Purpose and Scope

This document describes PG&E’s electric metering requirements for electric revenue metering applications for load-only entities and generators 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 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 land-line or cell phone are decided on a case-by-case basis. For a substation-type environment, the use of a Positron-type electronic device may be 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. Metering transformer neutral conductors must be insulated.
9. 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.
10. 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 25 on Page 3).
11. 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).

12. 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.

13. 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.

14. Stranded conductors can be used for the secondary PT and CT conductors.

### Distance From Metering Transformers to the Meter Enclosure

15. 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 Ω and the circuit length equals approximately 2 “Ds”. Use the clear cells in this table with burdens less that 0.5 Ω (or CT accuracy better than 0.3%). Do not use the shaded cells with burdens greater that 0.5 Ω (or over the accuracy limit of 0.3%).

<table>
<thead>
<tr>
<th>Conductor Size and Type</th>
<th>Burden Ω of 2 “Ds” (2 “Ds” is the metering circuit length)</th>
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<tr>
<td>12 Al</td>
<td>0.320 Ω</td>
</tr>
<tr>
<td>12 Cu</td>
<td>0.200 Ω</td>
</tr>
<tr>
<td>10 Al</td>
<td>0.200 Ω</td>
</tr>
<tr>
<td>10 Cu</td>
<td>0.120 Ω</td>
</tr>
<tr>
<td>8 Al</td>
<td>0.130 Ω</td>
</tr>
<tr>
<td>8 Cu</td>
<td>0.078 Ω</td>
</tr>
</tbody>
</table>

### Procedures

16. Electric metering personnel are responsible for the technical specifications, evaluation, and availability of metering products.

17. 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

18. The following are color codes of metering conductors as shown in Figure 1 on Page 4 and Figure 6 on Page 8.

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

### PG&E-Provided Equipment

19. PG&E owns, installs, maintains, operates, and reads its meters used for measuring the standby service load. These are PG&E-approved meters that are fully compatible with PG&E’s Meter Data Acquisition System (MDAS).
Customer-Provided Equipment

20. When the standby service is at the transmission voltage level (60 kV and above) or at the same service point as the generator’s interconnection, the generator shall provide the required combination metering units (PT/CT). Also, the secondary metering signals for PG&E’s standby meter shall be available at no cost to PG&E.

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 1 on Page 4).

22. When the generator requests PG&E to install non-PG&E standard metering (i.e., CAISO metering), PG&E will perform the work and charge the customer accordingly.

23. Analog outputs required by the customer require the use of a special type of revenue class meters. The use of these special meters will be for generator customer’s load rated 1 MW or greater.

24. Any other meter that will share the same metering circuit as the PG&E meter shall be a socket-based type meter.

General Notes

25. 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.


27. The use of capacitively-coupled 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).

28. 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.

29. 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

30. To order combination metering units (PT/CT), please consult PG&E meter engineering personnel.

References

<table>
<thead>
<tr>
<th>References</th>
<th>Location</th>
<th>Document</th>
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<td>Accessory Equipment for Revenue Metering</td>
<td>Substation Design Standard Drawings</td>
<td>026237</td>
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<td>Diagram of Connections for Metering Polyphase</td>
<td>OH: Meters/UG-1: Services</td>
<td>028162</td>
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<td>Loads Using Self-Contained Meters</td>
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<td>Revenue-Class Instrument Transformers 0–500 kV</td>
<td>Substation Design Standard Drawings</td>
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<td>Electric Revenue Meters</td>
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<tr>
<td>60kV &amp; 115kV Metering Transformer</td>
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</tbody>
</table>
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 Haefely Trench 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 (H₂) 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.
Customer-Provided Conduit and Wiring for 120Vac Power to Metering Enclosure for Lighting and Outlet Requirements.

Fence

Grounding Cadwell Connection

Perimeter of Station Ground Grid

Switch Operating Safety Platform

Physically Install Metering Units With H1 Bushing Polarity and Potential Transformers on Line Side of Service.

Disconnect Switch

Single-Phase Combination Metering Units

CT Terminals

PT Terminals

Power Line to PG&E's System

Customer to Provide Telephone Conduit Stub-Out 2" PVC

Non-Conducting Fence

Customer-Installed Ground Conductor 500 kcmil Copper, With 4' 0" Long Pigtail Inside Metering Enclosure

Metering CT and PT Wiring Installed by PG&E Customer to Provide 2" PVC Conduit and Installation

For Alternate #1, #2, and #3 Conduits Stub-Outs Configuration See Figure 3 on Page 6.

