



RETAIL REVENUE METERING STANDARDS GUIDE



A Metering Guide for Distribution Customers

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The Hydro One Retail Revenue Metering Standards Guide – 2019 Edition, provides direction for Customers, consultants and electrical contractors either requiring or installing an electrical service that will be energized by Hydro One. This Guide (as defined below) provides policies and specifications for retail metering configurations for electrical services of medium voltage from 2.4kV up to 44kV and low voltage from 120/240V up to 750V.

This Guide is governed by, without limitation, applicable CSA/ULC Standards, the *Electricity and Gas Inspection Act*, the Electricity and Gas Inspection Regulations, and the safety standards of Ontario Regulation 22/04: Electrical Distribution Safety.

Hydro One does not assume any responsibility for the application of this Guide by anyone other than Hydro One staff or Hydro One authorized contractors.

Where the information in this Guide conflicts with any of the documents listed in Section 1.1 of this Guide, the documents in Section 1.1 shall take precedence.

NOTWITHSTANDING ANYTHING CONTAINED IN THIS GUIDE TO THE CONTRARY, NOTHING CONTAINED IN THIS GUIDE SHALL AFFECT IN ANY WAY WHATSOEVER THE RESPECTIVE LIABILITIES AND LIMITATIONS OF LIABILITY OF HYDRO ONE, AND THE CUSTOMER, THAT ARE SET OUT IN SECTION 1.9 OF THE CONDITIONS OF SERVICE.

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1 INTRODUCTION

1.1 PREFACE

This Guide is governed by:

- Hydro One's Conditions of Service;
- The Ontario Energy Board's Distribution System Code and Retail Settlement Code;
- The Ontario Electrical Safety Code;
- Ontario Regulation 22/04: Electrical Distribution Safety and Ontario Regulation 332/12: Building Code; and
- *Electricity and Gas Inspection Act* and Electricity and Gas Inspection Regulations;



Hydro One's services are subject to all laws and regulations that are applicable in its service territories. Where this Guide exceeds the requirements (i.e. allows greater flexibility) of the documents above, this Guide shall take precedence.

Note: Some of the requirements identified by the latest edition of the Ontario Electrical Safety Code have been included in this Guide for convenience and reference purposes only, even though they may be under the Electrical Safety Authority (ESA) jurisdiction.

1.2 SCOPE

This Guide applies to all Hydro One personnel responsible for existing, new, and upgraded retail Meter Installations and shall apply to all retail billed Customers, including Customers acquired via acquisition.

This Guide also covers the requirements of the "Supply Authority" stated in the Ontario Electrical Safety Code, for service entrance, connection, and metering of electrical energy to Hydro One Customers.

This Guide does not apply to Wholesale Market Participants as they are different responsibilities for the ownership, installation and maintenance of the meter and responsible for contracting the services of a Registered Meter Service Provider.

1.3 PURPOSE

This Guide is intended to provide guidance on mandatory requirements to Hydro One Customers and their agents in the design of, preparation of, plans for, and construction of, a proposed electrical service installation with respect to retail revenue metering. The requirements apply to all existing, new, and upgraded services, both permanent and temporary, and are intended to provide an efficient and safe supply of electrical energy with respect to retail revenue metering.

It shall be the responsibility of the Customer to conform to the latest editions of this Guide, the Conditions of Service and all applicable laws and regulations including without limitation, the Ontario Electrical Safety Code.

The objective of this Guide is to help:

1. Ensure uniform safety requirements that comply with Hydro One Distribution Standards;
2. Provide uniform system reliability;
3. Provide uniform operating practices;
4. Permit economic bulk purchasing of materials;
5. Achieve optimum life cycle cost of plant construction; and
6. Effect efficient quality assurance.

1.4 INTENT

The words “shall”, “will” or “must” indicate provisions that are mandatory.

The word “should” indicates provisions that are normally and generally practical for the specified conditions.

1.5 COMPLIANCE WITH HYDRO ONE RULES

All primary and secondary metering installations shall be submitted to Hydro One, and subject to Hydro One’s review and approval, prior to construction. Hydro One reserves the right to refuse to energize the Customer’s Meter Installation if, in its sole discretion, it is deemed to not meet Hydro One’s requirements stated herein.

1.6 DEVIATIONS

A 'positive deviation' from the requirements of this Guide may be permitted (in Hydro One's sole discretion) with respect to an electrical installation where Hydro One reviews and approves that the positive deviation does not create an undue hazard to persons or property under the circumstances where Hydro One's approval has been requested.

2 METRIC UNITS

Recognized symbols for SI units have been used in the Canadian Electrical Code, Part I. For the convenience of the user, these symbols and the units they represent have been listed below:

A	ampere(s)
dBm	decibel
Hz	hertz
kcmil	1000 of Circular Mils
kW	kilowatt
kWh	kilowatt-hour
m	metre
mm	millimetre
Ω	ohm
V	volt
W	watts

3 DEFINITIONS & ABBREVIATIONS

Capitalized terms used in this Guide that are not defined below will have the meanings set out in Section 2 of the Ontario Electrical Safety Code or the Conditions of Service. Otherwise, capitalized terms used in this Guide will have the corresponding meanings as defined below in this Section 3.

400A Meter Base

A 400A rated, single phase, transformer type, 5-Jaw Meter Socket assembly with integrated CTs and 4 pole test-switch.

Acceptable

A product or service that meets Hydro One requirements.

AMI

Advanced Metering Infrastructure.

American National Standards Institute or ANSI

Is the primary organization for fostering the development of technology standards in the United States.

American Wire Gauge or AWG

The American (or Brown and Sharpe) Wire Gauge as applied to non-ferrous conductors and non-ferrous sheet metal.

Azimuth

The angle formed between a reference direction (typically north) and the direction of a point of interest.

Bar Type Current Transformer

See Current Transformers or CTs.

Billing Multiplier/Constant

The multiplier applied to meter readings for billing purposes:

“Billing Multiplier = CT Ratio x VT Ratio x Drawing Number Constant x Meter Multiplier”.

Bonding Point

A junction point in a Meter Socket, which connects the non-current-carrying metal parts of electrical equipment.

Burden

A load, usually expressed in volt-amperes, which is placed on instrument transformer secondary terminals by the associated meter coils, leads and other connected devices.

Typical burdens for current transformers (CT): BO.1 (2.5 VA), BO.2 (5 VA), BO.5 (12.5 VA), BO.9 (22.5 VA), B1.8 (45 VA).

Typical burdens for potential transformers (VT): W (12.5 VA), X (25 VA), Y (75 VA), Z (200 VA) and ZZ (400 VA).

Business Day

Any day that is not a Saturday, a Sunday, or a legal holiday in the Province of Ontario.

Central Metering

Meter two or more services, up to a maximum of four, belonging to one Customer with one transformer-type Meter Installation. Additional services must be connected downstream of the central metering point on a Pony Pole.

Connection Cost Agreement or CCA

Agreement signed by a Generator to recover the costs that are incurred by Hydro One to connect the project to Hydro One's distribution system. Refer to Distribution System Code for more information.

Conditions of Service or CoS

Describes Hydro One's operating practices and connection policies and sets out the terms and conditions upon which Hydro One offers and the Customer accepts Distribution Services.

Connection Wiring Diagram or CWD

An electrical diagram, which shows the terminal to terminal physical wiring connections from one device to another.

Current Transformer or CT

An instrument transformer designed for the measurement of current. The CT primary terminals are connected in series with the conductor carrying the current to be measured. There are three different types of Current Transformers – Bar Type, Donut Type and Window Type.

Bar Type Current Transformer

An instrument current transformer that has a fixed, insulated straight conductor in the form of a bar, rod or tube connected in series with the load.

Donut Type Current Transformer

A specific type of instrument current transformer, which has an opening in the centre, which is normally circular in shape, through which the primary conductor passes.

Window Type Current Transformer

A specific type of instrument current transformer that has an opening in the centre, which is rectangular in shape through which the primary (bus bar) conductor passes.

Canadian Standards Association or CSA

Canadian Standards Association is a provider of product testing and certification services for electrical, mechanical, plumbing, gas, and a variety of other products. It is recognized in the U.S. and Canada. A product with a CSA registered mark shows that it has been independently tested and certified to meet recognized standards for safety and performance. In addition, it authors the Electrical Safety Code.

Cellular Technologies

GSM: Global System for Mobile Communications, one of the two competing cellular technologies commonly referred to as 2G, offering data connections over the cellular networks.

HSPA: High Speed Packet Access, a cellular technology commonly referred to as 3G, offering improved speeds and latency compared to the GSM networks.

LTE: Long-Term Evolution, a cellular technology commonly referred to as 4G, offering further improvements over HSPA.

CT Multiplier

The CT multiplier is equal to the CT ratio for all applications except for 120/240V, 1 Phase, 3-Wire Service (e.g. Three-wire bar type CT nameplates may be labeled as either XXX-5A or XXX & XXX-5A (i.e. 400-5A or 400 & 400-5A). In either case, when the nameplate value of primary current (400 A) flows in both primary conductors at the same time, 5A is produced in the secondary circuit. For either nameplate, the CT ratio is 400:5 and the CT multiplier is also 400:5, or 80:1).

CT Ratio

A number that is derived by dividing the primary rating of the CT by the secondary current of the CT (e.g. for a CT rated 400:5 A, the ratio would be 80).

Continuous Current Rating Factor or CCRF

The maximum current at which a CT can operate continuously, without exceeding the thermal limits of its insulation, is the nameplate rating multiplied by the rating factor.

Customer

A person that has contracted for or intends to contract for connection of a building or an embedded generation facility. This includes developers of residential or commercial subdivisions.

Demand Meter

A metering device, which indicates or records the peak value of power consumed over specified time duration as approved by Measurement Canada, usually expressed in kW, kVA, or kVar.

Donut Type Current Transformer

See Current Transformers or CTs.

Disconnect switch (Isolation Device)

An isolating device that conforms to OESC Section 84 and additional Hydro One requirements in order to ensure a safe and reliable means of electrically isolating the generation or load facility from Hydro One's Distribution System.

Distribution Generator Interface Transformer or DGIT

Interconnection of Distribution Generators with the utility distribution feeders

Distribution Standards

Hydro One standards for design and construction of Retail Revenue Metering, Overhead and Underground installations for all Hydro One-owned Distribution System assets less than 44kV.

Distribution System Code or DSC

Distribution System Code sets the minimum conditions that a distributor must meet in carrying out its obligations to distribute electricity under its license and the Energy Competition Act, 1998. It applies to all retailers, generators, distributors, transmitters, and consumers of electricity who use the distributor's distribution system.

Ec/Io

See Signal Strength/Quality.

Elementary Wiring Diagram or EWD

A diagram which shows the electrical interconnections of the various circuit components.

Embedded Generator or Embedded Generation Facility

A generator whose generation facility is not directly connected to the IESO-controlled grid but instead is connected to a distribution system.

Emergency Backup Generation Facilities

Generation facilities that are designed to supply power to a load in the event that supply from the distribution system is lost, but not to feed power back into the grid or use for load displacement purposes.

Energy Meter

A meter which measures the total energy consumed over a period of time. This consumption is normally expressed in kilowatt-hours (kWh).

Energy Storage Facilities

Facilities designed to draw power from the grid during times of low demand and store it for eventual export back to the grid typically during times of high demand.

Electrical Safety Authority or ESA

ESA is a delegated administrative authority; an independent, not-for-profit corporation acting on behalf of the Government of Ontario with specific responsibilities for electrical safety. As part of its mandate, the ESA administers regulation in four areas: the OESC; licensing of Electrical Contractors and Master Electricians, electricity distribution system safety, and electrical product safety. The ESA also administers the Appeals Regulation.

GSM

See Cellular Technologies.

High Accuracy CT

A current transformer that meets ANSI 0.15s, capable of measuring the flow down to 1% of the nominal current rating and maintaining the necessary accuracy throughout its entire operating range.

Hydro One or HONI

Hydro One Networks Inc.

HSPA

See Cellular Technologies.

Independent Electricity System Operator or IESO

A not-for-profit corporate entity established by the Electricity Act, which operates the electricity grid in real time and oversees Ontario's Electricity Market.

Interval Meter

An electronic meter that measures and records electricity parameters and/or consumption on an hourly or sub-hourly basis.

Instrument Transformer

Voltage Transformer or Current Transformer that transforms the circuit voltage and current to lower levels for connection to a transformer type meter.

Instrument Transformer Enclosure

Outdoor rated NEMA Type 3R enclosures to house current and voltage transformers. Typically, these enclosures are 4' x 4' x 1' for three phase metering and 3' x 3' x 1' for single phase metering.

LTE

See Cellular Technologies.

Load Displacement Generation Facilities

Generation that is used to supply part or all of a Customer's electricity needs. The generator is located behind the meter that measures the customer's electricity supplied by the distributor.

Load Range

A term used to describe the limits of load variation.

Load Side

The part of the line or electrical installation located between a given point and the load

Location

Outdoor Location: Any location outside of a building or enclosed structure, exposed to the weather or in other words, if the location is sheltered from the weather, it shall not be considered outdoors.

Indoor Location: Any location that is not an Outdoor Location is considered an Indoor Location.

Local Distribution Company

A distribution company that is responsible for distributing power from transmission lines to residential, industrial and commercial customers.

Maximum Demand

The highest demand measured over a selected period of time, such as one month, and also referred to as peak demand.

MCM

Is an abbreviation for thousands for circular mils; an old measurement for wire gauge.

Measurement Canada or MC

The Federal Government authority responsible for revenue metering regulations in Canada, formerly known as Industry Canada and Consumer and Corporate Affairs Canada (CCAC) - more information can be found at <http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/Home> or 1-877-325-3996

Meter Change

When a site meter is changed without an upgrade to the rest of the existing Meter Installation. It may include an addition of a meter adapter to accommodate the newer meter jaw configuration.

Meter Enclosure

Outdoor rated metal enclosure to house a transformer type meter, test switch, fusing, wiring and associated equipment.

Meter Installation

The meter and, if so equipped, the instrument transformer(s), wiring, test links, fuses, lamps, loss of potential alarms, meters, data recorders, telecommunication equipment and spin-off data facilities installed to measure power, provide remote access to the metered data and monitor the condition of the installed equipment, whether or not such equipment is located in the immediate vicinity of the meter and includes, where applicable, AMI Network Equipment, and including all other equipment required for the Meter Installation.

Meter Multiplier

The actual amount of energy consumed is too large to be registered and the meter shows a fraction of the actual use. A multiplier is then applied to the difference between your present and previous readings to determine your actual energy use. The meter multiplier is determined by the meter manufacturer and is indicated on the meter nameplate. If the

meter multiplier is X1, it may or may not appear on the meter nameplate. All meter multipliers other than X1 will appear on the meter nameplate.

Meter Socket

Device for mounting a self-contained S-Base meter. In addition, there are transformer type meter sockets that come with test switch compartments in various jaw configurations required to install Hydro One supplied test switches and meters for Transformer Type Metering. Both types of Meter Sockets are referred to as a meter mounting device in the OESC.

Multiplier

A term used in metering circuits to express the ratio of instrument transformers or the rating on meters.

Multi position Meter Sockets or Ganged Meterbase Socket

A Multi-Position, self-contained meter sockets that house Hydro One's meters.

National Electrical Manufacturers Association or NEMA

The National Electrical Manufacturer Association (NEMA) uses a standard rating system that defines the types of environments in which an electrical enclosure can be used, and frequently signifies a fixed enclosure's ability to withstand certain environmental conditions.

Net Metering

A special service or program where eligible Customers with specific generation facilities can reduce their energy consumption costs by exporting generated energy back into the distribution grid for a credit towards their energy use.

Network Meter Installation:

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

Network Interface Device or NID

An interface terminal box to terminate wiring for telephone connection from an Interval meter and the connection to the telephone system.

Neutral Ground Resistor or NGR

A resistor that has been installed between the transformer neutral and ground.

Ontario Energy Board or OEB

Regulates the province's electricity and natural gas sectors in the public interest

Ontario Electrical Safety Code or OESC

The Ontario Electrical Safety Code is primarily a technical document that describes the standards for electrical installations in detail.

Optical Port

A communication interface on metering products, which allows the transfer of information, while providing isolation and metering security – the communications medium is typically infrared light transmitted and received through the meter cover.

Point of Common Coupling or PCC

Point of supply or demarcation point where the primary live clamp or line switch that is installed on or at the Hydro One distribution line where the Generator's facilities are to connect to Hydro One's distribution system.

Point of Supply

The point of interconnection to Hydro One Networks Inc.'s Wholesale System for the purpose of metering. For example, "Point of Supply to Toronto Hydro" refers to a wholesale metering point for Toronto Hydro, the Municipal Utility. This may be located at Hydro One Networks Inc. owned stations or Customer owned stations.

Polarity

The condition of being positive or negative with respect to some reference point – the designation of the relative instantaneous directions of the current entering the primary leads and leaving the secondary leads.

Pony Pole

A pole used for Central Metering installation, when greater than 4 services are required.

Potential Transformer

See Voltage Transformer.

Primary Metering Unit or PMU

A specific type of equipment, either single or three phase, consisting of instrument transformers connected to the primary distribution system. It consists of an assembly of individual VTs, CTs, and a bracket. May also be referred to as modular metering unit.

Pulse

An electrical signal which departs from an initial level for a limited duration of time and returns to the original level. For example, a sudden change in either the voltage or current in a digital circuit produced by the opening or closing of a contact and used to activate a counting device. In an electronic meter, each pulse represents a specific amount of energy that varies by meter model/type.

RSRP/RSRQ/RSSI

See Signal Strength/Quality.

Retail System

Hydro One Networks Inc.'s electrical distribution system (less than 44kV) used to supply retail Customers.

Retail Customer

An end-use Customer served directly by Hydro One Networks Inc. and not a wholesale market participant (i.e. registered with the Independent Electricity System Operator).

'S'-Base

A type of meter with a standard arrangement of blades at the back of the meter, which fit into a socket base and is normally connected directly in the Customer's supply circuit.

Self-Contained Meter

A meter designed to be connected directly in the Customers supply circuit, typically 100A or 200A. No instrument transformers are required.

Service Type

The number of phases and wires and the interconnection between them. The three main Hydro One metering service types are defined below:

1) Single Phase:

Two-wire (2W) service: typically has one conductor grounded (neutral) and a phase conductor, with a nominal voltage of 120V between them.

Three-wire (3W) service: typically has one conductor (neutral) which is grounded and two phase conductors with a voltage of 240V between them and 120V between each phase conductor and neutral.

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

3) Polyphase:

Three phase, three-wire (3W) service: has no neutral conductor and may be supplied by either an open delta or closed delta transformer bank.

Three phase, four-wire (4W) service: has three phase conductors and a neutral conductor where the phase to phase voltage is equal to the square root of 3 times the phase to neutral voltage.

Three phase, four-wire, delta service: has one transformer winding which is centre tapped and grounded. The voltage between the two adjacent phases and the centre tap is 120V, and the voltage of the third phase to the two adjacent phases is 240V. The voltage between the third phase and the centre tap is 208V.

Service Upgrade

Changing an existing Meter Installation to comply with the latest metering standard.

Single Stage of Transformation

Voltage supplied to the Customer following a single step down after an initial step down at a Distribution Station.

Shorting Device

A link or conductor used to provide an alternative current path in a CT secondary circuit, to prevent an open circuit condition when a meter is disconnected.

Signal Strength/Quality

RSSI: Received Signal Strength Indicator, a measure of the power present in a radio signal.

RSRP: Reference Signals Receiver Power, a measure of the power received from a single reference signal, typically the LTE reference signal.

Ec/Io: Energy per chip to Interference power ratio, a measure of the quality of a signal, comparing the received energy to noise or interference on the channel.

RSRQ: Reference Signal Received Quality, a measure of the quality of a received reference signal, comparing the power present in the received signal against the power present in all signals on the channel.

Single Line Diagram or SLD

A simplified notation for representing a three phase power system

Single Phase

Refer to Service Type.

Smart Meter

A smart meter records how much electricity used based on when it was used (typically hourly), and communicates this information automatically via wireless and other technologies. In contrast, conventional electricity meters are read manually and measure only how much electricity is used between readings.

Summator

A device, which adds or subtracts energy pulses from different sources to totalize the sum for metering purposes

Surge Suppressor

A device that is used to protect metering and telecommunications circuits from excessive or damaging voltage surges.

Test Switch

A device containing current and/or voltage isolating mechanisms, which are used to isolate meters from their current and voltage input sources.

Transformer (XFMR) Type Meter

A meter designed to be used with instrument transformers such as current and voltage transformers.

Transformer-Type Meter Installation

Comprised of the meter, meter enclosure, the instrument transformers, instrument transformer enclosure, wiring, test switch, fusing and all associated equipment required for the Meter Installation.

Underwriters Laboratories of Canada or ULC

Underwriters Laboratories of Canada (ULC) is an independent product safety testing, certification and inspection organization.

Voltage

Low Voltage – Any voltage exceeding 30V but not exceeding 750V

Medium Voltage – Any voltage exceeding 750V but not exceeding 44kV

Volt-amperes or VA

The mathematical product of voltage and ampere carried thereby.

