purpose other than housing metering equipment

c. All *meters*, *meter* test blocks, *meter* test links, *instrument transformer* terminal strips, and *meter* communication equipment shall be contained within a *meter* enclosure. The communication equipment, such as a wireless modem or a network router, may be located in a separate locked enclosure under strict control of the *metering service provider* provided that the equipment is supplied from an external power source; otherwise the communication equipment shall be contained in the *meter* enclosure.

8.1.1 Meter Test Blocks

Meter 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 isolated and tested.

8.2 Instrument Transformer Enclosure

8.2.1 Junction Box, Marshalling Box and VT Fuse Box

Instrument transformer secondary cabling and connections shall be contained inside a junction box (e.g. MEC box), a marshalling box and VT fuse box to connect the current and voltage from each *instrument transformer* to the *revenue meters*.

8.2.2 Switchgear Metering Cells and Metering Compartments

Instrument transformers shall be installed in current and voltage transformer metering cells, or current and voltage transformer metering compartments, in switchgear metering applications.

8.2.3 Secondary Cable Conduit

Instrument transformer secondary cabling shall be protected and housed in electrical conduit, or Teck cable, and routed in electrical raceways where applicable.

8.2.4 Bus Duct Enclosure

Where *instrument transformers* are installed in bus duct (e.g. isolated phase bus or gas insulated bus), the secondary cabling shall be protected and connect the current and voltage from each *instrument transformer* to the *revenue meters*.

– End of Section –

9. Security

9.1 Security Requirements

9.1.1 Meter Enclosure Security Requirements

The *meter* enclosure shall be secured by the *metering service provider*, in a manner approved by the *IESO*, which at a minimum complies with the following requirements:

a. the *meter* enclosure shall be locked and sealed in a manner approved by the *IESO* to ensure the detection of unauthorized access to the *instrument transformer* connections, *meters*, *meter* test blocks, test links, test link cover and fuses;

b. the *metering service provider* shall have access to the *meter* enclosure at all times;

c. access to the *meter* enclosure for purposes of isolation work protection or meter communications servicing by persons other than the *metering service provider* shall only be given under strict control of the *metering service provider*. Where a third party access is provided, the *metering service provider's* access and control procedure shall be subject to *IESO* approval; and

d. the *meter* enclosure that contains multiple *metering installations* (2 or more) shall be locked and sealed by the *metering service provider*, in a manner approved by the *IESO*. Internal *meter* components including *meter* sealing ring, *meter* adapter base and *meter* test block cover contained within the *meter* enclosure shall additionally be sealed to ensure the detection of unauthorized access to the individual *metering installation's instrument transformer* connections, *meters*, *meter* test blocks, test links, test-link cover and fuses.

9.1.2 Instrument Transformer Security Requirements

Instrument transformer connections to secondary cabling shall be secure and tamper proof, including at a minimum complying with the following requirements:

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

b. the *metering service provider* shall have access to the *instrument transformer* enclosures at all times; and

c. access to the *instrument transformer* enclosures for purposes of isolation work protection by persons other than the *metering service provider* shall only be given under strict control of the *metering service provider*. Where a third party access is provided, the *metering service provider's* access and control procedure shall be subject to *IESO* approval.

9.1.3 Bus Duct Security Requirements

Where *instrument transformers* are located inside bus duct, the secondary cabling and terminations shall be secure and tamper proof under the strict control of the *metering service provider*.

9.1.4 Bushing Security Requirements

Where current transformers are mounted on power transformer bushings or circuit breaker bushings, or inside circuit breaker housings, the secondary cabling and terminations shall be secure and tamper

proof under the strict control of the *metering service provider*. Any third party access to the power transformer control panels, or protection and control panels, shall be performed within the framework of the *metering service provider* access and control procedure.

9.2 Sealing Requirements

The overall sealing requirements of *metering installation* circuit access points include the *meter* enclosure, *instrument transformer* terminal box connections, *instrument transformer* switchgear cells and compartments, *instrument transformer* junction boxes and marshalling boxes, capacitive voltage transformer shorting switches, and secondary cable conduit and fittings. Where the *meter* enclosure contains multiple *metering installations*, the *meter* sealing ring, *meter* adapter base, *meter* test blocks, *meter* test links and fuses shall additionally be sealed.

9.2.1 Seals

The requirements for seals 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 seal log which:
   - identifies all *metering installation* circuit access points;
   - records seal serial numbers for each circuit access point; and
   - records subsequent seal changes, including reasons for the change, for each circuit access point.

9.2.2 Metering Installation Maintenance and On-site Audit

Each *metering installation* named in the *meter* seal log shall identify all associated circuit access points with a record of the date and seal serial number. Each seal that is removed and replaced during *metering installation* maintenance and on-site audit shall be recorded for inspection by the *IESO*.

– End of Section –

10. Special Provisions

10.1 Metering Installations for a Minor Embedded Generation Facility

Each *metering installation* for a 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 injects less than 17 GWh per annum can register with the *IESO* a *metering installation* for that *generation facility* comprised of a standalone *meter* consisting of either a main *meter* or an alternate *meter* from the Conforming Meter List.

10.1.1 Instrument Transformers Supplying Additional Loads

a. In accordance with Chapter 6, section 4.1.7.4 additional loads, such as measurement and control devices, can be supplied from the revenue metering *instrument transformers*, subject to approval by the *IESO*; and

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 5.8.3 for details; and
- Security and sealing requirement shall comply with section 9.

– End of Section –

PART II. ALTERNATIVE METERING INSTALLATION STANDARDS

11. Metering Installations – General Requirements

11.1 General Requirements – Revenue Meters

Each Alternative Metering Installation Standards (AMIS) *metering installation* shall contain *meters* which conform with the wholesale revenue metering hardware standard requirements as follows:

a. *meters* shall be listed on the Conforming Meter List and shall be programmed in accordance with the *IESO* Conforming Meter Framework;

b. comprised of two *revenue meters*, a main *meter* and an alternate *meter* in a *main/alternate metering installation*;

c. Main *meters* shall meet or exceed 0.2% accuracy of ANSI C12.20;

d. Alternate *meters* shall meet or exceed 0.5% accuracy of ANSI C12.20; and

e. *meters* are granted approval of type for the specific *meter* type by Measurement Canada.

11.2 General Requirements – Metering Installations

Each Alternative Metering Installation Standards (AMIS) *metering installation* shall comply with the wholesale revenue metering hardware standard requirements as follows:

a. an application shall be submitted to register a *metering installation* under the alternative standards specifying the Alternative Metering Installation Standard(s) for which registration is sought. *Metering installations* in service on April 17, 2000 or that are the subject of an application for registration filed prior to the *market commencement date* and in respect of which the major components were ordered or procured on or before May 17, 2000 shall be accepted into the *IESO-administered market*, subject to *IESO* approval;

b. an application may be submitted to retain registration under the Alternative Metering Installation Standards. Cases and conditions must be met for the *metering installation* to be considered for continued registration. Each application shall be subject to review and approval by the *IESO*;

c. registration of a *metering installation* that meets the conditions set out in the applicable section 1.1A.2, 1.4.2, 1.5.3 and 1.10.3 of the *market rules*: Chapter 6, Appendix 6.2 - Alternative Metering Installation Standards shall expire on the earliest expiry date of the seal period of any *meter* within the *metering installation.* These *metering installations* may be re-registered under the remaining alternative standards provided expired *meters* are replaced with *meter* types listed on the Conforming Meter List, and the expired alternative standards are upgraded to DOC compliance standards;

d. registration of a *metering installation* that meets the conditions set out in the applicable section 1.6.4, 1.7.4, 1.8.4, 1.9.4, 1.11.4, 1.12.3 and 1.13.3 of the *market rules*: Chapter 6, Appendix 6.2 - Alternative Metering Installation Standards shall expire on the date that the *metering installation* or *facility* undergoes substantial upgrade or refurbishment;

e. where the *metering installation* or *facility* undergoes substantial upgrade or refurbishment, the *metering installation* shall comply with the requirements of DOC;

f. *metering installations* that are not compliant with Blondel's Theorem shall only be accepted subject to *IESO* approval;

g. meet the security requirements established by the *market rules*, and any policy or standard established by the *IESO*; and

h. be commissioned in accordance with the *market rules*, and any policy or standard established by the *IESO*.

11.3 Configurations of Alternative Metering Installation Standards Metering Installations

Each Alternative Metering Installation Standards (AMIS) *metering installation* configuration shall be subject to IESO approval. AMIS *metering installation* may have the following configuration:

a. A *main/alternate metering installation* comprised of a single set of *instrument transformers* which are approved by Measurement Canada, or have special dispensation/temporary permission from Measurement Canada. The *instrument transformers* shall meet the requirements of section 12.3 – Accuracy Requirements for Instrument Transformers.

