Requirements for Remotely Read Load Profile Revenue Metering

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June 4, 2004

BC hydro

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1. Overview

This document contains the requirements for remotely read load profile revenue metering. A main meter and a backup meter record the power delivered by BC Hydro to the Customer/Power Generator and, if there is generation, the power received by BC Hydro from the Power Generator during each 30 minute time period. The revenue metering is read remotely by telephone.

Responsibilities are dependent upon whether the installation is:

- **Load Only** - where the **Customer** only purchases power from BC Hydro (BCH); or
- **Generation -** where the **Power Generator** typically sells power to BC Hydro but may occasionally purchase power from BC Hydro.

Load profile revenue metering may be used if the Customer/Power Generator is connected to either the BC Hydro Transmission System or the BC Hydro Distribution System.

BC Hydro Power System	BC Hydro Voltage Class	Nominal Voltage		CSA Equipment Voltage Class
Transmission System	230 kV	230,000 V	3 Phase, 3 Wire	245 kV
	138 kV	138,000 V	3 Phase, 3 Wire	145 kV
	69 kV	69,000 V	3 Phase, 3 Wire	72.5 kV
Distribution System	35 kV *	19,920/34,500Y V	3 Phase, 4 Wire	35 kV
	25 kV	14,400/24,940Y V	3 Phase, 4 Wire	27.5 kV
	12 kV	7,200/12,470Y V	3 Phase, 4 Wire	15 kV
	4 kV	2,400/4,160Y V	3 Phase, 4 wire	5 kV

* Restricted to a limited number of rural circuits in the Central Interior.

Changes to this revision are indicated by vertical lines in the left margin.

Comments are written in italics.

2. Disclaimer

This document is not intended as a design specification or as an instruction manual for the Customer/Power Generator and this document shall not be used by the Customer/Power Generator for those purposes. Persons using information included in this document do so at no risk to BC Hydro, and they rely solely upon themselves to ensure that their use of all or any part of this document is appropriate in the particular circumstances.

The Customer/Power Generator, its employees or agents must recognize that they are, at all times, solely responsible for the plant design, construction and operation. Neither BC Hydro nor any of their employees or agents shall be nor become the agents of the Customer/Power Generator in any manner howsoever arising.

BC Hydro's review of the specifications and detailed plans shall not be construed as confirming or endorsing the design or as warranting the safety, durability or reliability of the Customer/Power Generator's facilities. BC Hydro, by reason of such review or lack of review, shall be responsible for neither the strength, adequacy of design or capacity of equipment built pursuant to such specifications, nor shall BC Hydro, or any of their employees or agents, be responsible for any injury to the public or workers resulting from the failure of the Customer/Power Generator facilities.

In general, the advice by BC Hydro, any of its employees or agents, that the Customer/Power Generator's plant design or equipment meets certain limited requirements of BC Hydro does not mean, expressly or by implication, that all or any of the requirements of the law or other good engineering practices have been met by the Customer/Power Generator in its plant, and such judgement shall not be construed by the Customer/Power Generator or others as an endorsement of the design or as a warranty, by BC Hydro, or any of its employees.

The information contained in this document is subject to change and may be revised at any time. BC Hydro should be consulted in case of doubt on the current applicability of any item.

3. General

3.1 Approval

The proposed revenue metering equipment locations shall be approved by BC Hydro.

3.2 Location

Revenue metering equipment:

(a) Shall be installed in a clean readily accessible location free from severe or continual vibration; and
(b) Shall be installed in accordance with the latest edition of the Canadian Electrical Code; and
(c) Shall not be installed in locations which may be hazardous to persons installing, testing or maintaining the equipment; and
(d) Shall be protected from damage due to vandalism, vehicles etc.

In accordance with Section 2 of the Canadian Electrical Code, a minimum working space of 1 m shall be provided and maintained about revenue metering equipment.

3.3 Access

BC Hydro shall have reasonable access to the revenue metering equipment to permit its testing and maintenance.

3.4 Illumination

When installed indoors, the meter cabinet shall be installed in a location with a minimum illumination of:

- 100 to 200 lux horizontal at 750 mm (2’ 6”) above grade; and
- 100 lux vertical at the front face of the meter cabinet.

4. Point-of-Metering

The Point-of-Delivery/Receipt (PODR) is the power custody transfer point and is typically located at, or near, the Point-of-Interconnection (POI) to either the transmission system or the distribution system.

The revenue metering is located at the Point-of-Metering (POM). Subject to approval by BC Hydro, the POM may be on either the BC Hydro side of the power transformer(s) or the Customer/Power Generator side of the power transformer(s).

When there are multiple power transformers, the POM is generally on the BC Hydro side of the power transformers to avoid multiple POMs.

4.1 BC Hydro Side of the Power Transformer

Where the POM is on the BC Hydro side of the power transformer(s), it shall be on the Customer/Power Generator side of the service entrance disconnection device.

4.2 Customer/Power Generator Side of the Power Transformer

Where the POM is on the Customer/Power Generator side of the power transformer, a disconnect device shall not be installed between the power transformer and the POM.

This is to insure that no-load losses are correctly registered whenever the power transformer is energized

4.3 Loss Compensation

If the POM is not located at the PODR, a loss compensation calculation is applied to account for the losses between the POM and the PODR.

4.3.1 Power Transformer Loss Compensation

If the POM is on the Customer/Power Generator side of the power transformer, the following power transformer test date, certified by a Professional Engineer, shall be provided by the Customer/Power Generator:

- Rated kVA; and
- Rated primary voltage; and
- Rated secondary voltage; and
- No-load (Iron) losses corrected to 75° C (for 55C° rise) or 85C° (for 65C° rise); and
- Load (Copper) losses corrected to 75° C; and
- % Exciting current; and
- % Impedance.

4.3.2 Line Loss Compensation

Where line losses between the POM and the PODR, on either side of the power transformer, are significant, the following line data, certified by a Professional Engineer, shall be provided by the Customer/Power Generator:

- Per phase resistance at the mean anticipated conductor temperature; and
- Per phase inductive reactance.

5. Voltage Transformers and Current Transformers

5.1 General Requirements

The voltage transformers (VTs) and current transformers (CTs) shall be installed at the POM in accordance with the general requirements of this section and the specific requirements of the appropriate subsequent section.

Since the revenue metering is insensitive to phase rotation direction, the references to Phase A, B and C are totally arbitrary and do not necessarily comply with other designations in the Customer/Power Generators facility. If not explicitly identified, the convention of Phase A, B and C from left-to-right or from top-to-bottom is assumed.