Voltage Transformer or VT

An instrument transformer designed to reduce the measured voltage to a lower secondary value suitable for application of metering.

VT Ratio

The VT ratio is the primary voltage of the VT divided by the secondary voltage of the VT (e.g. For a VT rated at 4800V primary and 120V secondary, the ratio would be 40).

Window Type Current Transformer

See Current Transformers or CTs.

Wooden Post

A 6x6 wood post used mainly to mount a Meter Socket for padmount central metering installation.

4 GENERAL INFORMATION

4.1 APPLICATION FOR SERVICE

New connect or service upgrade load Customers may contact the Customer Communications Centre at 1-888-664-9376 or request a service upgrade or new service layout online. Customer inquiries for new or existing Generation projects may contact the Business Customer Centre at 1-877-447-4412 or email at DXGenerationConnections@HydroOne.com.

For all types of Customers, application for service should be submitted early in the planning stage of the project in order for Hydro One to meet the Customer's needs, to determine the best service arrangement, and to obtain necessary equipment.

Note: Customers shall only be connected when meeting Hydro One's retail metering requirements stated herein. There will be further non-metering requirements that are not covered in this guide and Customer should refer to the Conditions of Service for more information.

An unapproved Meter Installation may not be connected or may result in delay of connection while it is reviewed and may also require change of design potentially resulting in the customer incurring additional fees. Thus, before an electric service connection can be made to the Customer's wiring system, the Customer shall:

1. HAVE AN EARLY CONSULTATION

Customer shall provide general information in order for the Hydro One personnel to prepare applicable Meter Installation drawings and layout for the site, such as:

1. Required in-service date;
2. Service entrance capacity and voltage rating of the service entrance equipment;

3. Detailed information on heating equipment, air conditioners, and any other appliances and/or equipment with a high electricity consumption;
4. Detailed information for the connection of an Embedded Generation Facility for all Generators being connected in parallel to the Distribution System;
5. Survey plan or site plan, at the request of Hydro One, indicating the proposed location of the service entrance equipment relative to public rights-of-way and property lot lines;
6. All information required to set up an account for billing purposes; and
7. Additional information as noted on the Hydro One website at www.HydroOne.com or specified in writing by Hydro One.

2. OBTAIN CONSENT PRIOR TO INSTALLATION

The Customer shall supply equipment that is accepted by Hydro One. An [Approved Meter Socket Base List](#) is available for Customers to purchase equipment that is accepted by Hydro One and meets Hydro One Distribution Standards. In addition, these materials should be obtained in a timely fashion to avoid any unnecessary delays. A Hydro One accepted primary metering unit and/or other required equipment should be customer ordered at least 16 weeks prior to the in-service date.

Work associated with the installation of equipment should start only after the metering design has been reviewed and accepted by Hydro One. It is the Customer's responsibility to ensure that all requirements of the Hydro One Distribution Standards, and the rates, rules and regulations in effect and on file have been met.

3. COMPLETE CONSTRUCTION

The Customer shall install metering as required by Hydro One Distribution Standards. In addition, the ESA must approve all Customer electrical installations before Hydro One can proceed with connection to the Distribution System. If Hydro One requires the Customer to perform specific work on the Customer's premises, the Customer will do so as a prerequisite to Connection.

4.2 GENERAL REQUIREMENTS

4.2.1 CUSTOMER-OWNED FACILITIES

Customers will provide Hydro One, free of charge or rent, with a convenient and safe place for Hydro One's Facilities and Equipment, for example, a Meter Installation on the Customer's premises and/or Customer Equipment. Hydro One is not liable for any damages resulting from, arising out of, or related to the presence of Hydro One Facilities and Equipment on Customers' premises.

Customers will only allow Hydro One employees, authorized agents, or persons lawfully permitted to do so, to repair, remove, replace, alter or inspect Hydro One Facilities and Equipment on the Customer's premises and/or Customer Equipment.

In addition to Hydro One's rights under [Section 40](#) of the Electricity Act, Hydro One employees and its authorized agents may enter the Customer's property at any time, in order to:

1. Install, inspect, read, calibrate, maintain, repair, alter, remove or replace all or any part of a Meter Installation
2. Perform switching operations, or interrupt the Customer's supply, in order to maintain or improve the supply system or to provide new or upgraded services to other Customers.

3. Hydro One's employees and their authorized agents will use reasonable efforts to enter the Customer's premises during normal business hours and will identify themselves with proper identification.
4. If Meter Installations or meter rooms are located inside the Customer's premises, Customers will provide Hydro One with key access upon request. Hydro One's written approval is needed for any exceptions to this requirement.
5. If the Meter Installation is inaccessible, Hydro One will require Customers to relocate it to an accessible location, at the Customer's expense.

4.2.2 METER LOCATION

To accommodate Hydro One's Meter Installation, the Customer shall provide acceptable equipment as determined by Hydro One. In addition, this equipment shall be installed in a safe location subject to approval by Hydro One based on standards established by the OESC, the Conditions of Service, the Ontario Building Code, and the layout and/or subdivision design drawings.

All meters shall be located as per requirements listed in **Table 1 | Self Contained Metering Installation and Location Summary** and **Table 2 | Transformer Type Metering Installation and Location Summary**. These locations apply to both transformer type meter installations as well as self-contained meter installations.

In addition, these Meter Installations:

1. Shall be installed in a clean, readily accessible location free from severe or continual vibration, and tripping or slipping hazards (e.g. snow, ice, or overgrown vegetation);
2. Shall not be installed in locations which may be hazardous to persons installing, testing, reading, or maintaining the equipment. This includes any area where moving machinery, dust, vibration, fumes, falling debris, corrosive vapours, water, and/or moisture will be present;
3. Shall be easily and safely accessible (i.e. there shall be a safe entrance or egress);

4. Shall have adequate illumination and ventilation to carry out all work safely as per the OESC, if Meter Installations are located indoors;
5. Shall have guaranteed continuous access, by key or other appropriate means, provided to Hydro One or its authorized agent, when installed in dedicated metering rooms; and
6. Shall have poles installed, owned and maintained by the Customer when Meter Installations are located on poles on the Customer's property.

4.2.3 WORKING SPACE

The Customer shall meet latest amendments of OESC Rule 2-308 Working space around electrical equipment and 2-312 Accessibility for Maintenance and CSA B149.1-10 Natural Gas and Propane requirements for the working space around meters and metering equipment.

4.2.4 ENTRANCE TO, OR EXIT FROM, WORKING SPACE

The Customer shall meet latest amendments of OESC Rule 2-310 Entrance to, and exit from, working space requirements around meters and metering equipment.

4.2.5 ILLUMINATION

When installed indoors (e.g. service room, power shed, service closet, etc.), the metering equipment shall be installed in a location with a minimum illumination of:

- 100 to 200 lux horizontal at 750 mm above grade; and
- 100 lux vertical at the front face of the meter.

Lighting in spaces containing metering equipment shall be controlled by a wall switch at the room entrance.

4.2.6 UNSUPPORTED INSTALLATIONS

Hydro One reserves the right to refuse electrical connection to any installation not conforming to the requirements of Hydro One's Distribution Standards. These non-compliant installations include, but are not limited to:

1. Customer owned equipment in the secure lockable metering area of any service entrance gear;
2. All new or upgrades of existing 3-phase 4-wire wye configured Meter Installations using 2.5 element Meter Installation;
3. All new or upgrades of existing 3-phase 3-wire delta configured transformer-type or self-contained meters;
4. All new or upgrades of existing 347/600V Central Metering;
5. 5 jaw Meter Sockets with a jaw in 6 o'clock position instead of 9 o'clock position;
6. 120V, 100A, 1-phase, 2-wire self-contained meters;
7. All Meter Enclosures that are flush mounted with its conduits buried in an exterior building wall;
8. All transformer rated Meter Enclosures with any self-shorting CT circuit closing feature to short out CT upon removal of meter; and
9. All new and all reconstruction of existing Ringless Meter Sockets.

4.2.7 MOBILE HOME AND TRAILER PARKS

Parks containing Mobile Homes or Land Leased Community Homes that meet the Planning Act are treated like a subdivision. Thus, a typical [Section 6: Secondary Metering](#) shall apply depending on the Customer requirements.

In addition, a trailer park will provide, own, and maintain all distribution facilities, including transformers and individual metering as required, within the park boundary subject to OEB approval. For new developments, Customer may apply for primary metering, if secondary metering is not practical. However, it shall be at Hydro One's sole discretion to decide the preferred choice of metering.

4.2.8 UNMETERED SERVICES

Flat rate accounts are small accounts that produce limited predictable estimated consumption and thus provide minimal support to cover Hydro One connection costs.

Therefore the Customer must pay for all of the costs Hydro One incurs in connecting them, except for transformation, if necessary. Services that can be unmetered include street lighting, cable TV amplifiers, telephone switching devices, phone booths, bus shelters, railway crossing signals, traffic signals, and other small fixed loads. Only loads of less than 5 kW can be set up as unmetered.

In some areas of the Province, a direction has been taken by the municipality to amalgamate normally flat rate connections into a common distribution center. For example, intersection traffic lighting, streetlights, bus shelters, or cable amplifiers. Because these combined loads are now greater than 5kW, this connection must be metered, and treated as a New Connection. Unmetered connection shall be permitted at the sole discretion of Hydro One and meeting the obligations stated herein and the Conditions of Service: Appendix D, Unmetered Connection Overview.

4.2.9 METERING PULSES

For metering pulses or signals for load management purposes, Customer have two options:

1. The Customer supplies and installs instrument transformers and signal control equipment in a separate cabinet on the load side of Hydro One's Meter Installation; or
2. The Customer asks Hydro One to supply the pulses or signals, and customer will pay all costs. The pulse or signal from the revenue meter will be brought to a Hydro One terminal block by a Hydro One technician. The customer's wires from the signal control equipment will be installed by the customer and connected to the terminal block by a Hydro One technician. Customers will not have access to Hydro One's Meter Installation (customers are not permitted to connect to Hydro One's instrument transformers.)

4.2.10 TOTALIZED METERING

For Customers who wish to consolidate/totalize two or more delivery points, Hydro One will review the request, and at its discretion may allow the individual delivery points to be billed at the aggregate level for the load facility with consideration of the following conditions:

1. Totalizing will be accomplished by either primary or secondary interval metering;
2. If the Rate classification is Sub-Transmission, all points of delivery must be located on the same or contiguous properties, must be supplied by the same Hydro One feeder and all line transformers associated with the points of delivery must have the same owner (Hydro One or Customer owned); and
3. The points of delivery must all be on the same electricity pricing structure

4.2.11 PROTECTIVE BOLLARDS FOR METERING EQUIPMENT

For mechanical protection, the Customer shall supply, install, and maintain protective bollards around the metering equipment not inside the meter room to act as a mechanical barrier for Hydro One personnel against passing traffic.

Bollards shall be required, if the metering equipment installation:

1. Is located inside an area that can be accessed by motor vehicles easily achieving speeds in excess of 20km/hr; or
2. Is located in an area that will be subject to grounds maintenance equipment operating within 1000mm of the metering equipment such as snow clearing equipment and large riding lawn mowers.

If protective bollards are required, they shall be subject to all of the following:

1. Two bollards shall be installed at least 800mm of the front (operating side) of the metering equipment such as metering enclosure, padmount or pedestal. Alternatively, bollards may be required, at least 400mm, at the rear and side of the metering equipment for high traffic areas and large sized equipment.
2. Bollards shall be provided as shown in **Figure 14: Protective Bollards for Metering Equipment and Padmounts**. Location of bollards should not obstruct operation, maintenance and replacement of the equipment within. The equipment can consist of but not limited to enclosure, cabinet, padmount or pedestal.

3. When used to protect 1-phase metering, the bollards shall be no less than 900mm above grade; when used to protect 3phase metering, the bollards shall be no less than 1200mm above grade.
4. The bollard shall consist of a concrete filled galvanized steel pipe with rounded over concrete cap on top of steel pipe, painted "High Visibility" yellow.
5. The bollard shall have a cadweld connection or approved compression connector to provide a connection to ground grid using a #4 bare copper.

5 PRIMARY METERING

5.1 GENERAL REQUIREMENTS

A Primary metered Customer is eligible to be metered at the Hydro One supplied primary voltage present in the vicinity of the connection. These types of Customers use primary metering units (PMUs) consisting of single or three phase outdoor metering units designed for primary metering applications and include:

1. Hydro One disconnects at or near the Customer property line (demarcation point);
2. A PMU installed on the Customer property in a location acceptable to Hydro One;
3. Line and load side arrestors as per Hydro One Distribution Standards; and
4. Customer owned disconnect switch load side of PMU as per ESA requirements.

The content in this section is applicable to both load and generation Customers eligible for Hydro One's primary metering as per [Sub-Section 5.1.1 – Primary Metering Considerations](#) for Overhead & Underground Connections unless otherwise stated.

Customers requesting primary metering shall contact Hydro One prior to commencing work or buying equipment, to determine their eligibility and the primary voltage available at their location. All primary metering installations shall be reviewed and pre-approved by Hydro One prior to construction.

Note: Hydro One reserves the right to refuse to energize any installation if, in its judgment, the Customer's Meter Installation does not meet Hydro One's requirements stated herein.

All Hydro One supplied primary voltages and their respective configurations are listed in **Table 3 | Hydro One Supplied Primary Voltages.**

5.1.1 PRIMARY METERING CONSIDERATIONS

Primary metering service will be considered in the following situations:

1. The Customer's main disconnecting device exceeds 3000A;
2. The Customer requires a non-standard secondary voltage not listed under Table 5: Hydro One Metered Secondary Voltage below of this Retail Revenue Metering Standards Guide;
3. Secondary metering is considered impractical due to:
 - a. Economic evaluation (i.e. what is the overall most cost effective method for the service);
 - b. Site conditions that complicate a secondary metering installation;
 - c. Site location that poses safety hazards, environmental concerns, or lack of ease of access; or
 - d. Other factors and considerations requiring further assessment such as presence of neutral ground resistors, more than two stages of transformation and/or others; or
4. The Customer requests a primary metering service.

Examples of primary metered Customer include provincial parks, camp grounds, large distribution generators, and Customers who own their own distribution system. Where the Customer's load is insufficient, primary metering may not be possible. The smallest ratio CT available for PMU will dictate if primary metering is feasible.

5.1.2 INSTRUMENT TRANSFORMER SPECIFICATION

Customers supplied at sub-transmission or primary distribution voltages require a Professional Engineer certified PMU, which consists of medium voltage instrument transformer(s), ULC/CSA approved Meter Enclosure, junction box, conduit, and secondary conductor, all assembled as one unit.

Furthermore, as per the “Electricity and Gas Inspection Act” and “Electricity and Gas Inspection Regulations”, the primary voltage instrument transformers provided shall be approved by Measurement Canada in accordance with S-E-07, CSA C60044-1 and C60044-2. In addition, the VTs shall have a minimum 0.3% accuracy class with a rated burden adequate for the connected load. Typically, these primary VTs are rated for 0.3WXY or 0.3WXYZ accuracy with 115V or 120V rated secondary winding. The CTs shall have at least 0.3% accuracy class for load Customers and at least 0.15% accuracy class for Embedded Generation Customers. Refer to **Table 4 | Primary Metering Unit Specifications** for voltage class and BIL of CTs and VTs.

Note: PMUs are not stocked by Hydro One for new construction projects and typically require minimum 16 weeks lead time for procurement.

These revenue metering VTs shall be electrically connected on the line side of the CTs and connected in accordance to their reference polarity markings (i.e. H1 or ●) which shall always be oriented to the line side. As well, CT ratios shall be selected such that the maximum sustained primary current in the CT shall not exceed the primary tap multiplied by the Continuous Current Rating Factor of the CT. Also, the minimum sustained primary current during nominal operation shall not be less than 10% of the primary tap for a 0.3B accuracy class CT and 5% of the primary tap for a 0.15 accuracy class CT.

Hydro One shall order all PMUs for load Customers. Hydro One may bill the Customer for this PMU as appropriate per [Sub-Section 5.1.1 Primary Metering Considerations](#). However, Embedded Generators can choose to procure their own PMUs. Should they choose to do so, they shall submit the details of the proposed VTs and CTs, and the Measurement Canada approval number to Hydro One for approval in accordance with this Guide and to **Table 4 | Primary Metering Unit Specifications**.

5.1.3 METER REQUIREMENTS

Hydro One shall install an interval meter for all new or upgraded primary metered load Customers. For Large Distribution Accounts (equal to or greater than 2MW), with the exception of Wholesale Market Participants, Hydro One will supply and install a power quality meter e.g. Ion Meter, and the Customer will pay the required incremental costs for the PMU as per the exceptions stated in [Sub-Section 5.1.4 Responsibilities](#)

Embedded Generators shall follow the requirements set out in **Table 71 Metering Requirements – Embedded Generation Facilities including Net Metering**

At the location of PMU, Hydro One requires safe and unobstructed access to the PMU and ancillary equipment at all times. This includes a minimum of 1m of unobstructed easy and obvious access to the Meter Enclosure where the finished grade immediately in front shall be level for the entire width of the equipment and the entire extent of the clearance specified in this guide. The intent is to create a safe surface from which to perform work and operate electrical equipment. Refer to [Sub-Section 4.2.3 Working Space](#) and [Sub-Section 4.2.4 Entrance To, Exit From, Working Space](#) for more details.

5.1.4 RESPONSIBILITIES

The load Customer shall be primary metered under conditions listed in [Section 5.1.1 Primary Metering Considerations](#). In such circumstances, Hydro One shall install the PMU and the load Customer shall be responsible for the incremental cost of primary metering over the cost of secondary metering unless otherwise stated by Hydro One.

Note: The load Customer shall give a minimum 16 weeks of notice to allow sufficient time for the ordering of PMUs.

These incremental costs include, but not limited to:

1. Purchase and installation of primary metering equipment i.e. PMU and its ancillary equipment;
2. Purchase and installation of any poles, platforms, foundations or other supporting structures required for the equipment;
3. Changes and modifications to existing Hydro One facilities required to accommodate the primary metering;
4. Removal of any facilities required to accommodate the primary metering; and
5. Any other modifications or additions required to accommodate the installation.

However, at Hydro One's discretion, in cases where a secondary metering installation is deemed impractical as listed in [Sub-Section 5.1.1 Primary Metering Considerations \(Point](#)

#3), all incremental costs above secondary metering shall be borne by Hydro One for load Customers. When padmount PMU is requested, the load Customer shall pay the incremental cost above an overhead PMU installation.

Where minimal Customer loading makes primary metering impractical, Hydro One will only meter at a standard secondary voltage. In such circumstances, the load Customer requiring non-standard voltages is responsible for transformation beyond the secondary metering to their desired utilization voltage.

Unlike load Customers, Embedded Generators that apply for primary metering shall expense, supply and install the overhead PMU to Hydro One Distribution Standards. Hydro One shall commission the overhead PMU and then install the meter. However, load and generation Customers shall install, own, and maintain the load side of the PMU and have it approved by the ESA prior to energization.

5.2 PRIMARY POLEMOUNT METERING

5.2.1 CONSTRUCTION GUIDELINES

Overhead PMU shall be installed to Hydro One Distribution Standards. In addition, the Customer shall ensure following requirements have been met:

1. A PMU that includes instrument transformers with an overhead phase sequence that matches the PMU element color code;
2. Switches, brackets, grounding, Meter Enclosure, adapter, test switch, and/or communication equipment meets Hydro One requirements;
3. Ensure a minimum 30m is maintained between the line side service disconnect and the PMU.
4. Hydro One disconnects at or near the Customer property line (demarcation point) to provide visible proof of isolation and only when Customer load has been disconnected by other means;

Note: the distance between PMU pole and adjacent poles on line/load side shall be at least 7m to allow direct vehicle access for easier

accessibility to Hydro One equipment such as the overhead metering point and the Customer's load break disconnect switch.

1. Line and load side arresters rated for the system voltage requirements, installed to Hydro One Distribution Standards; and

The following additional requirements shall apply to Embedded Generators Only:

2. A load break switch (LBS) at the Point of Common Coupling (PCC) when Embedded Generator is connecting to Hydro One distribution system. A load break switch is not required at the PCC when Embedded Generator is connecting to an existing Customer owned facilities. It shall be visible break type, lockable, and accessible. It does not have to be fused if the Distributed Generator Interface Transformer (DGIT) is within 200m of the PCC. If the DGIT is within 200m of the PCC then fuses can be installed at the DGIT.
3. An isolation device on the load side of the metering when the Embedded Generator's PMU is greater than 200m from the PCC. It shall be visible break type, lockable, and accessible. It shall be motorized under the following conditions:
 4. For Embedded Generators greater than 250kW on feeders less than 15kV
 5. For Embedded Generators greater than 500kW on feeders greater than 15kV

Note: An isolation device can be combined with load break switch at the PCC as long as all the requirements of both disconnect switches are met.

In addition, the location of the PMU and its ancillary equipment shall be determined in consultation with, and subject to approval by, Hydro One. Typically, the PMU is to be located on the first pole on the Customer property. However, the location must be accessible, as Hydro One must install and maintain this PMU on an ongoing basis. If the location closest to the demarcation point and the most logical for accessibility is beyond the first pole, then this is acceptable.