   The single set of *instrument transformers* is connected to both the main and alternate *meters*.

   The voltage transformers have a single secondary winding only. Measurement and control devices may optionally be connected to the single voltage transformer secondary winding, subject to *IESO* approval.

11.4 Conformance with Blondel's Theorem

11.4.1 IESO Approval

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

11.4.2 Compliance with Measurement Canada Rulings

AMIS *metering 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, Sec 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".

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

Subject to specific site approval by the *IESO*, as detailed in section 11.4.4, the following installations that do not conform to Blondel's Theorem will be considered for *metering installation* 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*;

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*; and

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*.

11.4.4 Metering Installation that does not Conform to Blondel's Theorem

11.4.4.1 Metering Installation Registration in the IESO-Administered Market

An AMIS *metering installation* that does not conform to Blondel's Theorem may be registered in the *IESO-administered market*, subject to the approval of section 11.4.4.2 requirements by the *IESO*. At seal expiry, a *metering installation* described in section 11.4.3.b must be modified to meet the specification of section 11.4.3.a.

In addition, the two and one-half element *metering installation* shall be comprised of two *meters*, a main *meter* and an alternate *meter*, where:

a. both *meters* are on the Conforming Meter List;

b. the main meter has the capability to calculate the missing voltage; and

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

11.4.4.2 Registration Requirements for Metering Installation that does not Conform to Blondel's Theorem

The requirements for *metering installation* registration are:

a. the magnitude of maximum error due to non-conformance with Blondel's Theorem shall be determined and submitted to the *IESO* for approval;

b. where the maximum error due to non-conformance with Blondel's Theorem is less than 0.2% for both active and reactive power, the *metering installation* shall be approved by the *IESO* without a MEC correction factor to the *metering data*; and

c. where the maximum error due to non-conformance with Blondel's Theorem exceeds 0.2%, the *IESO* may grant approval to use the AMIS *metering installation* and apply a MEC correction factor to the *metering data*.

11.4.4.3 Maximum Error Exceeding 3.0%

Where the maximum error exceeds 3.0%, the *metering installation* shall be replaced with a *metering installation* that is compliant with Blondel's Theorem.

11.4.4.4 Application of MEC Correction Factors

A Measurement Error Correction (MEC) correction factor due to non-conformance with Blondel's Theorem, which is to be compounded into a single constant adjustment factor if more than one MEC factor is required, shall be applied in the following way:

a. *energy* flows in the received direction shall be decreased; and

b. *energy* flows in the delivered direction shall be increased.

– End of Section –

12. Instrument Transformers – General Requirements

12.1 Inclusion of Instrument Transformer

Metering installations shall include *instrument transformers*.

12.2 Instrument Transformers – AMIS Installations

12.2.1 Information Requiring IESO Approval

As part of the *metering installation* registration process, *instrument transformer* information shall be provided to the *IESO* in accordance with the requirements outlined in section 12.

12.2.2 Measurement Canada Approval

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

12.2.3 Dispensation for Instrument Transformers

Should further dispensation/temporary permission be required for *instrument transformers*, the *metered market participant* shall seek dispensation/temporary permission from Measurement Canada, and maintain records of the *instrument transformer* equipment granted dispensation.

12.3 Accuracy Requirements for Instrument Transformers

12.3.1 Accuracy

Instrument transformers shall meet the requirements of ANSI 0.3 accuracy. *Instrument transformers* that do not comply with the ANSI 0.3 accuracy requirements shall be approved by Measurement Canada or have special dispensation/temporary permission from Measurement Canada.

12.3.2 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. 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.

12.3.3 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 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 greater 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 active power at each test point.

12.3.4 Other Identical Units

Where an *instrument transformer* is identical to another unit tested on-site, as described in section 12.3.3, the *instrument transformer* shall be considered as having met the accuracy 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 test unit or within the measured ability of the tested unit.

12.4 Safety Requirements for Instrument Transformers

12.4.1 Requirements

Instrument transformers shall conform to the safety requirements of section 5.4.1.

12.5 Instrument Transformer Ratios

12.5.1 Selection of Current Transformer Ratios

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

a. the maximum sustained primary current shall not exceed the primary tap multiplied by the continuous current rating factor 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.

12.5.2 Selection of Voltage Transformer Ratios

DOC standards shall apply in accordance with section 5.5.2.

12.6 Instrument Transformer – Primary Connection Point

12.6.1 Requirements for Primary Terminals

Instrument transformers shall conform to the primary terminal requirements of section 5.6.1.

12.6.2 Location of Primary Terminals

The primary terminals of each *instrument transformer* shall be located such that:

12.6.2.1 Load Facility

In the case of a *metering installation* relating to a *load facility,* the *metering installation* shall:

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

12.6.2.2 Generation Facility

In the case of a *metering installation* relating to a *generation facility,* the *metering installation* shall:

a. where the current transformer is located on the grounded side of the generation facility, minimize the leakage current between the voltage transformer and the current transformer.

12.6.3 Physical Separation Error

Where the maximum error introduced by any physical separation of the primary terminals of the voltage transformer and the current transformer exceeds 0.02% for active power flow, a Measurement Error Correction (MEC) correction factor shall be provided by the *metering service provider* for *IESO* approval.

12.6.4 Primary Cable and Terminations Error

For AMIS installations, where the maximum error introduced by the primary cable and terminations connecting the primary terminals of an *instrument transformer* to the *IESO-controlled grid* exceeds 0.02%, a Measurement Error Correction (MEC) correction factor shall be provided by the *metering service provider* for IESO approval.

12.7 Instrument Transformer – Secondary Cabling and Connections

12.7.1 Instrument Transformer – Secondary Cabling and Connections

Where the secondary cabling and terminal connections do not comply with the requirements outlined in section 5.7 of the hardware standard, the secondary cabling and terminal connections shall be subject to *IESO* approval.

12.7.2 Secondary Cabling Requirements

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 sections 5.7 and 5.10.1 as practicable;
e. all non-conformance with the requirements of sections 5.7 and 5.10.1 shall be listed; and
f. where the requirements of sections 5.7 and 5.10.1 are not met, if applicable, a Measurement Error Correction (MEC) correction factor shall be submitted to the *IESO*.

12.7.3 Maximum Error – Secondary Cabling and Connections

Maximum error introduced by the secondary cabling and connections shall comply with the following limits:

a. where the maximum error is less than 0.02% the *metering installation* shall be approved without a MEC correction factor applied to *metering data;*
b. where the maximum error exceeds 0.02% a MEC correction factor shall be provided for *IESO* approval*;* and
c. the maximum error shall be subject to IESO approval.

12.8 Instrument Transformer Burdens

12.8.1 General

12.8.1.1 IESO Approval

Approval of the *IESO* shall be required in accordance with section 5.8.1.1.

12.8.1.2 Review Requirements

Approval of the *IESO* shall be required in accordance with section 5.8.1.2.

12.8.1.3 Secondary Connections or Burden

Approval of the *IESO* shall be required in accordance with section 5.8.1.3.

12.8.2 Verification of Connections

12.8.2.1 Tracing and Verification – Cabling

DOC standards shall apply in accordance with section 5.8.2.1.

12.8.3 Verification of Burden

12.8.3.1 Calculation of Burden

DOC standards shall apply in accordance with section 5.8.3.1.

12.8.4 Burden Calculation – Current Transformers

12.8.4.1 General Requirements

The burden calculation for a current transformer shall include:

a. the impedance of the secondary cabling;

b. the impedance of all *revenue meters*;

c. the impedance associated with connecting to the other current transformer secondaries;

d. the impedance associated with the sharing of a common current path through a measuring device with another current transformer;

e. the impedance associated with the sharing of an *IESO* approved common return conductor;

f. the impedance associated with the impedance of any other parallel connected current transformer(s) with subject *instrument transformer*;

g. burden under balanced power system conditions; and

h. worst-case unbalance, including single-phase power.

12.8.4.2 Determining the Burden

The calculation shall determine the burden imposed at the secondary terminals of the current transformer.

12.8.4.3 Rated Burden Limit

The calculated burden for AMIS installations shall not exceed the rated burden limit of the CT for the 0.3 ANSI accuracy class.

12.8.5 Burden Calculation – Voltage Transformers

12.8.5.1 General Requirements

The burden calculation for a voltage transformer shall include the impedance of all *revenue meters*, all secondary cabling, and the equivalent impedance of all connected devices at the secondary terminals of the voltage transformer.

