	<b>ELECTRIC REVENUE HIGH-VOLTAGE METERING</b>		<b>063436</b>
	<b>Asset Type:</b> Electric Metering	<b>Function:</b> Design	
<b>Issued by:</b> Albert Pham (A1P5) <i>albert Pham</i>	<b>Date:</b> 8-15-17		
<b>Rev. #05:</b> This document replaces Document 063436 Rev. #04. For a description of the changes, see Page 14.			

### Purpose and Scope

This document describes PG&E's electric metering requirements for electric revenue metering applications for load-only and generator customer interconnecting to PG&E's power system using wye-connected, revenue metering class, instrument transformers on three-phase, 3-wire transmission services.

### General Information

1. The requirements in this document apply to three-phase, 3-wire transmission services (60 kV or above) with wye-connected, metering transformer installations. These requirements include:
  - A. Grounding the neutral conductors of the wye-connected, metering transformer installations.
  - B. The minimum distance from the metering transformers to the meter enclosure.
2. The grounding procedures in this document are different from the electric metering personal-safety grounding procedures that apply when certain revenue metering work is being performed.
3. These requirements apply to all "load-only" and generator customers being served and metered by PG&E. Metering requirements are as follows:
  - A. Net Sale/Surplus Sale - Meter(s) will be installed to measure surplus power delivered to PG&E's system.
  - B. No Sale or Stand by Service Only - Meter will be installed to measure power delivered to customer. If the customer sells power to the California Independent System Operator (CAISO) grid, additional metering to satisfy CAISO's revenue metering requirements shall be the responsibility of the customer.
4. Generators selling all their surplus energy to PG&E may require additional metering to measure the generator output going back to the grid. Final determination of the additional metering shall be made by the metering group.

### Metering Requirements

5. Metering requirements fall under PG&E's approved tariffs. The electric revenue metering requirements depend on the type of service provided to the customer. This requires installing different types of meters to accurately measure/record energy provided to the customer.
6. For installations requiring communication circuits, the use of a regular voice-grade plain old telephone service (POTS) land-line is required. An Ethernet connection or the use of cell modem meters are decided on a case-by-case basis. For a substation-type environment, the use of a Positron-type electronic device is required to offset the ground potential rise (GPR) which causes noise on the circuit.
7. The grounding source must be on or very close to the ground level and must be the effective ground as specified in the CPUC [General Order \(G.O.\) 95](#). For PG&E-built substations, the grounding source is the ground grid, and the ground source inside the meter enclosure is Cadweld-connected to the substation ground grid.
8. The potential-transformer (PT) neutral conductors must be grounded as follows:
  - A. Ground the primary, PT neutral conductor at the base of the metering substructures.
  - B. Ground the secondary, PT neutral conductor at the meter enclosure near the meter panel.
9. The PT and current transformer (CT) secondary neutral conductors shall be grounded to the grounding source and have only one ground point inside the meter enclosure (see Note 24 on Page 3).

## Electric Revenue High-Voltage Metering

### Metering Requirements (contonued)

10. PT and CT secondary neutrals shall be on separate conductors and run from the metering transformers to the meter. The PT secondary neutral conductor is solid green (G), and the CT secondary neutral conductor is solid white (W).
11. During testing or maintenance, **never** disconnect the neutral conductors from the ground source. During in-service testing, do not lift the neutral conductor for the potential.
12. Open the neutral blade #10 (far right) on the 10-pole test switch during wiring. Close the neutral blade #10 after the wiring is completed.
13. Stranded conductors can be used for the secondary PT and CT conductors.

### Distance From Metering Transformers to the Meter Enclosure

14. Table 1 provides a matrix for selecting a conductor size and distance “D” to achieve the CT accuracy of 0.3% or better. Distance “D” is defined as the length of the underground conduit of the PT and CT secondary conductors from the metering transformers to the meter enclosure. The resistance of the current circuit is shown in burden  $\Omega$  and the circuit length equals approximately 2 “Ds”. Use the clear cells in this table with burdens less than 0.5  $\Omega$  (or CT accuracy better than 0.3%). **Do not** use the shaded cells with burdens greater than 0.5  $\Omega$  (or over the accuracy limit of 0.3%).

**Table 1 Distance “D” to Maintain 0.3% Accuracy of Current Transformer (or 0.5  $\Omega$  burden)**

Conductor Size and Type	Burden $\Omega$ of 2 “Ds” (2 “Ds” is the metering circuit length)							
	D=50 ft.	D=75 ft.	D=100 ft.	D=125 ft.	D=150 ft.	D= 200 ft.	D=250 ft.	D=300 ft.
12 Al	0.320 $\Omega$	0.480 $\Omega$	0.640 $\Omega$	0.800 $\Omega$	0.960 $\Omega$	1.280 $\Omega$	1.600 $\Omega$	1.920 $\Omega$
12 Cu	0.200 $\Omega$	0.300 $\Omega$	0.400 $\Omega$	0.500 $\Omega$	0.600 $\Omega$	0.800 $\Omega$	1.000 $\Omega$	1.200 $\Omega$
10 Al	0.200 $\Omega$	0.300 $\Omega$	0.400 $\Omega$	0.500 $\Omega$	0.600 $\Omega$	0.800 $\Omega$	1.000 $\Omega$	1.200 $\Omega$
10 Cu	0.120 $\Omega$	0.180 $\Omega$	0.240 $\Omega$	0.300 $\Omega$	0.360 $\Omega$	0.480 $\Omega$	0.600 $\Omega$	0.720 $\Omega$
8 Al	0.130 $\Omega$	0.195 $\Omega$	0.260 $\Omega$	0.325 $\Omega$	0.390 $\Omega$	0.520 $\Omega$	0.650 $\Omega$	0.780 $\Omega$
8 Cu	0.078 $\Omega$	0.117 $\Omega$	0.156 $\Omega$	0.195 $\Omega$	0.234 $\Omega$	0.312 $\Omega$	0.390 $\Omega$	0.468 $\Omega$

### Procedures

15. PG&E electric metering personnel are responsible for the technical specifications, evaluation, and availability of metering products.
16. The revenue metering scheme shall be submitted to PG&E during the early design phase of the project for review and approval. Failure to satisfy this requirement can result in a delay of the project.

### Wiring Diagram

17. The following are color codes of metering conductors as shown in Figure 1 on Page 4 and Figure 11 on Page 11.

B = Black  
 LB = Light Blue  
 O = Orange  
 P = Purple  
 R = Red  
 W = White  
 G = Green  
 Y = Yellow

### PG&E-Provided Equipment

18. PG&E owns, installs, maintains, operates, and reads its meters. These are PG&E-approved meters that are fully compatible with PG&E’s Meter Data Acquisition System (MDAS).
19. For load-only customers, PG&E will procure and own the combination metering units.
20. For a generator customer, the generator shall provide and install the required combination metering units (PT/CT), and is responsible for testing the metering units after they are mounted on the structure.

# Electric Revenue High-Voltage Metering

## PG&E-Provided Equipment (continued)

- 21. The customer is responsible for providing and maintaining the mounting structures for the PT/CT. Conduits, metering enclosure, meter socket(s), dedicated communication circuit, and other devices required for PG&E's revenue meter installation are the responsibility of the customer. The use of flex conduits is not acceptable (see Figure 7 and Figure 6 on Page 8).
- 22. When the generator requests PG&E owned metering (i.e., CAISO and/or customer owned meter), PG&E will perform the wiring work and charge the customer accordingly. However, PG&E will not set and program non-PG&E meter.
- 23. Any other meter that will share the same metering circuit as the PG&E meter must be a socket-type meter. Consult with PG&E metering engineering personnel if a socket-based meter cannot be used.