5.3 PRIMARY PADMOUNT METERING

5.3.1 CONSTRUCTION GUIDELINES

A padmount PMU is intended for use where the service is fed from underground and the revenue metering is measured at the primary voltage supplied by Hydro One. Currently, it is applicable to all three phase primary and sub transmission voltage class Customers and is available in ratings of 15kV through 35kV and up to 600A of load.

This padmount PMU shall be installed as per Hydro One Distribution Standards on customer owned property. It shall have a minimum clearance of 3 m on all sides of the metering unit with access doors for operating clearance purposes and 1m on remaining sides.

This type of padmount PMU shall consist of:

1. A Hydro One approved padmount assembly designed for medium voltage with a dead front design, outdoor rated and tamper proof, for above grade installation on a concrete vault designed to operate on a 60Hz system at the nominal system voltage listed in Table 4 | Primary Metering Unit Specifications for three phase application;
2. Measurement Canada approved instrument transformers located in a separate, enclosed, partitioned or isolated compartment of the enclosure for the purpose of the retail PMU. See [Sub-Section 5.1.2 Instrument Transformer Specifications](#) for additional details on instrument transformers;
3. A Hydro One approved Meter Enclosure installed on the right or left side of the padmounted unit, located $1.45\text{m} \pm 100\text{mm}$ from the base of the padmount assembly, when facing the dead front compartment as shown in **Figure 1: Dead Front Padmount PMU Assembly**. Hydro One approved elbows, bushing inserts, and caps to match the system voltage, cable size and load;

Note: Do not bend cables more than the permissible minimum bending radius of 10x diameter. Leave one full loop of cable in the vault to facilitate cable termination and operation.

4. Three sets of primary cable with concentric neutral supplied by the Customer and all terminations installed by Hydro One;

Note: The Customer to ensure concentric neutral tails are of sufficient length to allow operation of the elbows with live line tools.

5. A load break switch supplied by the Customer;
6. Three sets of elbow arresters which shall be installed as specified per system voltage; and
7. One set of three phase fault indicators.

Padmount PMU shall be connected in such a way that polarity markings will be made to the line side and phasing shall match the orientation. In addition, the secondary side of the metering instrument transformers shall be wired per Hydro One Distribution Standards unless otherwise specified.

6 SECONDARY METERING

Secondary metering is a Customer metered at the secondary voltage level or to the Customer's utilization voltage, the highest voltage at which the Customer uses or distributes power on the Customer's property. Hydro one will supply a single stage of transformation to the Customer's utilization voltage at standard voltages only. If a secondary voltage configuration other than those listed below in **Table 5: Hydro One Metered Secondary Voltages** below is required, the Customer shall supply the instrument transformers, associated ancillary equipment or alternatively customer may be primary metered (Refer to [Sub-Section 5.1.1 Primary Metering Considerations](#) for additional details).

This section is divided into two types of installations – [Sub-Section 6.1 Single Phase & Three Phase Self-Contained Metering](#) and [Sub-Section 6.2 Single Phase & Three Phase Transformer-Type Metering](#). Self-contained metering is used for all single and three phase Customers where the individual load does not exceed 200A and line-to-ground voltage does not exceed 347V. Transformer-type metering is used for all single and three phase Customers where the individual load exceeds 200A and line-to-line voltage does not exceed 600V.

The section requirements apply to both load and generation Customers eligible for Hydro One's secondary metering for overhead & underground connections after a single stage of transformation, where the interface transformers shall be designed to meet the energy efficiency standards in CSA C802.1 Minimum Efficiency Values for Power Transformers.

In conjunction, the Customer shall contact Hydro One prior to commencing work or buying equipment, to ensure the installation in its entirety shall be built in accordance to Hydro One Distribution Standards. In addition, the location of metering shall be such that it is safe and capable of being reached quickly for operation, renewal, or inspection, without requiring those to whom ready access is required to climb over or remove obstacles, or to resort to portable ladders, chairs, etc. Refer to [Sub-Section 4.2.3 Working Space](#) and [Sub-Section 4.2.4 Entrance To, Or Exit From, Working Space](#) for more information.

Note: Hydro One reserves the right to refuse to energize any installation if, in its judgment, the Customer's Meter Installation does not meet Hydro One's requirements stated herein.

6.1 SINGLE PHASE & THREE PHASE SELF-CONTAINED METERING

This section refers to Self-contained metering for all single and three phase Customers where the load does not exceed 200A and line-to-ground voltage does not exceed 347V. Any service exceeding these requirements shall require transformer-type Metering. Refer to **Table 5: Hydro One Metered Secondary Voltages** below for standard self-contained meter configurations.

In addition, it details the construction guidelines for different types of Hydro One approved single and three phase self-contained Meter Installations and identifies the responsibilities of the Customer as well as Hydro One.

Note: All DGs shall be Transformer-Type Metering with the exception of both Net Metering and MicroFITs under 10kW. Refer to [Sub-Section 6.2 Single Phase and Three Phase Transformer Rated Services](#) below for more information.

6.1.1 INDIVIDUAL METER SOCKETS

An individual Meter Socket refers to a single self-contained Meter Socket mounted on a building or a pole to meter a single Customer, where the main disconnecting device does not exceed 200A. This Meter Socket shall be Customer owned. Thus, it is the Customer's responsibility to supply a Meter Socket and a screw type sealing ring. Where a Customer has a combination meter/breaker unit, the Customer's responsibility includes the breaker. In all cases, regardless of any labels, stickers, or nameplates identifying otherwise, the Customer owns and is responsible for repairs to and maintenance of the Meter Socket, meter box, and breaker.

All Meter Sockets shall be certified in accordance with CSA standard C22.2 No. 115, Meter Mounting Devices. They shall be inspected by ESA for compliance to the OESC. For a list of Hydro One preferred Meter Sockets, see the [Approved Meter Socket Base List](#).

Meter Sockets shall be able to accommodate underground or overhead supply service. They shall be surface mounted per Hydro One Distribution Standards. Meter Sockets recessed in walls, enclosed in Instrument Transformer Enclosures or otherwise obstructed are not permitted. In addition to the [Sub-Section 4.2.2 Meter Location](#), [Sub-Section 4.2.3 Working Space](#) and [Sub-Section 4.2.4 Entrance To, or Exit From, Working Space](#) requirements, the Meter Socket shall be 1.75m ± 100mm above finished grade in accordance with **Figure 2: Individual Pole or Wall Mounted Meter Socket Installation**

6.1.1.1 347/600V SELF-CONTAINED, 200A INSTALLATIONS

Typically, all secondary voltage, three phase, 4 wire, self-contained, 347/600V, up to 200A Meter Installations shall be located indoors, such as in a dedicated electrical room. However, Customers that do not have a building facility available, such as electrical charging stations, shall be allowed to install a 16S Meter Socket in a permanent enclosure procured to the requirements stated below and Hydro One Distribution Standards.

A 16S Meter Socket shall be installed within a permanent enclosure outdoors provided:

1. The permanent enclosure shall be CSA or UL Listed and shall be at least NEMA Type 4 or NEMA Type 4X specifications if any of the following occurs:
 - a. The enclosure will be installed in a location that will allow it to be exposed to outdoor elements; or
 - b. The enclosure will be installed in a location that will allow it to be exposed to areas where the atmosphere contains one or more corrosive substances or any environment that can encourage, accelerate, or cause adverse electro-chemical or galvanic effects;
2. The enclosure shall contain a Meter Socket that is installed on the load side of the disconnect;
3. The enclosure shall be wall-mounted or pole-mounted such that it is level and plumb as determined by Hydro One. It shall not be recessed into the permanent

- wall it is mounted on, in order to aid in making the meter, and supporting structures, readily visible, and to facilitate maintenance for Hydro One personnel;
4. All structural members such as wooden posts shall be designed to carry the imposed loads: snow, wind, live and dead loads. Strength and deflection limits established by building codes, or accepted by Hydro One personnel shall be observed;
 5. The enclosure has a hinged door and is capable of opening outward at least 90 degrees with respect to the enclosure. Doors that operate from top to bottom or bottom to top shall not be permitted;
 6. A clearance of 380mm shall be provided between the inside of the closed enclosure door and the Meter Socket and a minimum of 100mm of clearance shall be provided between each side of the Meter Socket and the enclosure walls;
 7. The serviceability of the Meter Socket, including, but not limited to installation, reading or removal of the meter, shall not be hindered by any part of the larger enclosure it resides within;
 8. The enclosure and door shall not interfere with the installation or removal of the meter;
 9. There exists provision for padlocking as approved by local Hydro One design;
 10. There exists a viewing window that permits easy and obvious viewing into the permanent enclosure; and
 11. If any of the doors, locking hardware, or exterior of an enclosure that meets, or exceeds, the requirements of NEMA Type 4 or NEMA Type 4X specifications have been damaged, the enclosure shall be considered de-rated from its original NEMA specification and it shall be the Customer's responsibility to repair or replace the enclosure to the satisfaction of Hydro One.

See **Figure 3: Typical 16S Enclosure Layout** for typical layout arrangement for 16S Meter Enclosure.

6.1.1.2 RESPONSIBILITIES

Single and three phase load and generation Customers with individual self-contained Meter Sockets (i.e. up to 200A main disconnect device) shall provide equipment to comply with the following arrangements, and in a location acceptable to Hydro One.

The Customer shall:

1. Install, own, and maintain the pole, if required;
2. Install the metering's grounding system. Ownership shall be transferred to Hydro One prior to energization;
3. For single phase services, provide a 120/240V, 200A, single phase 4-jaw outdoor Meter Socket connected on the line side of the main disconnecting device or a 120/208V, 200A, single phase 5-jaw indoor Meter Socket connected on the load side of the main disconnecting device;
4. For three phase services, provide a 347/600V, 200A, three phase 7-jaw indoor Meter Socket on the load side of the main disconnecting device or a 120/208V, 200A, three phase 7-jaw indoor Meter Socket connected on the load side of the main disconnecting device;
5. For padmount facilities, install, own and maintain the vault and the grounding to ESA requirements;
6. For overhead connections, install, own and maintain up to the top of the service entrance stack; and
7. For underground connections, install, own and maintain the load side of the Meter Socket.

Hydro One shall:

1. Maintain the portion of the secondary service that it owns (e.g. repair and like-for-like replacement of a wire or cable that has failed irreparably); and
2. Install, own and maintain the meter.

6.1.2 MULTI-POSITION (GANGED) METER SOCKET

When metering is required for a residential townhouse or condominium development, consisting of no more than six units, each building shall be permitted to use a CSA/ULC approved horizontal or vertical trough style Multi-Position (Ganged) Meter Sockets. It shall:

1. Be an approved 120/240V, 1-phase, 400A, Multi-Position (Ganged) Meter Sockets, consisting of a maximum of six approved Meter Sockets. As the Multi-Position (Ganged) Meter Sockets are Customer owned, it is the Customer's responsibility to supply them with a screw type sealing ring;
2. Be certified in accordance with CSA standard C22.2 No. 115, Meter Mounting Devices, and inspected by ESA for compliance to the OESC. For a list of Hydro One preferred Meter Sockets, see the [Approved Meter Socket Base List](#);
3. Have a separate supply cable termination compartment and shall not be altered to accept more meters than factory installed Meter Sockets;
4. Have a supply cable termination compartment that is lockable by Hydro One.
5. Have horizontal/vertical main bus bars (factory installed), equipped with ½ studs on the line side of the Multi-Position (Ganged) Meter Sockets that allows for the primary connections of compression type lugs in the metering enclosure;
6. Come with factory installed mechanical lugs for the load side conductors in the Multi-Position (Ganged) Meter Sockets. Hydro One shall supply and install compression lugs for the line side conductors;
7. Not be equipped with automatic by-pass or shorting devices;
8. Have unused positions covered with a Customer supplied UV rated Lexan or UV rated strong plastic cover and a steel sealing ring if service will eventually be reinstated. Each unused metering position shall not have load side conductors installed;

9. Be installed such that it satisfies the requirements of [Sub-Section 4.2.2 Meter Location](#), and grouped together as shown in **Figure 4: Multi-Position (Ganged) Meter Sockets**;
10. Accommodate underground or overhead services. Underground Multi-Position (Ganged) Meter Sockets shall be jumbo size. Refer to [Approved Meter Socket Base List](#) for available options; and
11. Have each unit number permanently and legibly marked on each Meter Socket, unit door or frame and unit service panel prior to installation of the meters by Hydro One as shown in **Figure 4: Multi-Position (Ganged) Meter Sockets**.

Note: A Meter Centre can be used for complex exceeding six units. Refer to [Sub-Section 6.1.3 Meter Centre](#) for more information.

6.1.2.1 RESPONSIBILITIES

The Customer shall:

1. Install, own, and maintain a CSA approved, low voltage, Multi-Position (Ganged) Meter Socket as per Hydro One's [Approved Meter Socket base List](#) and [Sub-Section 6.1.2 Multi-Position \(Ganged\) Meter Socket](#) requirements;
2. Be responsible for the installation, access, and on-going maintenance of the Multi-Position (Ganged) Meter Sockets;
3. Install, own, and maintain all wiring, equipment, and facilities on the load side of the meter;

Hydro One shall:

1. Maintain the portion of the secondary service that it owns (e.g. repair and like-for-like replacement of a wire or cable that has failed irreparably); and
2. Install, own and maintain the meter.

6.1.3 METER CENTRE

When metering is required for a development consisting of more than six units, the Customer shall supply a meter center on the load side of the disconnect/breaker supplying each individual unit, and be located either inside or outside, immediately adjacent to the Service Entrance main disconnect for the building. These meter centres shall be applicable for up to 200A per position, 120/240V, 120/208V and 347/600V services.

Metering for 347/600V, three phase four wire circuits with more than one metering point per service entrance may use self-contained metering up to 200A on the load side of the Customer's service entrance. Metering of any three phase secondary voltages other than those specified must be transformer-type metering.

For the metering in the meter centre:

1. The Customer shall supply and install an approved meter centre which is certified in accordance with CSA C22.2 No. 229 Switching and Metering Centres and is accepted by Hydro One;
2. The meter center shall be installed such that it satisfies the requirements of [Sub-Section 4.2.2 Meter Location](#), and grouped together as shown in **Figure 5: Meter Centre for 120/240V, 120/208V and 347/600V Services**;
3. It shall have following distance between adjacent Meter Socket rims along the vertical:
 - a. For 100A, 4-Jaw or 5-Jaw Meter Sockets, not less than 75mm;
 - b. For 100A, 7-Jaw Meter Sockets, not less than 150mm; and
 - c. For 200A, 4-Jaw, 5-Jaw or 7-Jaw Meter Sockets, not less than 150 mm;
4. The minimum horizontal distance between the adjacent meter and sockets shall be 152mm rim to rim;

Note: The Customer shall ensure that RF communication is not obstructed or there is a conduit available for placing antennas

5. Centre point of the upper most meters shall be at a height of $1.83\text{m} \pm 100\text{mm}$ from finished grade. Centre point of the lowest meters shall be at a height of a $600\text{mm} \pm 100\text{mm}$ from finished grade;
6. It shall have provision for screw type sealing rings;
7. It shall have meter jaw arrangements factory installed and not retrofitted to meet service requirements;
8. It shall have protection for meter mounting devices (i.e. the meter mounting device shall be protected by a rated circuit breaker having adequate short circuit interruption capacity);
9. It shall have an associated circuit breaker connected ahead of the meter mounting device with a provision for locking in an open position;
10. It shall have any surplus meter positions removed/disabled by the contractor with a manufacturer supplied blanking plate to cover the socket opening and breaker section, and meter positions that are required for future additional loads shall have a blank plastic Meter Mount Cover and a meter sealing ring installed;
11. It shall have each Customer suite address or suite number permanently and legibly marked on each Meter Socket prior to installation of the meters by Hydro One as shown in **Figure 5: Meter Centre for 120/240V, 120/208V and 347/600V Services**;
12. It shall have identification of individual service (i.e. each circuit breaker required for an individual service shall have a permanent Customer identification plate (metal or engraved plastic) which cannot be erased or obscured by paint); and
13. It shall be installed in accordance with this Guide's requirements, and meet OESC. **Figure 5: Meter Centre for 120/240V, 120/208V and 347/600V Services** depicts a typical layout of the meter centre.

If the meter centre is to be installed outside of the building, it shall be subject to all of the following:

14. Metering shall be installed inside a permanent weatherproof enclosure of the Customer's construction. It shall consist of a permanent roof and walls that meets the requirements of the Ontario Building Code, and shall be covered with brick, siding, or stucco. It shall provide secure access to the metering equipment contained inside, and shall be subject to acceptance of Hydro One Metering Services;
15. When the meters are located inside a weatherproof enclosure, it must be secure from the general public and accessible to Hydro One's employees, agents, and contractors at all hours, to permit meter readings, the changing of meters, and access to metering equipment, and must be locked. The access doors must be able to accommodate a standard Hydro One padlock; and
16. The weatherproof enclosure shall provide adequate mechanical protection for the equipment inside against damage not caused by ordinary wear and tear or acts of god (not including any of insect infestation, animals, or plant/tree growth).

As the meter centre shall be Customer owned, it is the Customer's responsibility to ensure it is inspected by ESA for compliance with the OESC and is acceptable to Hydro One prior to procurement and installation of the Meter Centre.

6.1.3.1 RESPONSIBILITIES

The Customer shall:

1. Install, own, and maintain a CSA approved, low voltage, socket type meter centre as per requirements in [Sub-Section 6.1.3 Meter Centre](#);
2. Install, own, and maintain all wiring, equipment, and facilities on the load side of the meter; and
3. Provide clear, permanent and unambiguous nomenclature to identify each meter, as per the requirements stated in this guide, and shall allow for verification that the labeling is correct prior to energization of a new connect.

Hydro One shall:

1. Install, own and maintain the meter.

6.1.4 METERING INSTALLATION ON A WOODEN POST

For single phase and three phase services, up to 200A, it may be preferable to install the metering equipment on a wooden post due to the nature of the service (e.g. parks, temporary installation, utilities, sports facilities, etc.), or due to the location not being suitable to install the metering equipment in a permanent building.

The preference for padmount metering shall be as per [Sub-Section 6.1.1 Individual Meter Socket](#). However, Customers have the choice of providing metering on a wooden post for padmount or polemount services on the line side of the disconnect subsequent to obtaining Hydro One's consent. When metering on a wooden post:

1. The Customer is to construct a wooden post from 6" x 6" x 10' preservative treated wood posts or equivalent. Posts shall not be nailed together as a permanent meter support structure;
2. The posts shall be set a minimum of 36" deep and tamped well with native backfill. Approval from Hydro One shall be obtained prior to commencing construction or buying materials or equipment;
3. The envelope shall be at least 10" in diameter;
4. The Meter Socket shall be installed using corrosion resistant bolts, nuts and washers. They shall be fastened with galvanized or stainless steel thru bolts (lag type bolts are not acceptable);
5. All metal components are to be bonded and connected to an approved ground as per OESC;
6. The Meter Socket shall have bottom knockouts and be certified in accordance with CSA standard C22.2 No. 115, Meter Mounting Devices. The Meter Socket shall be inspected by ESA for compliance to the OESC. For a list of Hydro One preferred Meter Sockets, see the [Approved Meter Socket Base List](#);
7. Meter Sockets with breakers are permissible. However, all repairs shall be the responsibility of the Customer and shall be performed to Hydro One satisfaction;

8. Meter wooden post shall be located within 10 feet of the transformer pad and it may be connected via #6 bare copper ground wire to the ground grid to the transformer pad or ground rod for polemount services; and
9. The installation in entirety shall be to Hydro One's satisfaction.

6.1.4.1 RESPONSIBILITIES

The Customer shall:

1. Install, own, and maintain a CSA approved, low voltage, Meter Socket;
2. Install, own, and maintain the wooden post as per the requirements stated in [Sub-Section 6.1.4 Metering Installation On a Wooden Post](#);
3. Install, own, and maintain the conduits to the Meter Socket on both the line and load side, as well as any other construction materials (e.g. clamps, etc.) to CSA standard in accordance with the OESC;
4. Install, own, and maintain all wiring on the load side of the meter; and
5. Install, own, and maintain grounding to OESC.

Hydro One shall:

1. Terminate the conductors to the Meter Socket on the line side, if conductors are owned by Hydro One; and
2. Install, own, and maintain the meter.

6.2 SINGLE PHASE & THREE PHASE TRANSFORMER-TYPE METERING

Any single or three phase services where the total connected load is, or is anticipated to be, in excess of 200A shall use Transformer-Type Metering. For typical installation arrangements, refer to division of Sub-Sections below based on type of service.

120/240V	1Ph, 3W	>200A – 800A >600A >200A - 400A	<u>Sub-Section 6.2.1: Instrument Transformer Enclosure</u> <u>Sub-Section 6.2.2 Central Metering</u> <u>Sub-Section 6.2.3: 400A Meter Base with Integrated CTs</u>
120/208V 277/480V 347/600V	3Ph, 4W	>200A – 1000A	<u>Sub-Section 6.2.1: Instrument Transformer Enclosure</u>
120/208V 277/480V 347/600V	3Ph, 4W	>200A – 3000A	<u>Sub-Section 6.2.5: Low Voltage Switchgear</u>

Customers requesting a secondary service shall contact Hydro One prior to commencing work or buying equipment. All secondary installations shall be reviewed and pre-approved by Hydro One prior to construction.