12.8.5.2 Allowance for Cable Sizing

If the secondary cabling uses a common return, cable sizing for the neutral conductor must allow for loss of a secondary fusing event, or a single-phase power event, on the power system.

12.8.5.3 Rated Burden Limit

The calculated burden for AMIS installations shall not exceed the rated burden limit of the VT for the 0.3 ANSI accuracy class.

12.9 Operation of Switching Device – AMIS Installations

Instrument transformers shall conform to the switching device operation requirements of section 5.9, in addition to the following.

12.9.1 Information Required by IESO

If the operation of a power system switching device affects the normal operation of the AMIS *metering installation*, 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 *metering data*; and

c. a *metering data* correction factor.

12.9.2 Timing of Notification

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

12.9.3 Method of Notification

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

12.9.4 Interval Data and Adjustment Factors

At the time of *metering installation* registration, interval data and adjustment factors with which to edit the *metering data*, for abnormal metering operation due to operation of switching device, shall be supplied to the *IESO*.

12.9.5 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".

12.9.6 Metering Installations

Where operation of switching device affects the *metering installation* more than twice per annum, additional *metering installations* shall be installed to cover this contingency.

12.10 Parallel Connected Current Transformer Secondaries

12.10.1 IESO Approval

Where parallel connected current transformer secondaries existed within *facilities* in service on April 17, 2000 or that are the subject of an application for registration filed prior to the *market commencement date* and in respect of which the major components were ordered or procured on or before May 17, 2000, approval shall be obtained from the *IESO* for their continued use within the *IESO-administered market*.

12.10.2 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 *metering installation* shall have its own current test links;
f. paralleled secondaries shall be used to sum currents from no more than two *metering installations*;
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 referred to in requirement g above;
i. the burden on any current transformer shall not exceed the rated burden;
j. the burden shall be kept within the instrument transformer burden rating and shall take into account the effects of common secondary leads and worst-case unbalance as described in requirement k below;
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 measure 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.

– End of Section –

13. Meters

13.1 Requirement for Main Meters and Alternate Meters

DOC standards shall apply in accordance with section 6.1.

13.2 Verified and Sealed Meters

DOC standards shall apply in accordance with section 6.3.

13.3 Auxiliary Power Supply for Main and Alternate Meters

DOC standards shall apply in accordance with section 6.4.

– End of Section –

14. Communication

14.1 Communication System Requirements

Communication standards for *metering installation* shall apply in accordance with section 7.

– End of Section –

15. Enclosure

15.1 IESO Approval

AMIS *metering installations* shall be accepted into the *IESO-administered market*, subject to *IESO* approval.

15.2 Requirements for Approval

The requirements for approval are:

a. the *metering installation* shall be secure;

b. the *metering installation* shall comply with as many requirements of sections 8.1 and 8.2 as practicable; and

c. where the AMIS *metering installation* does not meet the requirements of sections 8.1 and 8.2, variances shall be listed and submitted to the *IESO* for approval.

– End of Section –

16. Security

16.1 Security Requirements

16.1.1 Meter Enclosure Security Requirements

DOC standards shall apply in accordance with section 9.1.1.

16.1.2 Instrument Transformer Security Requirements

DOC standards shall apply in accordance with section 9.1.2.

16.1.3 Instrument Transformer Shared Enclosure Security

Where the *instrument transformer* enclosure which contains *revenue meter* secondary cabling and terminations is shared with measurement and control apparatus, the secondary cable and connections shall be secure and tamper proof under the strict control of the *metering service provider* as practicable (see section 16.2.1 below).

16.1.4 Open Rack Terminal Strips Security

Where the *instrument transformer* secondary cabling and terminations connect to open rack terminal strips, the secondary cable and connections shall be secure and tamper proof under the strict control of the *metering service provider* as practicable (see section 16.2.1 below).

16.2 Sealing Requirements

Sealing requirements for *metering installation* shall apply in accordance with section 9.2, in addition to the following requirement.

16.2.1 Sealing As Practicable – AMIS Installations

a. All circuit access points where hardware sealing provision exists shall be sealed and recorded in the seal log; and
b. All circuit access points where no hardware sealing provision exists may remain unsealed, subject to *IESO* approval, until substantial upgrade or refurbishment of the *metering installation* or *facility*. The circuit access point shall conform with security sealing requirements upon registration as a DOC *metering installation*.

– End of Section –

PART III. CONFORMING METERS

17. Accuracy Requirements for Conforming Main Meters

17.1 Accuracy Requirements for Main Meters

17.1.1 Requirements

Accuracy requirements shall apply to all 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 interval data shall be within ± 0.05% (at full load kW) of the *energy* measured by the *meter*;

d. Measurement Canada test points shall be used; and

e. tolerance for all tests shall be 0.2% at unity power factor and 0.3% at 0.5 power factor.

17.1.2 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.

– End of Section –

18. Accuracy Requirements for Conforming Alternate Meters

18.1 Accuracy Requirements for Alternate Meters

18.1.1 Requirements

Accuracy requirements shall apply to all 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;

c. the pulse resolution of the interval data shall be within ± 0.05% (at full load kW) of the *energy* measured by the *meter*;

d. Measurement Canada test points shall be used; and

e. tolerance for all tests shall be 0.5% at unity power factor and 0.6% at 0.5 power factor.

18.1.2 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.

– End of Section –

19. Functional Requirements – Conforming Meters

19.1 Functional Requirements for Main Meters

Main *meters* shall meet the functional requirements listed below for acceptance on the Conforming Meter List:

Table 19.1: Main Meter Attributes

Item	Main Meter	Comments
Meter Measurements and Quadrants	4 Quadrant: - kWh/kvarh DEL - kWh/kvarh REC Loss quantities: - V2h - I2h	Measurement Canada approved for these units of measure.
Interval Data	5-minute 10 channel interval data recording: - kWh/kvarh DEL - kWh/kvarh REC - V^2h per phase - I^2h per phase For channel assignments, refer to section 19.3.	MDAS must be able to retrieve and translate kWh/kvarh DEL and kWh/kvarh REC interval data. MDAS must be able to retrieve and translate V^2h, I^2h per phase interval data.
Interval Data Storage	35 days of 5-minute time-stamped interval data; 100 event log.	35 days of 5-minute interval data, with at least 100 event log must be readable by MDAS.
Encoded Registers	Cumulative energy registers shall be available from the *meter*: - kWh/kvarh DEL - kWh/kvarh REC - V^2h per phase - I^2h per phase	MDAS must be able to remotely retrieve the cumulative energy registers associated with each interval data channel.
Meter Time Clock	The *meter* time clock shall be either line frequency and/or crystal clock.	The *meter* time clock shall be capable of being reset by the MDAS during collection operations.

Item	Main Meter	Comments
Data Collection Protocol	To enable data collection of all interval data, encoded registers, events and statuses. Must also support time synchronization functionality.	Using the data collection protocol, MDAS must be able to interrogate the *meters*, retrieve and translate interval data, encoded registers, events and statuses and support time synchronization.
Meter Electronic Access Protection	Electronic access to *meter* data shall be protected with a minimum of two levels of password. One for each: - 'read-only' - 'read plus synchronize time' Other levels of passwords will need to be identified.	MDAS must be able to retrieve interval data, encoded registers, event log and statuses and perform time synchronization with the `read plus synchronize time` password.
Built-in Battery Backup	In the event of power outage or depressed voltage, the *meter* maintains the interval data, event log and clock time for 35 days.	MDAS must be able to retrieve up to 35 days of *meter* data after power outage. Data is flagged as PO and power outage is reported in event log with correct start and stop time.
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.	MDAS must be able to upload statuses and events to detect critical errors.
Instrument Transformer 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 *IESO* MDAS must be able to upload and detect faulty equipment condition.
Interface	Identify the interface used to enable direct local download of *meter* data from the *meter*.	n/a
Communication	To enable connection via TCP/IP and telco (analog modem) with 9.6 Kb/s minimum.	MDAS must be able to communicate with the *meter* through an IP address for TCP/IP connection and dial-up access for analog modem connection.
Auxiliary Power Supply	Identify all auxiliary power supply options for the *meter*.	The *IESO* must be able to identify the *meter* applications for auxiliary power supply requirements (refer to section 6.4).