## General Notes

- 24. Requirements for grounding the neutral conductor of three-phase, wye-connected, revenue metering transformers are as follows:  
 One Ground Point - Because different ground-potential rises within a substation can cause ground current to flow through the electric meter (which is a safety hazard and results in significant billing errors), there must not be more than one ground point for the PT and CT secondary neutral conductors.
- 25. Never use three-phase metering units.
- 26. The use of coupling capacitor voltage transformers (CCVTs) for revenue metering applications is limited to 500 kV and above. Revenue metering applications involving installations served from 60 kV through 230 kV require the use of combination metering units (PT/CT).
- 27. In order to minimize the number of 90 degree bends (maximum of 3 per the [Electric and Gas Service Requirements](#)), the PT/CT units should be supported on a common structure as illustrated in Figure 1 on Page 4 and not on individual support structures.
- 28. The metering enclosure shall be sized accordingly if other equipment such as line protective relays, telecommunications, and/or EMS/SCADA equipment will be installed.

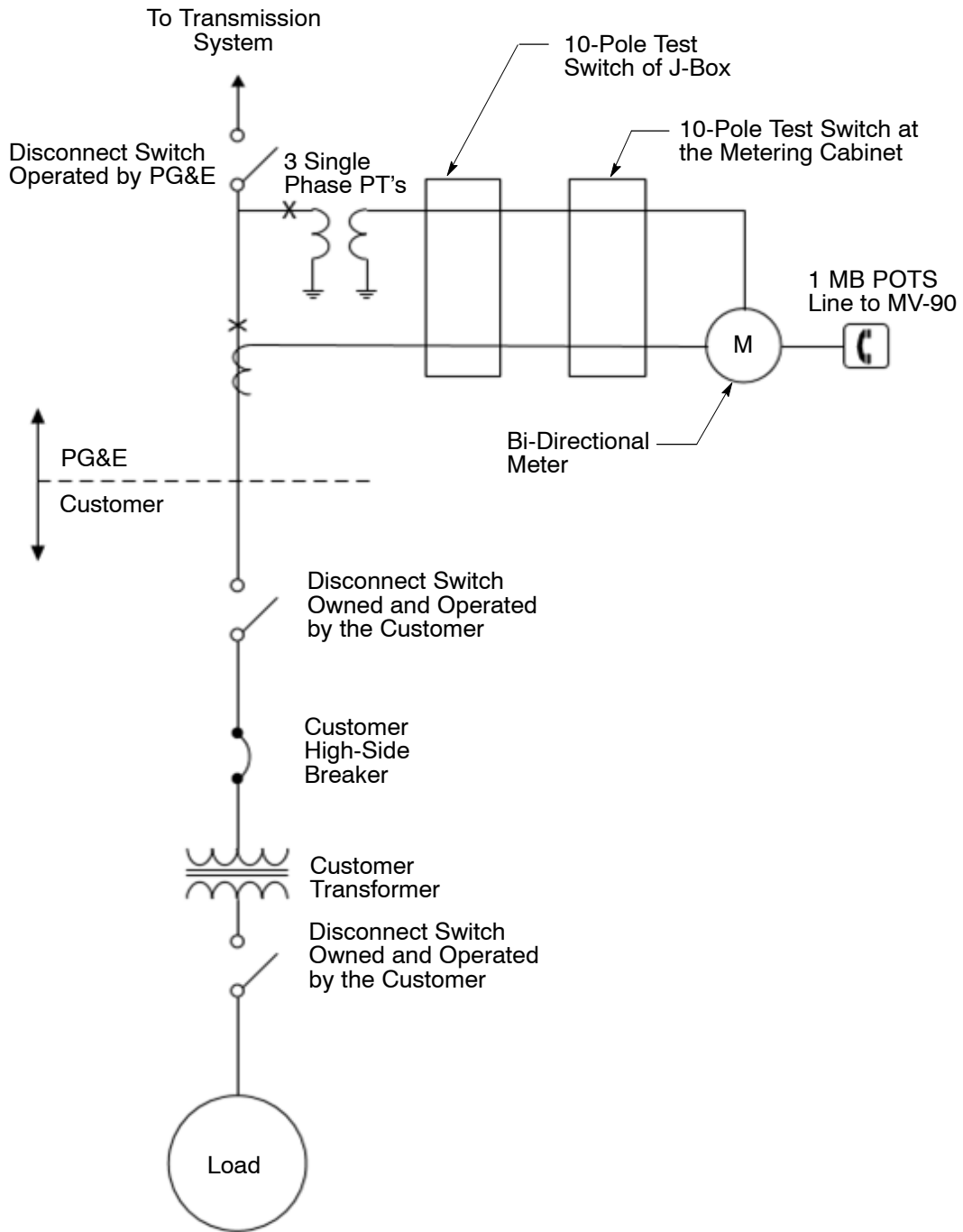
## Ordering Meter Units

- 29. Dual core CTs or PTs are not allowed.
- 30. To order combination metering units (PT/CT), please consult PG&E meter engineering personnel.
- 31. For generator customers, PG&E meter engineering personnel must approve before they are ordered by the customer.

References	Location	Document
Transmission Interconnection Metering Project Process .....		
Inspecting Transmission Metering Installations Maintaining .....		
<a href="#">Accessory Equipment for Revenue Metering Installations</a> .....	<a href="#">Substation Design Standard Drawings</a> ..	<a href="#">026237</a>
<a href="#">Diagram of Connections for Metering Polyphase Loads Using Self-Contained Meters</a> .....	<a href="#">OH: Meters/UG-1: Services</a> .....	<a href="#">028162</a>
<a href="#">Diagram of Connections for Metering Polyphase Loads Using Transformer-Rated Meters</a> .....	<a href="#">OH: Meters/UG-1: Services</a> .....	<a href="#">028163</a>
<a href="#">Revenue-Class Instrument Transformers 0–500 kV</a> ..	<a href="#">Electric Metering</a> .....	<a href="#">054340</a>
<a href="#">Electric Revenue Meters</a> .....	<a href="#">OH: Meters</a> .....	<a href="#">062208</a>
<a href="#">Outdoor Electrical Clearance Distances for Transmission and Distribution Substations</a> .....	<a href="#">Electrical Design Standard</a> .....	<a href="#">067908</a>
<a href="#">60kV &amp; 115kV Metering Transformer Support Structure</a> .....	<a href="#">Civil Design Standard</a> .....	<a href="#">376489</a>