Note: Hydro One reserves the right to refuse to energize any installation if, in its judgment, the Customer’s Meter Installation does not meet Hydro One’s requirements stated herein

6.2.1 INSTRUMENT TRANSFORMER ENCLOSURE

This section shall focus on metering requirements when the Instrument Transformers are housed in a CSA approved or ULC listed NEMA Type 3R Instrument Transformer Enclosure in conjunction with a separate, Hydro One accepted enclosure for the meter.

6.2.1.1 CONSTRUCTION GUIDELINE

The Instrument Transformer Enclosure:

1. Shall be applicable for all loads over 200A, up to 1000A. For a service greater than 1000A or a service that requires a cable size larger than 750MCM with more than two runs, the instrument transformer must be installed in a switchgear;
2. Shall be applicable for 120/240V, single phase, 120/208V, 347/600V metering, three phase, four wire circuits with only one metering point per service entrance and maximum parallel runs of 750MCM;

3. Shall have a 19mm conduit from the Instrument Transformer Enclosure to the Meter Enclosure for single phase services or a 31mm conduit from the Instrument Transformer Enclosure to the Meter Enclosure for three phase services;
4. Shall be rated and installed to meet appropriate short circuit current rating;
5. Shall be located on the load side of the main disconnect inside a building and all Customer load shall be on the load side of the Instrument Transformer Enclosure and meter;
6. Shall not house any Customer owned equipment and power factor correction monitoring equipment;
7. Shall not use elbows with covers or pull boxes for conduits between the Instrument Transformer Enclosure and the Meter Enclosure;
8. Shall arrange and install Measurement Canada approved CTs and VTs such that most efficient use of space inside the enclosure is accomplished and meets Hydro One Distribution Standards;
9. Where located indoors, shall be in the same room as the main disconnect within a maximum distance of 3m;
10. Where located indoors or outdoors, shall be weatherproof, padlockable, and as close as practical to the Meter Enclosure. It must be within a maximum distance dependant on CT burden and wire gauge, as described in Appendix A (e.g. within a maximum distance of 30m for 12AWG conductors);
11. If using multiple conductors per phase through the donut CTs, all conductors requires phase tape to clearly mark them for traceability;
12. Shall have provision for terminating a bonding conductor, within the enclosure, by providing a ground bar suitable for #12 to #8AWG conductor;
13. Shall have entry and exit points 150mm from the sides, top and bottom, and shall be mounted with the bottom of the Instrument Transformer Enclosure 900 –

1000mm above grade from the bottom (See **Figure 6: Typical Entry and Exit Points for Instrument Transformer Enclosure**);

14. Shall have a neutral enter the Instrument Transformer Enclosure. If the neutral is to be terminated in the Instrument Transformer Enclosure, an insulated neutral block centered at the bottom of the Instrument Transformer Enclosure is required;
15. Shall contain a maximum of three conductors per phase for cable sizes up to and including 500MCM. For conductors between 500MCM and 750MCM, only two conductors per phase is allowable;
16. Shall contain bar type CTs for a maximum of two cables per phase and up to 500MCM conductor size. Donut and/or window type CTs shall be used when there are three conductors per phase and may be used on any size conductor up to 750MCM; and
17. Shall have dimensional requirements as shown below in **Table 6 | Instrument Transformer Enclosure Dimensions and Other Requirements**.

If the above cannot accommodate the load, then the Customer shall install switchgear type equipment.

In order to avoid an arc flash hazard, the meter shall not be housed in the same enclosure as the instrument transformers. Hydro One shall supply a Meter Enclosure and ancillary equipment to the Customer to house the meter. In conjunction, Customers shall supply and install a continuous conduit (i.e. without elbows with covers or pull boxes), between the Instrument Transformer Enclosure and the Meter Enclosure.

METER ENCLOSURE:

1. Shall be a Hydro One approved bottom entry polyphase enclosure complete with a removable back plate to house a transformer rated revenue meter and ancillary components;
2. Shall be CSA certified or UL/CUL listed as a Type 3R enclosure;

3. Shall have a 10-port copper ground bar (nickel plated) mounted on the interior side wall of the enclosure, below the back panel, and a TA 2/0 dual connector ground lug installed on the inside rear wall and below the back panel;
4. Shall be located indoor or outdoor as per [Sub-Section 4.2.2 Meter Locations](#) with unrestricted access to the location for Hydro One personnel;
5. Shall have a bottom connected A-base adapter with a 10 pole test switch and other ancillary components arranged and wired to Hydro One Distribution Standards; and
6. Shall be mounted such that it satisfies the requirements stated in [Sub-Section 4.2.2 Meter Location](#). Refer to [Sub-Section 4.2.3 Working Space](#) and [Sub-Section 4.2.4 Entrance To, or Exit From, Working Space](#) requirements for additional details.

Where there is a potential for backfeed energization from the load side of the instrument transformer enclosure, such as from a Distribution Generation:

1. A lockable disconnect shall be provided on the load side of the Instrument Transformer Enclosure;
2. The load side disconnect shall meet the same requirements as the line side main service disconnect;
3. A warning notice shall be installed in a conspicuous place near the Instrument Transformer enclosure; and
4. A permanent, legible, single line diagram shall be installed in a conspicuous place near the Instrument Transformer Enclosure.

6.2.1.2 RESPONSIBILITIES

The Customer shall:

1. Supply and install an Instrument Transformer Enclosure with minimum dimensions as required by Hydro One in accordance with [Sub-Section 6.2 Instrument Transformer Enclosure](#);

2. Supply and install all required conduit, as specified by Hydro One;
3. Supply and install a conduit between the Instrument Transformer Enclosure and the Meter Enclosure; and
4. Shall install a Meter Enclosure within 30m of the Instrument Transformer Enclosure. Refer to [Appendix A](#) for additional lengths in accordance with CT burdens for 12 AWG conductor;

Hydro One shall:

1. Supply Measurement Canada approved instrument transformers for revenue metering. Upon request, Hydro One will ship the instrument transformers to the electrical contractor;
2. Supply, own and maintain a Meter Enclosure;
3. Make the VT primary connections; and
4. Install, own, and maintain the test switch, meter, and all remaining secondary wiring and terminations.

6.2.2 CENTRAL METERING

Hydro One, at its discretion, will consider requests from Customers to supply Central Metering to two or more buildings for single phase, 120/240V or three phase 120/208V, overhead and underground service. It is a cost effective solution to meter two or more buildings, up to a maximum of four, belonging to one Customer. Any additional services must be connected downstream of the Central Metering point at a remote location or pony pole.

For all Central Metering, the Customer shall pay incremental cost of the Central Metering above the cost of a single standard secondary metering installation. In addition, the Customer shall comply strictly with the OESC and Hydro One's Distribution Standards and ensures that they have an appropriately sized main disconnect and equipment for each service connected to the Central Metering

6.2.2.1 POLEMOUNTED CENTRAL METERING

Pole-mounted Central Metering will be permitted for single or three phase, 120/240V or 120/208V Transformer-Type Metering up to 600 amperes, where all Central Metering equipment will typically be located on a Customer owned pole ahead of the Customer owned disconnect switch. Customers are to supply and install CSA approved, or equivalent, Meter Socket to the requirements of Hydro One and the OESC. Refer to [Approved Meter Base List](#) for preferred Meter Socket for this application.

In addition, all single phase, 120/240V, pole-mounted Central Metering installation, shall use one CT arrangement (as shown in **Figure 7: Pole-mount, 120/240V, Central Metering**). However, a two CT arrangement may be practical if CT diameter is not sufficient to carry all primary conductors.

Note: Hydro One shall install a #10AWG green conductor, bonded to the down ground at the stack near the CT at the time of connection. Electrical Contractors shall not use copper ground wire to bond the Meter Socket on a pole.

6.2.2.2 PAD-MOUNTED CENTRAL METERING

At Hydro One's discretion, a Customer may install wooden post metering for single phase, 120/240V, padmount Central Metering, as long as the combined total rating does not exceed 600A and the service does not exceed 150V line to ground.

The padmount Central Metering shall consist of:

1. A wooden post which is 6" x 6" of treated lumber with a minimum length of 10' (See **Figure 8: Pad-mounted Central Metering**).
2. A Form 3S Meter Socket installed on the wooden post. This Meter Socket shall be 20A transformer rated with a 4 pole test switch and accepted by Hydro One prior to procurement. In addition, it shall have provisions for a padlock and a screw type sealing ring. Refer to the [Approved Meter Socket Base List](#) for a list of accepted Meter Socket manufacturers.

3. In addition, a PVC conduit from the vault to the Meter Socket shall be installed, using clamps to the wooden post, to carry the secondary conductor from the CTs to the line side lugs of the test switch in the Meter Socket. All construction shall use CSA approved materials.

Note: A commercial Meter Pedestal may be allowed upon Hydro One's discretion. It is the Customer's responsibility to obtain Hydro One's approval prior to procurement and installation.

6.2.2.3 RESPONSIBILITIES

The Customer shall:

1. For pole-mounted Central Metering, supply and install the Meter Sockets, masts, entrance conduits and Central Metering pole in conformance with OESC;
2. Supply and install all wiring, equipment, and facilities on the load side of the meter;

Note: Does not apply to 400A Meter Base and Instrument Transformer Enclosures

3. For pad-mounted Central Metering, install, own, and maintain a CSA approved, low voltage, socket type Meter Socket with test switch on a wooden post;
4. For pad-mounted Central Metering, supply and install conduits to the Meter Socket in conformance to OESC;
5. Install wooden post connection to the vault's ground grid in conformance with OESC; and
6. Pay the difference between Central Metering and the meter that Hydro One would have provided to the Customer under the Standard Supply Code where applicable, pay for labour and material costs as follows:
7. To convert an existing service under 45 kW, Customers will pay labour and incremental material costs;
8. To convert an existing service over 45 kW, Customers will pay labour costs only;

9. For new service under 45 kW, Customers will pay for incremental material costs;
10. For new service over 45 kW, Customers are not required to pay for labour or material.

Hydro One shall:

1. For pad-mounted Central Metering, supply and install electrical service up to and including the padmount transformer or wooden post.
2. Supply wire harness and CTs and install pole-mounted or pad-mounted Central Metering as per Hydro One Distribution Standards, including #10AWG green conductor to ground the Meter Socket; and
3. Install, own, and maintain the meter;

6.2.3 400A METER BASE WITH INTEGRATED CTs

6.2.3.1 CONSTRUCTION GUIDELINES

A general service single phase transformer type meter installation at 120/240V, where the rating of the Customer's main disconnecting device ranges from greater than 200A up to 400A, must be provided with an outdoor 120/240V, 20A, 5-Jaw Meter Socket assembly with integrated CTs with 4 pole test switch on the line side of the main disconnecting device. Acceptable Meter Sockets by Hydro One, for both underground and overhead applications, are listed in the [Approved Meter Socket Base List](#). Refer to **Figure 9: 400A Meter Base Socket with Test switch** of a 400A Meter Base with Integrated CTs.

6.2.3.2 RESPONSIBILITIES

The Customer shall:

1. Supply a Hydro One accepted 240V, 1 Phase, Form 3S (5 Jaw), up to 400A rated outdoor Meter Socket assembly with integrated CT in a location acceptable per Hydro One's Distribution Standards and the OESC; and
2. Own and install a 400A Meter Base on the wall as per the requirements stated in [Sub-Section 4.2.2 Meter Location](#).

Hydro One shall:

1. Supply, install, and connect the CT required for the 400A Meter Base. The CT installation will be completed by Hydro One on or before the date of connection; and
2. Supply and install the meter.

6.2.4 LOW VOLTAGE SWITCHGEAR

This section includes materials and installation requirements for secondary voltage, three phase, switchgear assembly for metering loads greater than 200A up to 3000A. As the switchgear assembly is Customer's responsibility, Customer shall ensure Metering Compartment is inspected and acceptable to Hydro One prior to procurement and installation of the switchgear assembly. This will avoid expensive alterations to equipment already built.

6.2.4.1 CONSTRUCTION GUIDELINES

Customer owned secondary switchgear should meet the aforementioned requirements in this Guide, in addition to the following. The switchgear:

1. Shall have a lockable Metering Compartment for instrument transformers within the switchgear. This Metering Compartment should be permanently identified "For Supply Authority Use Only";
2. Shall have a Metering Compartment which has a vertically hinged access door to the instrument transformers/Metering Compartment on the load side, and immediately adjacent to the switchgear main disconnect Compartment;
3. Shall have Metering Compartment for the exclusive use of Hydro One personnel only. It should not be used for any other purposes, including but not limited to, protection and control purposes, monitoring, data collection etc. It shall be dedicated to the use and purpose of revenue metering only. Refer to **Figure 10: Typical Low Voltage Switchgear Layout**;
4. Shall have Metering Compartment that meets CSA standards C22.2 No. 31 Switchgear Assemblies and C22.2 No. 244 Switchboards;

5. Shall have a fuse block on the load side of the VTs in the same Metering Compartment;
6. Shall be segregated (i.e. separate compartments or fibreboard or equivalent) off from other compartments and only have metering equipment or wiring;
7. Shall have provision for terminating a bonding conductor, within the compartment, with a mechanical connector suitable for a #12 to #18 AWG conductor;
8. Shall have provision for grounding #10AWG conductor;
9. Shall not have any Customer owned loads connected ahead of the metering equipment with the exception of firepump;
10. Shall have provisions for three CTs and up to four VTs and four fuses, if required in the same Metering Compartment, and accommodate Hydro One accepted instrument transformers thus, ensuring that the holes in the bus bar align with instrument transformer brackets hole;
11. If using multiple conductors per phase through the donut CTs, all conductors requires phase tape to clearly mark them for traceability;
12. Shall have CTs and VTs approximately 600 to 1800mm above the floor level;
13. Shall have mounting bolts or studs for support of the base of the instrument transformers installed in a manner which shall permit complete installation and/or removal of the instrument transformers from within the Metering Compartment in which they are installed;
14. Shall have bus sectionalized for window/donut type CT installation. The removable bus links through the CTs should be bolted in the vertical bus section directly above and below the CTs. When three window type CTs are used, for 3-Element metering, they may be mounted in a staggered arrangement;
15. Shall have bus connections drilled and tapped within the Metering Compartment of the switchgear maintained in accordance with the following **Table 7 I**

Minimum Spacing Requirements for Bus Bars in Metering Compartments of Low Voltage Switchgears below and foot note;

16. Shall be supplied and installed with an approved Meter Enclosure supplied by Hydro One. It shall be in an approved location, separate from the Switchgear assembly. The Customer shall supply and install a continuous run of conduit to house the secondary metering conductors connecting the Metering Compartment and the meter location in the electrical room;
17. Shall have 19mm conduit for single phase application and 31mm conduit for three phase application to run secondary conductor from the metering compartment to the Meter Enclosure;
18. Shall be provided with a Meter Enclosure that meet requirements of [Sub-Section 6.2.1.1 Meter Enclosure](#);
19. Shall provide accessibility to Metering Compartment and Meter Enclosure for Hydro One personnel to safely maintain the metering equipment as per [Sub-Section 4.2.3 Working Space](#) and [Sub-Section 4.2.4 Entrance to, or Exit from, Working Space](#); and
20. Shall have instrument transformers with the primary polarity mark toward the source of supply and VTs shall be connected to the bus work on the line side of the CTs.

For Embedded Generators Connections Only:

Where there is a potential for backfeed energization from the load side of the instrument transformer compartment:

1. A lockable disconnect shall be provided on the load side of the instrument transformer compartment;
2. The load side disconnect device shall meet the same requirements as the line side main service box;

3. A warning notice shall be installed in a conspicuous place near the instrument transformer compartment; and
4. A permanent legible single line diagram shall be installed in a conspicuous place near the instrument transformer compartment.

6.2.4.2 RESPONSIBILITIES

The Customer shall:

1. Supply and install a switchgear with an instrument transformer Compartment;
2. Securely mount CTs in the instrument transformer compartment;
3. Make all connections to the CT primaries;
4. Supply and install a conduit between the Metering Compartment and the Meter Enclosure; and
5. Install a Meter Enclosure provided by Hydro One in a location agreed upon by Hydro One personnel. Refer to [Appendix A](#) for additional lengths in accordance with CT burden for 12AWG conductor.

Hydro One shall:

1. Supply a Meter Enclosure as per Sub-Section 6.2.1 Instrument Transformer Enclosure; and
2. Supply Measurement Canada approved instrument transformers for revenue metering. Upon request, Hydro One will ship the instrument transformers to the electrical contractor;
3. Supply, own and maintain a Meter Enclosure; and
4. Make the VT primary connections and install, own, and maintain the test switch, meter, and all remaining secondary wiring and terminations.

6.2.5 UNIT SMART METERING

In March 2006, the Ontario Government passed Bill 21, the Energy Conservation Responsibility Act, which enables implementation of the smart metering initiative in Ontario homes and small businesses. As part of the review of its energy policies, the government implemented additional measures to enable installation of smart meters in condominiums. Thus, under the Distribution System Code 5.1.9, Hydro One shall install unit smart meters that meet the specifications stated by Ontario Regulation 389/10 to all multi-unit complexes when it is requested. This may include metering after second stage of transformation.

To allow Hydro One to meter individual units downstream of Customer owned dry core transformation:

1. The installation shall use conventional ANSI style meters installed in Meter Centres and abide by Hydro One Distribution Standards and the Guide;
2. The existing rate structure shall be sufficient for this installation and a transformer loss adjustment factor will not be taken into account;
3. A CSA approved transformer that meets the efficiency standard of CSA C802.1 shall be installed by the Customer and approved by ESA. The Customer will not be entitled to a Customer supplied transformation allowance;
4. Hydro One shall not provide unit sub-metering service for the Customer (i.e. meters in-line with a bulk meter and a breakdown of costs/metering for individual units). Customers may be required to hire a unit sub-metering contractor to provide this service; and
5. A review of a single line diagram by Hydro One may be required to ensure this option is the best solution for the Customer and Hydro One. A second supply of the desired voltage to the Customer may be appropriate.

6.2.6 NEUTRAL GROUNDING RESISTOR

Customers wishing to install or remove Neutral Ground Resistors (NGR) on the secondary side of the customer owned service transformer must obtain Hydro One's permission before proceeding, including obtaining approval for the metering configuration.

Customers will cover all costs associated with ensuring that metering complies with Hydro One Distribution Standards.

7 DISTRIBUTED GENERATION

7.1 GENERAL REQUIREMENTS

This section defines requirements for existing and new load Customers or generators, connected to Hydro One's distribution system, who has installed, plan to install, or are looking to modify embedded generation (EG). In particular, this section applies to the following types of generation:

1. Net Metering
2. IESO Contracted Generators
 - a. MicroFIT
 - b. FIT
3. Emergency Back Up
4. Load Displacement
5. Energy Storage Facilities

7.1.1 GOVERNING PRINCIPLES

1. Hydro One Networks Inc. shall comply with the conditions outlined in its Ontario Energy Board (OEB) Distribution License, and all regulatory and legal obligations.
2. Hydro One's requirements for embedded generation shall:
 - a. Minimize the risk of injury to the public and Hydro One employees;
 - b. Conform to applicable Market Rules and Distribution System Code requirements;
 - c. Comply with Measurement Canada, ANSI and Electrical Safety Authority requirements;

- d. Be cost effective to minimize barriers for embedded generation;
- e. Support Hydro One's meter reading and settlement requirements; and
- f. Be interoperable with Hydro One's Advanced Metering Infrastructure technology

7.1.2 RULES & REGULATIONS

1. These Embedded Generators shall obtain ESA approval of their installation. They shall provide free of charge or rent a suitable, easily accessible, and safe on premise space for revenue meters and other associated equipment such as wires, poles, cables, and transformer service equipment to be owned by Hydro One. This location shall be approved by Hydro one and comply with standards established in the OESC and the Ontario Building Code ([Sub-Section 4.2.2 Meter Location](#)).
2. An Embedded Generator shall, on being given reasonable notice, provide Hydro One personnel with access to the Customer's premise for the purpose of reading, inspecting, repairing, replacing, testing or removing equipment owned by Hydro One.
3. The location of revenue meters and the location of instrument transformer(s), if applicable, are subject to Hydro One's approval. Where practical, a dual meter base will be used to locate a new revenue meter for generation next to the existing load meter. Otherwise, the new metering for the generator will be located as close as possible to the existing load meter.
4. Embedded Generation shall be installed at the Point of Common Coupling (PCC), and no more than 30m away from PCC unless deemed impractical by Hydro One, and if it is not installed at the PCC, Hydro One shall apply loss factors to the output of the Embedded Generation facility in accordance with the OEB approved loss factors applied for retail settlements and billing.
5. Unlike load Customers, the Embedded Generator shall install Meter Installation in accordance with the requirements of the Distribution System Code, Technical Interconnection Requirements, Conditions of Service, Hydro One Distribution Standards and this Guide. Prior to installation, the Embedded Generator shall

provide Hydro One with the technical details of the Meter Installation for Hydro One's approval. All costs associated with the new or modified metering are the responsibility of the Embedded Generator.