19.2 Functional Requirements for Alternate Meters

Alternate *meters* shall meet the functional requirements listed below for acceptance on the Conforming Meter List:

Table 19.2: Alternate Meter Attributes

Item	Alternate Meter	Comments
Meter Measurements and Quadrants	4 Quadrant: - kWh/kvarh DEL - kWh/kvarh REC	Measurement Canada approved for these units of measure.
Interval Data	5-minute 4 channel interval data recording: - kWh/kvarh DEL - kWh/kvarh REC For channel assignments, refer to section 19.4.	MDAS must be able to retrieve and translate kWh/kvarh DEL and kWh/kvarh REC interval data.
Interval Data Storage	10 days of 5-minute time-stamped interval data with event log.	10 days of 5-minute interval data, with event log must be readable by MDAS.
Encoded Registers	Cumulative energy registers shall be available from the *meter*: - kWh/kvarh DEL - kWh/kvarh REC	MDAS must be able to remotely retrieve the cumulative energy registers associated with each interval data channel.
Meter Time Clock	The *meter* time clock shall be either line frequency and/or crystal clock.	The *meter* time clock shall be capable of being reset by the MDAS during collection operations.
Data Collection Protocol	To enable data collection of all interval data, encoded registers, events and statuses. Must also support time synchronization functionality.	Using the data collection protocol, MDAS must be able to interrogate the *meters*, retrieve and translate interval data, encoded registers, events and statuses and support time synchronization.
Meter Electronic Access Protection	Electronic access to *meter* data shall be protected with a minimum of two levels of password. One for each: - ‘read-only’ - ‘read plus synchronize time’ Other levels of passwords will need to be identified.	MDAS must be able to retrieve interval data, encoded registers, event log and statuses and perform time synchronization with the `read plus synchronize time` password.

Item	Alternate Meter	Comments
Built-in Battery Backup	In the event of power outage or depressed voltage, the *meter* maintains the interval data, event log and clock time for 10 days.	MDAS must be able to retrieve up to 10 days of *meter* data after power outage. Data is flagged as PO and power outage is reported in event log with correct start and stop time.
Meter Self Monitoring	n/a	n/a
Instrument Transformer Monitoring	n/a	n/a
Interface	Identify the interface used to enable direct local download of *meter* data from the *meter*.	n/a
Communication	To enable connection via TCP/IP and telco (analog modem) with 9.6 Kb/s minimum.	MDAS must be able to communicate with the *meter* through an IP address for TCP/IP connection and dial-up access for analog modem connection.
Auxiliary Power Supply	Identify all auxiliary power supply options for the *meter*.	The *IESO* must be able to identify the *meter* applications for auxiliary power supply requirements (refer to section 6.4).

19.3 Data Channel Assignments for Main Meters

Main *meters* will provide the following data channels:

Table 19.3: Data Channels for Main Meters

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

The channel numbers shown for main *meters* shall be the assignment in the *IESO-administered 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 V^2h per phase and channel 7 and channel 8 is I^2h per phase.

If the main *meter* records more than the minimum required channels in table 19.3, MDAS will be configured to only collect metering data for channels 1 through 10 for a three element *meter* or channels 1 through 8 for a two element *meter*.

19.4 Data Channel Assignments for Alternate Meters

Alternate *meters* will provide the following data channels:

Table 19.4: Data Channels for Alternate Meters

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

The channel numbers shown for alternate *meters* shall be the assignment in the *IESO-administered market*.

If the alternate *meter* records more than the minimum required channels in table 19.4, MDAS will be configured to only collect *metering data* for channels 1 through 4.

19.5 Internal Meter Identification Number

19.5.1 Identification Number

Each *meter* shall have an internal identification number.

19.5.2 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.

19.5.3 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*. Each manufacturer's assigned first character is posted to the Conforming Meter List.

19.5.4 First Character Specification

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

19.5.5 Remaining Characters Specification

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

19.6 Conforming Meter Framework

A Conforming Meter Framework shall be developed for each *meter* upon acceptance to the Conforming Meter List.

The Conforming Meter Framework will specify the *meter* configuration parameters for conforming *meters* to comply with the requirements of section 19 in the wholesale revenue metering hardware standard.

These parameters will include but are not limited to *meter* setup items such as for CT/PT ratios, Device ID, register rollover, security access rights, and communications port settings.

19.7 Optional Functional Requirements

19.7.1 Discretion

Optional metering functions are discretionary and subject to *IESO* approval.

19.8 Technological Advance

19.8.1 Future Considerations

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

– End of Section –

PART IV. GLOSSARY OF TERMS

20. Glossary of Terms

In addition to the terms listed here, refer to the definitions included in Chapter 11 of the *Market Rules*.

The following terms were used in this standard:

Alternate *meter*: A *meter* which meets the requirements of Sections 18.1, 19.2 & 19.4, and is on the Conforming Meter List. In a *main/alternate metering installation*, the alternate is used for validation of *metering data* from the main *meter*. Alternate *metering data* may be substituted when valid *metering data* from the main *meter* is unavailable.

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 and is determined in accordance with Appendix C: Blondel Conformance.

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.

Delivered direction: Flow of active or reactive power from the *IESO-controlled grid* into a *generation facility* ,*load facility* or *electricity storage facility*.

Conforming Meter Framework: A programming framework of *meter* configuration parameters for conforming *meters* which ensures compatibility with the *IESO* MDAS system, wholesale revenue metering hardware standard and *market rules*.

Conforming Meter List: *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 *metering installations* in the *IESO-administered market*, only *meters* on the Conforming Meter List shall be used. The Conforming Meter List 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 transformer (CT): 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 used to reduce primary current by a known ratio within the range of a connected measuring device.

Element: A combination of a voltage-sensing unit and a current-sensing unit which provides an output proportional to the electrical quantities measured. 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.

Electrical quantities: kWh/kvarh delivered, kWh/kvarh received, V^2h and I^2h units which are measured and recorded by the *meter*.

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

High accuracy voltage transformer: Reference to ANSI 0.15 accuracy class for voltage transformer type.

Main *meter*: A *meter* which meets the requirements of Sections 17.1, 19.1 & 19.3, and is on the Conforming Meter List. The main *meter* is always used for *settlement* where possible.

Maximum sustained primary current: The maximum primary current allowed at which the composite error of the current transformer conforms to the limits of the 0.3, 0.15 or 0.15S accuracy class at rated burden during normal metering operation.

Minimum sustained primary current: The minimum primary current allowed at which the composite error of the current transformer conforms to the limits of 0.3, 0.15 or 0.15S accuracy class at rated burden during normal metering operation.

Measurement Canada: The federal agency administering and enforcing the *Electricity and Gas Inspection Act*, R.S.C., 1985, c. E-4.

***Meter* Enclosure**: A cabinet or enclosure approved in accordance with section 8.1 and built to applicable codes to house metering equipment and devices associated with a metering installation.

***Meter point* documentation**: A package of documents forming part of the *metering registry* comprising an electrical single-line diagram showing the location of the *defined meter point*, a totalization table, documentation supporting site-specific loss adjustment and measurement error correction factors, emergency instrument transformer restoration plan, commissioning and routine/non-routine test documents. Other information required includes details needed for *metering data* collection, such as TCP/IP address and *meter* access passwords.

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

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

Normal operation: Operation where the CT secondary current is within the minimum and maximum sustained current for ANSI 0.3, 0.15 and 0.15S accuracy class, and where the VT sustained secondary voltage is within 90% and 110% of accuracy-rated voltage in Measurement Canada S-E-07 specifications.

Parallel connected current transformer: A method for deriving the combined power flow at two distinct *meter points*. The *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*.

Power Factor: The ratio of the active power to the apparent power.

Registration: The entry of information into the *IESO metering registry* and *metering database*. 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*.

Received direction: The flow of active or reactive power from a *generation facility*, *load facility*, or *electricity storage facility* into the *IESO-controlled grid*.

Substantial Upgrade or Refurbishment: Upgrading or refurbishment of a *metering installation* or *facility* is considered substantial when (i) two or more *instrument transformers* are replaced and/or (ii) major changes are made to the *facility*, as determined by the IESO.

TCP/IP: Transmission Control Protocol (TCP) and Internet Protocol (IP) are two distinct network protocols. IP corresponds to the Network layer (Layer 3) whereas TCP corresponds to the Transport

layer (Layer 4). The term TCP/IP refers to network communications where the TCP transport is used to deliver data across IP networks.

Voltage transformer (VT): An *instrument transformer* intended for measurement or 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.

VT Primary Switching: See Figure D-1 for valid VT Primary Switching devices and cases.