Customer to Provide 1/4" x 2" Copper Ground Bus

Operating Platform (Not Shown)

Figure 2
Symbolic Arrangement for Typical Metering Unit and Meter Enclosure Installation
Electric Metering

Electric Revenue High-Voltage Metering

Figure 3
Alternate Conduits Stub-Outs Configurations

Figure 4
Metering Enclosure Details

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

Metering Enclosure #2, Model #102
(Bally "Prefab" Modular Building)
Figure 5
Typical Metering Transformer Installation Structure
Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering

Figure 6
Wiring and Construction

Note
1. One-point grounding at meter enclosure, same grounding wherein the potentials are not stacked up on top of one another.

Requirements:
• Two (2) neutrals (1 PT-neutral and 1 CT-neutral)
Typical Connection of a Non-Utility Generator

Figure 7
Preferred Interconnection Surplus Sale
Disconnect Switch Wiring Diagram

Figure 8
One (1) Common Neutral for Both PT and CT
**Common Wire Customer Installation - Transmission Voltages 60 kV Through 230 kV When PG&E Owns Transformer and High-Side Breaker for Bundled Customers**

- **Disconnect Service Operated by PG&E**: Connected to the transmission system.
- **Bidirectional Meter**: (Transdata Mark V or Equivalent) measures KWH "In", KVARH "In" (lag), KWH "Out", KVARH "Out" (lag).
- **60 A 3-Pole, Secondary Voltage Safety Disconnect Switch**: Operated by PG&E.
- **Analog Phone Line to MV-90**: Provides communication for maintenance.
- **Customer Disconnect Device**: Owned and operated by the customer.
- **High-Side Breaker**: Owned by PG&E.
- **Dedicated Transformer**: Owned by PG&E.
- **Disconnect Device**: Operated by PG&E.

**Figure 9**

Small Power Producers and Co-Generators
ISO Metering With Standby Service

Note: Usage of another type of meter can affect actual field wiring.

Figure 10
Connection Diagram Showing a CAISO Meter and a PG&E Standby Meter

Notes
1. This is a typical connection of a generator selling power to the CAISO, that includes a PG&E meter to measure standby power.
2. Combination metering units (PT/CT) specified by PG&E and purchased by the customer (generator).
**ISO Metering Showing Primary and Backup Metering**

- **To Transmission System**
- **Existing Test Switch**
- **PG&E Seals**

- **Step-Up Transformer**
- **Metering CT**
- **Metering VT**

- **Primary CAISO Meter**
  - To 120 Vac
  - K1-9
  - K1-7

- **Backup CAISO Meter**
  - To MV90

- **PG&E Meter**
  - New PG&E Test Switch

- **Phone Line to MV90**

**Figure 11**

*Connection Diagram Showing PG&E Meter Coupled To Primary and Backup CAISO Meters*

*This test switch is optional.*

**Use of a third test switch is no longer recommended.**
**ISO Metering**

To Transmission System

Existing Test Switch
PG&E Seals

1 2 3

Generator

1 2 3

Step-up Transformer

Metering CT Ratio

Figure 12
Connection Diagram Showing PG&E Meter and One CAISO Meter

* This test switch is optional.

** The use of a third test switch is no longer recommended.
ISO Metering (continued)

Figure 13
Connection Diagram Showing PG&E Meter and One ISO Meter

* This test switch is optional.
Revision Notes

Revision 03 has the following changes:

1. Added Item 14 to the "Metering Requirements" section on Page 2.
2. Updated the "References" section.
3. Deleted a secondary potential safety disconnect switch from Figure 1 on Page 4.
4. Revised the ABS conduit to PVC conduit in Figure 1 on Page 4.
5. Added Note 5 on Page 4.
6. Added Figure 2 on Page 5, Figure 3 and Figure 4 on Page 6, and Figure 5 on Page 7.
7. Revised Figure 6 on Page 8.
8. Deleted figures for "Two (2) Common Neutrals (1 PT-neutral and 1 CT-neutral)" and "One (1) Common Neutral for Both PT and CT."
9. Performed minor revisions throughout the rest of this document.