### Electric Revenue High-Voltage Metering

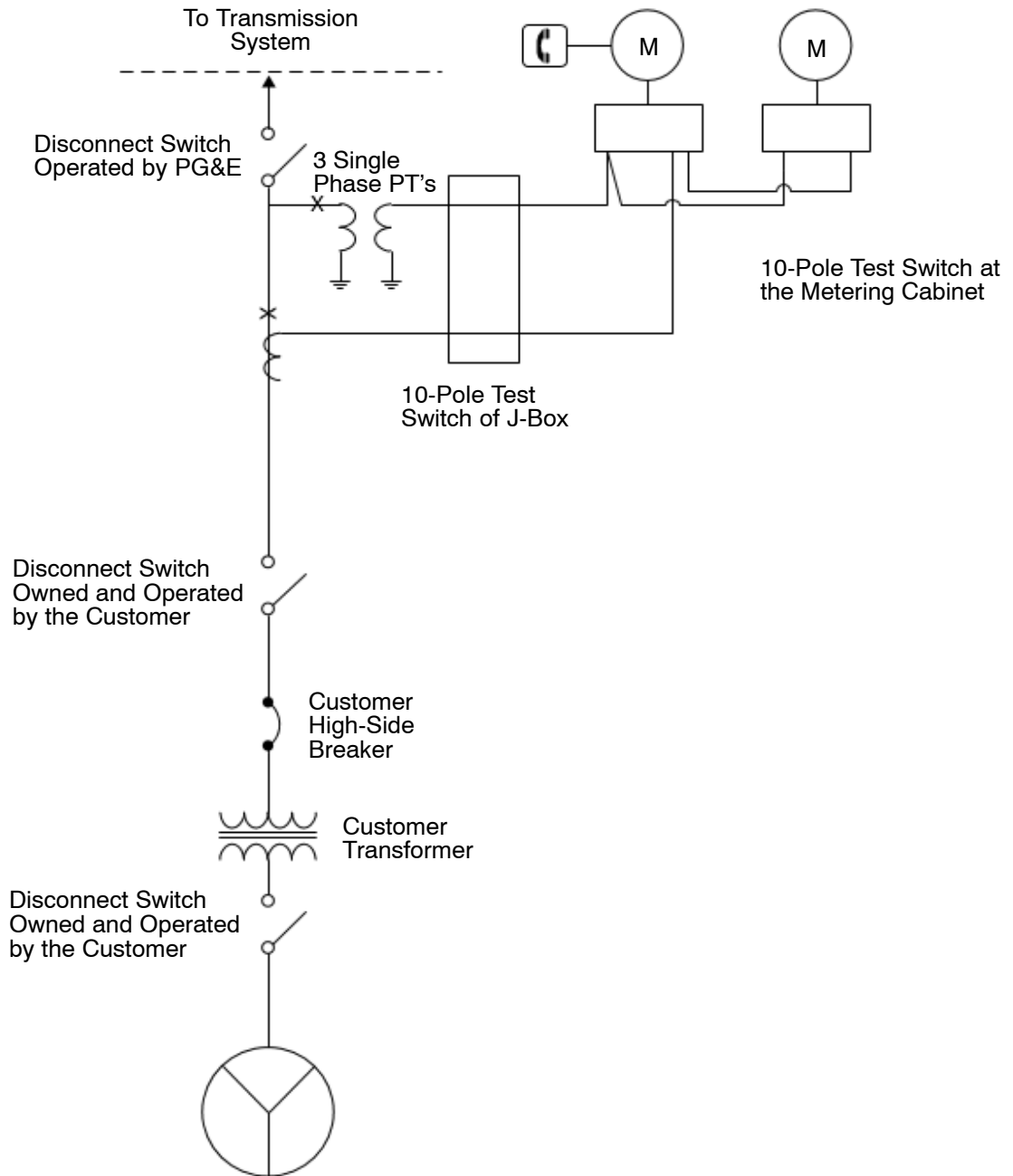
#### Single Line Diagram – Transmission Voltages 60 kV Through 230 kV



**Figure 1**  
**Typical Connection for Load-Only Customer**

### Electric Revenue High-Voltage Metering

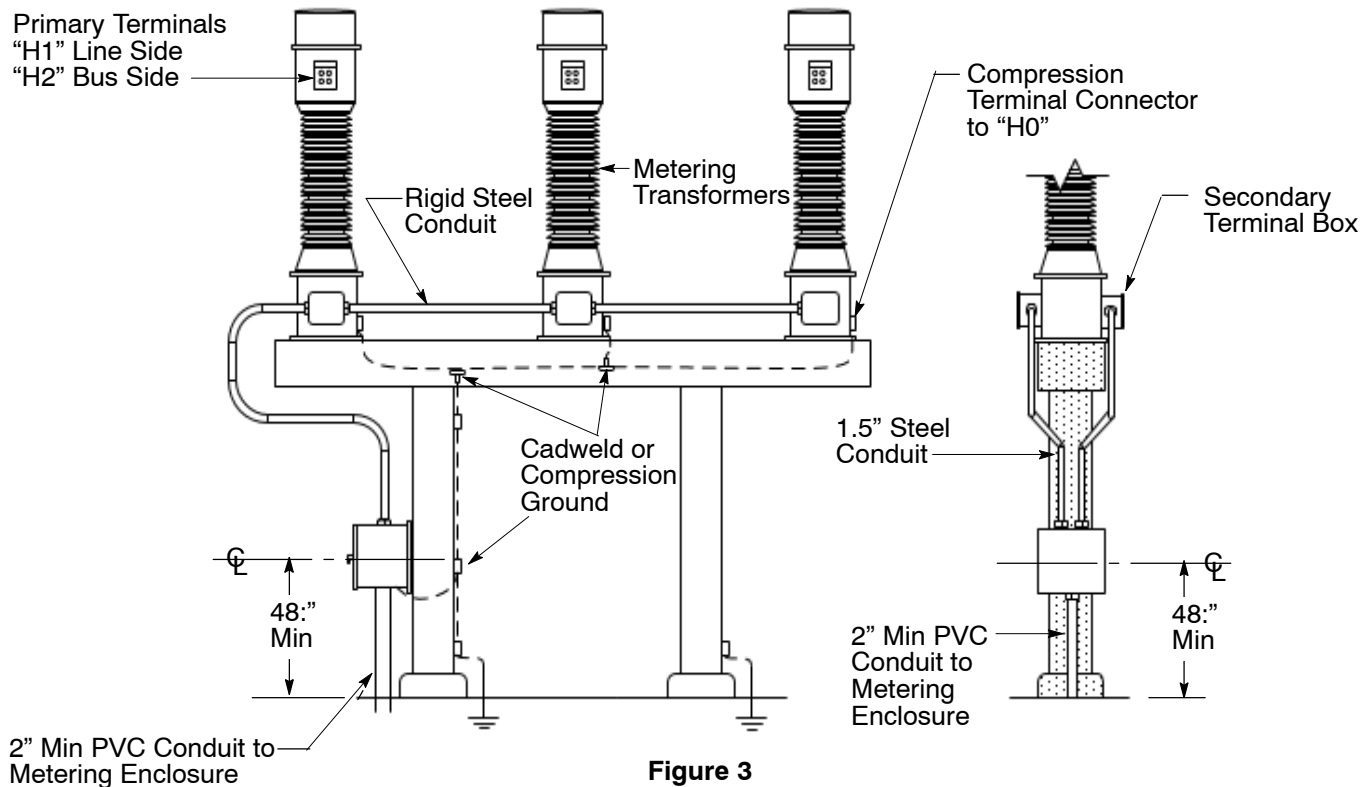
#### Single Line Diagram – Transmission Voltages 60 kV Through 230 kV (continued)



