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REVISIONS: UPDATED LEGAL ACKNOWLEDGEMENT FORM. FD MAR '16

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|---|-------------|--|---|---|----------------------------------|
| DESIGNED | RECOMMENDED | ACCEPTED | ENGINEER OF RECORD | <p>NOTICE FROM THE EXECUTIVE VICE PRESIDENT TRANSMISSION AND DISTRIBUTION AND CUSTOMER SERVICE</p> | |
| J. AGNOLIN | F. DENNERT | G. REIMER |  | | |
| <p>DISTRIBUTION STANDARDS</p> <p>BC Hydro</p> | | <p>ISSUED: MAR 2016 REPLACES: MAY 2004 ORIGINALLY ISSUED: NOV 1980</p> | | <p>PAGE 1 OF 2</p> | <p>ES43/53/54/55/65 A1-01.01</p> |
| | | | | R | 4 |

Scope

This manual is one of a series containing standards for construction of the BC Hydro electrical distribution plant within the service area of BC Hydro. A new distribution plant shall be designed, constructed, owned, operated, maintained and repaired to these standards.

Purpose of Standards

BC Hydro objectives require standardization to:

- a) Ensure uniform safety requirements comply with BC statutes and regulations.
- b) Provide uniform system reliability.
- c) Provide uniform operating practices.
- d) Permit economic bulk purchasing of materials.
- e) Achieve optimum life cycle cost of plant construction.
- f) Effect efficient quality assurance.

Responsibility

The Distribution Standards Department prepares these standards and verifies that specified plant and procedures will perform adequately under all normally expected conditions encountered throughout the province of British Columbia. These standards are approved by Professional Engineers. It is the responsibility of BC Hydro Managers to ensure that the standards are followed unless abnormal conditions are encountered that require variations. These variations should be kept to a minimum and their performance shall be the responsibility of the Professional of Record in charge of the project, who will record and seal the variation based on satisfactory qualifications and experience to do so. As per the latest revision of the BC Hydro Distribution Owner's Engineer Guide, these variations must be accepted by BC Hydro's Owner's Engineer.

Use of Stock Materials

The electrical distribution plant covered by these standards is built using stock materials approved by a Professional Engineer as required by law. The use of non-stock materials for special and unusual situations must be approved by Distribution Standards or the BC Hydro Engineer responsible for the project.

Revisions to Manual





These standards are revised from time to time to improve the safety, performance, workability, cost effectiveness or appearance of the plant. The existing plant built to previous standards need not be updated unless so specifically advised by BC Hydro. When maintenance or other work, such as voltage conversion or conductor change is being done, updating plant to current standards is encouraged.

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REVISIONS: UPDATED LEGAL ACKNOWLEDGEMENT FORM. FD MAR '16

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|--|--|--|---|--|---------------------------|--------|
| DESIGNED J. AGNOLIN | RECOMMENDED  F. DENNERT | ACCEPTED  S. REIMER | ENGINEER OF RECORD  F. U. DENNERT PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA | NOTICE FROM THE EXECUTIVE VICE PRESIDENT TRANSMISSION AND DISTRIBUTION AND CUSTOMER SERVICE | | |
| DISTRIBUTION STANDARDS  BC Hydro | | ISSUED: MAR 2016 REPLACES: MAY 2004 ORIGINALLY ISSUED: NOV 1980 | | PAGE 2 OF 2 | ES43/53/54/55/65 A1-01.02 | R 4 |

Secondary Services Single-Phase up to 600 A 120/240 V Wiring and Revenue Metering Connections

ES53 S1-01

Application

This standard describes BC Hydro schematics and wiring diagrams for various configurations of customer-owned single-phase 120/240 V up to 600 A single or multiple metered underground services for small residential and commercial customers. See ES54 S1-01 through S1-04 for meter socket sizes and acceptable customer service configurations. The underground schematics and wiring diagrams in this standard also include BC Hydro revenue metering requirements.

Revision Notes

Removed “Hold for future” watermark from Figure 5. Changes are marked by green vertical revision lines in the left margin. This revision released concurrently with Standards and Equipment Advisory Information Bulletin 2023-029 *Limited Release of Single-Phase Secondary 320A 120/240V Services with Self-Contained Metering*.

References

BC Hydro Distribution Standards


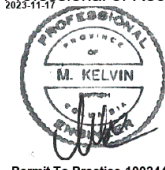




| | |
|------------|---|
| ES53 F1-02 | Transformer Single-Phase Low-Profile Pad-Mount General Layout and Wiring Details |
| ES53 M1-02 | Structures on Wood Poles Cable Attachment Methods |
| ES53 U1-01 | Cable and Conductor Data, New Construction |
| ES54 S0-05 | Services General Notes, Service Ducts and Trenches |
| ES54 S1-01 | Secondary Single-Phase Services 200 A Single and 400 A Multiple Self-Contained Meter Installation |
| ES54 S1-02 | Secondary Single-Phase Services 320 A Self-Contained Meter Installation |
| ES54 S1-03 | Secondary Single-Phase Services 400 A and 600 A CT-Based Meter Installation |
| ES54 S1-04 | Secondary Single-Phase Services 200 A to 600 A Pad-Mounted Kiosk and Pedestal, Self-Contained and CT-Based Meter Installation |
| ES55 S5-03 | Short-Circuit Assessment in Low-Voltage Networks |

Other BC Hydro Documents

| | |
|--------------------|--|
| Secondary Metering | Requirements for Secondary Voltage Revenue Metering (750 V and less) |
| DI S10-1 | Electric Service Connections – General |
| DI S10-4 | Electric Service Connections – Voltages |
| ETR 040 | Presence of High Fault Currents on 120/240 V Customer Services and Proposed Mitigation |

External Documents

| | |
|--------------------|---|
| BCEC | Canadian Electrical Code, Part I (CSA 22.1) adopted for BC and endorsed by Technical Safety BC (TSBC) |
| CSA 22.2 No. 115 | Meter-mounting devices |
| TSBC D-EI 2017-01 | Directive: Exemptions to public utilities |
| TSBC IB-EL 2017-04 | Information Bulletin: Electrical Safety Regulation application to public utilities |

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|------------------------------------|---|---|---|----------------|
| Designed: M. Kelvin, P. Eng |  | Professional of Record 2023-11-17  Permit To Practice-1002449 | Secondary Services Single-Phase up to 600 A 120/240 V Wiring and Revenue Metering Connections | |
| Checked: M. Kelvin, P. Eng |  | | | |
| Reviewed: M. Stevens, P. Eng |  | Issued: 2023-11-17 Effective: 2023-11-17 | DISTRIBUTION STANDARDS  | ES53 S1-01 R12 |
| Approved: H. Giesbrecht, P. Eng |  | | | |

Notes

1. General

- a. Table 1 shows customer service configuration options and corresponding schematics diagrams per ES54 S1-01 through S1-04.
- b. Customer service, bonding, and grounding conductors shall be installed and terminated on the load side of the meter socket and the customer service main breaker before BC Hydro installs utility supply cables on the line side and seals the meter socket and all unmetered cables and buses for BC Hydro access only.