6. An Embedded Generator, excluding Micro Generators, shall provide Hydro One with a copy of the final single line diagram showing revenue metering connections in the format specified by Hydro One; and if Hydro One deems that losses are material, a loss calculation must be supplied by the generator in the format specified by Hydro One so that losses may be applied to the generation output. The single line diagram and the loss calculation if required must be signed and stamped by a Professional Engineer registered in the Province of Ontario.
7. Hydro One and the Customer shall install only Measurement Canada approved revenue meters and associated instrument transformers. Where an existing Embedded Generator's meter does not conform to Measurement Canada requirements or the accuracy class of instrument transformers cannot be confirmed, the Embedded Generator must have the Meter Installation tested and apply a Measurement Canada correction factor to meter readings until such time conformity to the standards is achieved. If pursuing an IESO contract, the Generator will upgrade metering to current Hydro One Distribution Standards within a time period acceptable to Hydro One.
8. Where an existing Embedded Generator has non-standard voltage on the secondary side of the transformer and is metered at the secondary voltage, or the existing Meter Installation does not comply with Hydro One Distribution Standards, the Embedded Generator will own and maintain the metering, including the Communication Line, per Measurement Canada requirements. If pursuing an IESO contract, the Embedded Generator will update metering to Hydro One Distribution Standards within a time period acceptable to Hydro One. Refer to [Section 5 Primary Metering](#) and [Section 6 Secondary Metering](#) for various Hydro One approved Meter Installations.
9. When Hydro One has agreed to allow separate metering for station service, the metering must meet all Hydro One metering requirements, including Hydro One's

retail revenue metering standards, communication requirements and location requirements.

10. An Embedded Generator that receives energy (including for station use or back-up supply) will be placed in the appropriate Rate classification and billed for the energy consumed.
11. In all cases where the Embedded Generator is responsible for any Meter Installation, the generator is also responsible for the quality of the equipment and installation, including all work and materials related to the Meter Installation.
12. Deficiencies in any Meter Installation that require remediation, as determined by Hydro One, will be corrected by Hydro One at the cost of the Embedded Generator, including, but not limited to, replacement costs and labour. The Embedded Generator shall be responsible to Hydro One for Meter Installation deficiencies for a period of two (2) years after Hydro One becomes the owner of the Meter Installation.
13. Where the existing Meter Installation for an Embedded Generation Facility was installed prior to July 14, 2000, the Embedded Generator shall upgrade the Meter Installation to be in accordance with Hydro One's standard metering requirements and Hydro One's policy directive for Embedded Generation Facility metering by no later than the meter seal expiry date. All costs associated with metering are the responsibility of the Embedded Generator.
14. If multiple generators are connected at the DG Facility, one disconnect switch shall be capable of isolating all the generators simultaneously. The disconnect shall be visible i.e. have contact operation verifiable by direct visible means
15. Any Customer with an Embedded Generation Facility that sells energy and settles through Hydro One's retail settlement system will responsible for all costs for Hydro One to provide and install metering as per **Table 7: Metering Requirements – Embedded Generation Facilities including Net Metering** below and for the costs to have a Communication Line installed if required, unless the Embedded Generator makes other arrangements for the Meter Installation that are acceptable

to Hydro One and provides Hydro One with the technical details of their Meter Installation.

16. The Embedded Generator metering will conform to current Hydro One Distribution Standards at the time of construction and Hydro One will subsequently own and maintain the metering and the communication line. For an existing Meter Installation on the meter's seal expiry date, unless an earlier transfer date is established by Hydro One, the Embedded Generator shall be responsible for all costs for Hydro One to provide and install metering as per **Table 7: Metering Requirements – Embedded Generation Facilities including Net Metering** below for Embedded Generators to replace the existing metering per current Hydro One Distribution Standards.

7.2 NET METERING

Subject to the requirements outlined in the latest revision of the Distribution System Code, Ontario Regulation 541/05, and the latest revision of Hydro One's Conditions of Service, Hydro One shall offer net metering to eligible Customers on a first come, first served basis.

Hydro One shall apply the [Sub-Section 7.1.2 Rules and Regulations](#) in conjunction with one of the following specifications to net metering eligible load Customers installing embedded generation stand alone or in parallel with MicroFIT:

1. [Section 5: Primary Metering](#)
2. [Sub-Section 6.1: Secondary, Single & Three Phase Self-Contained Metering \(Up to 10kW\)](#)
3. [Sub-Section 6.2: Secondary, Single & Three Phase Transformer-Type Metering \(Above 10kW up to 500kW\)](#)

In addition, Hydro One shall install a meter as noted in **Table 7: Metering Requirements – Embedded Generation Facilities including Net Metering** below and the communication line, if required, at no charge to the Customer. The Customer may be responsible for any other costs incurred in order to connect the generator.

The following figure demonstrates a typical Embedded Generation Facilities Meter Installation and is intended to show the location of the metering relative to the Customer Load and the generator. These are not a complete list of all possible Meter Installations but represent a typical Meter Installation.

Figure 11: Metering Arrangement for an Embedded Generator - Net Metering is intended to show the location of the metering relative to the Customer Load and the generator. The generation facility must follow the technical requirements contained in the Technical Interconnection Requirements for Distributed Generation, Micro Generation & Small Generation, 3-phase, less than 30 kW DT-10-20 or the Distributed Generation Technical Interconnection Requirements, Interconnection at Voltages 50 kV and Below DT-10-015 as applicable.

7.3 IESO CONTRACTED GENERATORS

Hydro One may offer a MicroFIT or FIT option for load Customers installing Embedded Generation, provided the generators meets criteria set out in the Conditions of Service. All projects under the MicroFIT/FIT are eligible to be connected through any one of the two options:

1. Direct Connection
2. Indirect Parallel

In a direct connection, the Embedded Generator is directly connected to the grid or to the existing point of connection of the load service, if any, and not connected to an existing electricity supply. Metering shall be on the secondary side of the transformer, if transformation is involved, and transformation loss will be applied in accordance with Retail Settlement Code for settlement of generation. **Refer to Figure 12: Metering Arrangement for Directly Connected Embedded Retail Generators**

In the indirect parallel connection, the Embedded Generator is connected to an existing transformer installation where, metering of Embedded Generator shall be independent of metering load services and emergency services. Refer to **Figure 13: Metering Arrangement for Indirectly (Parallel) Connected Embedded Retail**

Generators. Therefore, indirect parallel connection of Embedded Generator requires to be connected as follows:

1. On the line side of the meter, if only one meter is available for load service metering;
2. On the line side of the main disconnect switch, if more than one meter is available, for load service metering; or
3. On the secondary side of the transformer, where transformation is involved and the existing primary metering of load service is changed to secondary meter as well.

Hydro One shall witness the commissioning and testing of the connection of generation facilities greater than 10kW to its distribution system. The Customer shall obtain written approval from Hydro One with respect to technical details of the Meter Installation. Alternatively, a Customer may request Hydro One to provide an estimate to install the required meter and have the meters installed by Hydro One.

To accomplish this, the design of the metering equipment used at or for the connection of the Embedded Generator facility must meet specific minimum requirements as stated in this Guide and the Hydro One Distribution Standards. A generation load meter shall be installed beside the existing load meter, provided the location is agreeable to Hydro One (i.e. exterior of the building or in approved meter location such as meter room), accessible, and no more than 30m from the Hydro One demarcation point.

Note: The existing rules from the Conditions of Service apply when a MicroFIT generator is requesting connection at a central meter location. The maximum number of services to be connected at a Central Metering location is four. The generator is considered a service connection.

Depending on the capacity and electrical characteristics of the connecting Embedded Generator facility, specific additions and/or modifications may be required to Hydro One's existing metering equipment to facilitate the connection. Where reverse power flow is possible, all existing voltage regulating and metering devices shall be made suitable for bi-directional flow. The Embedded Generator shall provide the proposed design of all

metering equipment used at the Embedded Generator facility to Hydro One for review, as metering requirements vary with the type and intent of the Embedded Generator facility.

In addition, Hydro One shall apply [Sub-Section 7.1.2 Rules and Regulations](#) in conjunction with **Table 7: Metering Requirements – Embedded Generation Facilities including Net Metering** below and one of the following specifications to IESO contractor generators eligible load Customers:

1. [Section 5: Primary Metering](#)
2. [Sub-Section 6.1: Secondary, Single & Three Phase Self-Contained Metering \(Up to 10kW\)](#)
3. [Sub-Section 6.2: Secondary, Single & Three Phase Transformer-Type Metering \(Above 10kW\)](#)

This drawing is intended to show the location of the metering relative to the Customer Load and the generator. Metering may be installed as primary metered or secondary metered. The Embedded Generation Facility must follow the technical requirements contained in the Technical Interconnection Requirements for Distributed Generation, Micro Generation & Small Generation, Three phase, less than 30 kW DT-10-20 or the Distributed Generation Technical Interconnection Requirements, Interconnection at Voltages 50 kV and Below DT-10-015 as applicable.

Embedded Generator metering must be implemented using Hydro One meters approved by Measurement Canada. The Embedded retail Generator will be responsible for all costs to supply and install metering. See **Table 7: Metering Requirements – Embedded Generators including Net Metering**. When the meter is not installed at the point of supply, loss factors will be applied to the generation output for retail settlements and billing.

This drawing is intended to show the location of the metering relative to the Customer Load and the generator. The Embedded Generation Facility must follow the technical requirements contained in the Technical Interconnection Requirements for Distributed Generation, Micro Generation & Small Generation, Three phase, less than 30 kW DT-10-

20 or the Distributed Generation Technical Interconnection Requirements, Interconnection at Voltages 50 kV and Below DT-10-015 as applicable.

Embedded Generator metering must be implemented using Hydro One meters approved by Measurement Canada. The Embedded retail Generator will be responsible for all costs to supply and install metering as per See **Table 7: Metering Requirements – Embedded Generators including Net Metering** for Embedded Generators. When the meter is not installed at the point of supply, loss factors will be applied to the generation output for retail settlements and billing.

7.4 EMERGENCY BACK UP GENERATION

Hydro One customers are allowed to purchase a portable emergency backup generators. These generators must be installed on the load side of the Hydro One metering point. For portable emergency backup generation, residential Customers can install a Hydro One approved Meter Socket plug-in transfer device onto a 200A, 4-jaw Meter Socket that is installed outdoors. All installations must meet Hydro One approval requirements and will only be considered for residential Customers with 120/240V, single-phase and up to 200A service.

In addition, Customers can install a Hydro One approved permanently affixed Automatic Transfer Switch or Meter Base with disconnect. These installations must meet Hydro One Distribution Standards and will only be considered for Customers with 120/240V, single-phase services up to 600A.

Customers shall contact Hydro One prior to commencing work or buying equipment, to ensure the installation in its entirety shall be built in accordance to Hydro One Distribution Standards. Following a Hydro One field visit at the Customer's residence to determine the feasibility of the installation, the Customer will be advised whether to proceed to make arrangements to have the applicable back up generation equipment installed by an electrical contractor that is licensed by the ESA. In addition, at the time of installation, a service disconnection/reconnection and breaking/resealing of the revenue meter will be required and shall be performed by Hydro One. The Customer shall enter into a connection agreement and pay for associated Hydro One costs.

Note: The installation of a Meter Socket plug-in transfer device is not permitted where a Customer location has a distributed generation installation (i.e. Micro Feed-in Tariff, Feed-in Tariff, Net Metering, Load Displacement, and Renewable Energy Standard Offer Program).

7.5 LOAD DISPLACEMENT REQUIREMENTS

In Load Displacement, the output of the generation facility is used or intended to be used exclusively for the customer's own consumption. The existing load service remains the same and depending on the system, the existing load meter may be used or be replaced with a bidirectional revenue meter. No credit is issued for generation and the Embedded Generator shall ensure that the generation output does not back feed onto the Distribution System.

A meter replacement shall not be required for any existing load meter for all Load Displacement Embedded Generators greater than 10kW and less than 500kW. However, all Load Displacement Embedded Generators, greater than 500kW, shall require a bi-directional 4-Quad Ion meter at PCC.

In addition, Gross Load Billing (GLB) applies to Load Displacement Generation Facilities operated in parallel with or in isolation from the Hydro One Distribution System, if they meet the criteria outlined in Conditions of Service, Section 2.4.5. Gross Load Billing Customers with a rated capacity less than 20 MW must have a retail point-to-point meter installed at the generator terminal. Hydro One will provide the meter as well as the telecommunication connection. Where possible, Hydro One will own and maintain the meter and will add an additional meter charge to the Sub-Transmission settlement. If the meter requires a dedicated phone line for communication purposes, Hydro One will pay the monthly communication bill.

7.6 ENERGY STORAGE FACILITIES

Customers with an Energy Storage Facility, whether it is portable or permanently affixed, shall comply with the requirements of the Technical Interconnection Requirements and all of the applicable criteria of the Electrical Safety Code. Furthermore, the Customer is

responsible for complying with all Applicable Laws in respect of the Energy Storage Facility, including, all applicable environmental requirements. Customers with permanently affixed Energy Storage Facilities shall notify Hydro One regarding the presence of such equipment and shall enter into a DCA with Hydro One.

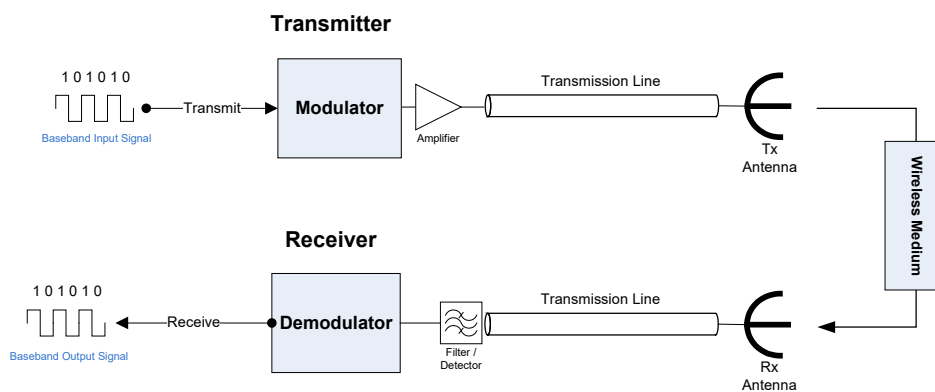
8 APPENDIX A: COMMUNICATIONS

8.1 OVERVIEW

An important part of metering is collecting the data into billing systems. In today's era, that is typically accomplished via radio frequency (RF) communication. Using RF systems, metering data can be gathered in real-time, without requiring visits from field staff. RF installations are also typically significantly cheaper and easier than the phone line installations that would have been required prior to wide-spread implementation of these systems.

As these RF communication systems are relatively new to metering, the intent of the section is to provide background information and best practices related to the set up and installation of these systems.

There are a number of factors that impact whether an RF system will communicate successfully, allowing the data to be passed into the data repository for further processing like billing, outage management, power quality, etc. These factors can either improve the signal (referred to as a gain) or decrease it (referred to as a loss). Collectively, these factors are referred as a Link Budget. The Figure below shows an overview of these factors, and in general terms, they are:



Transmitter Power: the amount of power that the radio transmitting the signal puts out. A more powerful radio means the entire system is starting with a stronger signal, and

can handle more losses in the downstream components before the signal becomes unusable.

Transmitter and Receiver Losses: the losses inherent in the system connecting the transmitting and receiving radios to the wireless medium that the signal will be transmitted across. Any cabling and connections in the system will cause the signal to degrade slightly, decreasing what is available to broadcast onto the wireless medium, or to feed into the radio for processing, respectively.

Transmitting and Receiving Antennas: the gains or losses created by the focusing effects of the antennas in the transmitting and receiving systems. Antennas focus the signal into specific areas, similar to a mirror placed behind a light, creating areas of stronger and weaker signal. Typically a system would be designed such that the antennas are in areas of gains with respect to each other.

Path Losses: The loss in signal as it spreads out through space in transit to the receiving system and interacts with any obstructions in the path. These losses account for the majority of losses between the two systems, and are what must be compensated for in the other components.

Receiver Sensitivity: the pair to the transmitter power, it is the threshold of signal that the receiving radio needs to pick up to be able to use the signal effectively. A more sensitive radio is able to pick a weaker signal out of the background noise it is hearing.

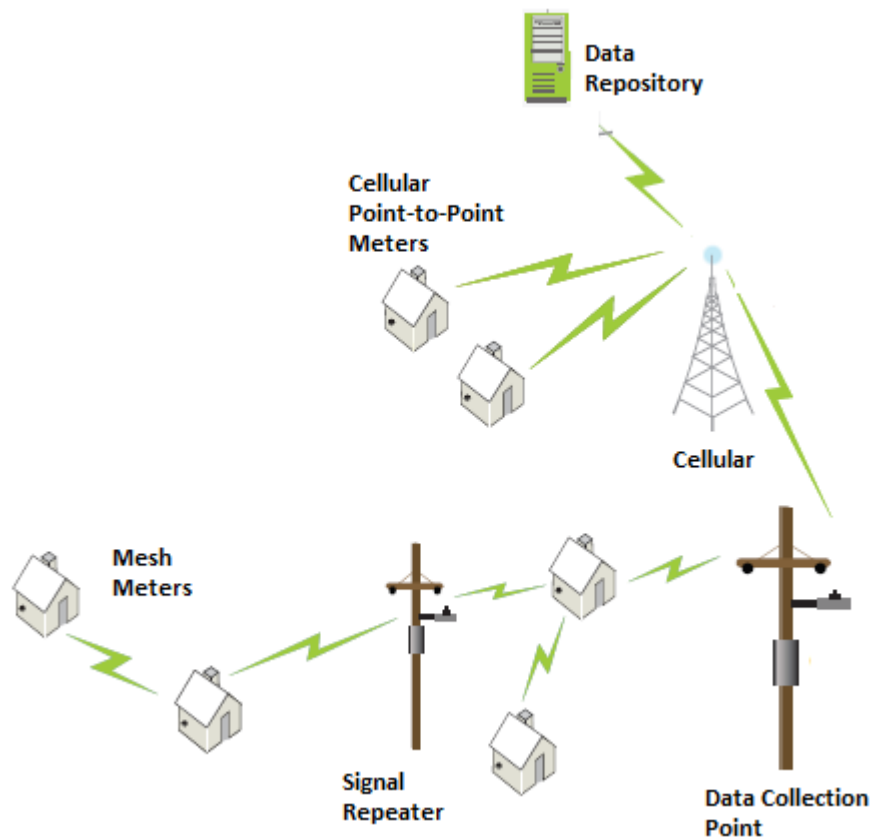
It's important to note that none of these factors are all or nothing. Because they all have an impact, if one portion is particularly strong, it can compensate for other weak parts. As such, when installing or configuring a system, it is possible to do something incorrectly but still have the system work. Nonetheless, it is important to install components correctly, so that if the factors outside the installer's control are weak, it will still have the best possible chance of being successful.

Because the above factors typically have multiplicative impacts on the power in the system, a decibel scale is frequently used to measure power. Hydro One primarily refers to dBm – decibels relative to a milliwatt. However, decibels relative to a watt (dBW) is

also occasionally used by other parties. The conversion table below shows the comparisons between these units for some commonly seen values.

W	dBm	dBW
1 kW	60	30
5 W	37	7
1 W	30	0
250 mW	24	-6
1 mW	0	-30
10 nW	-50	-80
1 pW	-90	-120

For its metering installations, Hydro One has options for either mesh or point-to-point RF systems, as shown in the figure below.



In a mesh system, many nodes communicate with one-another, dynamically forming paths to send data through multiple nodes back to a central take-out point. As such, for a

metering installation to use this system, available signal from other nearby nodes is required.

In a point-to-point system, the node communicates directly with a single base station, typically a cell tower. For this system, an available signal from the relevant base station is required.

Note that both options may not be available for all metering applications. Where possible, a mesh system is preferred.

8.2 FREQUENCY

Much of the physical behavior of radio waves is dictated by the wavelength of the waves. The table below gives the approximate wavelength for the frequencies in use by Hydro One.

Frequency	Use	~Wavelength (cm)
2.4 GHz	Mesh	12.5
900 MHz	Mesh	33.3
1.9 GHz	HSPA	15.75
850 MHz	HSPA	35.25
2.1 GHz	LTE	14.25
750 MHz	LTE	40
400 MHz	400MHz	75

Lower frequency/longer wavelength waves generally offer lower losses and better penetration for our use, and can therefore reach locations that higher frequencies cannot. However, higher frequencies allow greater data speeds, typically have less background noise, and require smaller antennas/ground planes, making them more convenient where both are available.

Many frequency bands require a license for operation. The 2.4 GHz band, also called the ISM band, is an exception, as it is set aside for free Industrial, Scientific and Medical use, and therefore does not require licensing. The 900 MHz band is also set aside as

free-use. However, both of these bands have specific requirements (power output, etc.) of their users to attempt to minimize interference from multiple users.