5.1.1 BC Hydro Side of the Power Transformer.

Where the POM is on the BC Hydro side of the power transformer, the following VT and CT primary winding connections shall be made:

BC Hydro Power System POI and POM	**Metering Elements**	**VTs** (Connected to the phases on the BC Hydro side of the CTs)	**CTs** (H1 Polarity towards BC Hydro)
69 kV class or higher Transmission System (3 wire)	3	Qty=3, Single Bushing, Connected: • Phase A to Ground (H1 Polarity to Phase A) • Phase B to Ground (H1 Polarity to Phase B) • Phase C to Ground (H1 Polarity to Phase C)	Qty=3 • Phase A • Phase B • Phase C
25 kV class or lower Distribution System (4 wire)	3	Qty=3, Single Bushing, Connected: • Phase A to BC Hydro System Neutral (H1 Polarity to Phase A) • Phase B to BC Hydro System Neutral (H1 Polarity to Phase B) • Phase C to BC Hydro System Neutral (H1 Polarity to Phase C)	Qty=3 • Phase A • Phase B • Phase C

5.1.2 Customer/Power Generator Side of the Power Transformer.

Where the POM is on the Customer/Power Generator side of the power transformer, the following VT and CT primary winding connections shall be made:

Customer/Power Generator Power System POM	**Metering Elements**	**VTs** (Connected to the phases on the BC Hydro side of the CTs)	**CTs** (H1 Polarity towards BC Hydro)
3 Wire • Delta; or • Ungrounded Wye; or • Impedance Grounded Wye	2	Qty=2, Two Bushing, Connected: • Phase A to Phase B (H1 Polarity to Phase A) • Phase C to Phase B (For all applications, except switchgear, H1 Polarity to Phase C) (For switchgear applications only, H1 Polarity to Phase B)*	Qty=2 • Phase A • Phase C
4 Wire • Solidly Grounded Wye	3	Qty=3, Single Bushing, Connected: • Phase A to Neutral (H1 Polarity to Phase A) • Phase B to Neutral (H1 Polarity to Phase B) • Phase C to Neutral (H1 Polarity to Phase C)	Qty=3 • Phase A • Phase B • Phase C

** For switchgear applications only, and as an exception to the industry convention, the Phase C to Phase B VT primary winding polarity is reversed to simplify the connections. To correct the VT primary winding polarity reversal, BC Hydro also reverses the secondary winding polarity.*

5.1.3 Primary Winding

The VT primary windings shall be connected to the phases on the BC Hydro side of the CTs. The CT H1 polarity marks shall be towards BC Hydro.

The VT or CT shall not be used to support the primary winding connections or bus. The primary winding connections shall:

(a) Not subject the VT and CT bushings to strain; and
(b) Facilitate the easy replacement of the VT and CT.

5.1.4 VT and CT Specification

As per the Responsibilities section of this document, for Generation applications, if the Power Generator is responsible for supplying the VTs and CTs, they shall be in accordance with the requirements of this section.

This section is not applicable to Load Only applications since BC Hydro (not the Customer) is responsible for supplying the VTs and CTs.

5.1.4.1 Measurement Canada Approval

As per the *"Electricity and Gas Inspection Act and Regulations"*, the VTs and CTs shall be approved by Measurement Canada in accordance with CSA Standard CAN3-C13-M83. The Measurement Canada approval number shall be permanently marked on the nameplate.

Measurement Canada maintains an online database of approved VTs and CTs at:
http://strategis.ic.gc.ca/cgi-bin/sc_mrksv/meascan31b/noa.cgi/noasrche.w

5.1.4.2 VT Requirements

The VTs shall have:

A 0.3% accuracy class; and
A burden adequate for the connected load; and
A 115 V or 120 V secondary winding.

A 0.3WXY or 0.3WXYZ VT accuracy and burden is typical.

5.1.4.3 CT Requirements

The CTs shall have:

A 0.3% accuracy class; and
A burden adequate for the connected load; and
A 5 A secondary winding.

A 0.3B0.9 or 0.3B1.8 CT accuracy and burden is typical.

5.1.4.4 BC Hydro Approval

The Power Generator shall submit the details of the proposed VTs and CTs, and the Measurement Canada approval numbers, to BC Hydro for approval.

5.1.5 Lightning Arrestors

Where exposed to lightning, the VTs and CTs shall be located within a lightning arrestors zone of protection.

5.2 Individual Outdoor VTs and CTs

Where individual VTs and CTs are installed on an outdoor support structure, they shall be installed in accordance with the requirements of this section.

5.2.1 Meter Cabinet at the Support Structure

Where the meter cabinet is located at the base of the support structure, armoured cables shall connect the individual VTs and CTs directly to the meter cabinet. These armoured cables shall not be installed underground.

5.2.2 Meter Cabinet not at the Support Structure

Where the meter cabinet is not located at the base of the support structure, armoured cables shall connect the individual VTs and CTs directly to a junction box located at the base of the support structure. These armoured cables shall not be installed underground.

An armoured cable shall connect the junction box to the meter cabinet. This armoured cable may be installed underground.

5.3 Outdoor Metering Kits

A metering kit consists of three VTs and three CTs mounted on a common support rack.

Where a pole top outdoor metering kit is installed, for 4 wire 3 element 12 kV class and 25 kV class power line applications, it shall be installed in accordance with the requirements of this section.

BC Hydro does not offer metering kits for 3 wire 2 element power line applications.

5.3.1 Meter Cabinet at the Base of the Pole

Where the meter cabinet is located at the base of the pole, an armoured cable shall connect the metering kit secondary winding terminal box directly to the meter cabinet. This armoured cable shall not be installed underground.

5.3.2 Meter Cabinet not at the Base of the Pole

Where the meter cabinet is not located at the base of the pole, an armoured cable shall connect the metering kit secondary winding terminal box to a junction box located at the base of the pole. This armoured cable shall not be installed underground.

A second armoured cable shall connect the junction box to the meter cabinet. The second armoured cable may be installed underground.

5.3.3 Typical Installation Drawing

See the separate drawing ES43 J7-01.01 *in the "BC Hydro Distribution Standards Overhead Electrical ES43 series"* document. This drawing is for manually read revenue metering. For remotely read load profile revenue metering;

- Change the designation of the "Source" side of the metering kit to "To BC Hydro"; and
- Change the designation of the "Load" side of the metering kit to "To Customer/Power Generator"; and
- Where the meter cabinet is at the base of the pole, replace the meter cabinet (item 2) with the much larger meter cabinet used for remotely read load profile revenue metering; and
- Where the meter cabinet is not at the base of the pole, replace the meter cabinet (item 2) with a junction box and armoured cable for connection to the larger meter cabinet used for remotely read load profile revenue metering.

5.4 Individual Indoor VTs and CTs

Where individual indoor VTs and CTs are installed in switchgear, they shall be installed in accordance with the requirements of this section.

5.4.1 Instrument Transformer Compartment

The VTs and CTs shall be installed in a switchgear instrument transformer compartment. The instrument transformer compartment shall:

(a) Be barriered off from other compartments; and
(b) Not be used as a splitter; and
(c) Not contain devices other than the BC Hydro revenue metering equipment;
(d) Not require access through other compartments; and
(e) Be permanently labelled as "BC Hydro Metering".

It is acceptable to provide openings, of sufficient size to maintain the required phase bus clearances, through the sides of the instrument transformer compartment, i.e. there is no requirement to completely barrier these openings with insulating material up to and/or contacting the phase buses.

Where it is necessary to route the VT and CT secondary winding wiring through other switchgear compartments, the VT and CT secondary winding wiring shall be installed in a continuous conduit, without access fittings, within the switchgear.