– End of Section –

PART V. APPENDICES

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
Notification of Power Switching	IMO_FORM_1464

– End of Section –

Appendix B: Metering Installation Figures

The following figures are provided in this appendix:

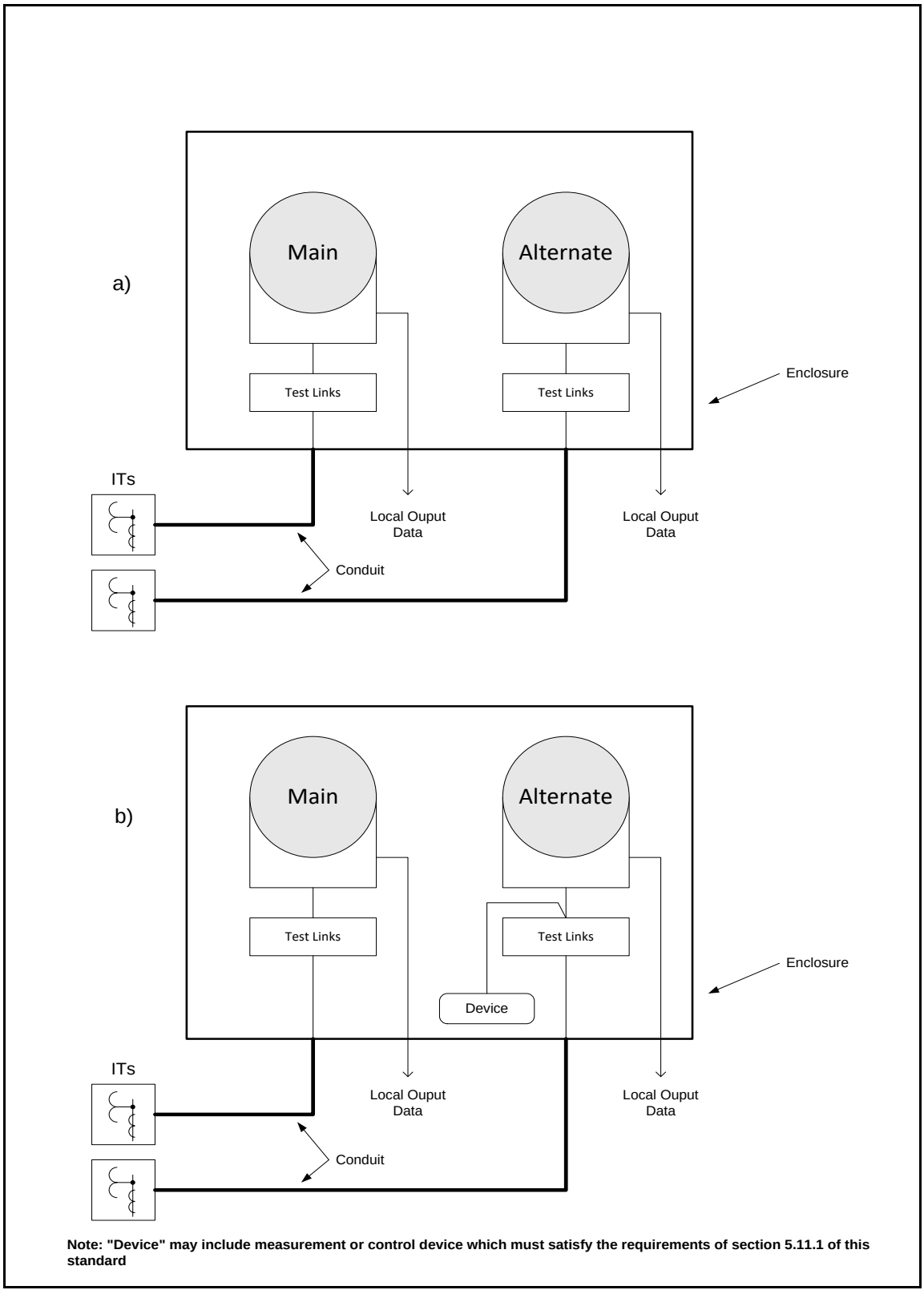

Figure B-1: Dual Main/Alternate Metering Installation

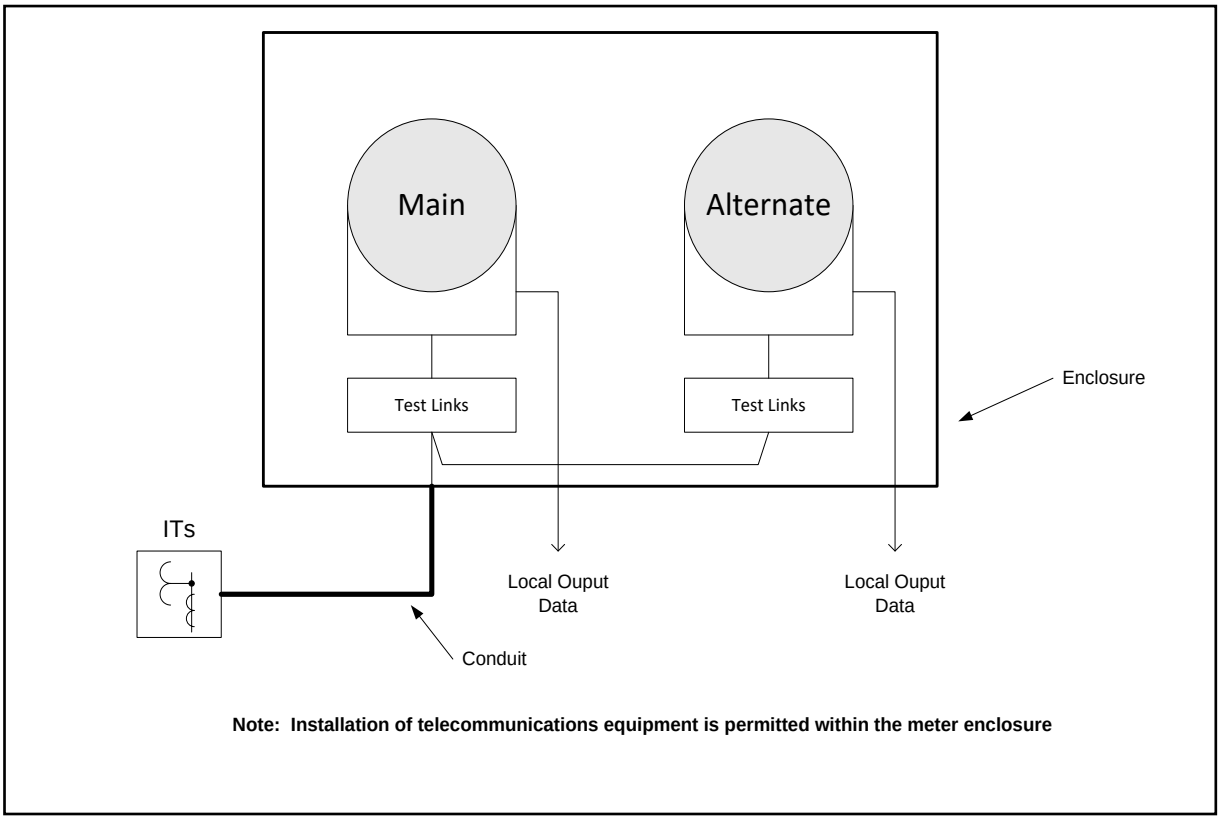

Figure B-2: Single Main/Alternate Metering Installation

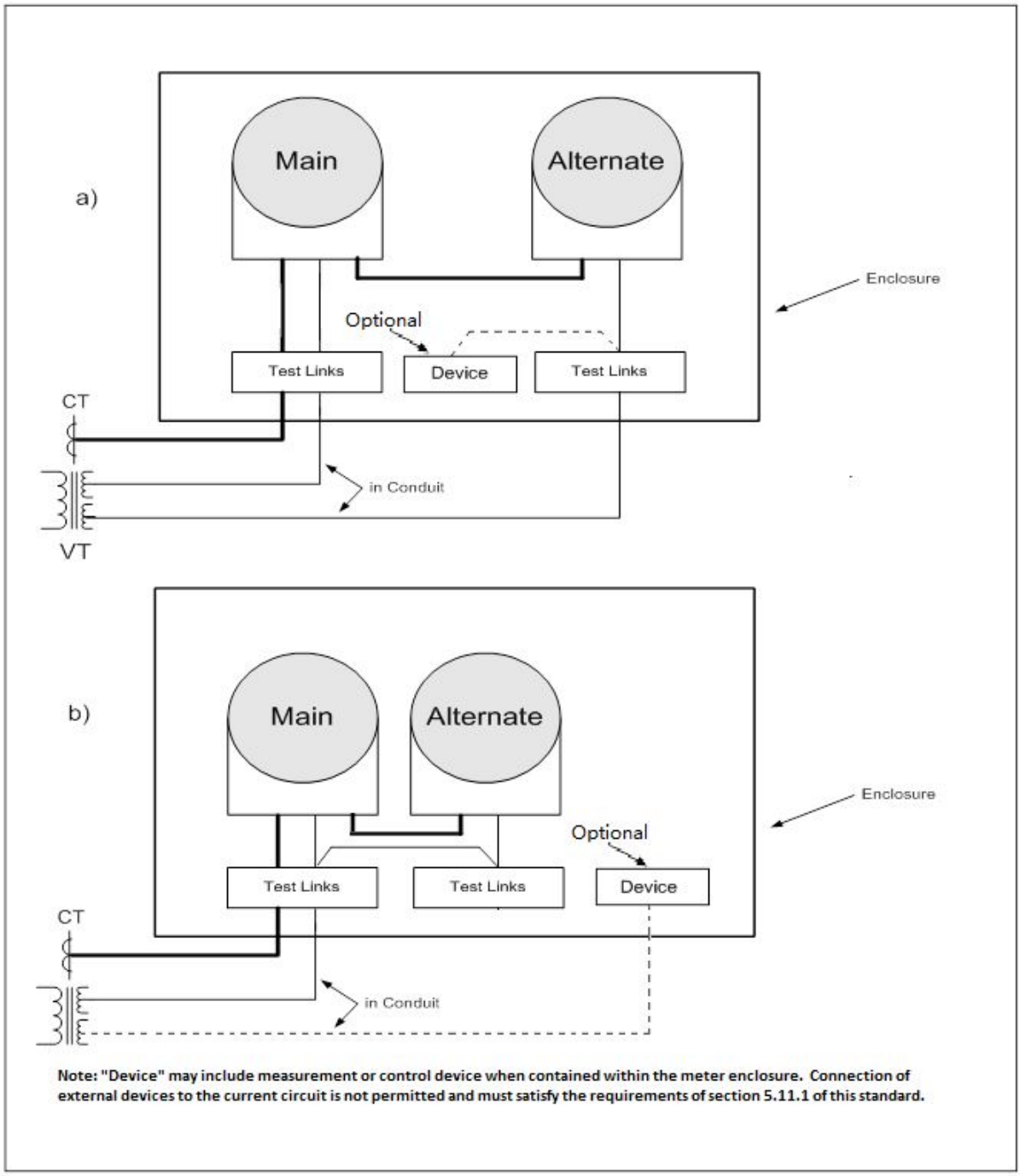

Figure B-3: Single Main/Alternate Metering Installation – Double VT Secondary Windings