**Figure 2**  
**Typical Connection for a Generating Customer**  
**with a CAISO and PG&E Meter**

## Electric Revenue High-Voltage Metering

### Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering

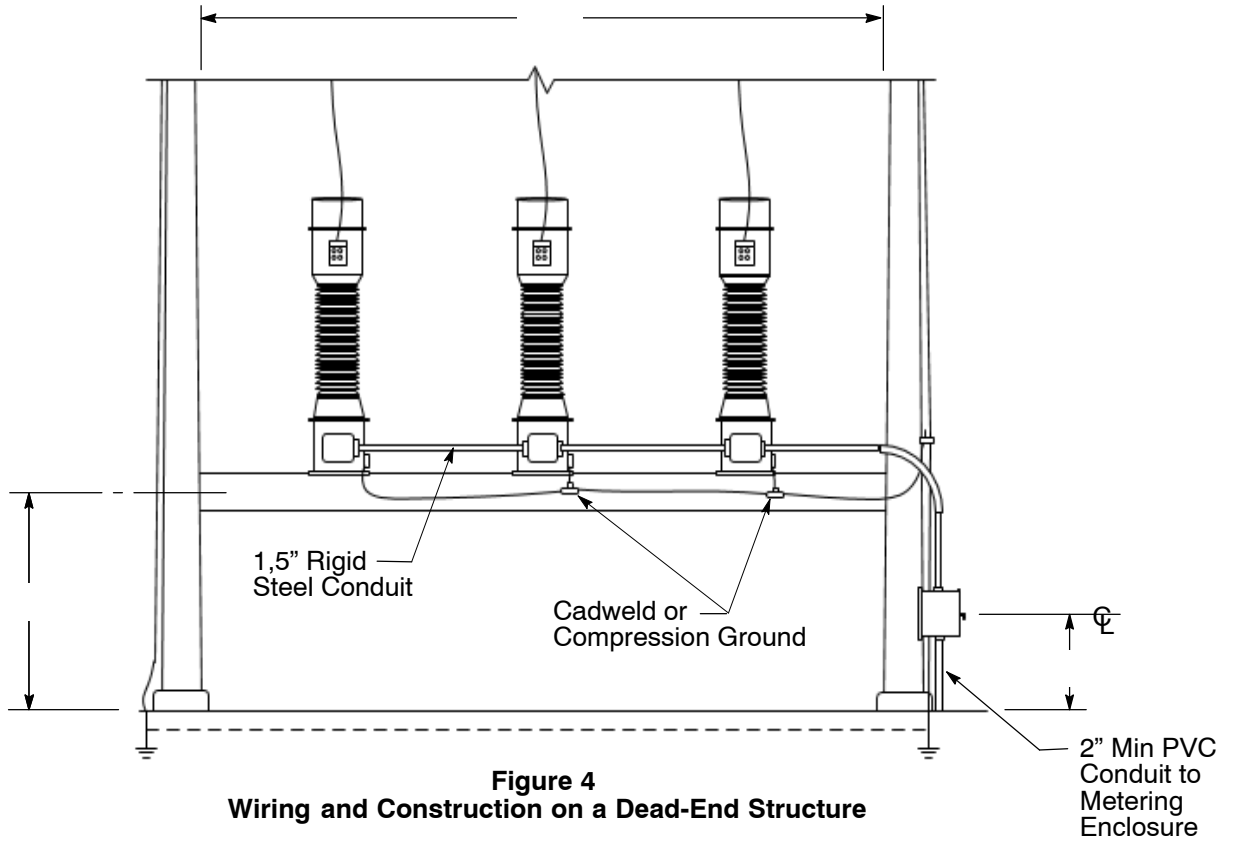


#### Notes

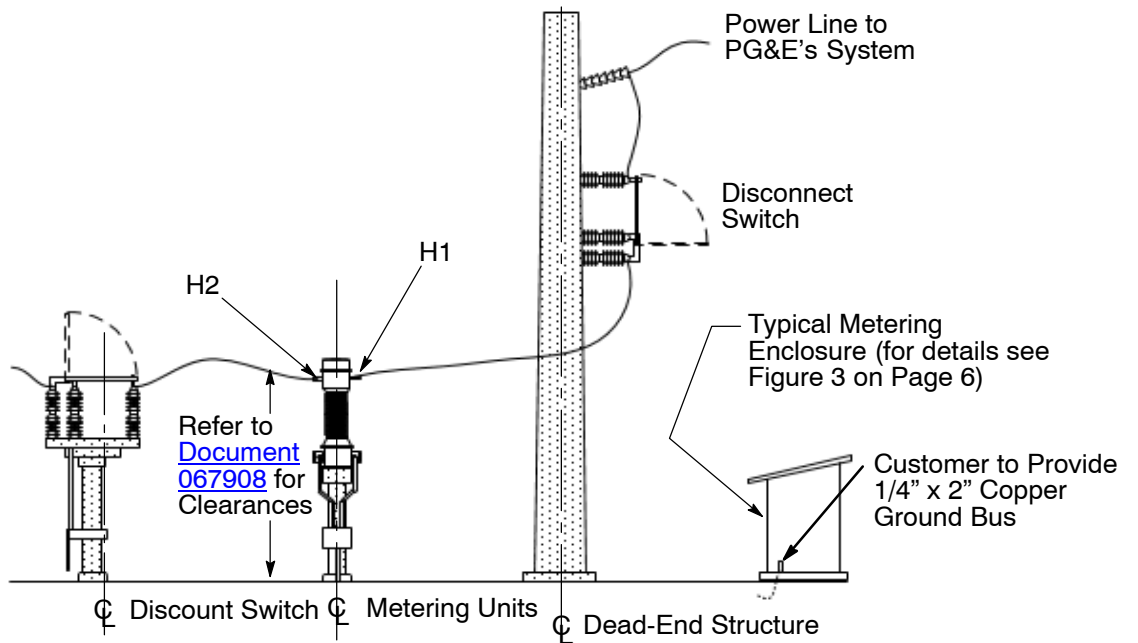
1. The use of flex conduit is not acceptable.
2. For proper spacing and clearances of PT/CTs, please consult PG&E.
3. The secondary terminals of current transformers are short-circuited at the factory prior to shipment. These short circuits should remain in place until the secondary connections are made. If connections are not made to one or more secondary windings at the time the transformer is placed in service, keep the short circuits on unused secondaries since they will have no effect on the accuracy of the other independent secondary windings. When not connected into a circuit, it is a good practice to ground the current transformer secondary windings. This applies only where separate secondary windings are on separate cores and does not apply to tapped portions of windings on a single secondary core.
4. On voltage transformers, the secondary should never be short-circuited. It is a good practice to ground one side of each secondary winding whether that winding is used or not. Make sure the neutral bushing is securely connected to the base ground. These units are designed to be installed on systems having a solidly grounded neutral. The ground connection of the neutral (H0) bushing must be in place when the transformer is energized.
5. Refer to PG&E Drawing [376489](#) for an alternative metering unit structure for 60 kV and 115 kV only.
6. Single structure pedestals for the metering units are not allowed.
7. Refer to Figure 4 on Page 7 for dead-end structure wiring and construction.
8. Junction box must be tied to the substation ground grid with Cadweld or compression connectors.