5.4.2 Instrument Transformer Compartment Doors

When (viewed through the open front instrument transformer compartment door) the phase buses are “side-by-side” and all VT and CT primary winding and secondary winding connections are readily accessible, only a front hinged instrument transformer compartment door is required. See drawing TM-A-1144.

However, when (viewed through an open instrument transformer compartment door) the phase buses are “one-behind-the-other”, both a front and a rear hinged instrument transformer compartment door shall be provided. See drawing TM-A-1145.

No means of access, other than through the hinged instrument transformer compartment door(s) shall be provided. Each door shall have provision for locking with an 8 mm (5/16”) shank padlock.

5.4.3 Interlocks

All instrument transformer compartment doors shall be key interlocked.

The provision in CSA Standard C22.2 No. 31 8.4.1.7 permitting locking in lieu of an interlock is not acceptable.

Where there is both a front and a rear door, providing a latching mechanism, that can only be released from within the switchgear instrument transformer compartment, in lieu of a second key interlock, is not acceptable. Key interlocks are required on both doors.

5.4.3.1 Load Only Applications

For **load only** applications, **where there is not a likely potential for power backfeed,** all instrument transformer compartment doors shall be key interlocked with a BC Hydro (line) side disconnect device. The key interlock shall prevent opening the instrument transformer compartment door(s) unless the disconnect device is visibly open.

For **load only** applications, **where there is a likely potential for power backfeed,** all instrument transformer compartment doors shall be key interlocked with a BC Hydro side (line) disconnect device and a Customer (load) side disconnect device(s). The key interlocks shall prevent opening instrument transformer compartment door(s) unless all disconnect devices are visibly open.

Examples of the potential for power backfeed include:

- *Where, by special permission from BC Hydro, there are multiple POMs on the Customer side of multiple power transformers and the power transformer secondary windings may be paralleled; or*
- *Where the Customer has power generation that may be synchronized with BC Hydro.*

However, where the Customer has generation connected via a BC Hydro approved transfer switch, no potential for power backfeed is deemed to exist and only a BC Hydro (line) side disconnect is required.

5.4.3.2 Generation Applications

For **generation** applications, all instrument transformer compartment doors shall be key interlocked with a BC Hydro side disconnect device and a Power Generator side disconnect device(s). The key interlocks shall prevent opening instrument transformer compartment door(s) unless all disconnect devices are visibly open.

Where the POM is on the Power Generator side of the power transformer, the BC Hydro side disconnect device shall be on the BC Hydro side of the power transformer to insure that no-load losses are correctly registered whenever the power transformer is energized.

5.4.3.3 Commissioning

Prior to energization, the Customer/Power Generator shall:

- Completely install and test the key interlock system; and
- Remove and secure any spare keys; and
- Demonstrate the complete operation of the key interlock system to the BC Hydro field meter technician.

Problems arise more frequently when the Customer/Power Generator obtains the key interlock system from one vendor and is required to mount components on equipment supplied by another vendor. All of this work must be complete and functional.

5.4.4 Neutral Bus

For 4 wire 3 element revenue metering applications, the neutral bus, or a neutral bus tap extension, shall be extended to the instrument transformer compartment. It shall be rigid bus not less than 25 mm x 6 mm (1" x 1/4"). Except where it connects to the ground bus, it shall be supported on insulators.

5.4.5 Ground Bus

The switchgear ground bus shall:

(a) Be extended to the instrument transformer compartment; and
(b) Have provision for terminating the BC Hydro installed meter cabinet conduit bonding conductor with either:
    - A 10-32 screw and washer; or
    - A mechanical connector suitable for a #12 to #8 AWG conductor.

5.4.6 Working Ground Points

In compliance with the Worker Compensation Board of British Columbia Occupational Health and Safety Regulations, working ground points, complete with a permanently mounted 25 mm (1") diameter ball type ground stud Hubbell Chance C600-2102 (or equivalent), shall be provided at the following locations within the instrument transformer compartment:

(a) For 3 wire 2 element revenue metering applications:

- On each side of the phase A CT; and
- On each side of the phase C CT; and
- On phase B; and
- On the ground bus,
  i.e. a total of 6 ground studs.

(b) For 4 wire 3 element revenue metering applications:

- On each side of the phase A CT; and
- On each side of the phase B CT; and
- On each side of the phase C CT; and
- On the ground bus,
  i.e. a total of 7 ground studs.

Each ground stud shall be positioned for unobstructed application of a ground clamp using a hot stick.

The ground bus ground stud shall be located immediately behind the instrument transformer compartment door.

Where there is both a front and a rear instrument compartment door, a single ground bus ground stud may be located immediately behind either door.

5.4.7 VTs and CTs

5.4.7.1 Installation

The VTs and CTs should preferably be installed, and the primary winding connections made, at the switchgear manufacture's factory. Alternatively, this work may be done by the Customer/Power Generator in the field. Regardless of where the work is done, the Customer/Power Generator shall be solely responsible for insuring that the installation is in accordance with the switchgear manufacturer's and the inspection authorities requirements.

5.4.7.2 Electrical Clearances

Minimum electrical clearances shall be in accordance with the published switchgear manufacturer's requirements.

While the following clearances are typical:

- *150 mm (6") for 12 kV class Phase-to-Phase; and*
- *125 mm (5") for 12 kV class Phase-to-Ground; and*
- *230 mm (9") for 25 kV class Phase-to-Phase and Phase-to-Ground;*

it is essential that the specific switchgear manufacturer's requirements be maintained since the switchgear certification and electrical performance is based on maintaining the published clearances.

Clearances between the VT or CT body and adjacent VT or CT bodies and ground shall be maintained. Contact BC Hydro for specific VT/CT body clearance requirements.

5.4.7.3 Accessibility

The VT and CT primary winding terminals and secondary winding terminals shall remain accessible and the nameplates shall remain visible. The installation shall facilitate the easy replacement of the VTs, VT fuses and CTs.

When the phase buses are "one-behind-the-other", the VT secondary winding terminals typically face the side of the instrument transformer compartment. 300 mm (12") clearance should be maintained between the side of the instrument transformer compartment and the VT secondary winding terminals.

5.4.7.4 VT Installation and Connections

The VT primary winding fuses shall be in the horizontal position.

The VT H1 primary winding conductors (and for 3 wire 2 element applications, the H2 primary winding conductors):

(a) Shall be sized and supported in accordance with the switchgear manufacturer's requirements with regard to clearances, fault current bracing, partial discharge etc.; and
(b) Shall be permanently connected. *Drawout or automatic self-disconnecting VT primary winding connections are not acceptable*. and;
(c) For 12 kV class and lower voltages, shall be not less than a #6 AWG conductor; and
(d) For 25 kV class voltages, shall be a 1" x ¼" rigid bus. See drawing TM-A-1146. *The fuse holder(s) for 25 kV class VTs is typically cantilevered from the primary winding VT terminal(s). The 1" x ¼" rigid bus is required to provide support and stability to the fuse holder and to prevent its rotation*.