Table 1 – Service configurations and schematics up to 600 A 120/240 V services

| Wiring diagram figure | Service size | Service main breaker | Metering type ¹ | CT provision |
|-----------------------|--------------------|----------------------------------|----------------------------|--|
| 1 | Up to 125 A single | Up to 125 A | Hot | No |
| 2 | Up to 200 A single | Up to 200 A load side | Hot | No |
| 3 | 400 A multiple | Up to 200 A load side | Hot | No |
| 4 | 320 A | 300 A or 200 A + 125 A load side | Hot | No |
| 5 | 400 A | 400 A line side | Cold | Meter socket, c/w test block |
| 6 | 400 A | 400 A line side | Cold | Integral service assembly CT, c/w test block |
| 7 | Up to 600 A | Up to 600 A line side | Cold | CT compartment |
| 8 | Up to 600 A | Up to 600 A line side | Cold | Meter socket and CT compartment |
| 9 | Up to 600 A | Up to 600 A metering kiosk | Cold | Self-contained or transformer rated meters |

Note 1. Hot-metered direct connection to utility supply with no overcurrent protection device. Cold-metered connection after customer overcurrent device.

2. Service in Duct

- a. Underground service duct should be installed outside the foundation walls and run on the surface of the exterior building walls as shown in ES54 S0-05. Service duct may be installed within the foundation and building wall if encased in concrete.
- b. Service runs shall be thoroughly sealed with duct seal (material no. 141-1345) at the point where BC Hydro conductors enter the meter socket enclosure. The BC Hydro designer may specify Rayflate duct sealant (material no. 141-1383) for earth gases and downward sloping services.
- c. The service location on the building shall be on the wall closest to the stub-off point or within 1 m back from that wall on either side.
- d. BC Hydro will supply, pull, and install service cables inside customer-owned service cable ducts. Service cables will be sized in accordance with the rating of the customer service main breaker or the rating of the customer service panel or assembly. Table 2 shows a list of BC Hydro service cable sizes and material numbers.
- e. BC Hydro will not supply 120/240 V customer services larger than 600 A. Larger services shall be fed from BC Hydro 120/208 V supply or customer-owned transformation.
- f. Service cable ampacities are calculated using 0.8 load factor and conduits per ES53 U1-01.

Table 2 – Service cable sizes and material numbers for services up to 600 A

| Customer service size | Aluminum | | | Copper | | |
|-----------------------|----------------|---------------------------------|----------------------|----------------|---------|-----------------|
| | No. of bundles | Size | Material number | No. of bundles | Size | Material number |
| Up to 125 A | 1 | #1 | 382-3100 | N/A | N/A | N/A |
| 200 A | 1 | #4/0 | 382-3102 | 1 | #1/0 | 380-1971 |
| 320 A | 1 | 350 kcm | 382-3102 | N/A | N/A | N/A |
| 400 A | 1 | 350 kcm or 500 kcm ¹ | 382-3102 or 382-3105 | 1 | 350 kcm | 380-1973 |
| 600 A | 2 | 350 kcm | 382-3104 | 2 | #4/0 | 380-1972 |

Note 1: 400 A 80% rated service may be supplied with 350 kcm Al triplex. For longer service runs and voltage drop presence install 500 kcm Al or 350 kcm Cu triplex.

- g. BC Hydro will supply and install all service cable clamps inside sealed utility cable compartment. Cushioned-type cable clamps will be mounted onto customer-owned support channels as shown in ES54 S1-03 and S1-04 standards. Table 3 shows a list of cable clamps and material numbers as standard BC Hydro stock items.

Table 3 – BC Hydro-supplied cable clamp sizes and material numbers

| Cable description | Clamp size | Cable OD range (mm) | Material number |
|---------------------|------------|---------------------|-----------------|
| 4/0 AWG, copper | ¾" | 17-19 | 97008227 |
| 350 kcmil, copper | 7/8" | 19-22 | 97008228 |
| 500 kcmil, copper | 1" | 23-25 | 97008229 |
| 4/0 AWG, aluminum | 5/8" | 14-16 | 97008226 |
| 350 kcmil, aluminum | 7/8" | 19-22 | 97008228 |
| 500 kcmil, aluminum | 1" | 23-25 | 97008229 |

- h. Secure cables using cable grips attached to customer provided channel for service installations in high flood plains where cables are terminated in a mezzanine floor above the flood plain. Size cable grips per ES53 M1-02.

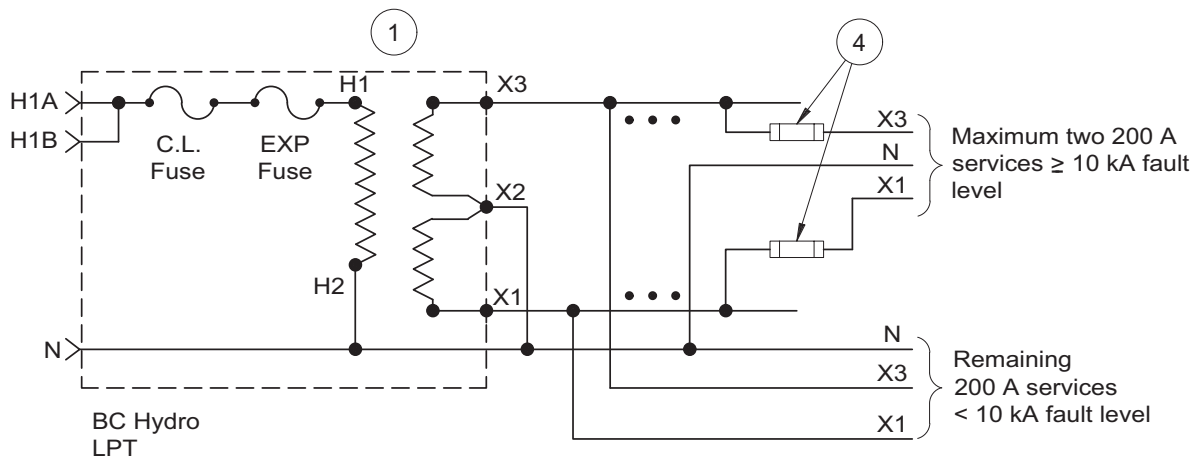
3. BC Hydro Supply Transformers

- a. BC Hydro will supply and install the necessary transformers required to meet customer load demand. Customer-owned service fed from underground duct may be supplied by a BC Hydro overhead pole-mounted transformer or pad-mounted low-profile transformer. Table 4 shows the list of BC Hydro transformer sizes corresponding to a single customer service.

Table 4 – BC Hydro nominal transformer sizes for a single customer service 120/240 V supply

| Customer main breaker size | Overhead transformer (kVA) | Low-profile transformer (kVA) |
|----------------------------|----------------------------|-------------------------------|
| Up to 125 A | 25 | 25 |
| 200 A | 50 | 50 |
| 400 A | 75 | 75 |
| 600 A | 100 | 100 |

- b. Table 4 transformers are based on 80% demand with sustained peak loads up to 110% of transformer kVA, per note 2. A BC Hydro designer may specify a smaller transformer size subject to load diversity factor calculations.
- c. BC Hydro-supplied transformers are rated for 110% of the nameplate kVA for a maximum duration of 8 hours within a 24-hour period, with a continuous preload of 80% and a maximum temperature rise of 65°C over 30°C ambient.
- d. BC Hydro continues to install larger pad-mounted transformers with higher available fault level above 10 kA to meet increasing customer load demand. New construction and upgraded customer-owned service breaker panels shall therefore have 22 kA minimum interrupting capacity.
- e. BC Hydro continues to replace existing smaller low-profile transformers with larger transformers with available fault level above 10 kA to meet growing load demand by existing customers. As most existing customer breaker panels are only rated to 10 kA fault current level, BC Hydro designers shall follow ES55 S5-03 to determine if current limiting fuses are required.
- f. Figures 1 and 2 show a schematic diagram and installation details for current limiting fuses when BC Hydro upgrades an existing low-profile transformer to a larger size having increased available fault current level above 10 kA. Figure 2 shows the requirement for a pyramid pad installation when installing current limiting fuses inside a new low-profile transformer.