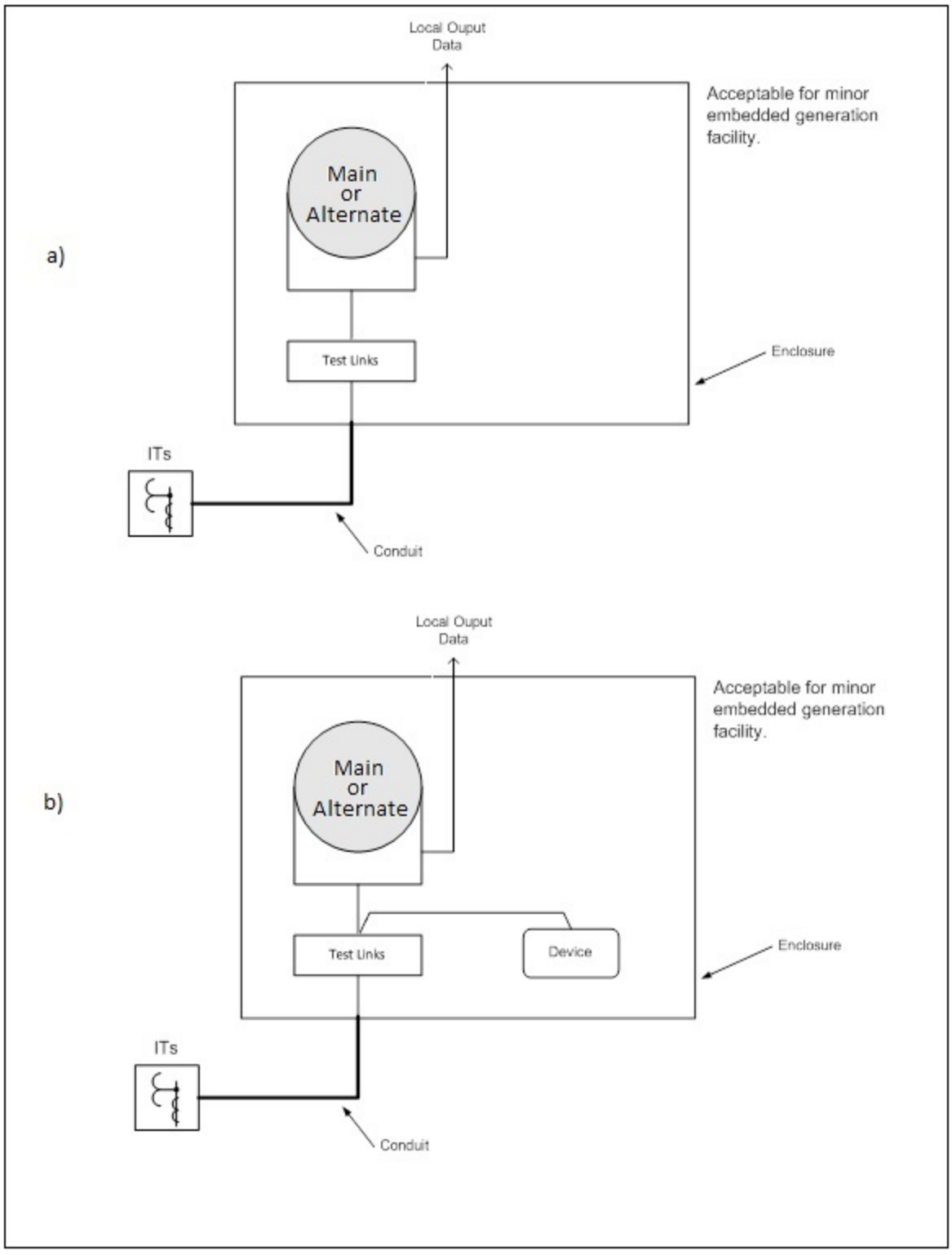

Figure B-4: Conforming Standalone Main Metering Installation

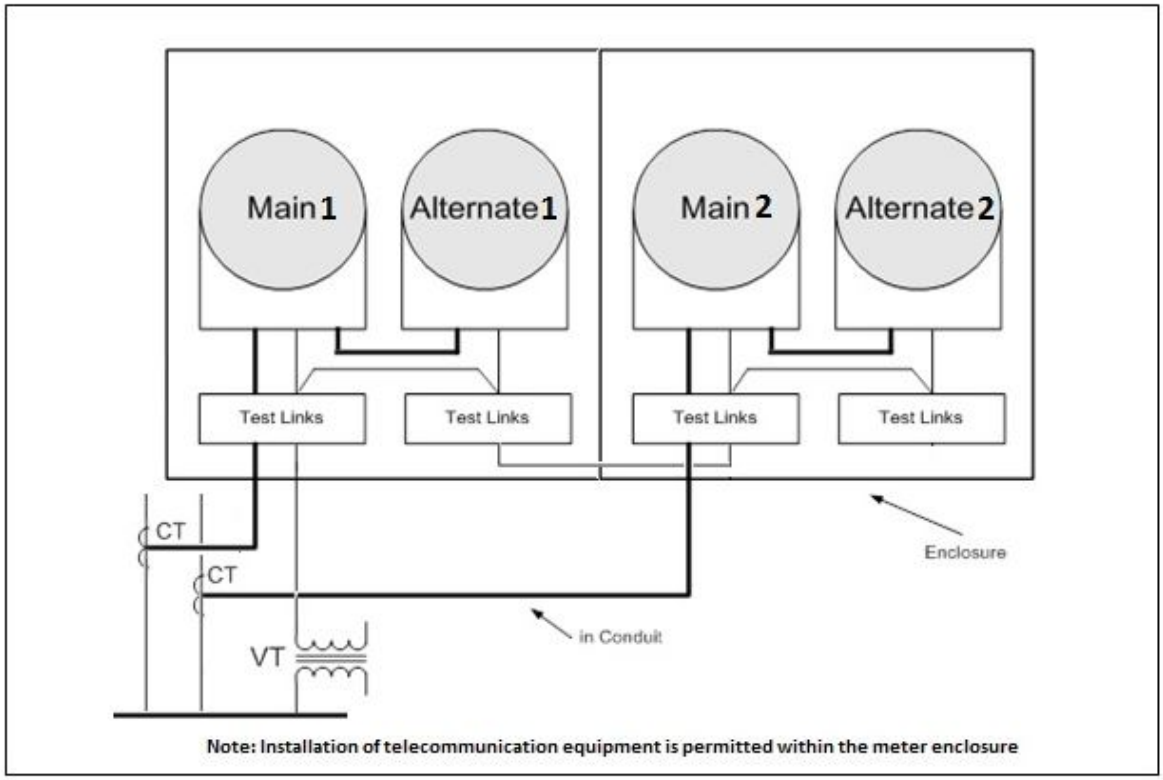

Figure B-5: Common Solid Bus – Single VT Secondary Winding

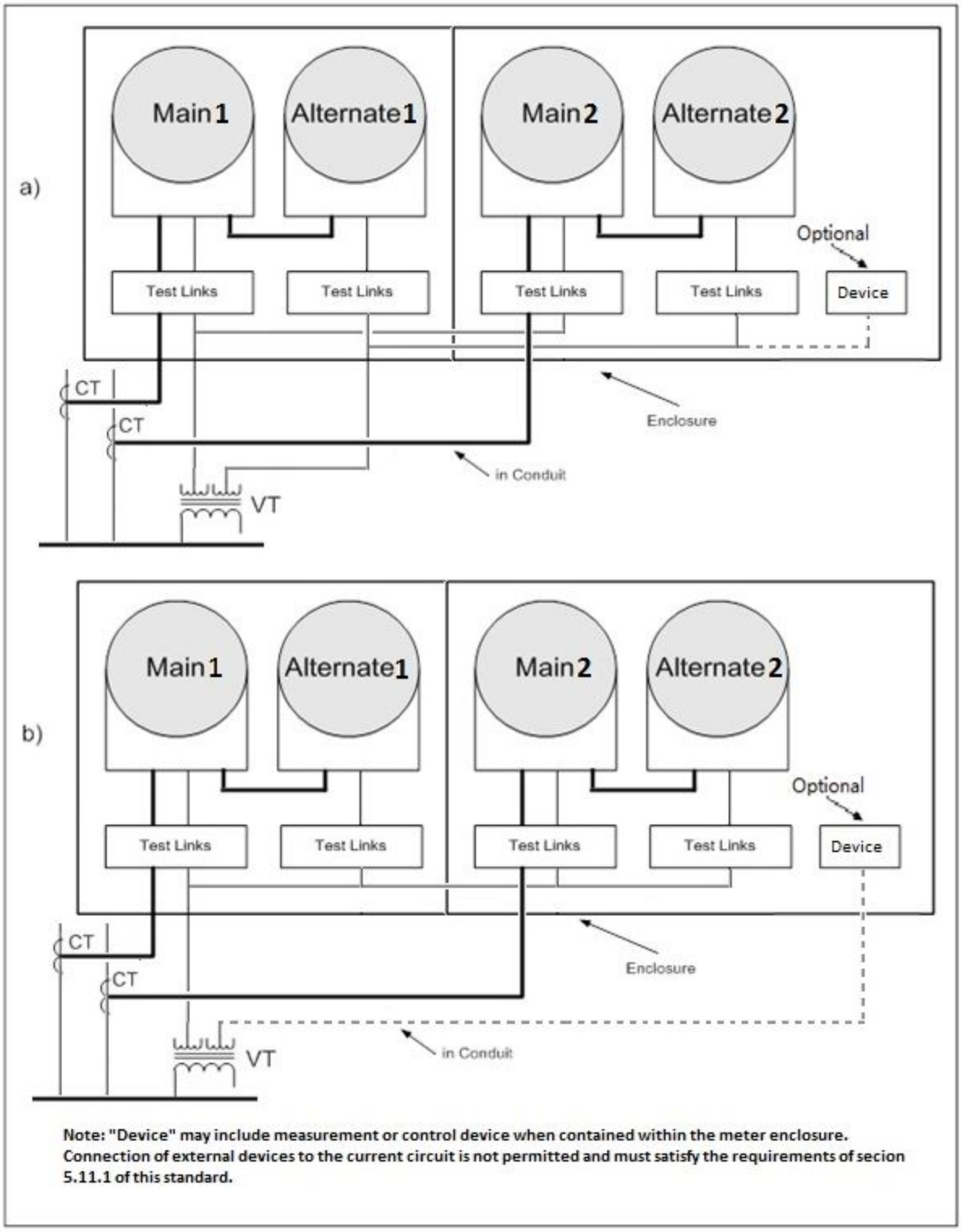

Figure B-6: Common Solid Bus – Double VT Secondary Windings

– End of Section –

Appendix C: Blondel Conformance

C.1 Blondel's Theorem

C.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."

C.1.1.1 Number of Conductors

The number of conductors in the circuit is determined if a ground current could possibly flow past the *meter point*. A ground current can flow if the connections on both sides of the *meter point* are grounded.

The fourth conductor, if present, could provide a return path for the current. Examples of the fourth conductor could be:

- System neutral
- Sky wire
- Ground wire
- Earth

C.1.2 Blondel's Theorem – Metering Installations

C.1.2.1 Elements Required

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 Figure C-1 for illustrations of Blondel compliant metering.