### Electric Revenue High-Voltage Metering

#### Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering (continued)



**Figure 4**  
**Wiring and Construction on a Dead-End Structure**



**Figure 5**  
**Typical Arrangement of Metering Transformer and Meter Enclosure**

Electric Revenue High-Voltage Metering

Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering (continued)

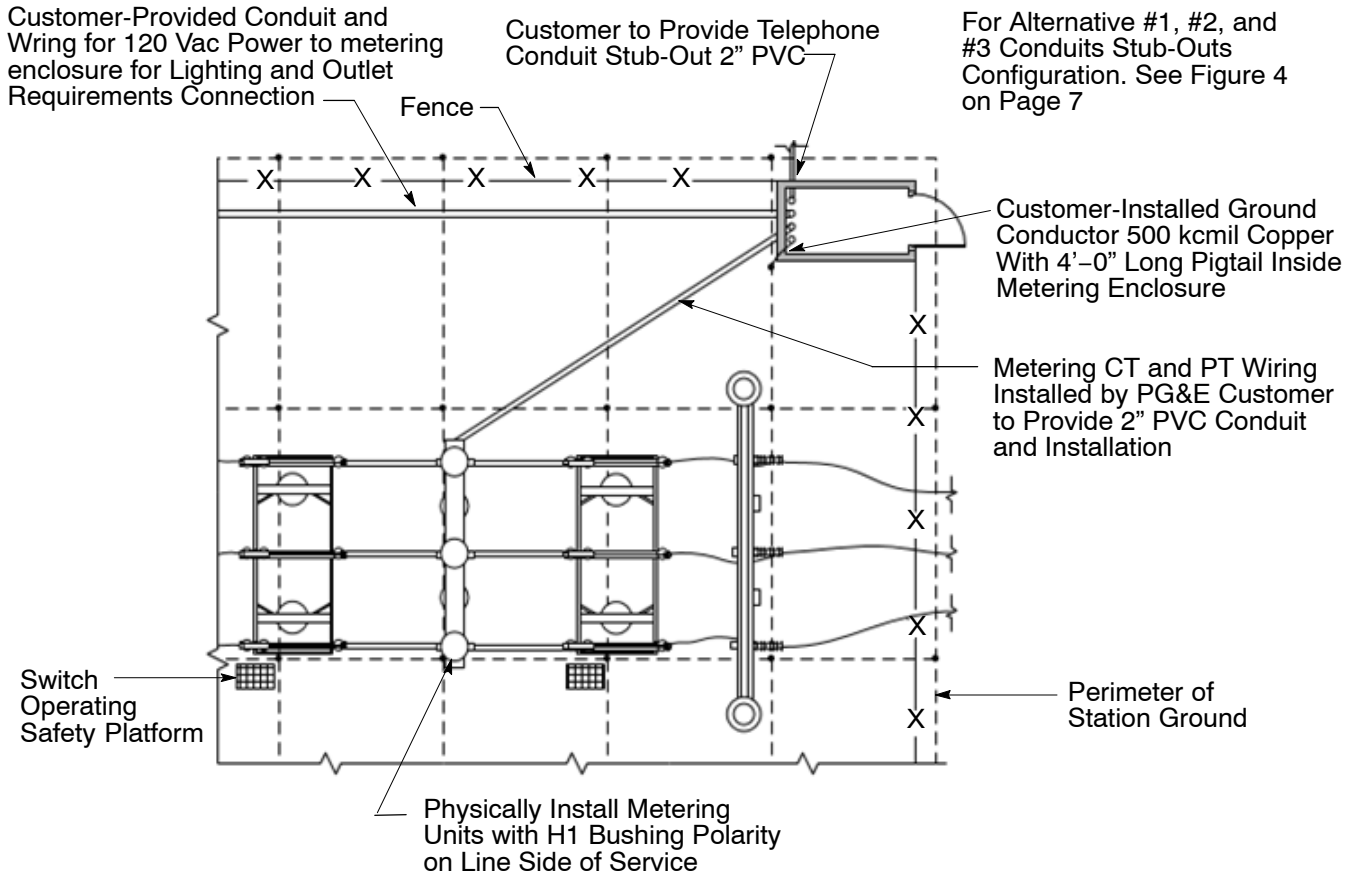


Figure 6  
Typical Substation Layout of Metering Transformer and Meter Enclosure

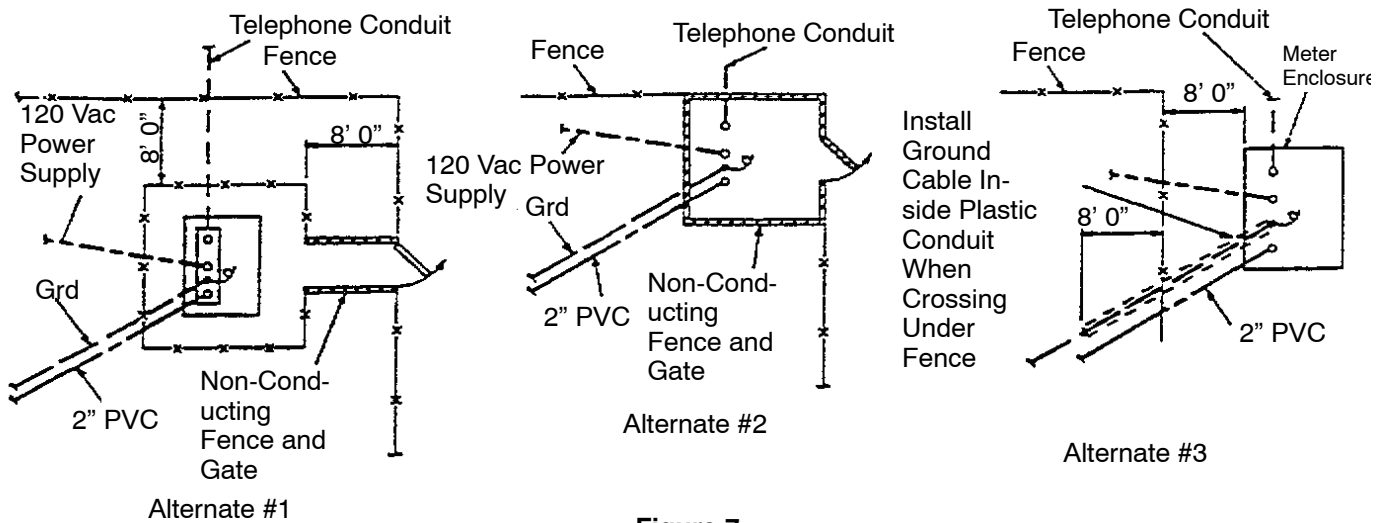
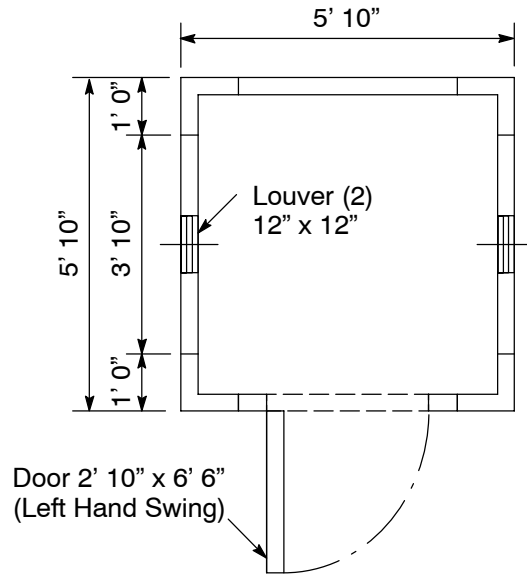