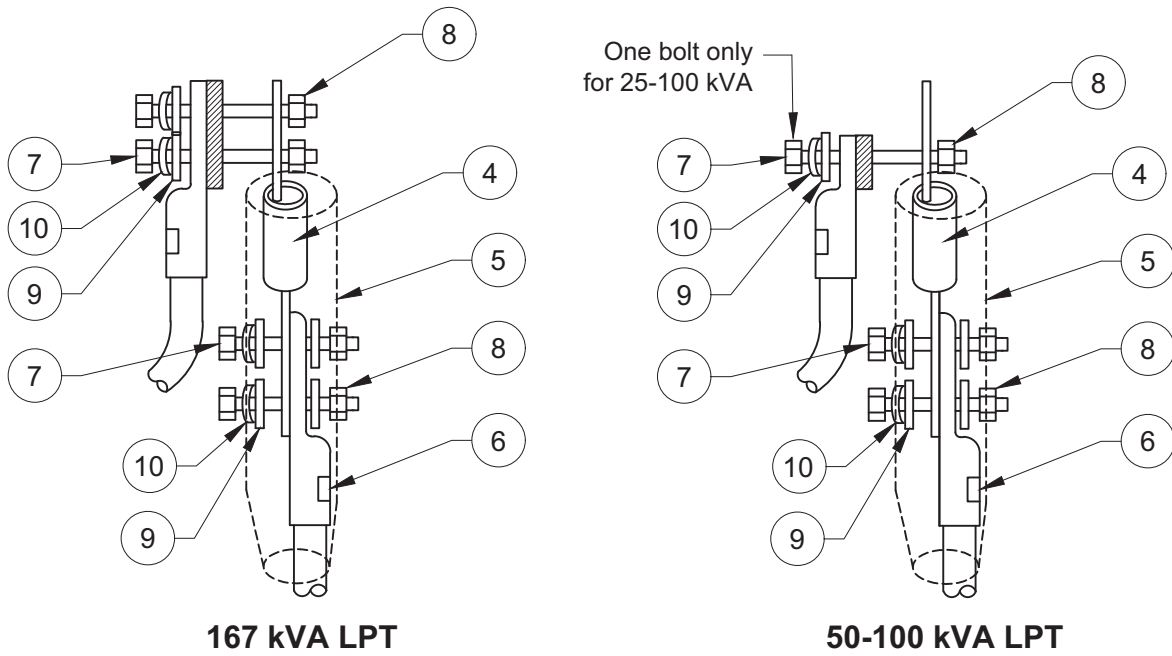
CAUTION
 Fault limiter fuses shall not be installed on flat transformer pad. Pyramid pad shall be used.

Figure 1 – Installation schematic for current-limiting fuses

- g. Look-up tables previously available in this standard have been moved to ES55 section S5 *Voltage Drop*, including minimum service cable length. This information and construction details will eventually be moved to ES64 maintenance standards, a new class of standards.
- h. Table 5 lists the materials needed for installing the current limiting fuses shown in Figure 2.

Table 5 – Materials required for 50 kVA to 167 kVA

| Item | Description | Material number | Quantity |
|------|--|----------------------|----------|
| 1 | Transformer 50-167 kVA, 7.2/14.4 kV - 120/240 V | BC Hydro | 1 |
| 2 | Bussman cable limiter fuse | 96022507 | 2 |
| 3 | Rubber sealing sleeve | 388-2008 | 2 |
| 4 | Compression connector | 388-0458 | 3 |
| 5 | Capscrew zinc plated ½" x 64 mm Capscrew zinc plated ½" x 38 mm | 100-6630 100-6626 | 12 |
| 6 | Nut hex zinc plated ½" | 102-1225 | 12 |
| 7 | Washer flat zinc plated ½" | 102-4136 | 24 |
| 8 | Washer disc spring ½" | 102-4131 | 12 |



Detail 1

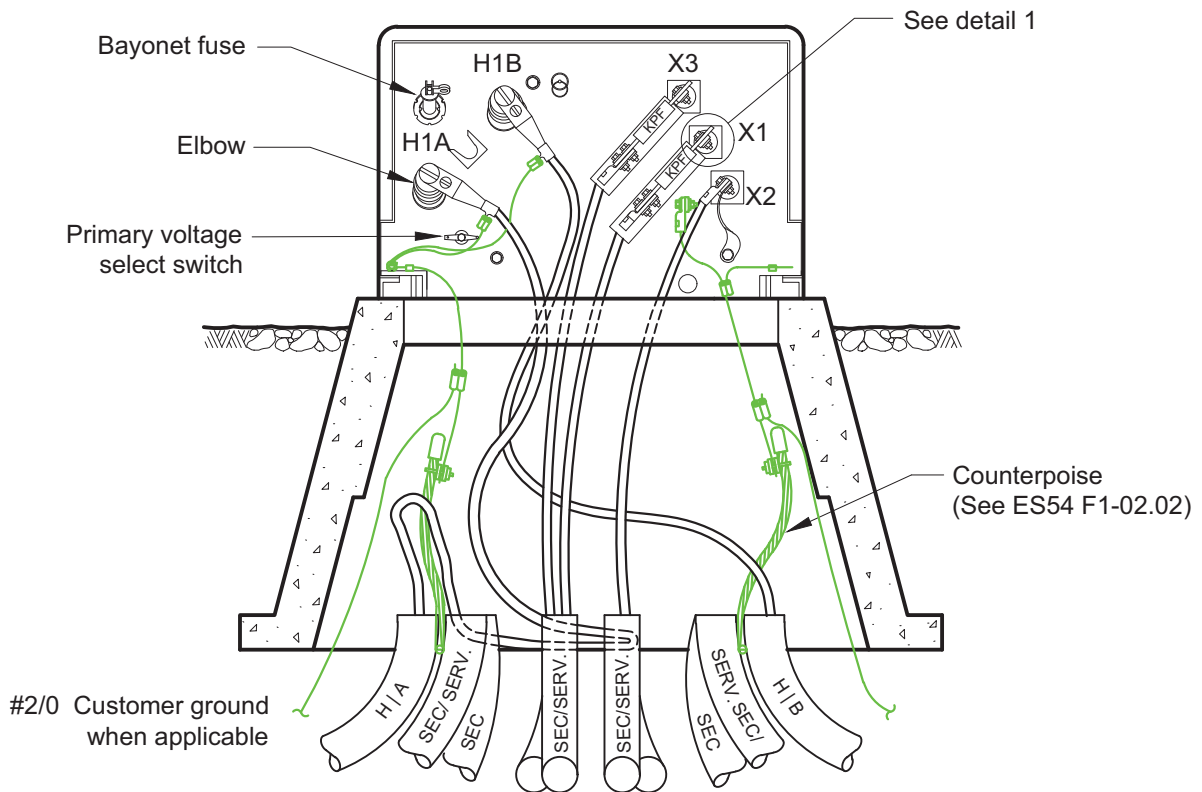


Figure 2 – Installation details for current-limiting fuses

4. Meter Socket and Service Cable Requirements

- a. The underground service duct should enter on the left side of the meter socket to accommodate the bending radius of the incoming BC Hydro large service cables and to avoid crossing customer service conductors.
- b. Line-side lugs shall be tunnel-type and accept the conductors listed in Table 2. All BC Hydro conductors have compact stranding.