The cellular (HSPA/LTE) bands are licensed, but do not require a license by the end user. This is because the cellular providers obtain a license for the band, and the end-users are covered under this license. They are thus bound by the requirements (including fees) set forth by the provider.

The 400 MHz band requires specific licenses from Industry Canada, which are obtained by Hydro One prior to any deployment using this frequency.

8.3 SIGNAL STRENGTH/QUALITY

The usability of the signal that arrives at the receiving radio is measured in both signal strength and signal quality. Signal strength refers to how much power is in the signal that arrives, while quality refers to how that compares to the power of all the background or non-signal noise that is also heard.

Lower background noise makes it easier for the receiving radio to pick out the signal, and therefore allows the system to communicate successfully with lower signal strengths. As such, both values must be considered when evaluating a system.

In Hydro One's mesh systems, and in HSPA cell systems, the Signal Strength is measured by the value RSSI, and the Signal Quality is measured by E_c/I_o . In an LTE cell system, these values are measured by RSRP and RSRQ respectively.

The table below categorizes the relative quality of different values for these measurements. Hydro One requires a system to be "good" or "excellent" to be considered acceptable. A "fair" value may work occasionally, but is not considered to be reliable enough to meet the needs of the meter billing systems, as defined by the OEB.

RSSI	Signal Strength
-79 dBm	Excellent
-80 dBm to -89 dBm	Good
-90 dBm to -100 dBm	Fair
< -100 dBm	Poor
-110 dBm	No Signal

EC/IO	Signal Quality
0 to -6	Excellent
-7 to -10	Good
-11 to 15	Fair
< -15	Poor

RSRP	Signal Strength
-95 dBm	Excellent
-96 dBm to -107 dBm	Good
-108 dBm to -118 dBm	Fair
-119 dBm to -125 dBm	Poor
<-125 dBm	Unusable/No Signal

RSRQ	Signal Quality
>-9 dB	Excellent
-9 dB to -13 dB	Good
-14 dB to -20 dB	Fair
<-25 dB	Poor

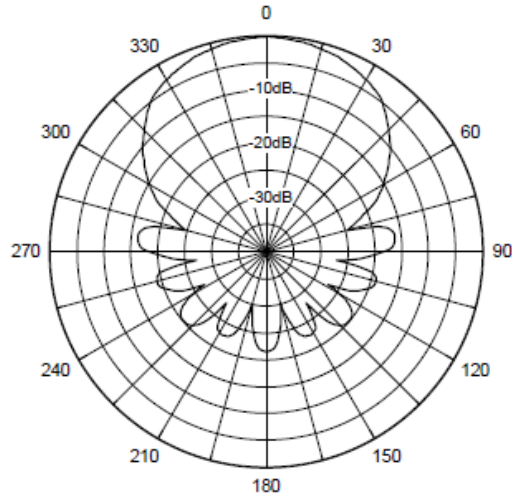
8.4 ANTENNAS

An antenna serves to focus the radiated signal into specific areas. This creates areas of gains and losses based on the radiation pattern of the antenna. Antennas are tuned to work with specific frequencies, and the size of the antenna is dependent on the wavelength of the signals for which it is tuned. For example, the most basic antenna is a dipole antenna, which is a half wavelength long. The amount of focusing that is desired also affects the size and shape of the antenna.

Using an antenna for a frequency for which it is not tuned introduces additional losses into the system by creating an impedance mismatch, as the impedance of an antenna varies with frequency. When an impedance mismatch is present, it causes some of the power that is meant to be transmitted to be reflected back into the radio. Thus it is not available to the overall system, making the transmitted signal weaker. Additionally, since this power has to go somewhere, it tends to dissipate as heat inside the radio, potentially damaging components over time. The ratio of reflected power is measured by Voltage Standing Wave Ratio (VSWR). While there is potential for an impedance mismatch when adding any components to the system, impedance values are typically standardized, so poor antenna tuning is the most likely cause outside of damaged components.

By default, Hydro One uses omnidirectional antennas. These antennas offer equal gain in all horizontal directions, at the cost of null areas directly above and below the antenna. As they are doing minimal focusing, the gain is not high, but since all directions are equal, no additional tuning or orientation is required for the installation.

Where required, directional antenna options are available, that will focus the gain in a specific direction at the expense of other directions. These antennas need to be aimed in the correct direction. The figure below shows an example gain pattern – in addition to the primary direction, there will frequently be additional lobes of in-between gain that can be considered when planning antenna aiming.

Horizontal Pattern

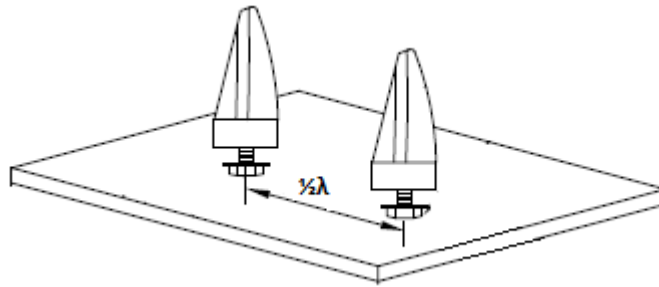
The table below lists the antennas that are available by default. Peak values are given, but there may be minor differences throughout the full frequency range

Antenna	Form Factor	Peak Gain (dBi)	Beamwidth	Frequencies (MHz)
MA241 Genesis	Bar	3.41	Omni	698-896 1710-2700
RM-WLF	Dual Nub	3	Omni	694-894 1700-2700
DL-9	Puck	6.1	Omni	704-960 1710-2690
DP-0727-758	Panel	16	68°	698-96 1710-2700
RO2406NM	Fiberglass Whip	6	Omni	2400-2500
HG2412P	Panel	11.14	54°	2400-2500

Some of these antennas additionally require a ground plane to perform optimally. A ground plane is a flat conducting surface that essentially replaces half of the antenna by reflecting a portion of the radiated signal. The ground plane needs to be at least a quarter of the signal's wavelength in diameter, and the antenna needs to be centered to avoid distorting the pattern

Some RF systems will use multiple antennas to improve performance. In such cases, the antennas must be spaced out by at least a half-wavelength of the signal being transmitted

to avoid them coupling with one-another and to ensure best performance, as shown in the figure below



When aiming a directional antenna, it is important to note that azimuths can be in degrees to true north or to magnetic north. The difference between these two values depends on the location of the site and will vary over time as the earth's magnetic pole drifts. Hydro One uses true degrees and care should be taken that any instrument used to measure is also in true degrees or that the values are converted.

8.5 CABLING

The cabling connecting the various parts of the RF system introduces some amount of loss as well. Though these losses are typically small relative to path loss introduced in the transmission across the wireless medium, they still must be accounted for, particularly in situations with long runs of cable.

In addition to increasing with the distance of the cabling, losses also increase with the frequency of the signal. Each connector between different cables or components also causes some loss. Though these losses are small for each connection, the cumulative impedance mismatch can cause larger losses in systems with multiple connectors or adaptors, so care should be taken to minimize them when they are not necessary.

Care must also be taken not to bend the coaxial cable too sharply. Doing so can disturb the common axis of the cable, and introduce additional losses. The damage caused by this is frequently invisible once the cable has been re-straightened, but is still present, and can therefore be a challenge to identify once the damage is done.

The table below lists the bend radius and losses at example frequencies for the cable types typically used by Hydro One.

Cable	Bend Radius (single) (mm)	Bend Radius (repeated) (mm)	Loss @ 700 MHz (dB/100m)	Loss @ 2100 MHz (dB/100m)
RG-58	24	50	41.4	75.4
LMR-240	19.1	63.5	21.8	38.7
LMR-400	25.4	101.6	11.2	20.2

8.6 HEALTH CANADA

Health Canada Safety Code 6 governs the safe application of RF radiation.

9 TABLES

Table 1 | Self Contained Metering Installation and Location Summary

Service Configuration	ANSI Form Factor	Meter Installation and Policy	Single or Multi-Position Base	Installation of Base with Respect to Disconnect Switch
1 Φ 120/240V Self Contained	Form 2S (4-jaw)	Outdoor <i>See Note 1</i>	Single Meter Socket	Line Side
1 Φ 120/240V Self Contained	Form 2S (4-jaw)	Indoor/Outdoor <i>See Note 2 and 3</i>	Multi-Position 200A Main	Line side
			Multi-Position with main rating >200A	Load side
1 Φ 120/208V Self Contained	Form 12S (5-jaw Network)	Indoor <i>See Note 2 and 3</i>	Single Meter Socket	Load side
			Multi-Position 200A Main	
			Multi-Position with main rating >200A	Load side
3 Φ 120/208V Self Contained	Form 16S (7-jaw)	Indoor/Outdoor <i>See Note 1 and 4</i>	Single Meter Socket	Load side
3 Φ 277/480V Or 3 Φ 347/600V Self Contained	Form 16S (7-jaw)	Indoor <i>See Note 4</i>	Single Meter Socket	Load side
3 Φ 600V Self Contained	Form 12S (5-jaw)	Indoor <i>See Note 4</i>	Single Meter Socket	Load side

Note 1 | Centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 2 | Horizontal gang base configuration may be installed indoors or outdoors. Centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 3 | Vertical gang base configuration installed indoors. Centre point of the upper most and lowest meter shall be at a height of 1.83m \pm 100mm and 600mm \pm 100mm from finished grade respectively. Indoor dedicated metering room accessible from outside of building.

Note 4 | Indoor dedicated metering room accessible from outside of building. Centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 5 | On the pole, wall mounted, or in a dedicated electrical room, meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 6 | Customer may be asked to install a $\frac{3}{4}$ PVC, 3m long conduit above grade for outdoor communication

Table 2 | Transformer Type Metering Installation and Location Summary

Service Configuration	ANSI Form Factor	Meter Installation and Policy	Single or Multi-Position Base	Installation of Base with Respect to Disconnect Switch
1 Φ , 120/240V CM Service	Form 3S (5-Jaw)	Outdoor <i>See Note 5</i>	Single Meter Socket with test switch	Line Side
1 Φ , 120/240V 400A Meter Base	Form 3S (5-Jaw)	Outdoor <i>See Note 5</i>	Single Meter Socket with integrated CT and test switch	Line Side
1 Φ , 120/240V	Form 3S (5-Jaw)	Indoor/Outdoor <i>See Note 5</i>	Meter Enclosure	Load Side
3 Φ , 600V Transformer Type Meter Installation	Form 45S (8-Jaw)	Indoor/Outdoor <i>See Note 5</i>	Meter Enclosure	Load Side
3 Φ 277/480V Or 3 Φ 347/600V	Form 9S (13-Jaw)	Indoor/Outdoor <i>See Note 5</i>	Meter Enclosure	Load Side

Note 1 | Outdoor centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 2 | Horizontal gang base configuration may be installed indoors or outdoors. Centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 3 | Vertical gang base configuration installed indoors. Centre point of the upper most meter shall be at a height of 1.83m \pm 100mm from finished grade. Centre point of the lowest meter shall be at a height of 600mm \pm 100mm from finished grade. Indoor dedicated metering room accessible from outside of building.

Note 4 | Indoor dedicated metering room accessible from outside of building. Centre point of the meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 5 | On the pole, wall mounted, or in a dedicated electrical room, meter shall be at a height of 1.75m \pm 100mm from finished grade.

Note 6 | Customer may be asked to install a $\frac{3}{4}$ PVC, 3m long conduit above grade for outdoor communication

Table 3 | Hydro One Supplied Primary Voltages

Hydro One Supplied Primary Voltages		System Configuration	No. of Phases and Wires	No. of Elements	Meter ANSI Form Factor
2400 V		-	1 phase, 2 W	1 CT, 1 VT	Form 3S
4800 V		-	1 phase, 2 W	1 CT, 1 VT	Form 3S
7200 V		-	1 phase, 2 W	1 CT, 1 VT	Form 3S
8000 V		-	1 phase, 2 W	1 CT, 1 VT	Form 3S
Sub-transmission Customers	14400 V	-	1 phase, 2 W	1 CT, 1 VT	Form 3S
	16000 V	-	1 phase, 2 W	1 CT, 1 VT	Form 3S
	44000 V	Delta	3 phase, 3 W	2 CTs, 2 VTs	Form 45S
	16000/27600 V	Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
	14400/25000 V	Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
	8000/13800 V	Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
7200/12500 V		Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
4800/8320 V		Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
2400/4160 V		Wye	3 phase, 4 W	3 CTs, 3 VTs	Form 9S
27600 V		Delta	3 phase, 3 W	2 CTs, 2 VTs	Form 45S

Table 4 | Primary Metering Unit Specifications

Hydro One supplied primary voltages	System Configuration	Primary to Secondary Ratio	Voltage Class (For CTs and VTs)	BIL (For CTs and VTs)
44000V	Delta 3 Phase, 3 Wire	46000:115V	50kV	250KV
*27600V	Delta 3 Phase, 3 Wire	27600:115V		
*16000/27600V Or *16800V	Wye 3 Phase, 4 Wire Or 1 phase, 2 Wire	16800:120V Or 16100:115V	35kV	170kV
*14400/25000V Or *14400V	Wye 3 Phase, 4 Wire Or 1 Phase, 2 Wire	14400:120V		
8000/13800V Or 8000V	Wye 3 Phase, 4 Wire Or 1 Phase, 2 Wire	8400:120V	25kV	95kV
*7200/12500V Or 7200V	Wye 3 Phase, 4 Wire Or 1 Phase, 2 Wire	7200:120V	15kV	95kV
*4800/8320V Or 4800V	Wye 3 Phase, 4 Wire Or 1 Phase, 2 Wire	4800:120V	15kV	95kV
*2400/4160V Or 2400V	Wye 3 Phase, 4 Wire Or 1 Phase, 2 Wire	2400:120V	15kV	95kV

*Available for padmount type PMUs

Table 5 | Hydro One Metered Secondary Voltages

Hydro One Standard secondary voltages	System Configuration	No. Phase and Wires	Meter Form Factor	
			Self-Contained	Transformer Rated
120/240V	-	1 phase, 3 W	Form 2S 4-Jaw	Form 3S 5-Jaw
120/208V (Network)	-	2 phase, 3 W	Form 12S 5-Jaw	-
*277/480V	Wye	3 phase, 4 W	Form 16S 7-Jaw	Form 9S 13-Jaw
120/208V Or 347/600V	Wye	3 phase, 4 W	Form 16S 7-Jaw	Form 9S 13-Jaw
600V	Delta	3 phase, 3 W	Form 12S 5-Jaw	Form 45S 8-Jaw

*Indicates that although Hydro One provides metering at these voltages, these are non-standard secondary voltages where the transformers are supplied by the Customer.

Table 6 | Instrument Transformer Enclosure Dimensions and Other Requirements

Voltage (V)	Phase and No. of Wires	Max Allowed Amps	Minimum Instrument Transformer Enclosure Size
120/240V	1Ph, 3W	>200 – 400A	914mm x 914mm x 304mm
120/240V	1Ph, 3W	>400 – 800A	1219mm x 1219mm x 304mm
120/208V	3Ph, 4W	>200 – 1000A	1219mm x 1219mm x 304mm
277/480V 347/600V 600V	3Ph, 4W Or 3Ph, 3W	>200 – 1000A	1219mm x 1219mm x 304mm

Table 7 | Minimum Spacing Requirements for Bus Bars in Metering Compartment of Low Voltage Switchgears

Nominal Voltage Rating (V)	Minimum Spacing (mm)			
	Opposite Polarity		To Ground	
	Through Air	Over Surface	Through Air	Over Surface
120V	12.5	19	12.5	19
240V	19	31	19	25
480V	22	44	22	34
600V	25	50	25	38

Note: Where a neutral is involved, the spacing between the neutral and other current-carrying parts may be based on the lower voltage that normally occurs between them. The spacing from neutral to grounded metal parts is to be the same as those between the current carrying conductors and grounded metal parts.

Table 81 Metering Requirements – Embedded Generation Facilities including Net Metering

Generator Capacity	Metering Requirements (For all single and three phase Embedded Generators)
≤ 10 kW	Smart bi-directional
>10 kW to ≤ 250 kW	4-Quadrant Interval
>250 kW	4-Quadrant PQ

- Smart bi-directional: A dual register meter measuring kWh delivered and kWh received, which may be manually or remotely read
- 4-Quadrant Interval: Bidirectional meter with a minimum of four recording channels kWh & kVArh delivered and received with telephone or other communication (interval meter and remotely read)
- 4-Quadrant PQ Meter: A meter with multiple recording channels that includes power quality information.

Table 9 | Minimum Wire Gauge Requirements: Current Transformer

Run Length (m)	5A current transformer rated burden					
	0.1	0.2	0.5	0.9	1.0	1.8
2	14	16	16	16	16	16
5	12	14	16	16	16	16
10	8	12	16	16	16	16
15	6	10	14	16	16	16
20	8+8	8	12	14	16	16
30	6+6	6	10	12	14	16
50		6+6	8	10	12	14
70		6+6	6	10	10	12
100			8+8	8	8	10
200			6+6	8+8	8+8	8
300				6+6	6+6	6

This is the load that may be imposed on a transformer secondary without causing an error greater than the stated accuracy classification. For Metering Class CTs burden is expressed as ohms impedance.

Table 9 | Minimum Wire Gauge Requirements: Current Transformer above indicates the minimum wire gauges required for a given run length of wire connected to a current transformer of a given rated burden

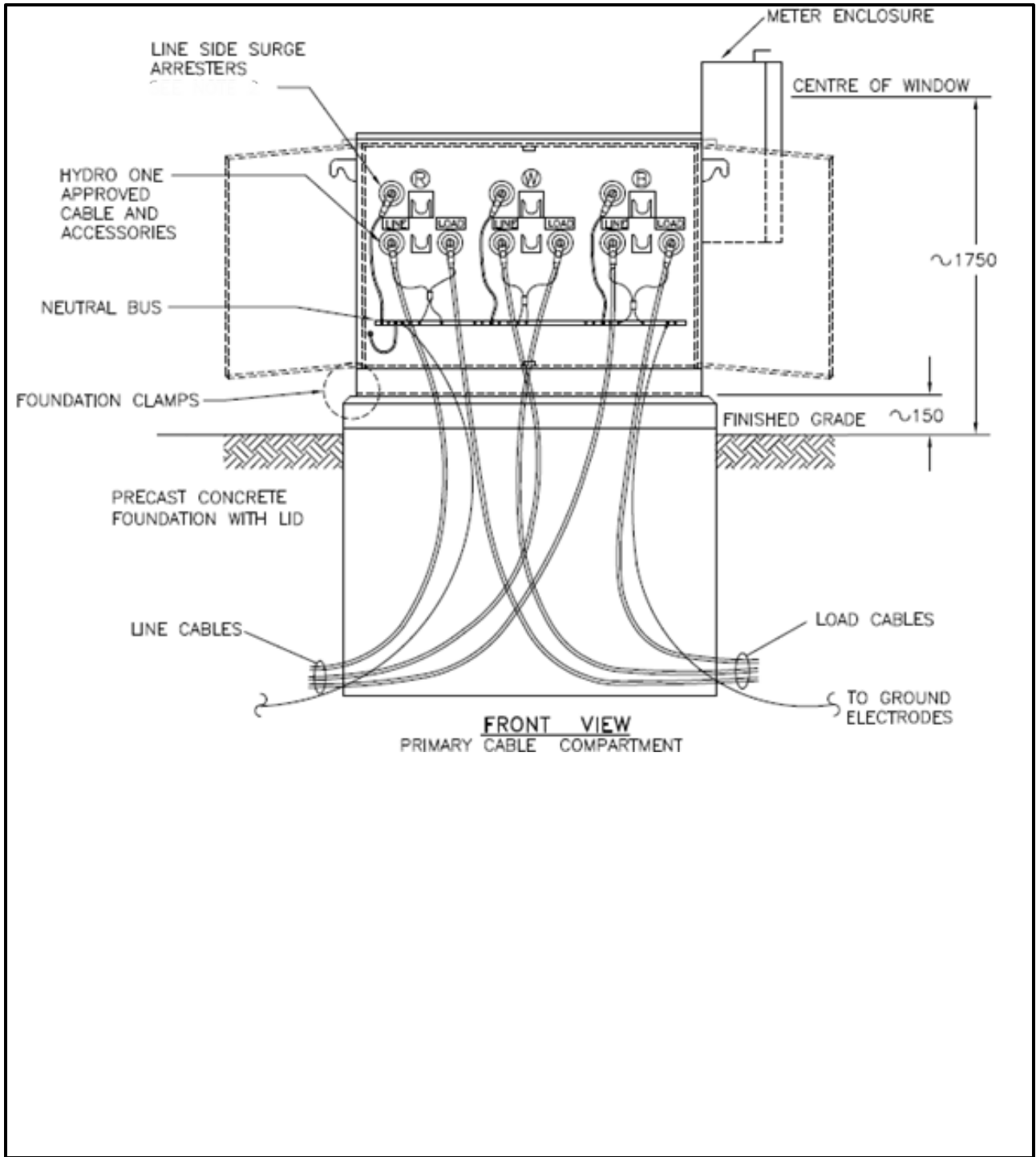
Table 10 | Minimum Wire Gauge Requirements: Voltage Transformer

Run Length (m)	Potential Transformer Rated Burden				
	W	X	Y	Z	ZZ
3	16	16	16	16	12
5	16	16	16	14	10
7	16	16	16	12	10
10	16	16	14	10	8
15	14	16	14	8	6
20	12	16	12	8	8+8
30	10	16	10	6	
50	8	14	8	6+6	
70	8	14	6		
100	6	12	8+8		
200	6+6	8			
300		6			

Table 10 | Minimum Wire Gauge Requirements: Voltage Transformer

above indicates the minimum wire gauges required for a given run length of wire connected to a potential transformer of a given rated burden.

