

## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

### SUMMARY

This bulletin specifies the technical requirements for all customers requesting electric service at one of Pacific Gas and Electric Company's (PG&E) primary distribution voltages as defined in Rule 2. It is intended to give the customer a clear understanding of what their responsibilities are to receive Primary Service (PS) and those of PG&E. PG&E has developed these technical requirements in order to provide safe and reliable service to all the customers the Company serves.

If the PS customer already has or intends to install distributed generation, then also refer to the information and requirements described in the [Distribution Interconnection Handbook](#).

### AFFECTED DOCUMENT

None

### TARGET AUDIENCE

All utility employees working with primary service design and installation.

### WHAT YOU NEED TO KNOW

#### 1 General Requirements

Customers meeting the Rule 2 requirements for PS shall install, own and operate their distribution system beyond their Point of Service (POS). While there are a number of technical requirements associated with a PS, two requirements are particularly important:

- PG&E must approve the POS.
- PG&E must approve the protection scheme that the customer installs, owns and operates at the POS.

Satisfying these requirements assists PG&E in providing safe and reliable service to other customers connected to the Company's system. Customers considering a PS should contact PG&E early in the design process.

#### 2 Primary Service Arrangements

PG&E prefers that the POS, protective device and revenue meter for a PS be at or near the property line nearest to PG&E's primary distribution. The PG&E-approved and customer installed primary protection must be at the POS to protect other PG&E customers from outages due to faults on customer facilities. The revenue-metering should also be at this point because the PS customer is responsible for the line losses on their primary conductor and transformer(s) as well as their load. However, unlike the requirement for the protective device, it is not an absolute requirement.

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The sections below explain the primary protection requirements and revenue-metering location requirements for PG&E's preferred PS arrangements. Please note that non-preferred service arrangement proposals may take longer to approve and involve additional cost for the customer.

### 2.1 Preferred PS Arrangements

PG&E's preferred PS arrangements are either: a) when the PS customer's primary distribution line is underground (UG) and the POS is less than 500 feet from the property line, or b) when the PS customer's primary distribution line is overhead (OH) and the protective device pole (if separate from the POS pole) is less than 50 feet from the property line.

#### 1. UG Conductor and POS < 500 Feet

If the PS customer's primary line is underground and the POS is 500 feet or less from the property line, refer to Figure A3-1 and Figure A3-2. The following requirements apply:

- a. The PS customer must provide a PG&E approved enclosure for PG&E's revenue-metering equipment. See Section 9 (Page 10) for detailed revenue-metering requirements.
- b. The PS customer must install primary protection at the POS. This protection may consist of a circuit breaker with phase and ground relays or, depending on the customer's load, fuses may suffice. If PG&E determines that fuses will not coordinate with PG&E's source-side protection, then the customer must use a circuit breaker. See Section 4 (Page 4) for circuit breaker and fuse requirements.
- c. The PS customer must install conduit from the POS to PG&E's box (if UG) or pole (if OH).
- d. PG&E will pull one continuous run of cable and connect to the customer's POS termination facility, not to exceed 500 feet (subject to an acceptable number of bends in the conduit).

#### 2. OH Conductor

If the PS customer's primary line is overhead, then the first pole at the customer's property line is the POS. Refer to Figure A3-3. The following requirements apply:

- a. PG&E will install pole-top revenue-metering on the first pole on the PS customer's property. See Engineering Standard 058779 for pole-top revenue-metering requirements.

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- b. The PS customer must install primary protection on the second pole on their property, not to exceed 50 feet from the revenue metering pole. This protection may consist of a recloser or, depending on the customer's load, fuses may suffice. If PG&E determines that fuses will not coordinate with PG&E's source-side protection, then the customer must use a recloser. See Section 4 (Page 4) for recloser requirements.
- c. PG&E will interconnect its system with the customer's system at the revenue-metering pole.

### 2.2 Non-Preferred PS Arrangement Proposals

PS customers may propose a non-preferred PS arrangement. This typically occurs when the PS customer's primary distribution line is UG and the proposed location for the primary switchgear is greater than 500 feet from the property line. PG&E will consider such proposals, however, non-preferred service arrangement proposals may take longer to design, approve and can involve additional customer expense. Customers should contact PG&E early in the design process if they are considering a non-preferred PS arrangement.

A non-preferred PS arrangement may consist of: a) a splice box with an underground interrupter or subsurface fuse within 500 feet of the property line, or b) padmounted switchgear within 500 feet of the property line that includes a protective device such as a breaker or fuses. In these cases, the substructures and equipment are installed and owned by the customer. As with preferred arrangements, PG&E must approve the location, substructure/equipment arrangement and protective devices. In addition, note that the following requirements still apply:

1. The PS customer must provide space for PG&E's revenue-metering in their switchgear. See Section 10 (Page 12) for detailed metering requirements.
2. The PS customer must install conduit from the POS to PG&E's box (if UG) or pole (if OH).
3. PG&E will pull one continuous run of cable, not to exceed 500 feet, to the POS (subject to an acceptable number of bends in the conduit).