Figure 7  
Alternate Conduits Stub-Outs Configurations

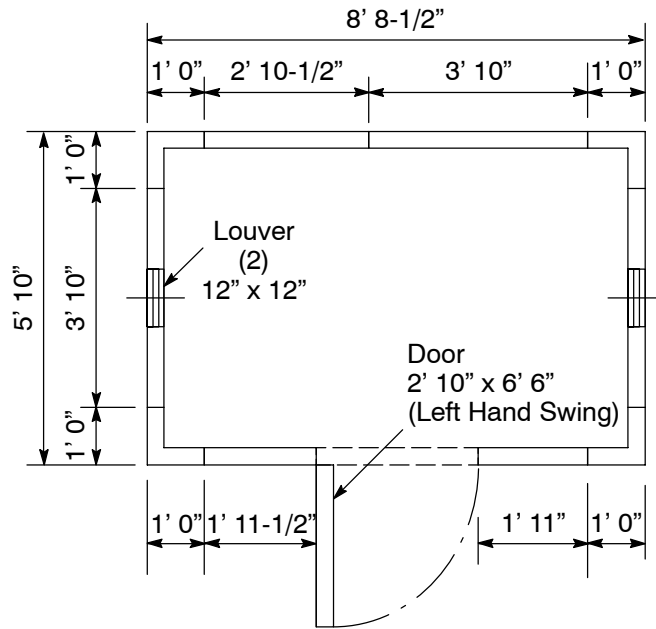


### Electric Revenue High-Voltage Metering

#### Metering Enclosure and Cabinet Specifications



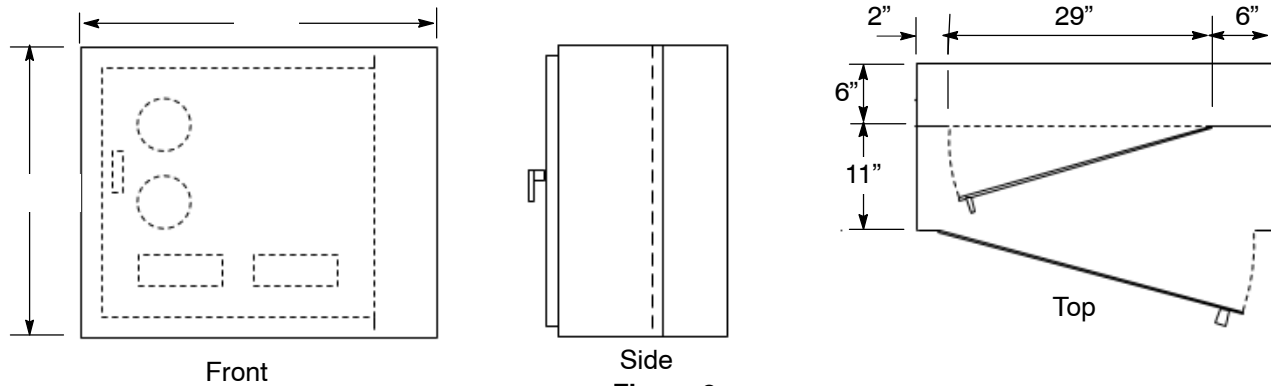
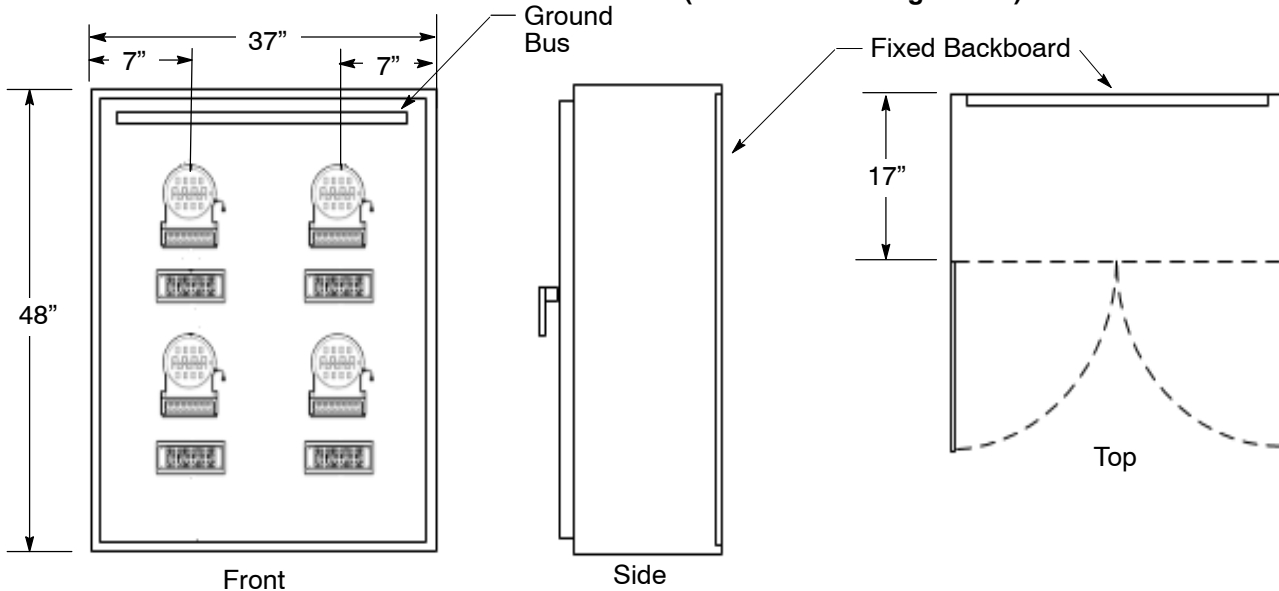
Metering Enclosure #1, Model #101  
(Bally "Prefab" Modular Building)



Metering Enclosure #2, Model #102  
(Bally "Prefab" Modular Building)

**Figure 8**  
**Metering Enclosure Details**

## Electric Revenue High-Voltage Metering

**Metering Enclosure and Cabinet Specifications (continued)****Figure 9****Wall-Mounted Meter Cabinet (1 - 2 Meter Configuration)****Figure 10****Wall-Mounted Meter Cabinet (3 - 4 Meter Configuration)****Notes**

1. The enclosure must be:
  - A. Equipped with a device to secure the door in the open position at 90° or more.
  - B. Secured in the closed position with a handle-operated latching mechanism, and lockable with a padlock.
2. Install a placard with the site name and address, service voltage, and load/generation output.
3. Meter sockets for a 1-2 meter cabinet will furnished and installed by the customer and must be a 15-jaw, ring-type.
4. For a 3-4 meter cabinet, the customer will provide and install a Marwell A-base adapter, part # 220-N SP -2885-6, with a 1" width notch at the 6 O'clock position. A Brooks test switch part # 110-54580 or States equivalent, will be provided and installed by the customer. A clear and slotted cover is required for the test switch.
5. The PG&E meter height must be 48" minimum, 72" maximum from centerline of the meter to ground level.
6. For floor standing metering cabinets, PG&E metering personnel.