10 FIGURES



TITLE:

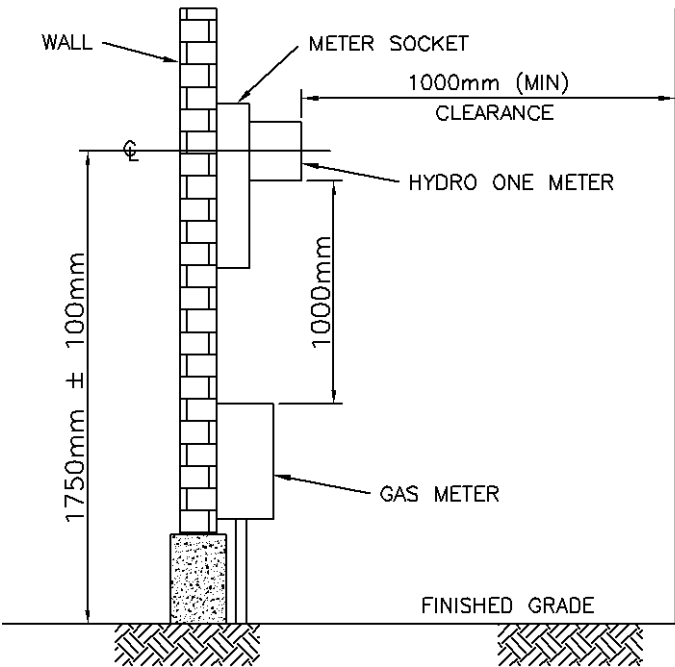
DEAD FRONT PADMOUNT PMU ASSEMBLY



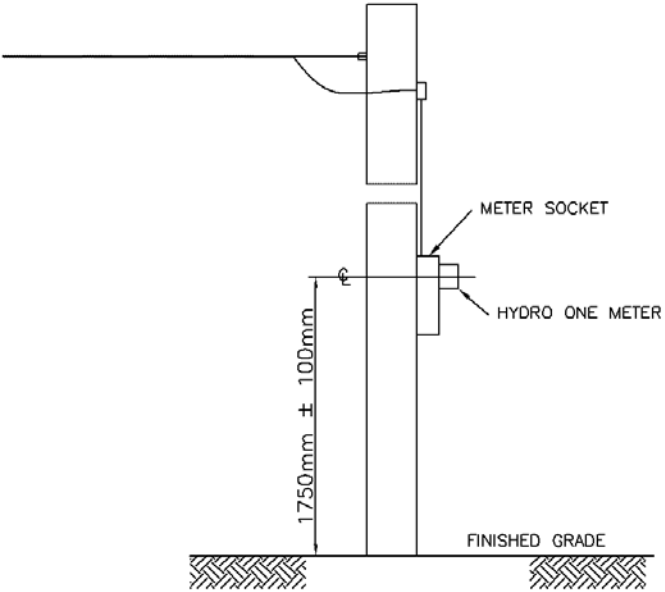
FIGURE:

Figure 1





(A) Wall-Mounted Meter Socket



(B) Pole-mounted Meter Socket

TITLE:

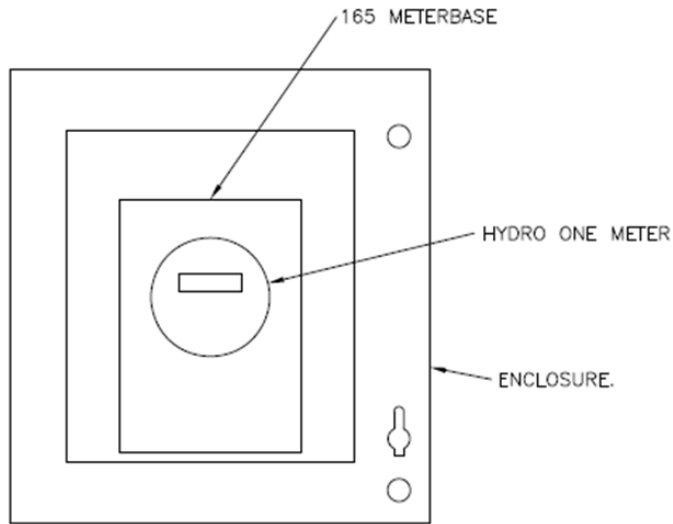
INDIVIDUAL POLE OR WALL MOUNTED METER SOCKET
INSTALLATION



FIGURE:

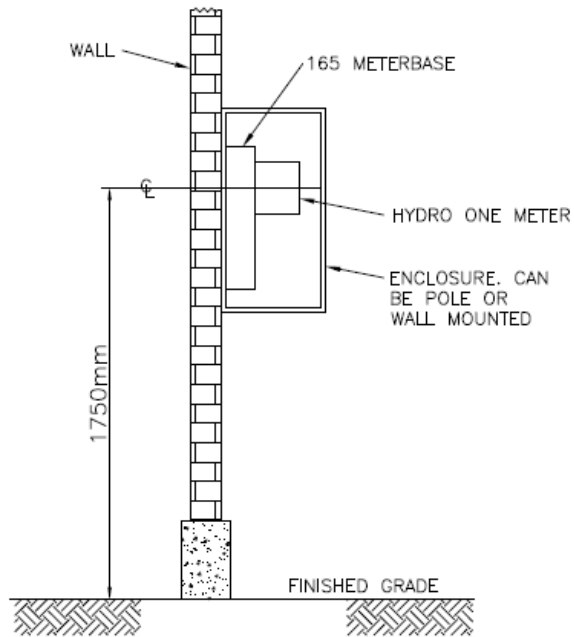
Figure 2





ENCLOSURE (FRONT VIEW)

(A) FRONT VIEW



(B) SIDE VIEW

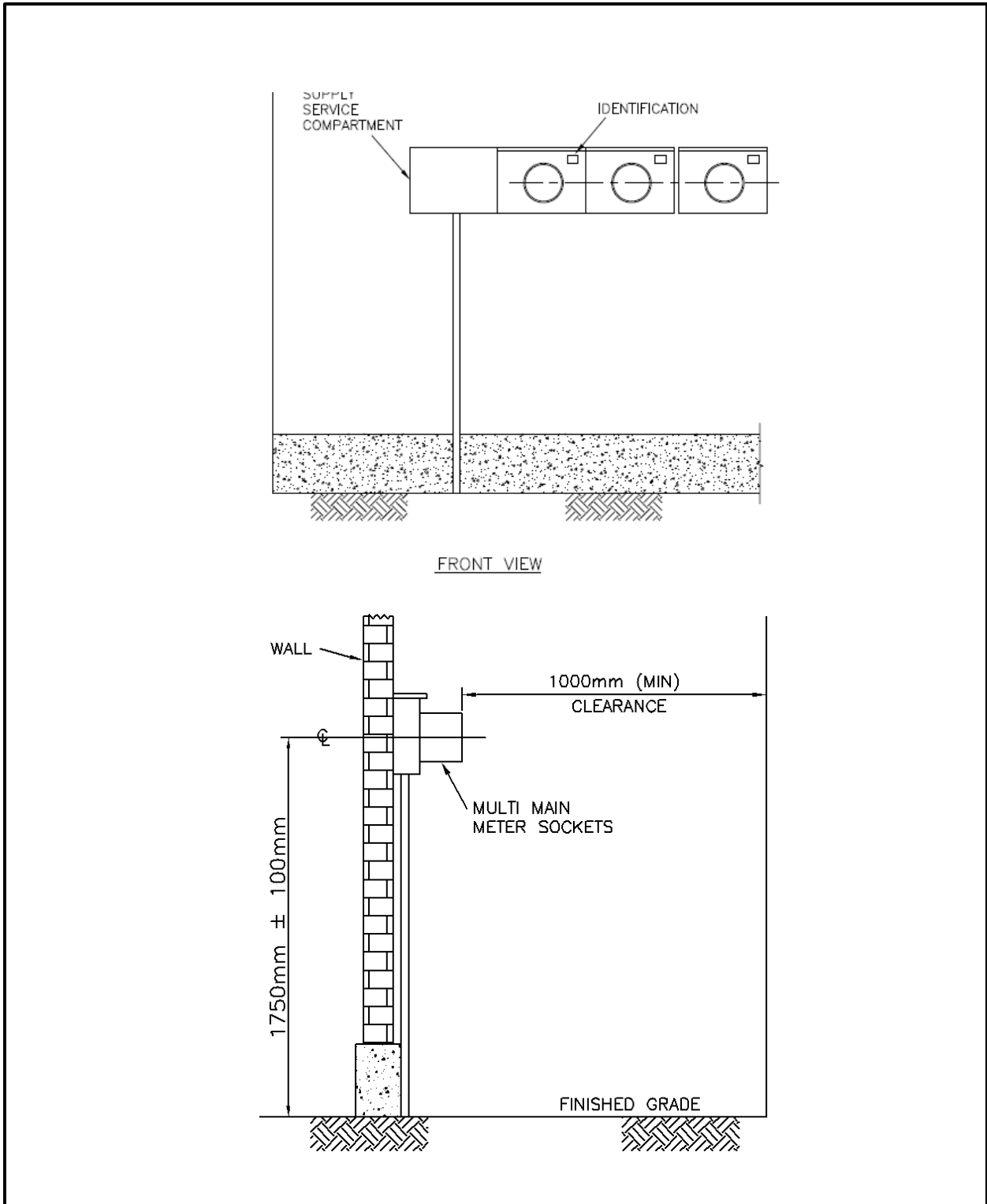
TITLE:

TYPICAL 16S METER ENCLOSURE LAYOUT



FIGURE:

Figure 3



TITLE:

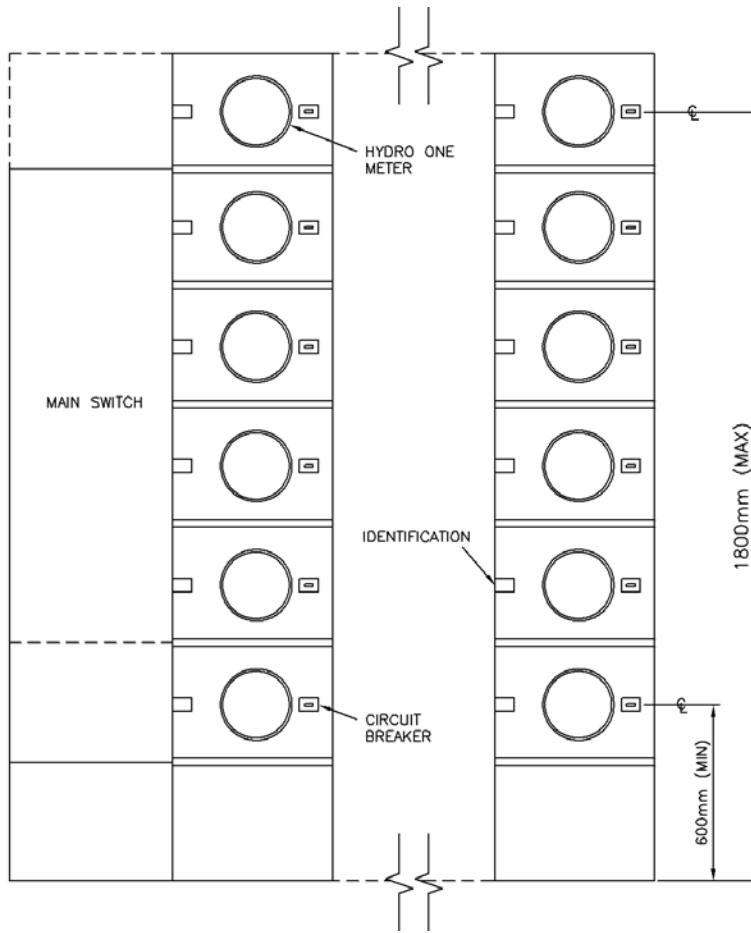
MULTI-POSITION (GANGED) METER SOCKETS



FIGURE:

Figure 4





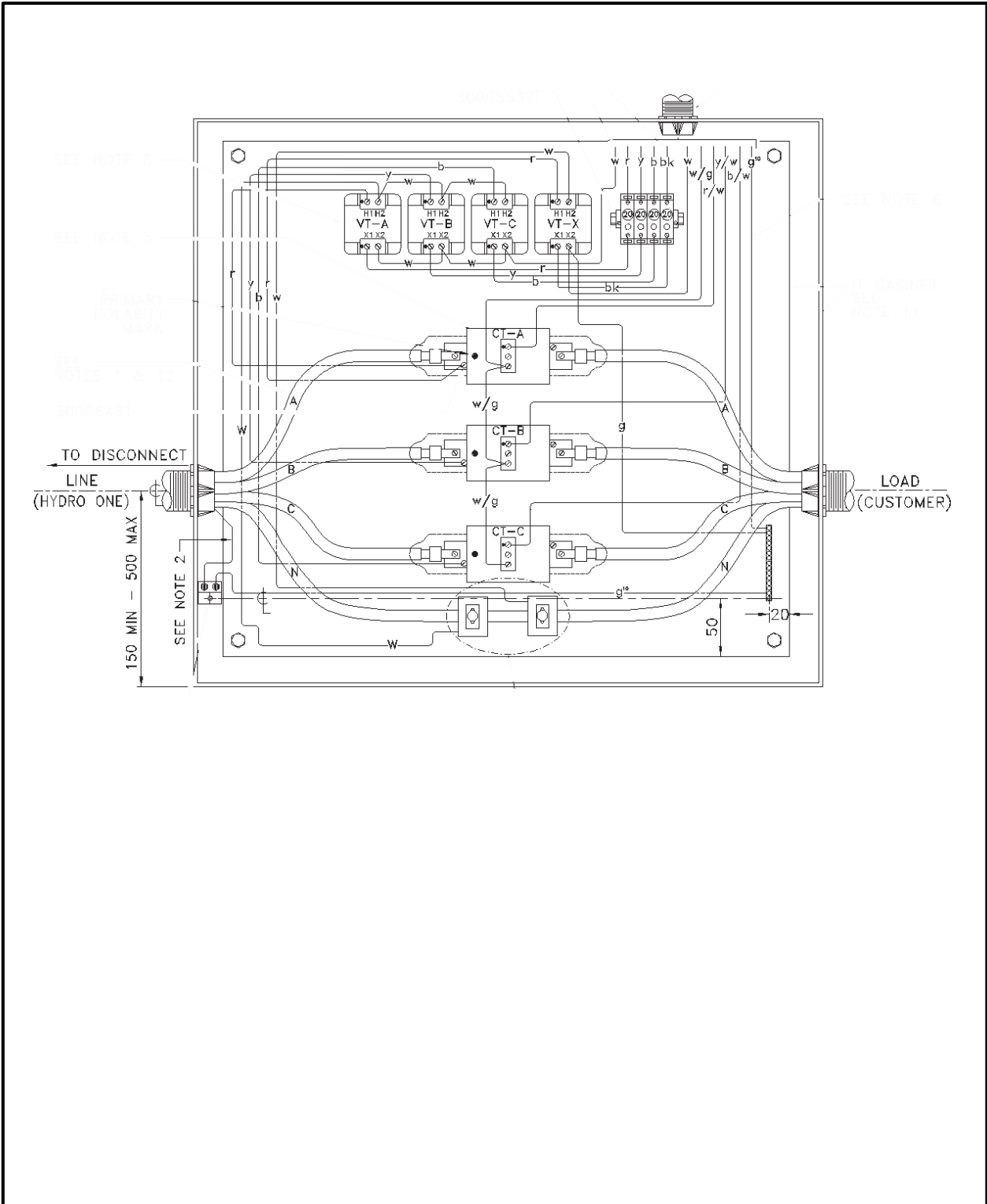
TITLE:

METER CENTRE FOR 120/240V, 120/208V and
347/600V SERVICES



FIGURE:

Figure 5



TITLE:

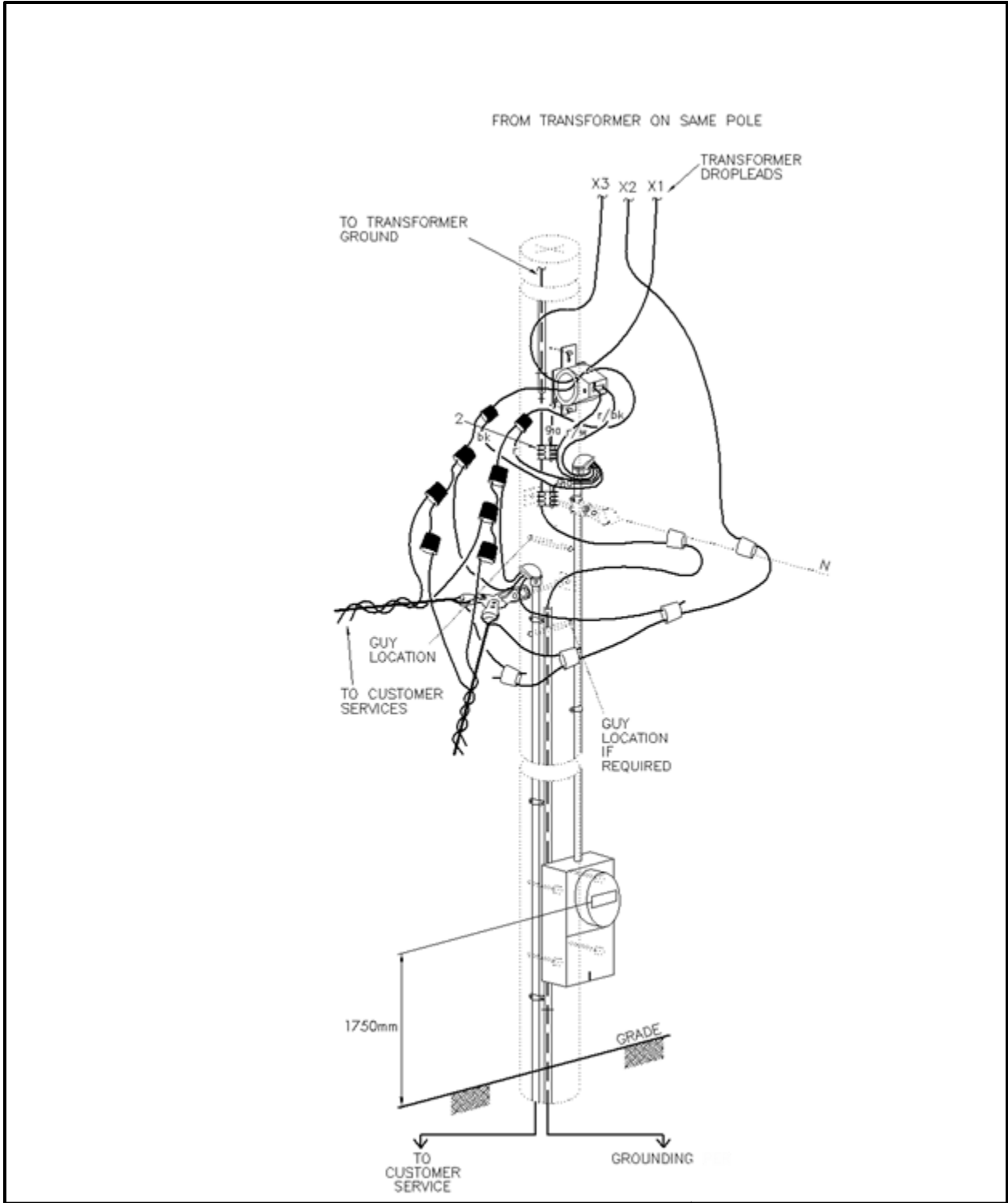
TYPICAL ENTRY AND EXIT POINTS FOR INSTRUMENT TRANSFORMER ENCLOSURE



FIGURE:

Figure 6





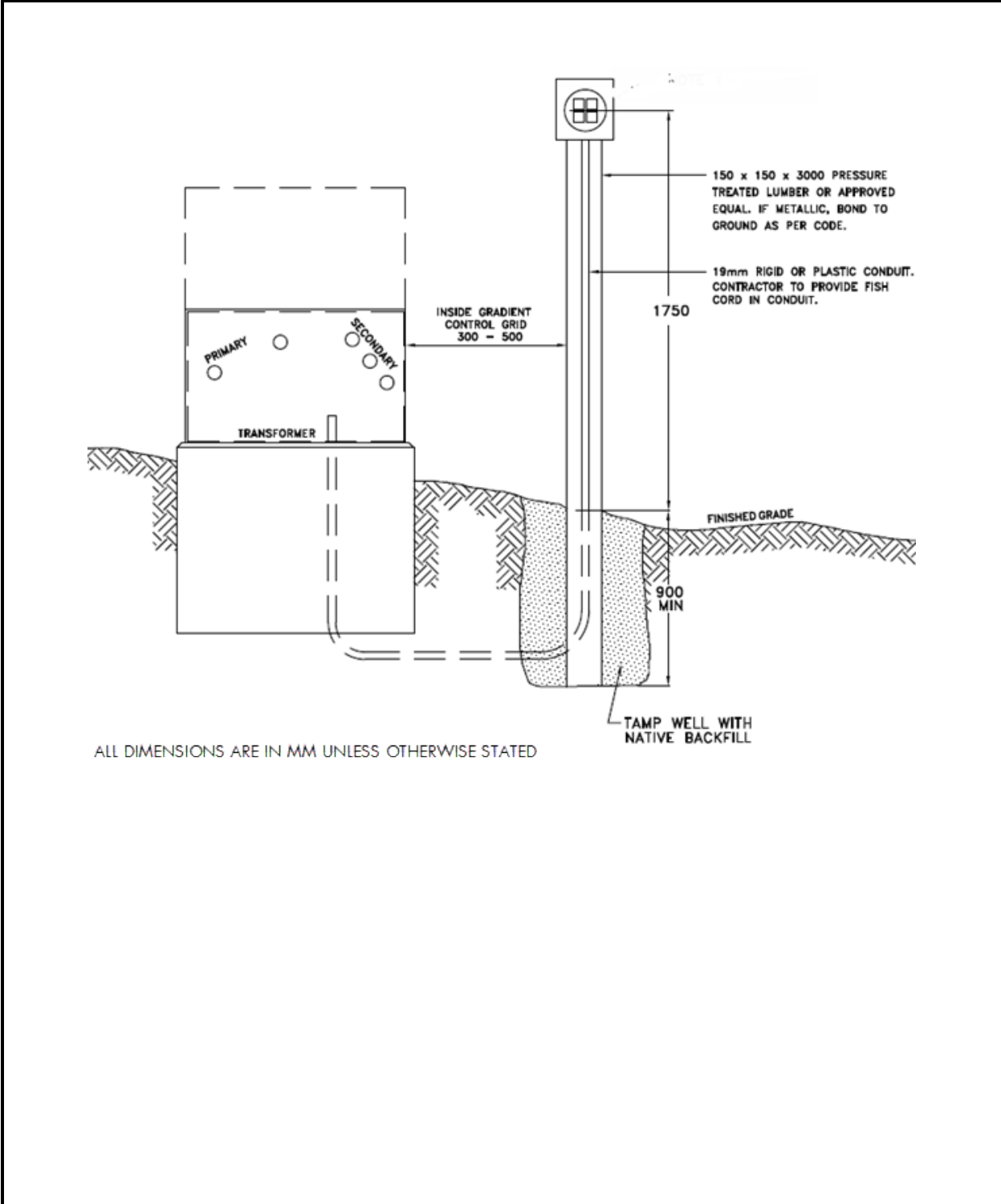
TITLE:

POLE-MOUNT, 120/240V, CENTRAL METERING



FIGURE:

Figure 7



TITLE:

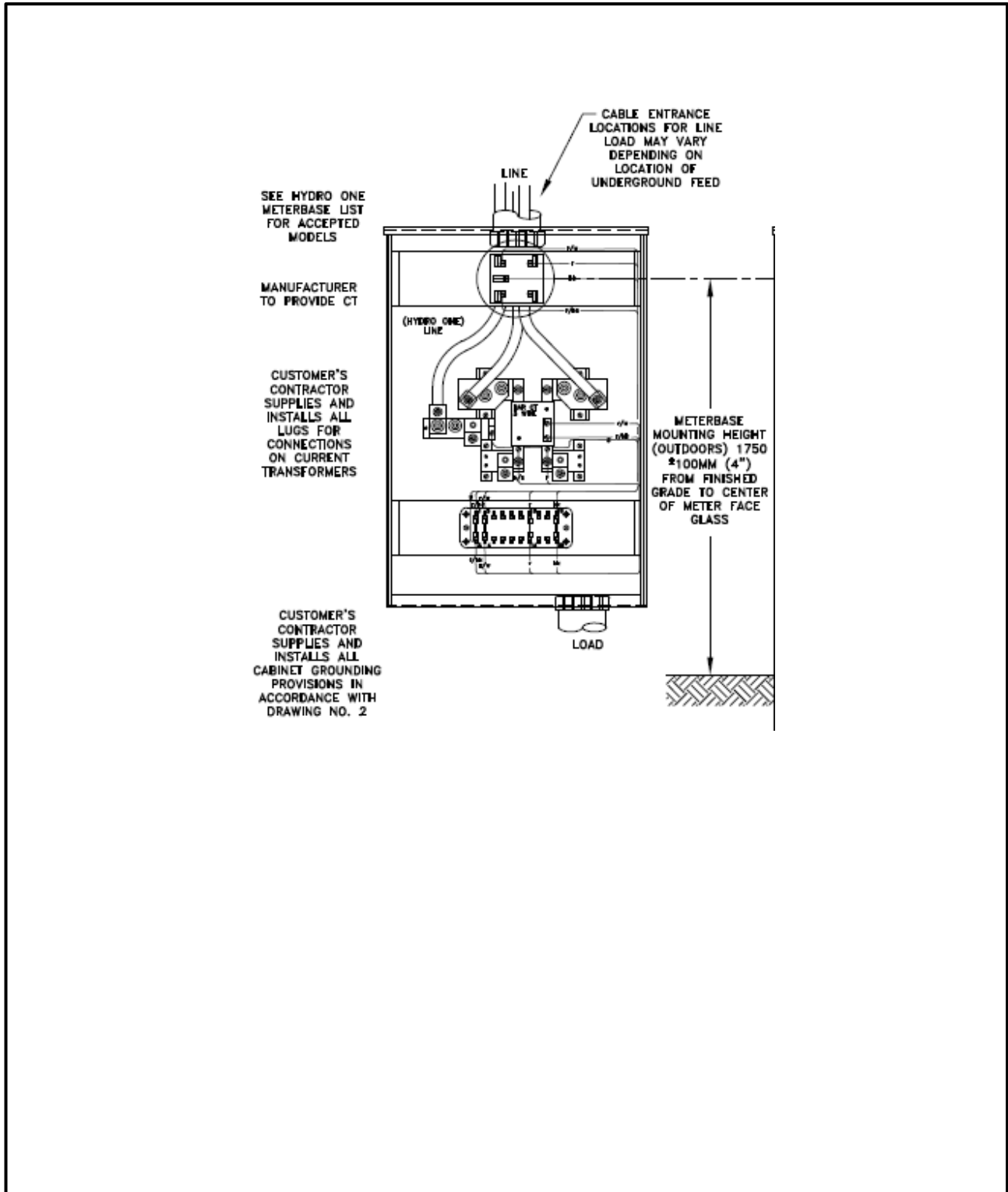
PADMOUNT, CENTRAL METERING



FIGURE:

Figure 8

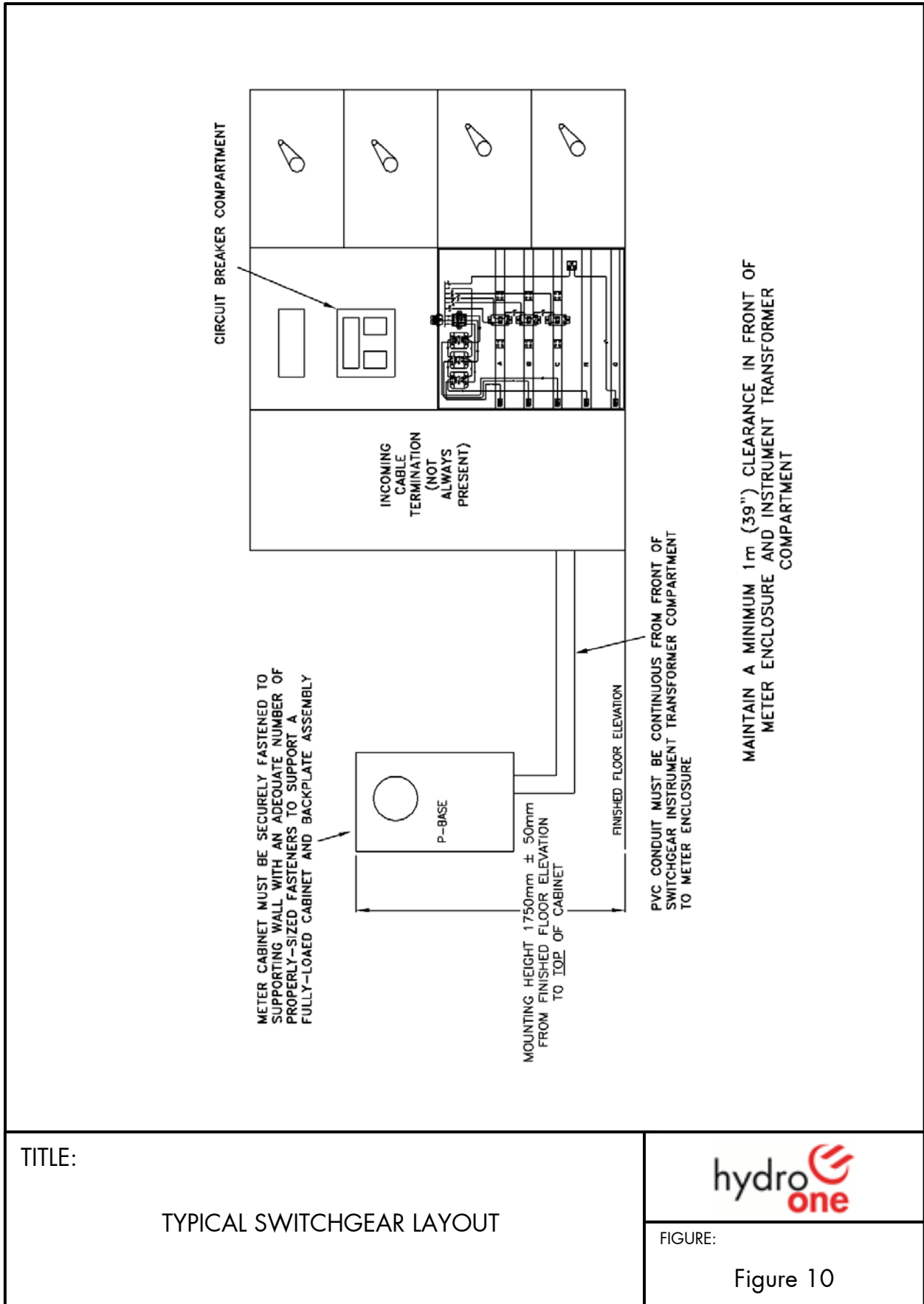


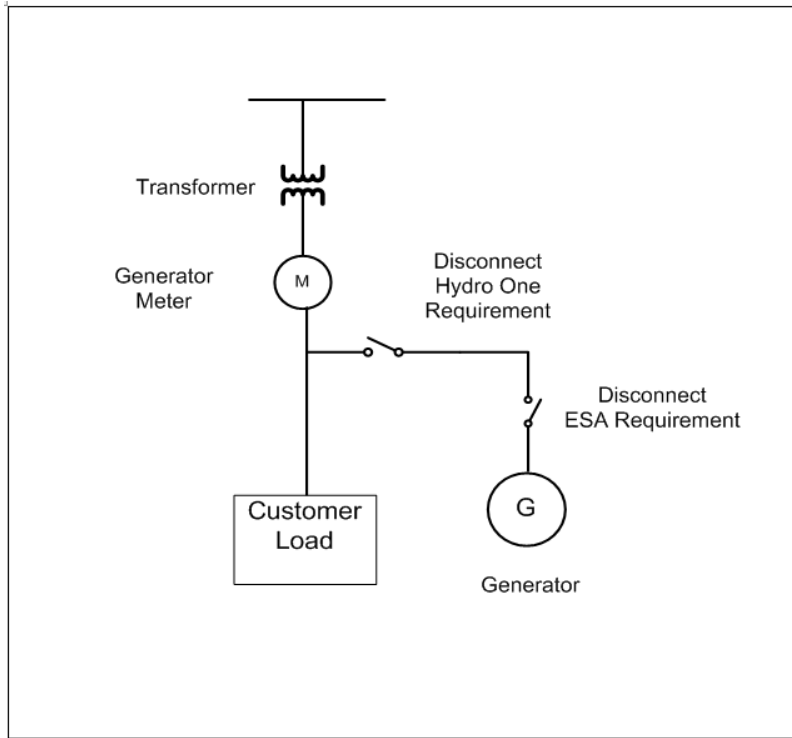


TITLE:
400A METER BASE SOCKET WITH TEST SWITCH



FIGURE:
Figure 9





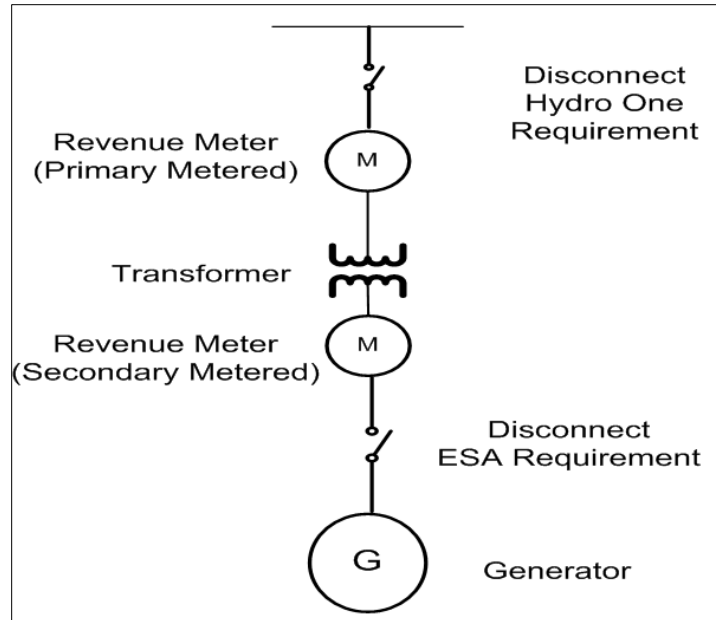
TITLE:

METERING ARRANGEMENT FOR AN EMBEDDED GENERATOR – NET METERING



FIGURE:

Figure 11



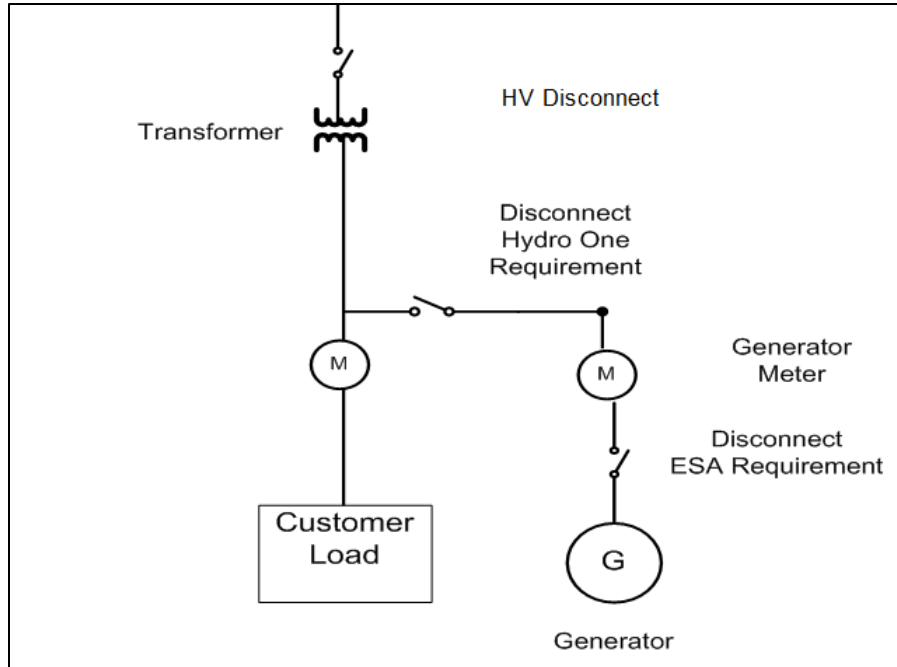
TITLE:

METERING ARRANGEMENT FOR DIRECTLY CONNECTED
EMBEDDED RETAIL GENERATORS

hydro
one

FIGURE:

Figure 12



TITLE:

METERING ARRANGEMENT FOR INDIRECTLY (PARALLEL)
CONNECTED EMBEDDED RETAIL GENERATORShydro
one

FIGURE:

Figure 13

Protective Bollards for Metering Equipment and Padmounts

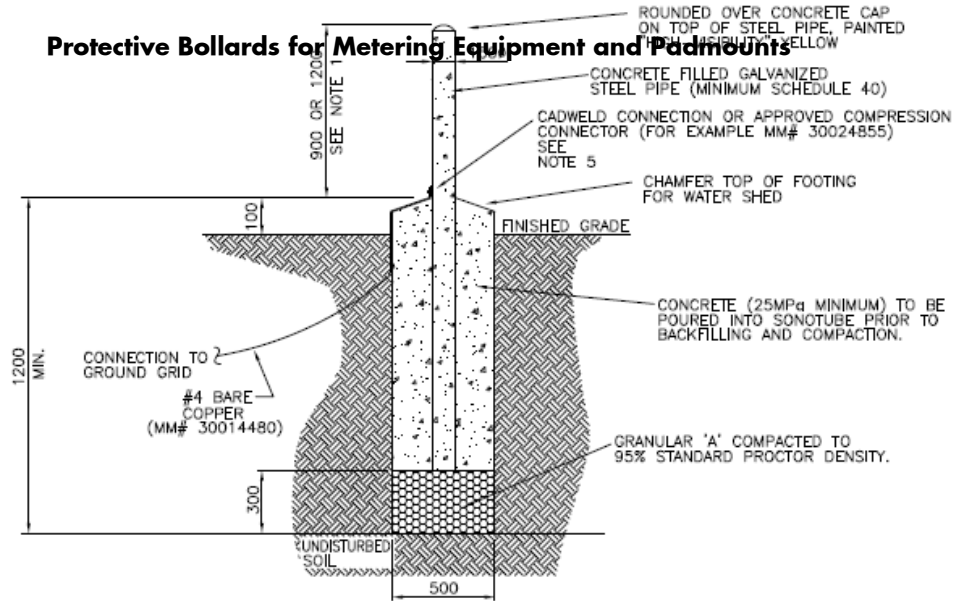
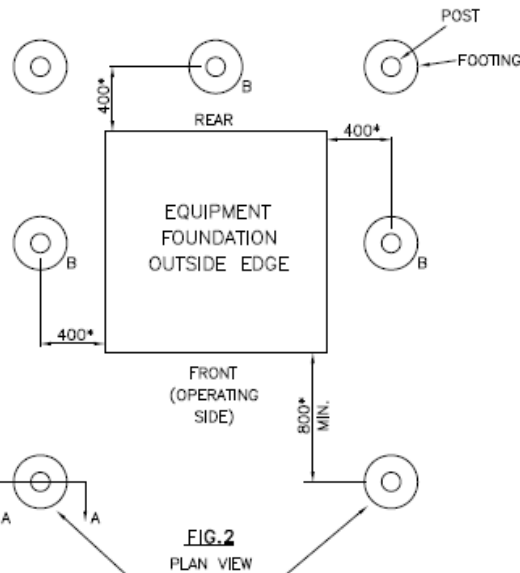


FIG.1
SECTION A-A
ELEVATION VIEW



THESE BOLLARDS ARE NON-OPTIONAL SEE NOTE 3

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED

NOTES:

1. PROTECTIVE BOLLARD HEIGHT ABOVE GRADE:
FOR SINGLE PHASE EQUIPMENT - 900mm
FOR THREE PHASE EQUIPMENT - 1200mm
2. BOLLARDS SHALL BE PROVIDED AS SHOWN ON DESIGN DRAWINGS.
3. BOLLARDS AT 'B' ARE OPTIONAL AND WOULD ONLY BE REQUIRED FOR HIGH TRAFFIC AREAS AND LARGE SIZED EQUIPMENT. BOLLARDS AT 'B' ARE GENERALLY NOT REQUIRED FOR SINGLE PHASE EQUIPMENT DUE TO THEIR SMALL SIZE. ALSO BOLLARDS AT THE REAR AND SIDE OF THE EQUIPMENT MAY BE OMITTED AT LOCAL DISCRETION IF THE LIKELIHOOD OF DAMAGE/IMPACT IS LOW.
4. LOCATION OF BOLLARDS SHOULD NOT OBSTRUCT EQUIPMENT OPERATION, MAINTENANCE AND REPLACEMENT.
5. WHEN USING COMPRESSION CONNECTOR DRILL THROUGH HOLE IN THE PIPE AND REMOVE PAINT FROM CONNECTION AREA OF THE PIPE.
6. DIMENSIONS WITH * ARE PREFERRED TO BE 1500mm WHERE POSSIBLE

TITLE:

PROTECTIVE BOLLARDS FOR METERING EQUIPMENT AND
PADMOUNTS



FIGURE:

Figure 14