5. Revenue Metering Requirements

A single 200 A meter socket or individual meters for multiple main meter sockets shall meet the following BC Hydro revenue metering requirements:

- a. Each meter socket enclosure's dimensions and service assemblies shall not be smaller than the dimensions shown in ES54 S1-01 through S1-04.
- b. Each meter socket shall carry CSA 22.2 No. 115 certification of compliance and meet BC Hydro requirements contained in section 4.1 of the Secondary Metering guide.
- c. Each 200 A meter socket shall have a single cover plate secured to the meter socket enclosure with a pull bar having a latch tab located inside the revenue metering round cut-out with a drip flange. Split or multiple cover plates requiring a BC Hydro padlock are not acceptable to BC Hydro.
- d. After inserting, the revenue metering is fastened to the cover plate round cut-out using a seal ring, sealed for restricted access to BC Hydro only.
- e. Revenue meter socket cover plate removal does not require the use of tools in proximity to energized jaws to undo screws holding the revenue meter socket cover plate in place.
- f. Metered, unmetered, line, and load conductors shall not be installed inside the same raceway and shall not cross each other.
- g. BC Hydro no longer connects 120 V 100 A single-phase two-wire services. For such services, the customer shall supply and install a standard 120/240 V 200 A or 100 A single-phase meter socket for BC Hydro to connect three-wire supply service cables and plug in a standard 200 A revenue meter. The customer could then connect 120 V 100 A single-phase two-wire service on the load side of the revenue meter.
- h. If an existing 120/240 V 200 A single or 200 A or 400 A multiple position meter socket has been submerged in water due to flooding in the affected area, the submerged meter socket shall be replaced with new meter sockets before BC Hydro can re-energize the service.
- i. All unmetered cables and buswork to the point of connection shall have sealable covers for restricted access to BC Hydro personnel only. BC Hydro shall not accept any residential service installation up to 600 A 120/240 V single-phase located inside single-family dwellings or a building.
- j. The maximum number of meter sockets for multiple main services is four. For multiple main installations with more than four meter sockets, BC Hydro requires a service switch ahead of the multiple service main, in accordance with BC Hydro requirements for secondary voltage revenue metering.
- k. All multiple main enclosures shall have a separate utility cable compartment for the BC Hydro underground service cable connection.

6. Meter Sockets for Self-Contained Revenue Meters

- a. BC Hydro supplies and installs two types of self-contained 120/240 V revenue meters:
 - i. 200 A load-break rated plug-in self-contained meter with remote link; and
 - ii. 320 A plug-in self-contained meters with remote link, no loadbreak rating, requires bypass switch in meter socket for meter installation and removal – HOLD FOR FUTURE.

For smaller loads, the customer may install a 100 A meter socket with special approval from the Revenue Metering department. BC Hydro will supply and install 200 A self-contained revenue meters.

- b. Figure 3 shows typical wiring schematics for a 200 A 120/240 V meter socket having a self-contained 200 A revenue meter. Each meter is equipped with an internal loadbreak switch suitable for remote operation by BC Hydro. The internal loadbreak switch may not be used as means of safety isolation.

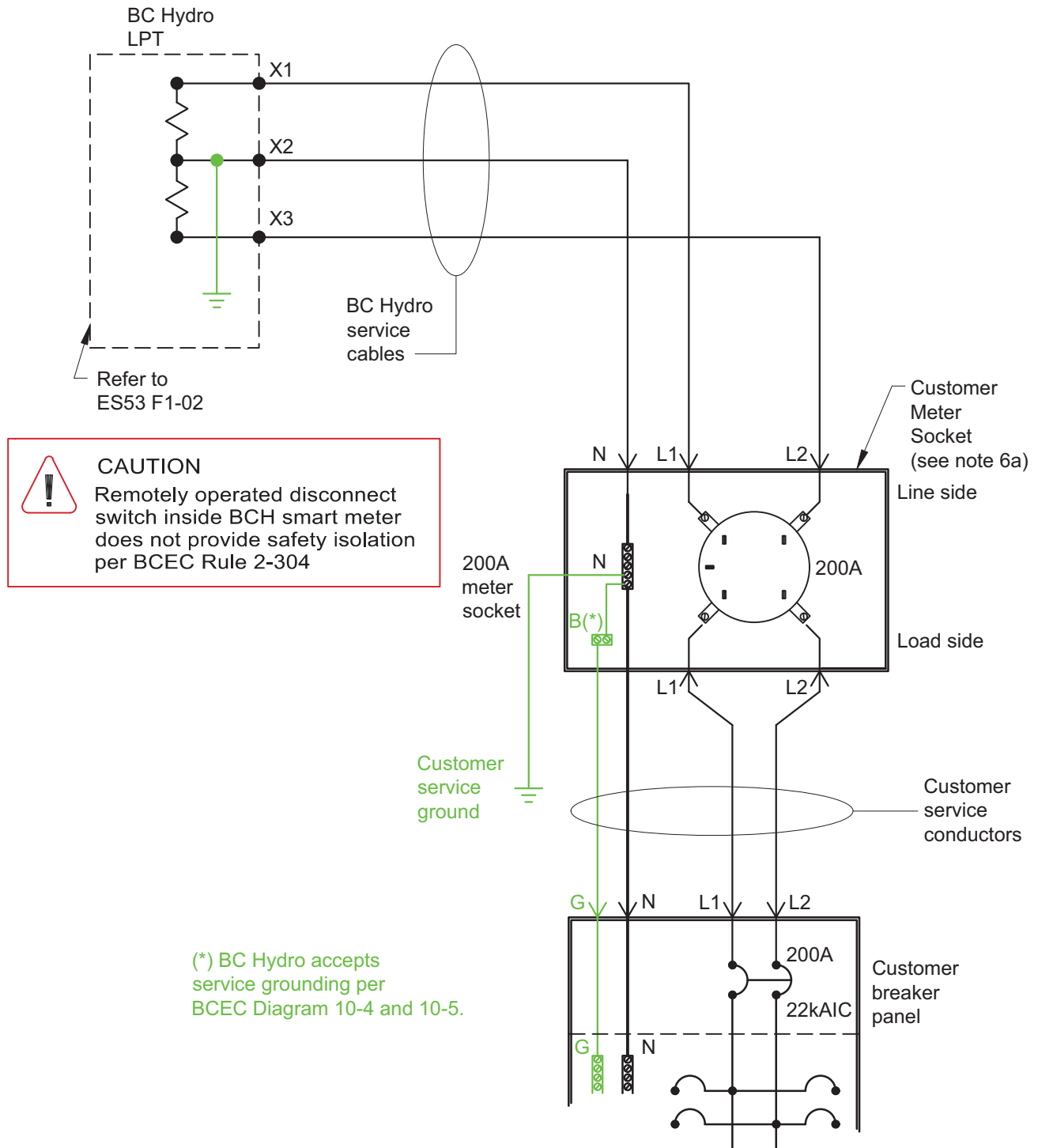


Figure 3 – 200 A 120/240 V service typical schematic diagram

- c. Figure 4 shows a multiple main meter socket, suitable for the installation of up to four revenue meters described in note 6a. The customer service grounding conductor is terminated in the customer portion of the meter sockets. A metal enclosure serves as a conductive path for bonding connections.