Electric Revenue High-Voltage Metering

Weiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering

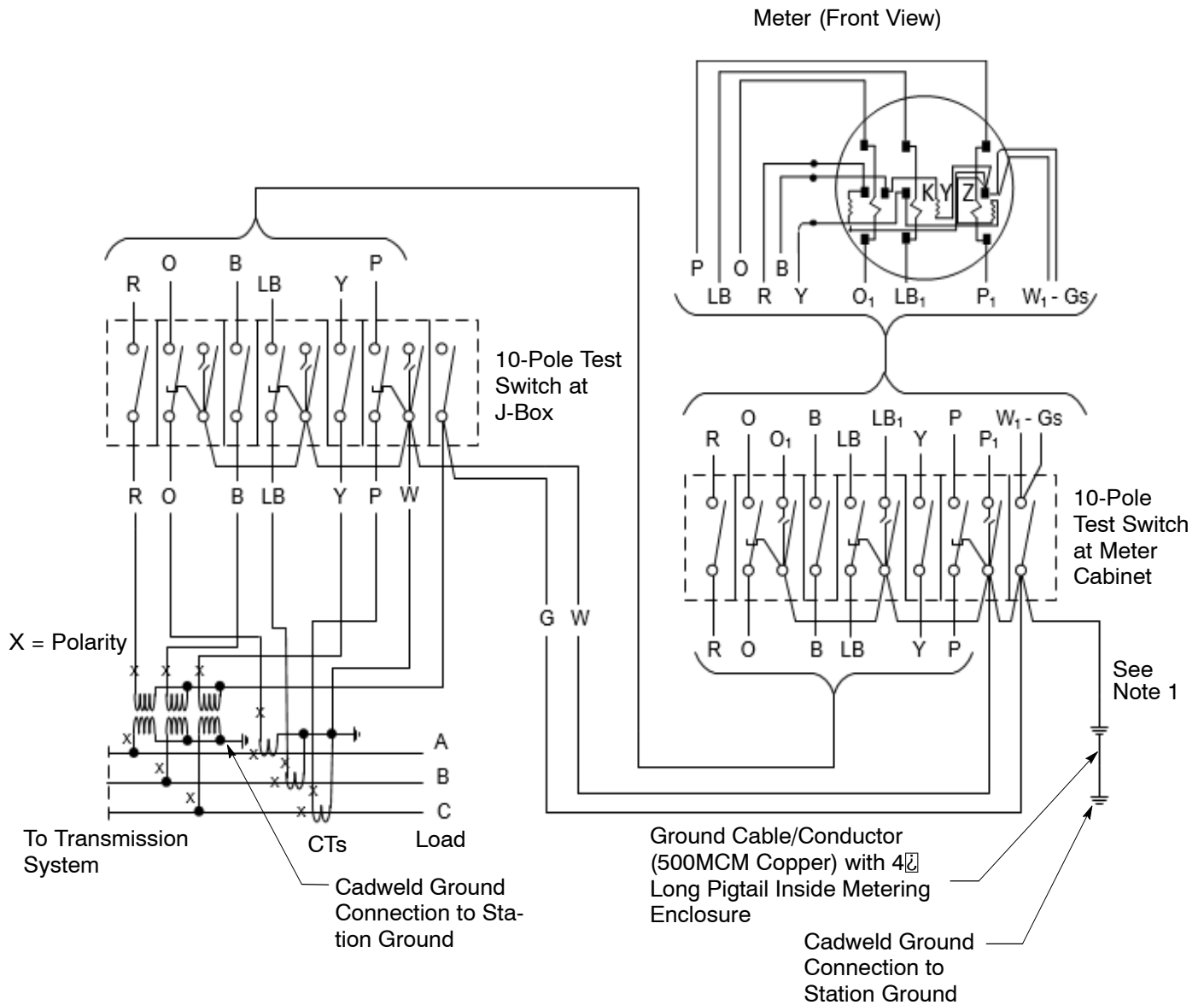
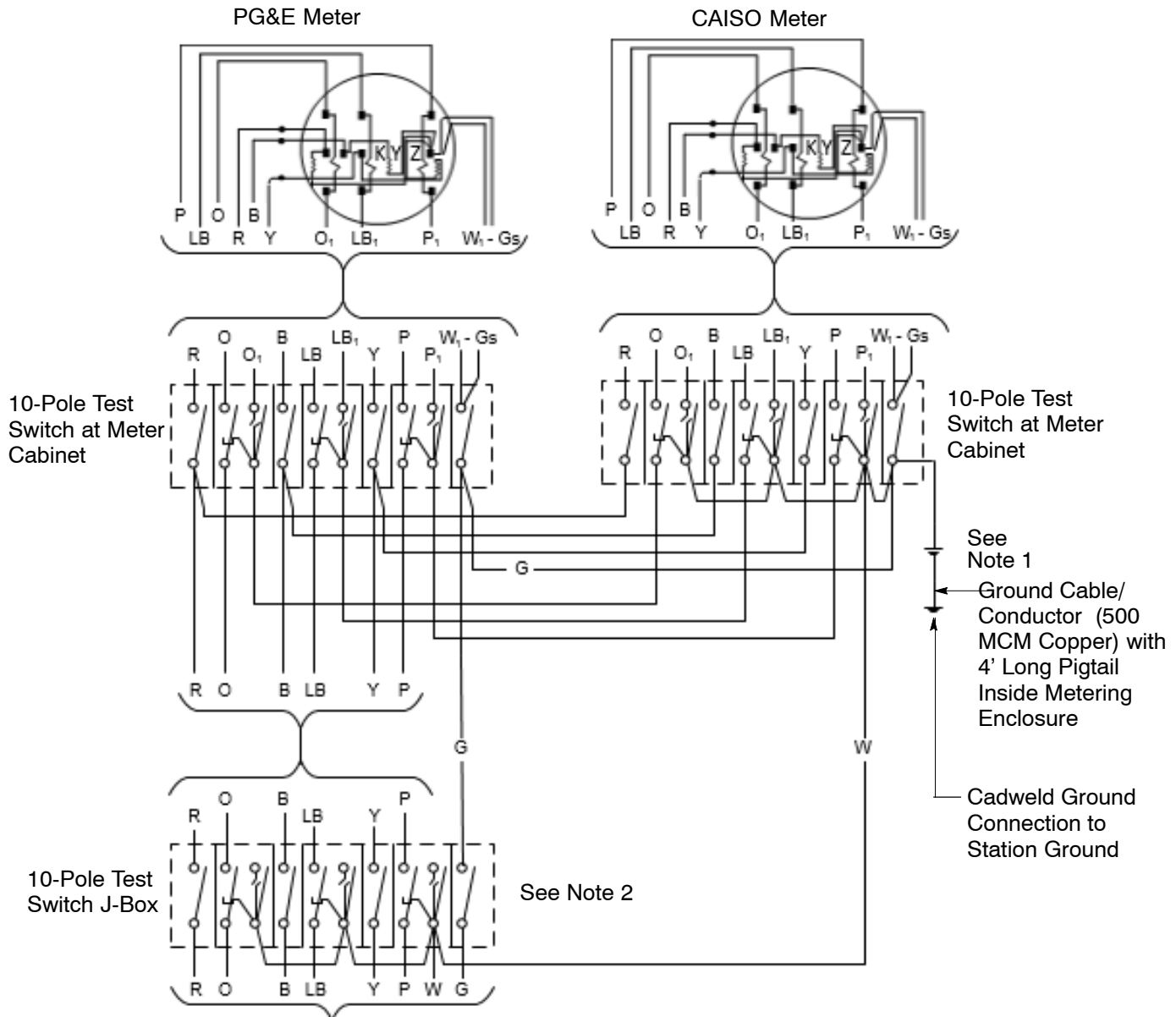


Figure 11  
Meter and Test Switch Wiring

Notes

1. One-point grounding at the meter enclosure, same grounding wherein the potentials are not stacked up on top of one another.
- Two (2) neutrals (1 PT-neutral and 1 CT-neutral) are required.