For 4 wire 3 element applications, each VT H2 primary winding terminal shall be connected to the neutral bus with a separate minimum #8 AWG white insulation conductor, *i.e. daisy chaining is not acceptable.*

5.4.7.5 CT Installation and Connections

The CT H1 primary polarity marks shall be towards BC Hydro. Except that, if this orientation prevents access to the secondary winding terminals, the primary winding polarity marks may be towards the Customer/Power Generator. BC Hydro shall be advised if this exception occurs. *In this instance, to correct the CT primary winding polarity reversal, BC Hydro also reverses the secondary winding polarity.*

5.4.7.6 Mounting and Grounding

The VTs and CTs shall be bolted to grounded metal panels using all of the supplied mounting holes. Paint or other protective coatings shall be removed to ensure a low impedance ground connection. Lockwashers shall be installed.

If the VTs or CTs **have** an external ground connector, it shall be connected to the ground bus with a minimum #8 AWG bare or green insulation conductor.

*If the VTs or CTs **do not have** an external ground connector, the mounting bolts and lockwashers are considered to provide adequate bonding.*

6. Meter Cabinet

6.1 Location

The meter cabinet shall be installed in an outdoor or indoor location acceptable to BC Hydro.

Indoor locations are preferred. For outdoor locations, the meter cabinet is supplied complete with thermal insulation and a heater.

6.2 Installation

The, BC Hydro stock number 372-9210 drawing G-D08-A160 Page 1, meter cabinet shall be wall or post mounted. The top of the meter cabinet shall be 1,500 mm (5') to 1,800 mm (6') above finished grade. The VT and CT secondary winding armoured cable or conduit shall enter the meter cabinet through the bottom approximately 405 mm (16") from the left only.

Drawing G-D08-A160 Page 3 indicates a typical outdoor post mounted meter cabinet installation.

6.3 Grounding

In accordance with Section 36 of the *Canadian Electrical Code*, an external meter cabinet ground conductor, not less than #2/0 AWG copper, shall be installed to bond the meter cabinet to the station ground grid electrode.

A #2/0 AWG copper conductor is required since, due to skin effect, its large surface area provides a low impedance path for high frequency electrical noise.

6.4 Auxiliary Power

A dedicated high reliability 120 V AC 15 A circuit shall be provided to the meter cabinet.

Where there is a critical power bus, supplied via a transfer switch from an emergency generator or multiple supply lines, the meter cabinet shall be supplied from the critical power bus. However, a battery powered UPS supply is not required.

7. VT and CT Secondary Winding Wiring

7.1 General

No other devices shall be connected to the VT and CT secondary windings used by the BC Hydro revenue metering equipment.

As per the Responsibilities and Charges section of this document, BC Hydro is responsible for all VT and CT secondary winding conductor terminations. BC Hydro will wire directly to the VT and CT secondary winding terminals with the Measurement Canada approved multi-colour insulation conductors.

7.2 Access to the Second set of Secondary Windings

69 kV class and greater VTs and CTs supplied by BC Hydro typically have a second set of secondary windings. Customer/Power Generator access to the second set of secondary windings may be provided for a one-time fee. Where the Customer/Power Generator elects to use the second set of VT and CT secondary windings:

(a) Use of these windings shall be restricted to the connection of:

- Check metering;
- Demand or energy management devices;
- Voltmeter, ammeter or other similar instruments; or
- Under-frequency relay.

These windings do not have a protective relaying rating. Therefore, other than for under-frequency applications, they may not be used for protective relaying.

(b) The connected load shall not exceed the VT or CT secondary winding maximum nameplate burden; and

(c) The VT and CT secondary winding circuits shall be grounded at single locations only. Failure to comply with this requirement may result in equipment damage and/or personnel injury; and

(d) The VT secondary winding circuit shall not be short circuited. Failure to comply with this requirement may result in equipment damage and/or personnel injury; and

(e) The CT secondary winding circuit shall not be open circuited. Failure to comply with this requirement may result in equipment damage and/or personnel injury; and

(f) BC Hydro will provide a test block as the demarcation point between the BC Hydro and the Customer/Power Generator wiring. The Customer/Power Generator shall not alter the wiring on the BC Hydro side of the test block. The Customer/Power Generator shall be solely responsible for the wiring and the equipment on their side of the test block.

7.3 Cables

7.3.1 Typical Configurations

Typical cable configurations are:

From	To	Typical Cable
Individual Outdoor VTs and CTs	Junction Box or Meter Cabinet	Armoured cable strapped to VT/CT support structure*
Outdoor Metering Kit	Junction Box or Meter Cabinet	Armoured cable strapped to pole
Junction Box	Meter Cabinet	Armoured cable in underground PVC conduit or above ground cable tray
Individual Indoor VTs and CTs located in the Switchgear Instrument Transformer Compartment	Meter Cabinet	Individual conductors in conduit

* For 69 kV class and greater applications, where the Customer/Power Generator has requested access to the second set of secondary windings, there are 2 armoured cables per VT/CT.

7.3.2 Armoured Cable Requirements

Where applicable and practicable, the armoured cables between individual outdoor VTs and CTs and the junction box or meter cabinet should preferably not be installed underground.

Where applicable, the armoured cable between the outdoor metering kit and the junction box or meter cabinet shall not be installed underground.

Where applicable, the armoured cable from the junction box to the meter cabinet may be installed underground. Underground armoured cable shall be installed in a 3” rigid PVC conduit. It shall not be installed in rigid metal conduit or be directly buried.

The VT secondary winding circuits in the armoured cable from the individual outdoor VTs and CTs do not have overcurrent protection. To reduce the chance of a fault, these armoured cables may not be installed underground. A possible exception is made where individual outdoor VTs and CTs are installed on separate outdoor pedestals and it is impractical to provide cable support between them and the junction box or meter cabinet.

When a junction box is used, it contains a circuit breaker to protect the VT secondary winding circuits in the armoured cable between the junction box and the meter cabinet.

Water in conduits can cause crushing and expansion of conductor insulation due to repeated freezing and thawing cycles. It has been BC Hydro's experience that, since it does not expand as much as PVC conduit, rigid metal conduit installations may result in conductor insulation damage.

7.3.3 Individual Conductors in Conduit Requirements

Where applicable, a conduit shall be installed between the switchgear instrument transformer compartment and the meter cabinet.

The conduit shall be either rigid metal, EMT or rigid PVC. The conduit shall have not more than the equivalent of three 90° bends and shall not exceed 25 m in length. The conduit minimum trade size shall be:

- 1 ¼" (35) trade size for lengths up to 10 m; or
- 1 ½" (41) trade size for lengths from 10 m to 25 m.

The conduit shall be continuous and without access fittings. Except that, a "LB style" fitting may be installed immediately adjacent to the meter cabinet provided the cover remains clearly visible and has provision for the installation of a cover seal.

The conduit shall remain visible for its entire length except where it is embedded in a concrete floor or, subject to approval by BC Hydro, where it passes through a wall.

Where it is necessary to route the VT and CT secondary winding wiring through other switchgear compartments, the VT and CT secondary winding wiring shall be installed in a continuous conduit, without access fittings, within the switchgear.

A pull string shall be left in the conduit.