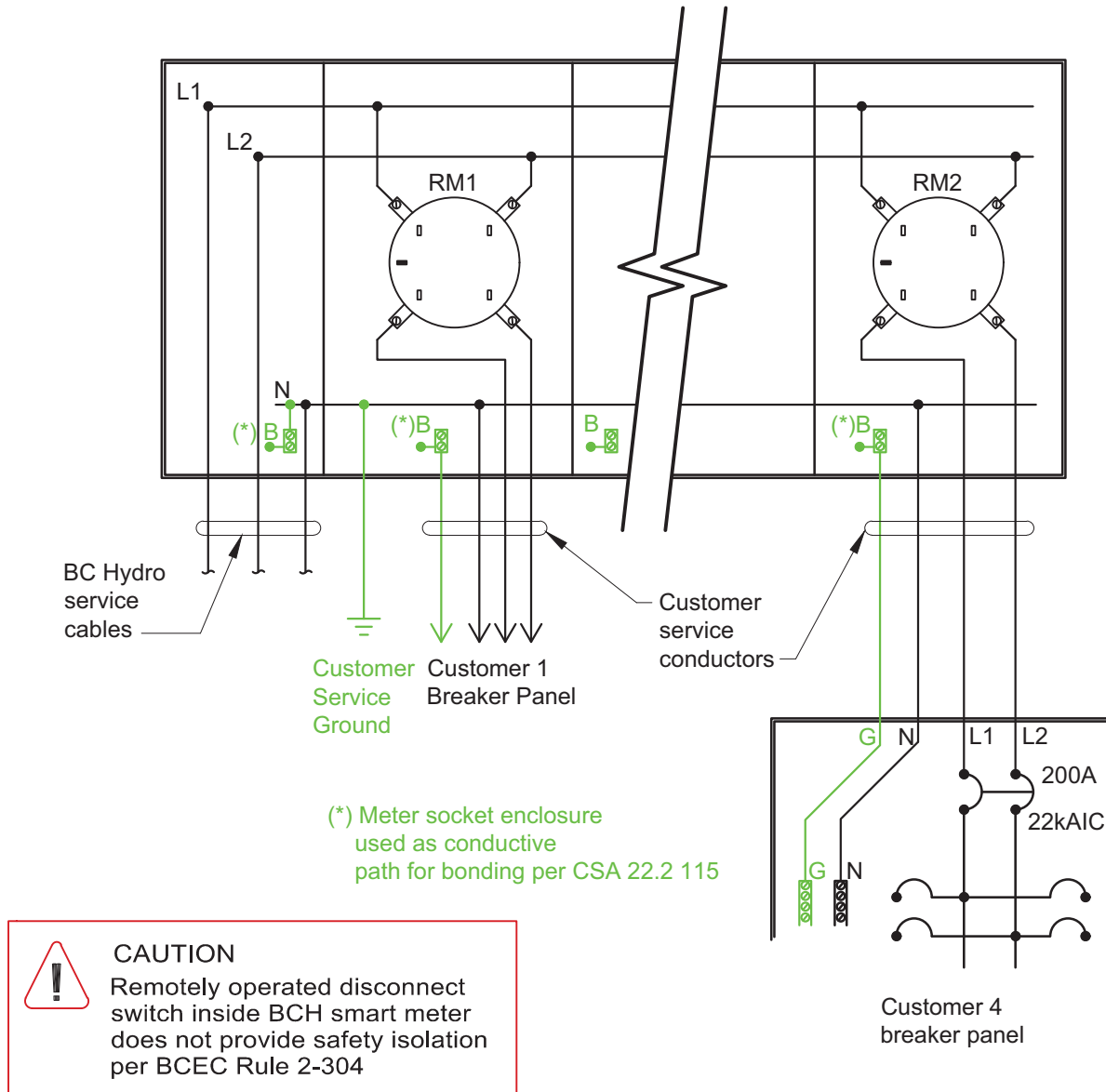


Figure 4 – Multiple meter socket typical schematic diagram

- d. Figure 5 shows typical wiring schematics for a 320 A meter socket having an integral by-pass switch. The 320 A revenue meter does not have an integral loadbreak switch for BC Hydro remote operation. The revenue meter shall be installed and removed manually when the switch is in “By-Pass Mode”. Once the meter is secured in place, the bypass switch may be placed into “Meter Mode”.