## Electric Revenue High-Voltage Metering

**Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering (continued)**

Refer to Figure 10 on Page 10 for Bottom Wiring of the Test Switch of the Junction Box

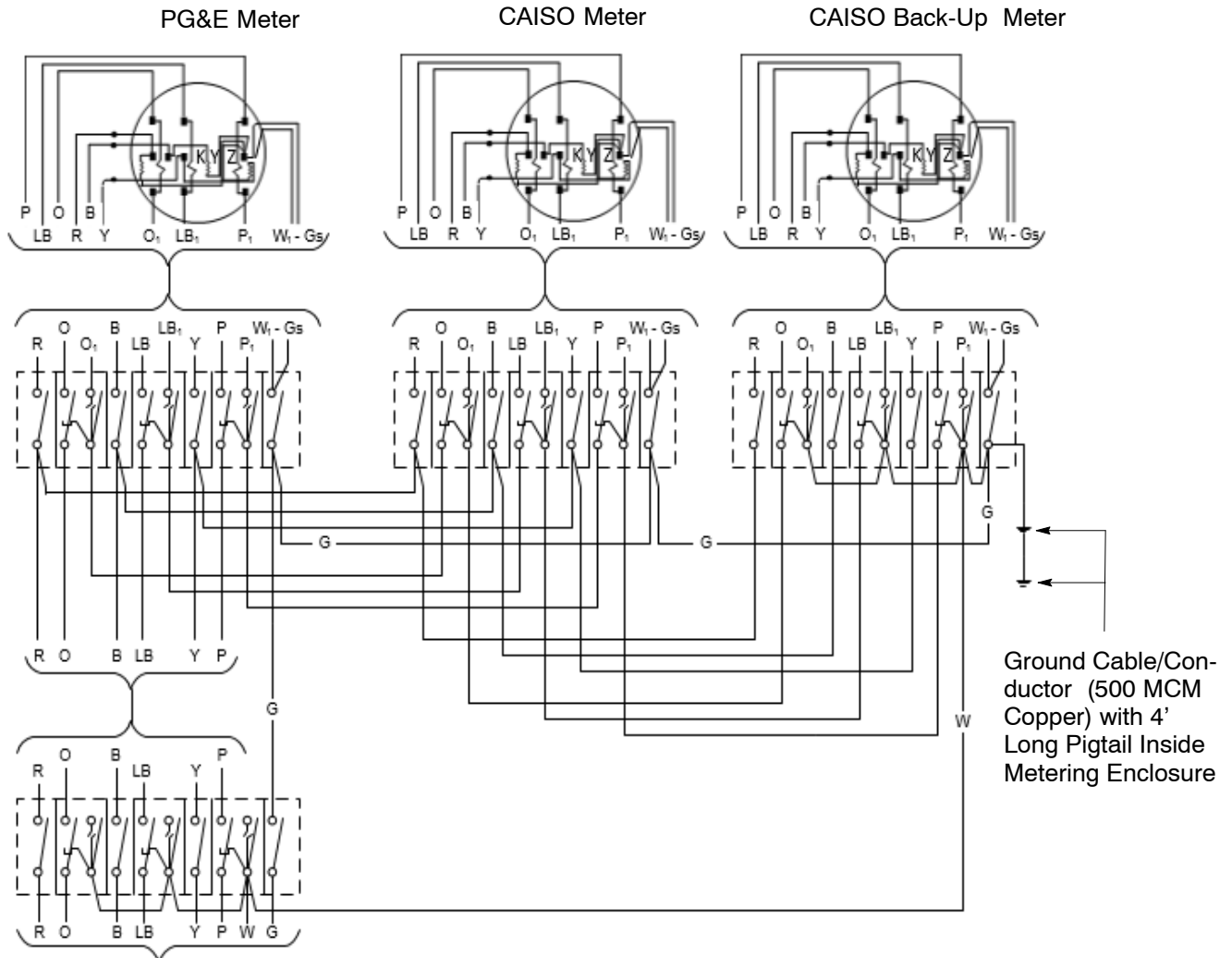
**Figure 12**  
**Meter and Test Switch Wiring for a PG&E and CAISO Meter**

**Notes**

1. One-point grounding at the meter enclosure, same grounding wherein the potentials are not stacked up on top of one another.  
Two (2) neutrals (1 PT-neutral and 1 CT-neutral) are required.
2. Run the PT neutral secondary wire through the test switch. CAISO meters may be powered by an auxiliary source and breaking the PT neutral at the J-box will prevent any backfeed.

Electric Revenue High-Voltage Metering

**Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering (continued)**



Refer to Figure 10 on Page 10 for Bottom Wiring of the Test Switch of the Junction Box

**Figure 13**  
**Meter and Test Switch Wiring for a PG&E and CAISO Primary Back-Up Meter**

**Notes**

1. One-point grounding at the meter enclosure, same grounding wherein the potentials are not stacked up on top of one another.  
Two (2) neutrals (1 PT-neutral and 1 CT-neutral) are required.
2. Run the PT neutral secondary wire through the test switch. CAISO meters may be powered by an auxiliary source and breaking the PT neutral at the J-box will prevent any backfeed.

**Revision Notes**

Revision 05 has the following changes:

1. Minor language change to Purpose and Scope section on Page 1.
2. Minor language change to Note 4 on Page 1.
3. Revised Note 6 on Page 1.
4. Updated language in Note 19 on Page 2.
5. Added new Note 20 on Page 2.
6. Re-numbered Notes 20 – 22 to Notes 21 – 23 and added additional language on Page 3.
7. Deleted Note 23 regarding analog outputs required by the customer on Page 3.
8. Added additional requirements to Note 23 on Page 3.
9. Minor language change to Note 26 on Page 3.
10. Added new Note 30 on Page 3.
11. Added new Note 30 on Page 3.
12. Added References with 3 metering work procedures on Page 3.
13. Added a new Figure 1, “Typical Connection for a Load-Only Customer”, on Page 4
14. Added a new Figure 2, “Typical Connection For a Generating Customer with a CAISO Meter and PG&E Meter”, on Page 5.
15. Revised Note 4 and Note 7 on Page 6.
16. Added a new Figure 3, “Wiring and Construction”, on Page 6 and included additional Notes 6 and 7.
17. Added new Figure 4, “Wiring and Construction on a Dead-End Structure” and Figure 5, “Typical Arrangement of Metering Transformer and Meter Enclosure” on Page 7.
18. Added a new Figure 6, “Typical Substation Layout of Metering Transformer and Meter Enclosure”, on Page 8.
19. Re-numbered Figure 3 on Revision #04 to Figure 7 on Page 8.
20. Re-numbered Figure 4 on revision #04 to Figure 8 on Page 9.
21. Added new Figure 9, “Wall-Mounted Meter Cabinet (1 – 2 Meter Configuration)”, Figure 10, “Wall-Mounted Meter Cabinet (3 – 4 Meter Configuration)”, and Notes on Page 10.
22. Added new Figures 11,12, and 13 on Pages 11 through 13.