8. Telephone Line

A telephone line is required for remote reading of the main meter and backup meter. Conventional wire-line or alternative technologies may be used, e.g. cellular, fiber optic, microwave, satellite etc. The supply and installation shall be co-ordinated between BC Hydro, the Customer/Power Generator and the telephone company.

As indicated in the following section, because of the complications associated with transmission system connected facilities using conventional wire-lines telephone lines, alternative technologies are preferred.

8.1 Transmission System Connected Facilities with Wire-Line Telephone

Where the POI is to the 69 kV class or higher BC Hydro transmission system **and** where a conventional wire-line telephone is installed, ground potential rise (GPR) protection shall be provided.

When a power system ground fault occurs, all or some of the fault current returns via the earth through the ground grid and produces a potential difference between the ground grid and remote earth. This potential difference is defined as power station ground potential rise (GPR). Where a wire-line circuit is used, GPR protection designed, installed and maintained in accordance with "IEEE Standard 487 Guide for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations" is required. Failure to follow this standard may result in equipment damage and/or personnel injury.

Wire-line GPR protection typically includes an optical isolator, manufactured by Positron Industries Inc. or equivalent, located in a non-metallic telephone GPR isolation cabinet.

The telephone GPR isolation cabinet shall be connected, via a high voltage telephone cable used for no other purpose, to the telephone companies general feeder cable at a point beyond the power station GPR zone of influence. To provide additional protection within the power station, the high voltage telephone cable shall be installed within a continuous PVC conduit. The PVC conduit shall extend to a point not less than 3 m beyond the substation fence and ground grid. Once the high voltage telephone cable leaves the conduit, it may be direct buried. The direct buried cable shall not be installed within 300 mm (12") of any metallic object. The high voltage telephone cable shall not be spliced.

In addition to the revenue metering wire-line circuit, there may be numerous other voice, data, instrumentation and control circuits which may also require GPR protection by the Customer/Power Generator.

8.2 Distribution System Connected Facilities with Wire-Line Telephone

Where the POI is to the 25 kV class or lower BC Hydro distribution system, a Circa model 1357-1SB Order No. 837042 high speed telephone line electronic protector is required. It shall be mounted external to the meter cabinet and shall be bonded to ground with a minimum #6 AWG ground wire.

The high speed electronic protector is in addition to the telephone company's protector. It should be located on the Customer/Power Generator side of the telephone companies protector. It is for use with one balanced pair and is complete with an enclosure. Suppliers are Nedco, Texcan and Anixter in Vancouver. Further information is available at WWW.CIRCATEL.COM (Products / Station Protectors / Station Protector Enclosures / 1-2 Pair).

9. Measurement Canada

This section is applicable to Power Generators only.

As the seller of electricity, the Power Generator, is required by Measurement Canada to hold a Certificate of Registration and to be in compliance with the "*Electricity and Gas Inspection Act and Regulations".* Power Generators shall submit a copy of their Certificate of Registration and/or the approval number to BC Hydro.

Power Generators may find additional information and forms at:
http://strategis.ic.gc.ca/epic/internet/inmc-mc.nsf/vwGeneratedInterE/h_lm02128e.html

These requirements apply for all generation applications even though BC Hydro supplies the meter(s).

The "Electricity and Gas Inspection Act and Regulations" uses the term "Contractor" to refer to the Power Generator.

10. Responsibilities and Charges

The revenue metering responsibilities and charges shall be in accordance with the specific Customer or Power Generator contractual documents. *However, the following sections indicate the typical Customer or Power Generator responsibilities and charges.*

10.1 Responsibilities

The following table defines specific responsibilities.

- BCH BC Hydro
- Cust Customer
- PG Power Generator

Item		**For Load Only Applications By**	**For Generation Applications By**
For Individual Outdoor VT and CT Applications Only			
VTs and CTs	Material	BCH	BCH or PG
	Support Structure	Cust	PG
	Installation	Cust	PG
	Primary Winding Conductor Terminations	Cust	PG
	Secondary Winding Conductor Terminations	BCH	BCH
Junction Box (where applicable)	Material	BCH	BCH
	Installation	Cust	PG
	Conductor Terminations	BCH	BCH
Cable and Connectors between: VTs and Junction Box CTs and Junction Box Junction Box and Meter Cabinet	Material	BCH	BCH
	Installation	Cust	PG
	Conductor Terminations	BCH	BCH

Item		For Load Only Applications By	For Generation Applications By
For Outdoor Metering Kit Applications Only			
Metering Kit complete with VTs and CTs	Material	BCH	BCH
	Pole	Cust	PG
	Installation	Cust	PG
	Lightning Arrestors Material	BCH	BCH
	Lightning Arrestors Installation	Cust	PG
	Primary Winding Conductor Terminations	Cust	PG
	Secondary Winding Conductor Terminations	BCH	BCH
Junction Box at Base of Pole (where applicable)	Material	BCH	BCH
	Installation	Cust	PG
	Conductor Terminations	BCH	BCH
Cable and Connectors between the Metering Kit, Junction Box (where applicable) and Meter Cabinet	Material	BCH	BCH
	Installation	Cust	PG
	Conductor Terminations	BCH	BCH
For Individual Indoor VT and CT Applications Only			
VTs and CTs	Material	BCH	BCH or PG
	Switchgear Instrument Transformer Compartment	Cust	PG
	Installation	Cust	PG
	Primary Winding Conductor Terminations	Cust	PG
	Secondary Winding Conductor Terminations	BCH	BCH
Cable Between VTs, CTs and Meter Cabinet	Conduit Material and Installation	Cust	PG
	Cable Material	BCH	BCH
	Cable Installation	BCH	BCH
	Conductor Terminations	BCH	BCH

Item		**For Load Only Applications By**	**For Generation Applications By**
For All Applications			
Measurement Canada Certificate of Registration	Documentation	BCH	PG
Main Meter	Material & Installation	BCH	BCH
Backup Meter	Material & Installation	BCH	BCH
Meter Cabinet	Material	BCH	BCH
	Installation	Cust	PG
	Connections	BCH	BCH
Meter Cabinet Ground	Material & Installation	Cust	PG
Meter Cabinet 120 V AC Auxiliary Power	Material & Installation	Cust	PG
Telephone Line	Installation Co-ordination	BCH, Cust and Telephone Company	BCH, PG and Telephone Company
	Installation Cost	BCH	PG
	Operating Cost	BCH	PG
Telephone Switcher	Material & Installation	BCH	BCH
Ground Potential Rise (GPR) Protection (Applicable to Transmission System Connected Facilities using Wire-Line Telephone Lines)	Design, Material, Installation & Maintenance	BCH	PG (See * Note)
High Speed Telephone Line Electronic Protector (Applicable to Distribution System Connected Facilities using Wire-Line Telephone Lines)	Material, Installation & Maintenance	BCH	PG

* For Transmission System Connected Generation Facilities, where a conventional wire-line telephone circuit is used:

- The Power Generator shall provide written confirmation, signed by a professional engineer, that "Ground potential rise (GPR) protection has been designed and installed in accordance with IEEE Standard 487 *Guide for the Protection of Wire-Line Communication Facilities Serving Electric Power Stations* and the GPR equipment manufacturers requirements"; and
- The Power Generator shall provide written confirmation that “The Power Generator will maintain the ground potential rise (GPR) protection in accordance with the GPR equipment manufacturers requirements".