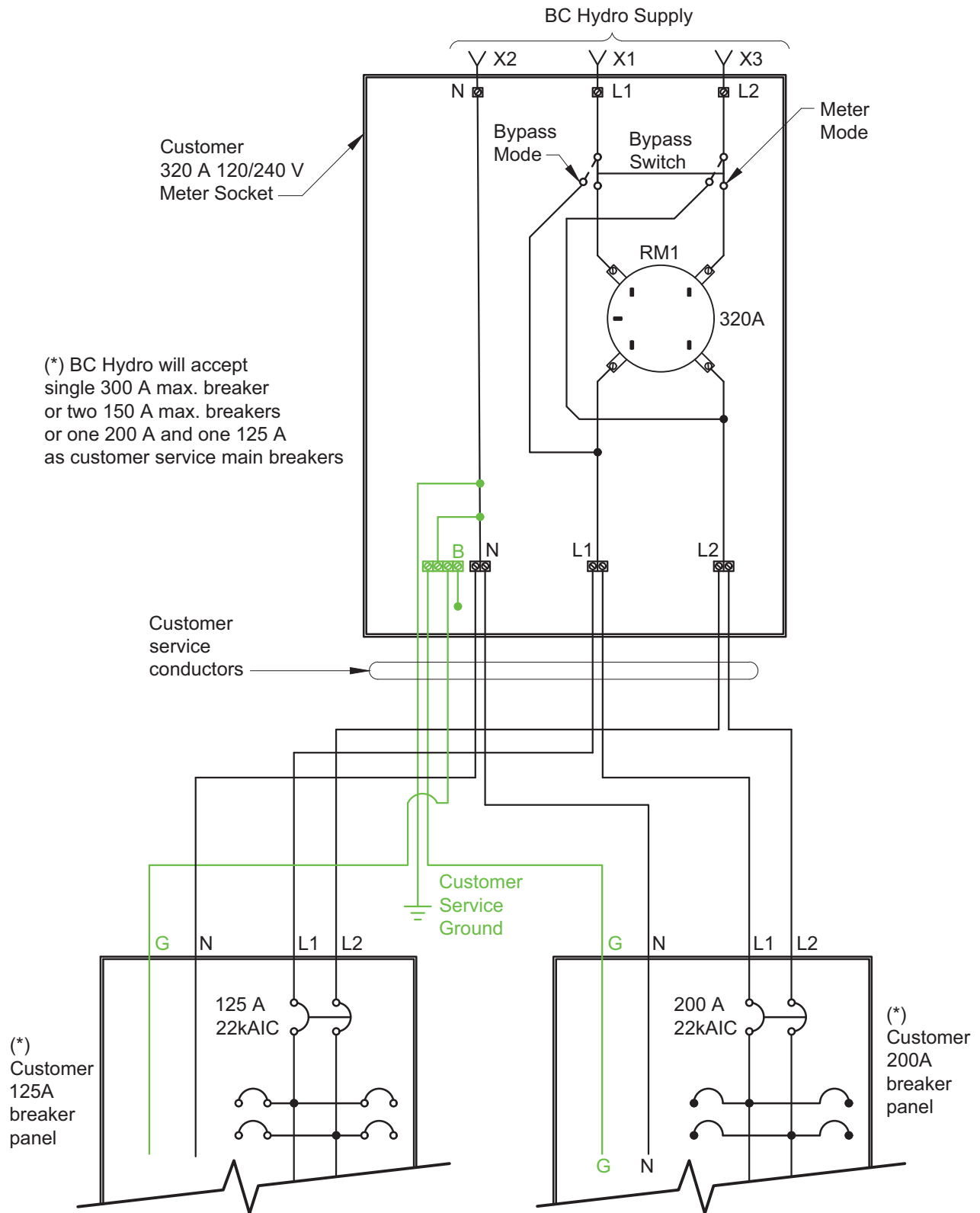


Figure 5 – 320 A service connection diagram for new and existing installations

7. 400 A Services with Integral CT and Test Block

- a. BC Hydro accepts two types of 400 A 120/240 V service assemblies:
 - i. 400 A prefabricated service assembly by Hydel having integral 400 A service main breaker, 400 A CT, CT test block, and transformer-rated revenue meter with remote link; and
 - ii. 400 A field assembled service with 400 A breaker enclosure with utility cable compartment, 400 A splitter, and separate 400 A integral meter socket with CT test block
- b. Figure 6 shows the wiring schematics for the Hydel prefabricated 400 A service assembly.

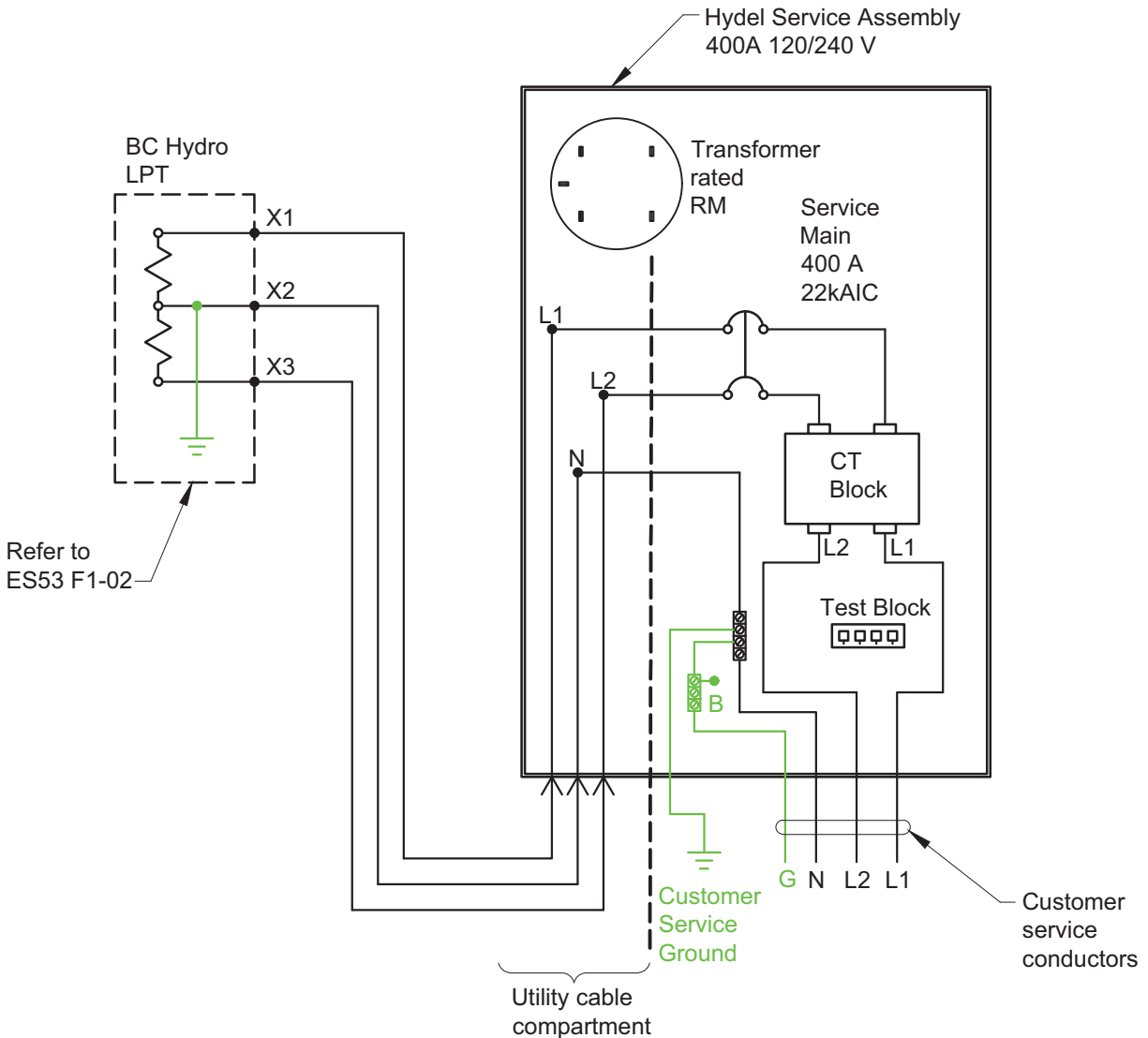


Figure 6 – 400 A prefabricated service assembly schematic diagram

c. Figure 7 shows the wiring schematics for a field-assembled 400 A customer service.