C.2 Elements Required for Blondel Compliant Metering

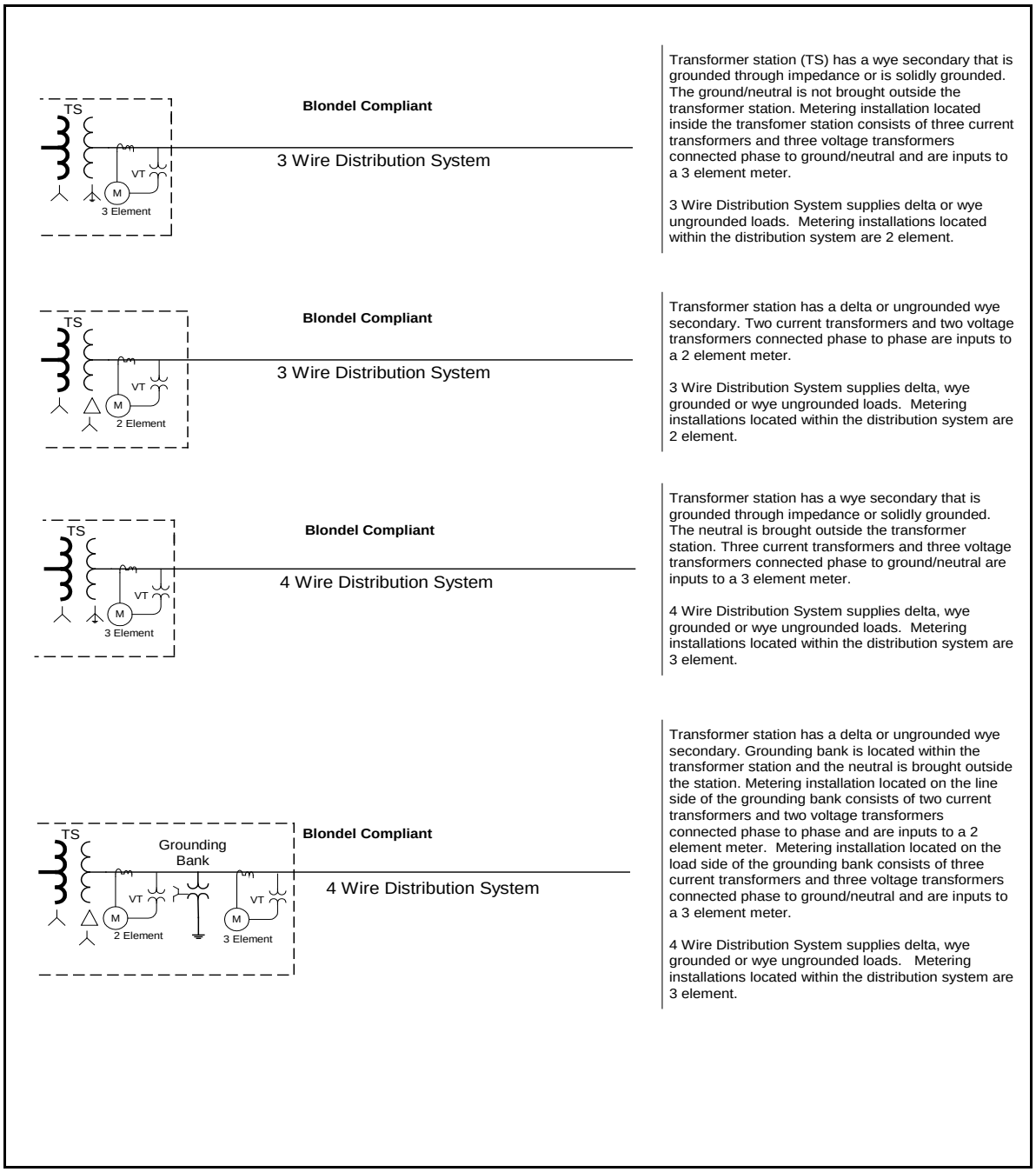

Figure C-1: Illustrations of Blondel Conformance

– End of Section –

Appendix D: VT Primary Switching

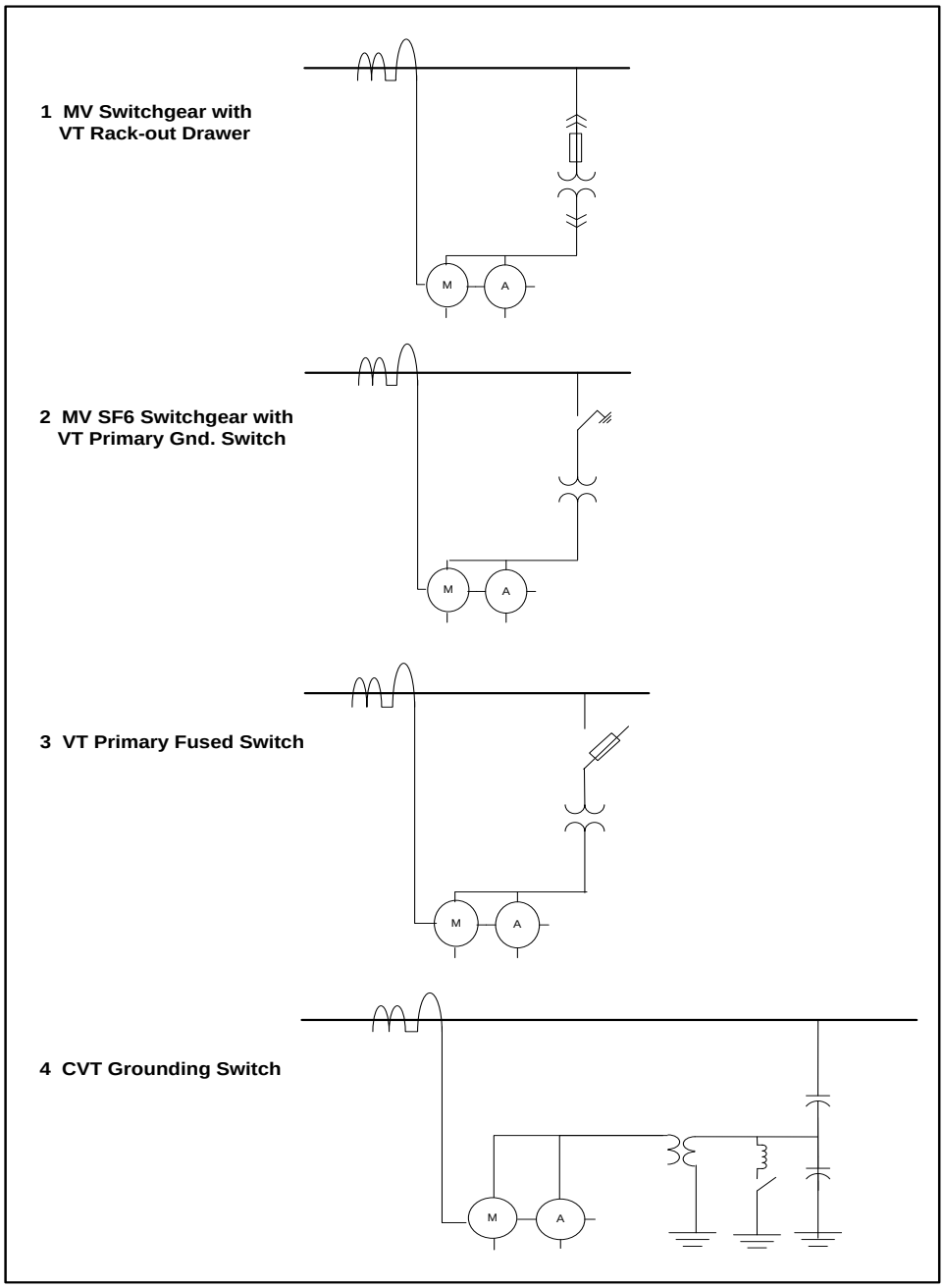

Figure D-1: VT Primary Switching Devices and Rack-out Mechanisms

– End of Section –

PART VI. POLICY

21. Policy

PURPOSE:

Minimum hardware standards and requirements for *metering installations* are specified in the wholesale revenue metering hardware standard.

APPLICATION OF POLICY:

Policy provides precedent rulings, and interpretation for standards application and metering performance, as applicable for specific *metering installation* configurations and operating conditions of use.

Policy exceptions to the wholesale revenue metering hardware standards shall only be permitted subject to *IESO* approval. Each of the following policy applies to the wholesale revenue metering hardware standard:

1. Minimum Sustained Primary Current

   During normal metering operation, the CT composite error of the ratio and phase angle correction factor shall be within the limits of transformer correction factor for the respective ANSI accuracy class.

   a. By Time: Assess for an 80% proportion by time duration measurement in compliance with the minimum current range recognized by the applicable 0.3, 0.15 or 0.15S ANSI accuracy class.

   b. By *Energy*: Assess for an 80% proportion by kWh volumetric measurement in compliance with the minimum current range recognized by the applicable 0.3, 0.15 or 0.15S ANSI accuracy class.

2. Maintaining *Meter* Clock during Power Outage Event

   A Conformance Monitoring Request shall be opened upon a third occurrence of a *meter* clock time drift greater than 60 seconds which is associated with a power outage event or depressed voltage.

3. Strict control requirements for access to the *meter* enclosure and the *instrument transformer* enclosure must be implemented and practised by the *metering service provider* (MSP) and the *metered market participant* (MMP)/third party as follows:

   a. If the *metering installation* is being accessed by a MMP/third party for operational purposes, the MSP must be notified in advance of the planned operating procedure or within 24 hours after unplanned/emergency operating procedure.