10.2 Charges

10.2.1 Customer Charges for Load Only Applications

For a single POM, the Customer is typically not charged for the revenue metering material and labour provided by BC Hydro. However, if the Customer requests a single POM, different from the most cost effective POM determined by BC Hydro, the Customer is typically charged for the incremental cost of their requested POM.

If the Customer requests multiple POMs, the Customer is typically charged for the incremental cost associated with the additional POM.

10.2.2 Power Generator Charges for Generation Applications

The Power Generator shall lease the main meter from BC Hydro. Under the terms of the lease, Hydro is responsible for the supply, programming, testing, verifying, sealing, maintaining, re-verifying, repairing and/or replacing the main revenue meter in accordance with the “Electricity and Gas Inspection Act and Regulations” as administered by Measurement Canada.

The Power Generator is not charged for the backup meter.

The Power Generator is typically charged for all other revenue metering material and labour provided by BC Hydro.

11. Drawings

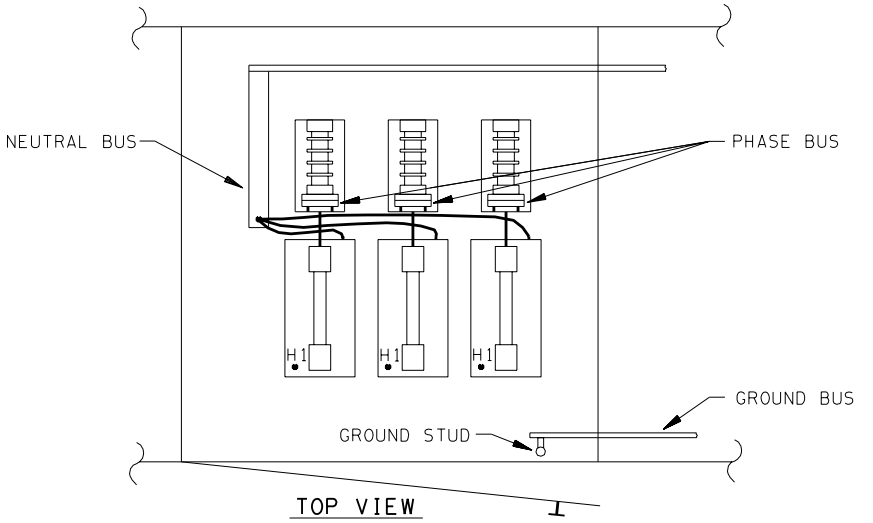
Individual Indoor VTs and CTs

TM-A-1144	Switchgear Instrument Transformer Compartment “Side-by-Side” Phase Buses
TM-A-1145	Switchgear Instrument Transformer Compartment “One-Behind-the-Other” Phase Buses
TM-A-1146	Switchgear Instrument Transformer Compartment 25 kV Class VT Primary Winding Connections

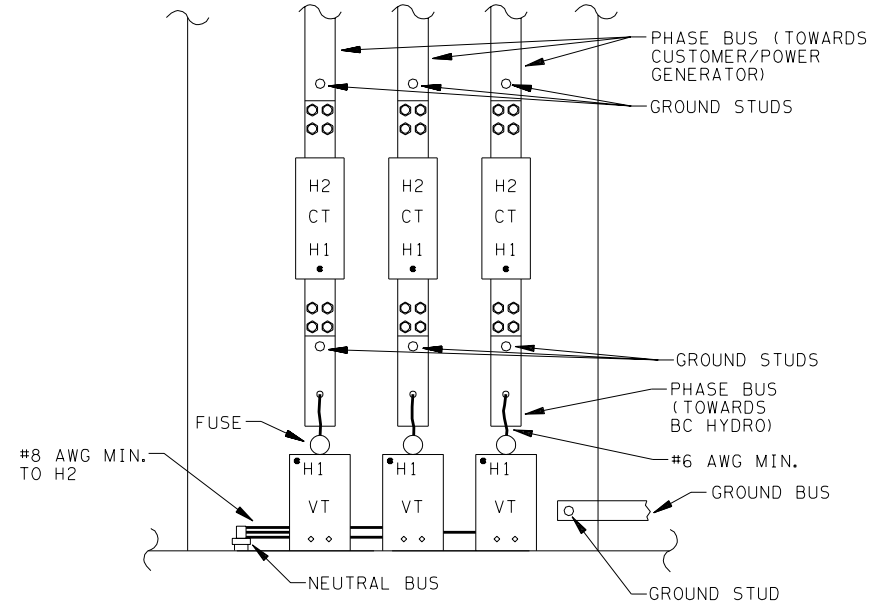
Meter Cabinet

G-D08-A160 Page 1	Remotely Read Load Profile Indoor or Outdoor Meter Cabinet
G-D08-A160 Page 3	Remotely Read Load Profile Indoor or Outdoor Meter Cabinet – Outdoor Post Mounting

TM-A-1144



TOP VIEW



FRONT VIEW

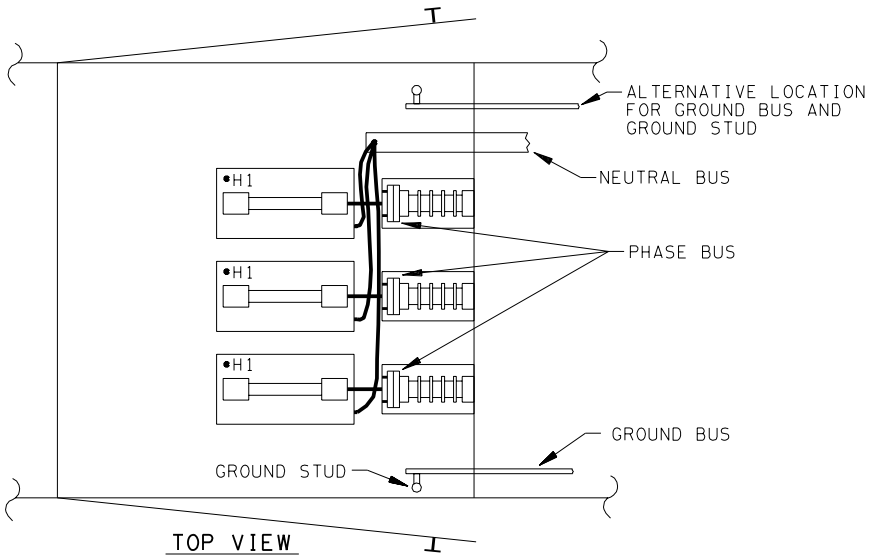
NOTES:
1. 12 kV CLASS 4 WIRE 3 ELEMENT ILLUSTRATED.
2. ONLY A FRONT DOOR IS REQUIRED.