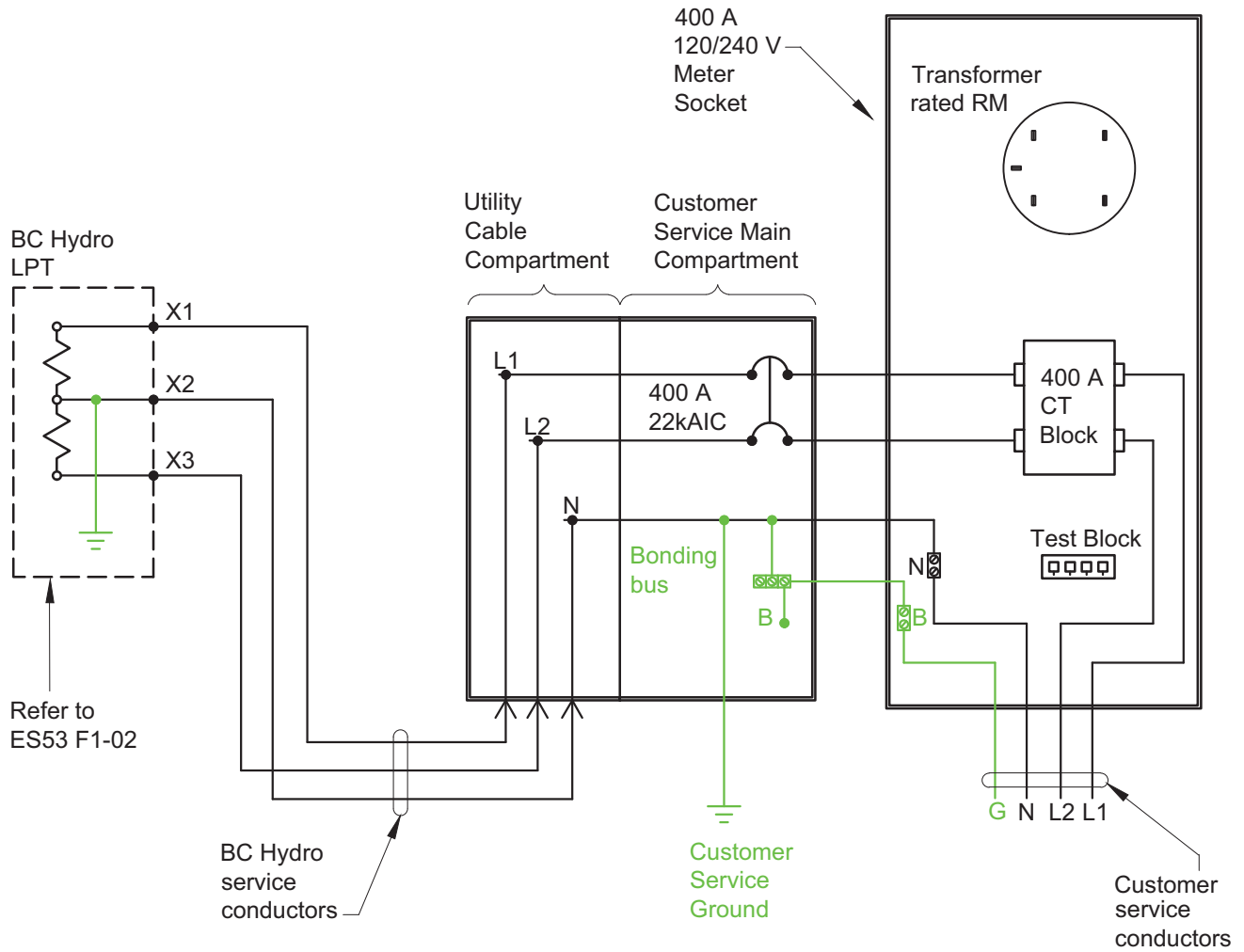


Figure 7 – 400 A field-assembled customer service schematic diagram

8. Grouped Subservices up to 600 A Field Assembled

BC Hydro accepts field assembled and individually metered customer grouped subservices. Figure 8 shows an example of wiring schematics for grouped subservices fed from a customer-owned splitter. Such installations may include a separate revenue metering CT enclosure or separate 200 A and 400 A meter sockets.

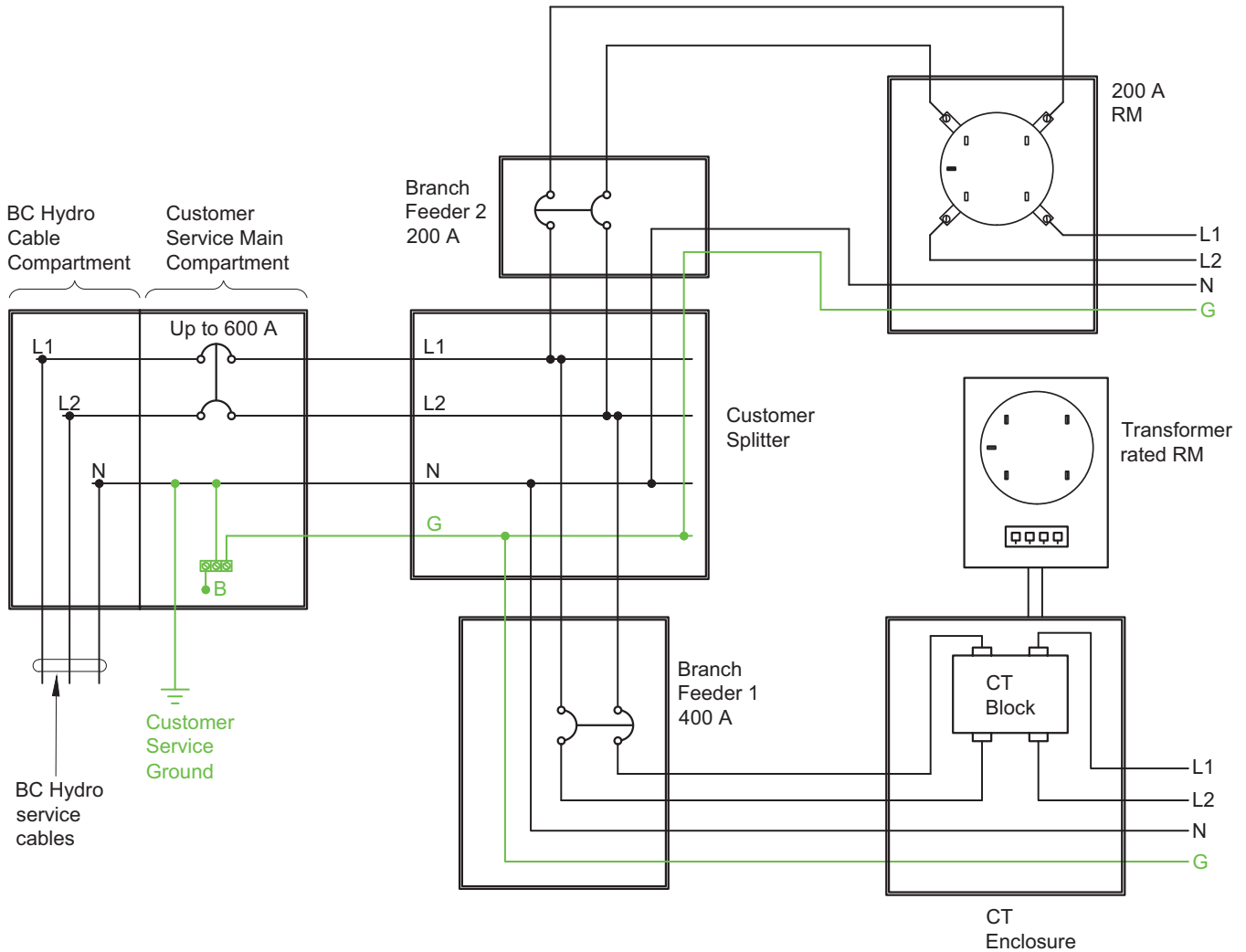


Figure 8 – Illustrative example schematic diagram of field-assembled grouped sub-services up to 600 A

9. Service Kiosk up to 600 A

- a. BC Hydro accepts two types of customer-owned service kiosks:
 - i. Free-standing single customer service kiosk; and
 - ii. Free-standing metering kiosk for multiple customer services.
- b. Figure 9 shows an example of wiring schematics for a single customer service kiosk having an integral breaker and revenue metering CT compartment located below the service main breaker. BC Hydro accepts meter sockets mounted externally on 1½" channels for the transformer-rated revenue meter. The customer may request Revenue Metering to install a meter socket inside the kiosk. See the Secondary Metering guide for more information.

