

Blondel Compliance

Revenue Metering Sub Committee Meeting
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- q Chapter 6, section 4.1.1.4 states; each metering installation shall meet the accuracy requirements set forth in this Chapter and in any policy or standard established by the IESO pursuant to this Chapter; and
- q Wholesale Revenue Metering Standard, section 4.4.1 states Blondel's Theorem; The total power delivered to a load system with n conductors requires n wattmeters. If the wattmeters are configured in a specific manner, $n-1$ wattmeters can be used.
 - ü 3 element metering required for a 4 wire circuit
 - ü 2 element metering required for a 3 wire circuit
- q Obvious in theory but challenging in practice
 - Defend the design to those who want to reduce costs.
 - ü Load is balanced, ground connection for protection purposes, no phase-ground loads, transformer configuration is wye/delta, etc.
 - How many conductors are in the circuit?

Blondel's Theorem

Number of Conductors ?

- q **Fourth conductor provides a return path for the neutral current.**
- q **Need to determine whether or not a ground current could possibly flow past the metering point (location of the CT's is defined as the metering point).**
- q **A ground current can flow if the connections on both sides of the metering point is grounded.**
- q **The fourth conductor could be:**
 - **System Neutral**
 - **Sky wire**
 - **Ground wire**
 - **Earth (regardless of the perceived conductivity)**

q Wholesale Revenue Metering Standard, section 4.2.1 lists the number elements required to conform with Blondel's Theorem

- Number of elements is determined by the power source (power source is defined as the grid side of the physical meter point)
 - ü Ungrounded Delta or Ungrounded WYE – 2 element metering
 - ü Grounded WYE (solid, resistance, reactance) – 3 element metering
- Downstream load connections are not taken into consideration
 - ü Delta, WYE ungrounded and WYE grounded loads may be connected to the power source. 3 element metering is accurate under all loading conditions.

Blondel Compliance New Installations – Exceptions

- q Exceptions for new installations?
- q Occurs when the fourth wire is not accessible to the MMP and ground connection of loads is not permissible - determined by a connection agreement
- q Examples are illustrated in the Wholesale Revenue Metering Standard, Appendix C
- q Case # 1
 - MMP connected to WYE grounded transformer station which is owned by HydroOne (connection made at the LV breaker of TS)
 - Transmission connection agreement determines the type of load connections permitted (grounded or ungrounded loads)
 - If the meter installation is located inside the transformer station – 3 element metering is required
 - If the meter installation is located outside the transformer station – # of elements is determined by the transmission connection agreement
 - ü 2 element for ungrounded loads
 - ü 3 element for grounded loads
 - A typical example is an LDC that is connected to a 46kV transformer station

q Case # 2

- LDC operates a grounded distribution system
- Embedded MMP is connected to the LDC
- Connection agreement determines the type of load connections permitted by the LDC (grounded or ungrounded)
- # of elements determined by the connection agreement
 - ü 2 element for ungrounded loads
 - ü 3 element for grounded loads
- A typical example is a large industrial consumer (embedded MMP) that is connected to a 27.6kV distribution system. Connection agreement may restrict MMP from connecting grounded loads.

- q If the MMP has access to the system neutral, IESO assumes that MMP is permitted to connect grounded loads – 3 element metering required.**
 - The Electrical Safety Authority may requires the MMP’s local grounding system to be connected to the LDC’s system neutral.**
- q In some cases, it is possible for a meter installation that is registered under the Declaration of Compliance to lose it’s registration status if there is a change to the connection agreement.**
 - Meter installation no longer complies with Blondel’s Theorem.**
 - This may also have a ripple effect to all upstream metering installations.**

- q **Chapter 6, section 4.4 and Appendix 6.2, section 1.2 permit registration of existing metering installations that do not comply with Blondel's Theorem – Alternative Metering Standard.**
 - Non-Blondel errors between 0.2 and 3.0% subject to MEC
 - Non-Blondel errors greater than 3.0% is not permitted
- q **Wholesale Revenue Metering Standard – section 4.3.3 identifies existing non-Blondel installations considered for registration (grandfathering provisions based on past metering practices).**
 - 2.5 element metering installations
 - Delta metering using 2 CT's and 3 VT's
 - 2 element metering installations where grounded WYE source supplies ungrounded loads

Blondel Compliance Existing Installations

- q IESO recently discovered a former Ontario Hydro non-Blondel metering practice which is not included in the grandfathering provisions of the Hardware Standard.
- q This non-Blondel meter practice is specific to a NUG facility.
- q NUG facility consists of:
 - A grounded transformer
 - A grounded generator with a delta connected SS transformer
 - Metering installation is 2 element (non-Blondel)
- q New provision to be added to Wholesale Revenue Metering Standard, section 4.3.3.e
 - Two element metering of a generation facility where the metering installation is located between a grounded power transformer and a grounded generator and all load connections (station service) are delta connected – using two current transformers and two voltage transformers connected phase to phase and a two element meter.