DRAFTER	DESIGNER	APPROVED	SWITCHGEAR INSTRUMENT TRANSFORMER COMPARTMENT "SIDE-BY-SIDE" PHASE BUSES
JW	W. CROSS	B. HUGHES	
ORIGINAL ISSUE DATE: APRIL 2004			

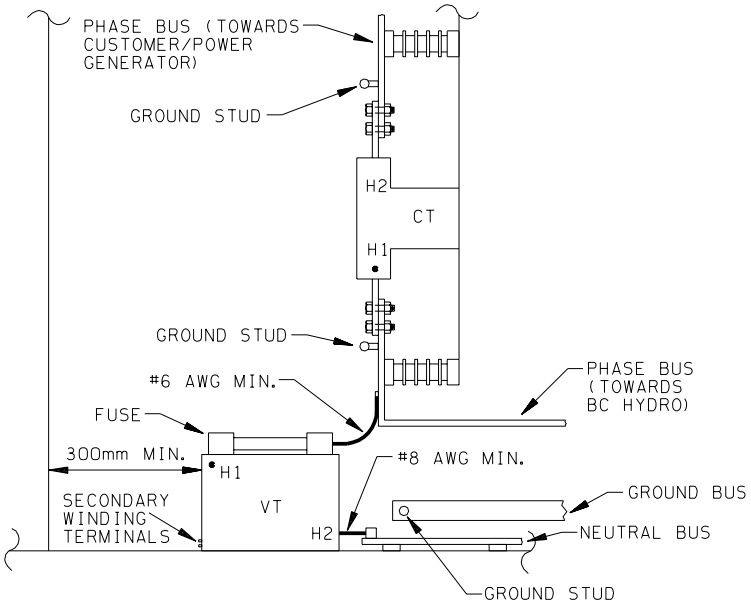
REVISED

BC hydro — REVENUE METERING | PAGE 1 OF 1 | TM-A-1144 | R. 0

TM-A-1145



TOP VIEW



FRONT VIEW

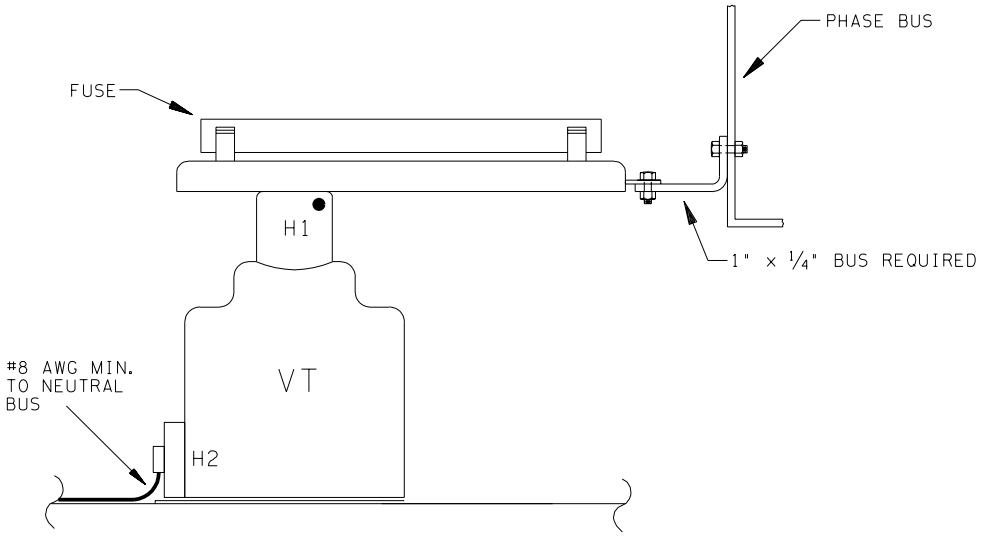
NOTES:
1. 12 kV CLASS 4 WIRE 3 ELEMENT ILLUSTRATED.
2. BOTH A FRONT AND A REAR DOOR ARE REQUIRED.

DRAFTER	DESIGNER	APPROVED	SWITCHGEAR INSTRUMENT TRANSFORMER COMPARTMENT "ONE-BEHIND-THE-OTHER" PHASE BUSES
JW	W. CROSS	B. HUGHES	
ORIGINAL ISSUE DATE: MARCH 2004			

REVISED

BCHydro — REVENUE METERING | PAGE 1 OF 1 | TM-A-1145 | R. 0

TM-A-1146



NOTE:

1. THE 1 X ¼" BUS IS REQUIRED TO PROVIDE SUPPORT AND STABILITY TO THE FUSE HOLDER AND TO PREVENT ITS ROTATION.

DRAFTER	DESIGNER	APPROVED	INDOOR 25 kV VT PRIMARY WINDING CONNECTION
JW	W. CROSS	B. HUGHES	
ORIGINAL ISSUE DATE: APRIL 2004			

REVISED

BCHydro — REVENUE METERING | PAGE 1 OF 1 | TM-A-1146 | R. 0

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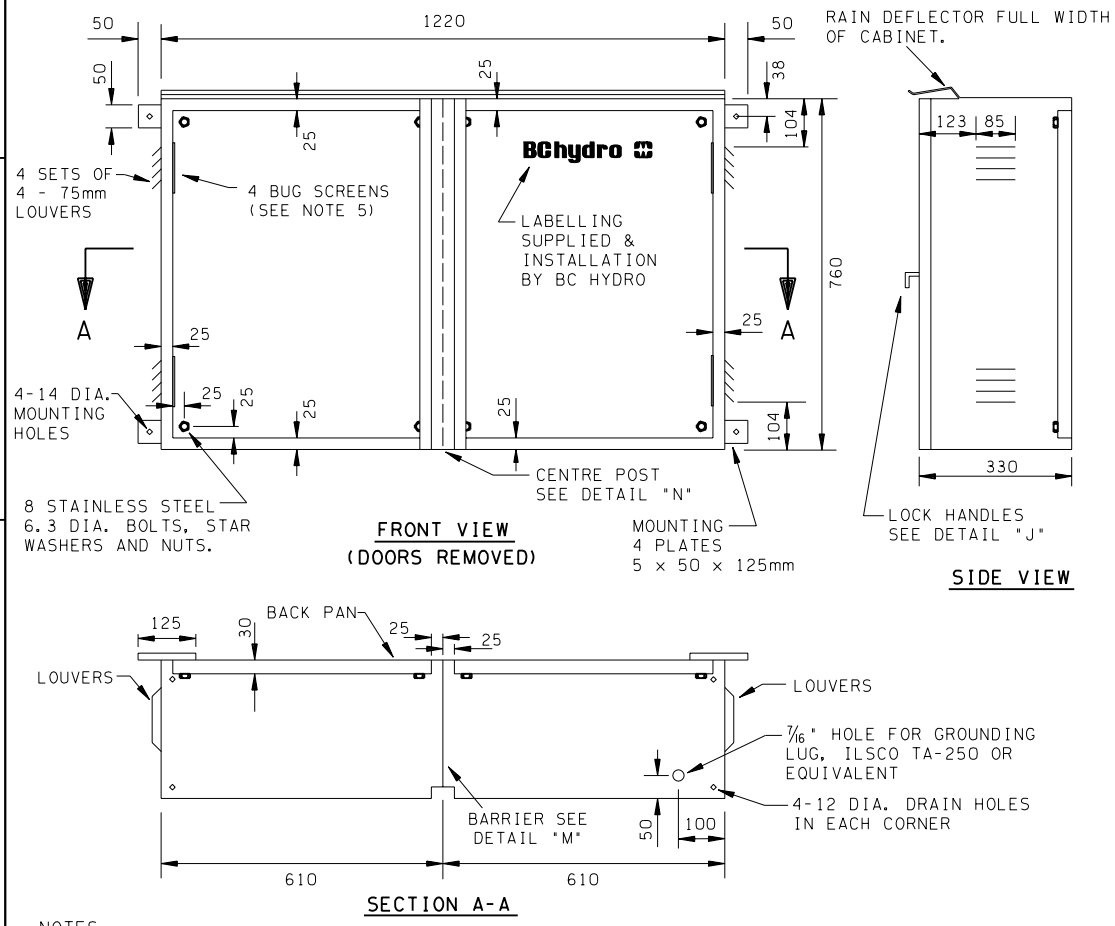