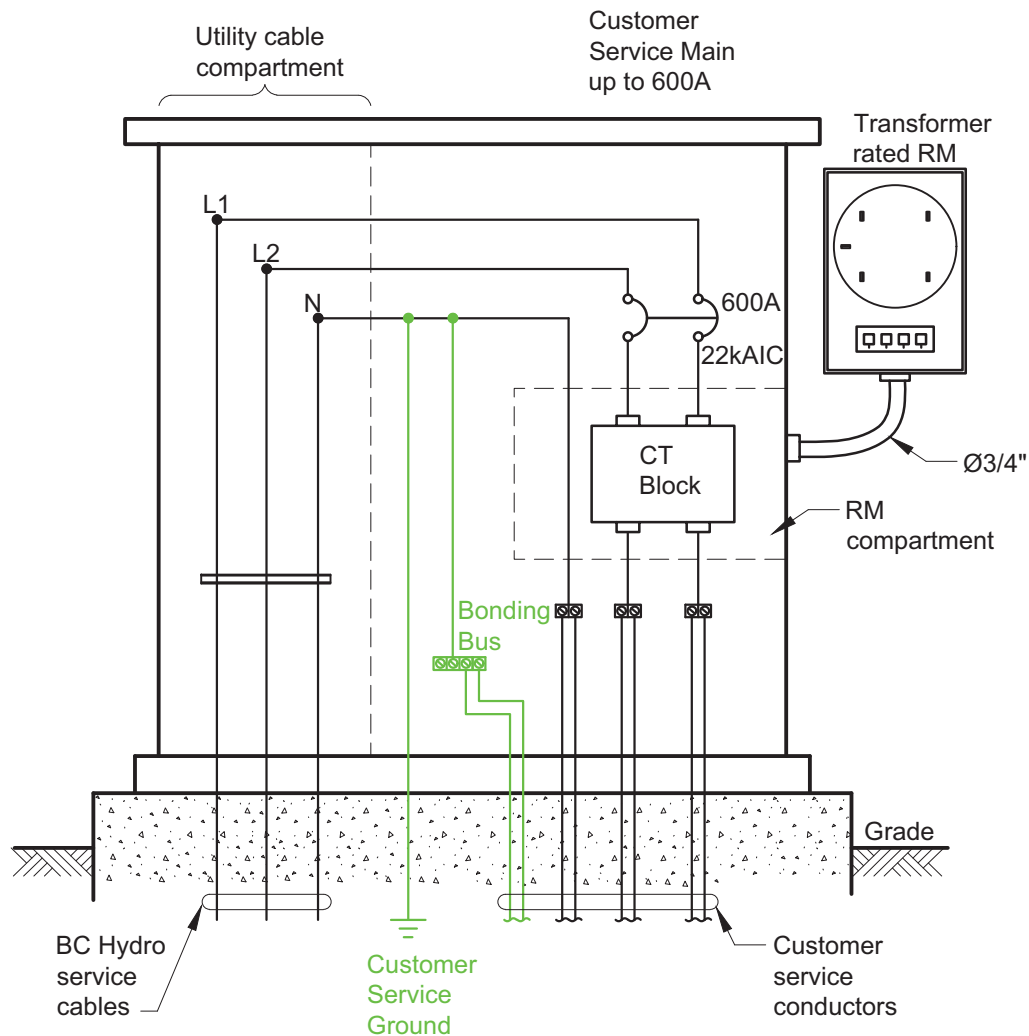


Figure 9 – Service kiosk for single customer service up to 600 A typical schematic diagram

- c. Figure 10 shows a wiring schematic example for a metering kiosk up to 600 A 120/240 V serving up to 12 individual customer services. The metering kiosk has a separate sealed utility cable compartment and separate sealed service main breaker. A fused loadbreak switch is not acceptable as it lacks sealing provisions.

Individual customer service is fed from a separate meter socket with integral breaker, which provides overcurrent protection for individual customer service cables. All meters are equipped with a remote link and communicate through a Plexiglas cut-out on the cover door.

See the Secondary Metring guide for more information.

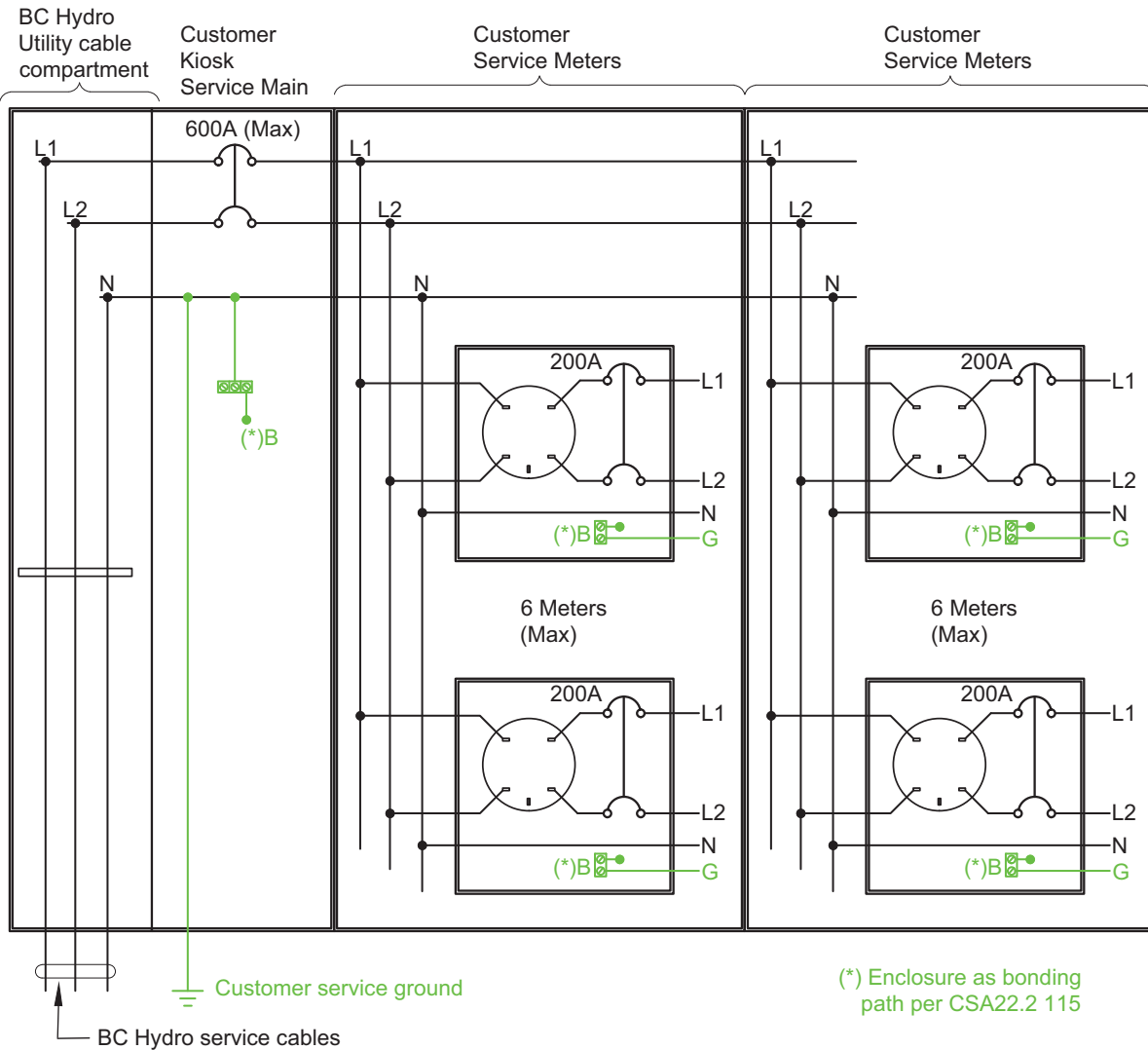


Figure 10 – Metering kiosk up to 600 A for multiple customer services typical wiring schematic diagram

10. Standby Generator and Transfer Switch

See ES54 S1-01 for BC Hydro requirements.