   b. The MSP must have an Operating Agreement with the MMP/third party to document strict control procedure for operational purposes.

   c. The Operating Agreement must include, but is not limited to:

      - obligations of both the MSP and the MMP/third party under this agreement and the *market rules*;
      - the MSP strict control procedure over MMP/third party access;
      - documentation and notification of seals removal;
      - contact information of both the MSP and the MMP/third party representatives responsible in coordinating the operating procedure effort ensuring strict access control; and
      - authorized representative signatories of both the MSP and the MMP/third party.

d. Upon request, the MSP must submit the Operating Agreement to the *IESO*. The *IESO* shall be able to monitor and enforce for strict control.

- End of Section -

PART VII. REFERENCES

References

Document Name	Document ID
Market Rules: Chapter 6 – Wholesale Metering	MDP_RUL_0002_06
Market Rules: Chapter 6 – Wholesale Metering Appendices	MDP_RUL_0002_06A
ANSI/IEEE C57.13-1983 “IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases”	
Ontario Electrical Safety Code	
ANSI C12.20-2015 for “Electricity Meters 0.1, 0.2 and 0.5 Accuracy Classes”	
Measurement Canada Bulletin E-24E (rev.1) dated 2002-11-29	
Measurement Canada “S-E-07 – Specifications for the approval of measuring instrument transformers”	
Measurement Canada “S-E-08 – Specifications for the Installation and Use of Electricity Meters – Measurement Canada Standard Drawings for Electricity Metering Installations”	
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”	
IEEE C57.13.3-2014 “Guide for Grounding of Instrument Transformer Secondary Circuits and Cases”	
IEEE C57.13-2016 “IEEE Standard Requirements for Instrument Transformers”	
CAN/CSA-C61869-2:14 “Instrument transformers – Part 2: Additional requirements for current transformers”	
CAN/CSA-C61869-3:14 “Instrument transformers – Part 3: Additional requirements for inductive voltage transformers”	
CAN/CSA-C61869-4:14 “Instrument transformers – Part 4: Additional requirements for combined transformers”	
CAN/CSA-C61869-5:15 “Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers”	
CAN/CSA-C60044-8:07 “Instrument transformers – Part 8: Electronic current transformers”	
Handbook for Electricity Metering, Eleventh Edition	

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