NOTES:

1. MATERIAL FOR THE ENCLOSURE SHALL BE 14 GAUGE MAGNETIC STAINLESS STEEL, TYPE 3CR12 OR 410S.
2. MATERIAL FOR THE BACK PAN SHALL BE 10 GAUGE ALUMINUM.
3. MATERIAL FOR HINGES SHALL BE STAINLESS STEEL. IF WASHERS ARE USED, BOND THEM TO HINGE.
4. MATERIAL FOR HEATER COVER SHALL BE ALUMINUM FLATTENED EXPANDED MESH (1/2"-.081F). HEATER COVER TO BE SUPPLIED BY CONTRACTOR. TO BE SHIPPED TAPED INSIDE CABINET.
5. THE BUG SCREEN SHALL BE INSECT CLOTH #18 (.017" DIA. WIRE-.039" OPENING).
6. A FLEXIBLE GROUND STRAP WILL BE SUPPLIED AND INSTALLED BY B.C. HYDRO. THIS GROUND STRAP IS INSTALLED NEAR TO AND ACROSS THE LOWER HINGE OF EACH DOOR. WELD 5/16" DIAMETER X 3/4" LONG THREADED STUDS COMPLETE WITH NUT AND WASHER. CENTRE STUD WITH LOWER HINGE, 75mm TO THE INSIDE OF EACH DOOR AND INSIDE THE CABINET.
7. GROUND CONNECTOR FOR #4/0 CU. WILL BE SUPPLIED AND INSTALLED BY B.C. HYDRO.
8. FOR CABINET DETAILS SEE PAGE 2. FOR MOUNTING DETAILS SEE PAGE 3.

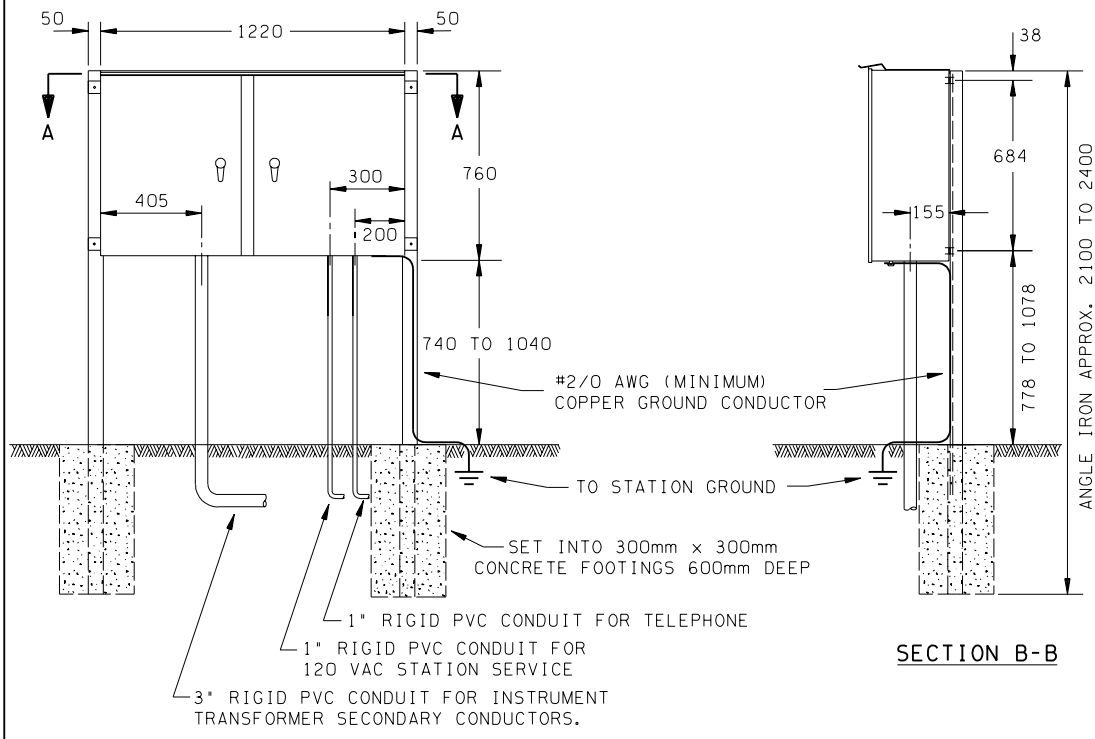
STOCK NO. 372-9210

DRAFTER	DESIGNER	APPROVED	REMOTELY READ LOAD PROFILE INDOOR OR OUTDOOR METER CABINET
JW	MB/SC	E. VALOIS	
ORIGINAL ISSUE DATE: JUNE 1997			

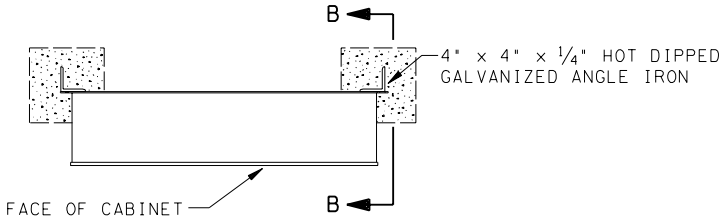
BChydro DISTRIBUTION STANDARDS | PAGE 1 OF 3 | G-D08-A160 | R. 6

REVISED | R4-GENERAL REVISIONS JAN. '01 SC | R5-HOLE DIMEN. REVISED MAY '01 SC | R6-TITLE REVISED MARCH '04 WC

G-D08-A160 Page 3



SECTION B-B



SECTION A-A

OUTDOOR POST MOUNTING

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE STATED.
2. METER DEPARTMENT OR DISTRICT MANAGER TO DIRECT METER CABINET LOCATION.
3. FOR METER CABINET DETAILS SEE PAGES 1 AND 2.

STOCK NO. 372-9210.

R6-TITLE REVISED AND MOUNTING HEIGHT ADJUSTED MARCH '04 WC

REVISED

DRAFTER	DESIGNER	APPROVED	REMOTELY READ LOAD PROFILE INDOOR OR OUTDOOR METER CABINET
JW	MB/SC	E. VALOIS	
ORIGINAL ISSUE DATE: JUNE 1997			

BC hydro DISTRIBUTION STANDARDS | PAGE 3 OF 3 | G-D08-A160 | R. 6