### 2.3 Location of Revenue-Metering

The preferred revenue meter location is at the POS. High-side metering is PG&E's preferred metering configuration. If PG&E approves low-side metering, a 2% adjustment factor will be applied at each stage of the transformation before the meter. See Section 9 (Page 10) for additional revenue-metering requirements.

### 2.4 Service Wire Configuration

If the PG&E point of service is at a protective device and not at the customer owned switchgear the wiring configuration, 3-wire or 4-wire, of the customer's service from the protective device to the switchgear must be the same as PG&E's.

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### 3 General Protection Requirements

It is important to minimize the potential hazard to life and property when interconnecting facilities to the PG&E distribution system. This requires the automatic detection of abnormal conditions and trouble related to a PS customer's equipment and the isolation of the condition and/or equipment within a reasonable time.

As a general rule, neither party should depend on the other for system protection. As such, PG&E's minimum protection requirements are designed and intended to protect the PG&E power system only. Moreover, the interconnection of a PS customer to the PG&E distribution system must not degrade existing PG&E protection and control schemes or interfere with the service of other customers (see Rule 2).

The PS customer's facilities must isolate any fault or abnormality that could adversely affect the PG&E electric system or the electric systems of other entities connected to the PG&E electric system.

PG&E assumes no liability for damage to the PS customer-owned facilities resulting from a lack of adequate coordination between the PS customer's protective device(s) and PG&E's protective devices, or negligence due to the PS customer's failure to maintain protective and/or isolation equipment.

PG&E recommends that the PS customer acquire the services of a qualified and licensed electrical engineer to review its plans. The PS customer must, at its expense, install, operate, and maintain system protection facilities in accordance with all applicable regulatory rules and requirements, and in accordance with this bulletin.

#### 3.1 Data the PS Customer Provides to PG&E

1. The PS customer must provide the information necessary for PG&E to determine the interconnection requirements before PG&E approves the specific PS installation. This information includes, but is not limited to, the following:
  - a. Single-Line diagrams.
  - b. Meter and Relay diagrams.
  - c. Three-Line diagrams of required protective device.
  - d. Control diagrams including direct current (dc) tripping circuit.
  - e. Proposed relay specifications and settings.
  - f. Relay manufacturer, model, style, type, ranges, settings, and a copy of the relay instruction manual.

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- g. Projected electrical demand (i.e., kilowatt [kW]), including the following information:
    - (1) Power factor
    - (2) Load factor
    - (3) Large motor sizes
    - (4) Motor starting currents
    - (5) Customer's transformer size
    - (6) Estimated breakdown of the electric energy use (i.e., kilowatt hours [kwh]) by month
  - h. Full-size phase and ground coordination curves showing full coordination with PG&E's system.
  - i. A registered electrical engineer must prepare and stamp the fault-study results.
  - j. Maintenance program documentation for PG&E-required switches, interrupting devices, and protective equipment.
2. PG&E strongly recommends that the PS customer, or their representative, provide the above information before ordering equipment and finalizing the design.
3. Also, before energizing the new PS facility, the PS customer must also provide a copy of the on-site test reports for the switches, devices, and relays at least 30 working days before energizing the service. This allows sufficient time for review, modification, and final PG&E approval. Qualified personnel must prepare these on-site test reports. Refer to Section "Equipment Test Requirements," and Section "Pre-Energizing Test" for further details.

### 3.2 Data that PG&E Provides to the Applicant

PG&E provides the following engineering data to the PS customer:

- 1. System fault-duty at the property line.
- 2. Settings for PG&E source-side protective devices and the required clearance time to comply with PG&E protection standards.
- 3. Relay curves for PG&E source-side protective devices, if requested by the PS customer.

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### 4 Specific Protection Requirements

PG&E must review and approve the fault-interrupting devices that the PS customer selects. There are four basic types of fault-interrupting devices available for distribution systems:

- Circuit breakers
- Reclosers (without bypass) and Interrupters
- Fuses

The following sections provide specific requirements for each of these devices.

#### 4.1 Circuit Breaker Requirements

The interconnecting circuit breaker must have sufficient capacity to interrupt the maximum available fault current at its location. Phase and ground relays approved by PG&E (see Table 1, PG&E Approved Relays, on Page 7) must be used to trip the circuit breaker for phase and ground faults. These relays must coordinate with PG&E's source-side protection. It must also include the following features:

1. Shunt-trip via a trip signal supplied through a battery external to the circuit breaker.
2. Lock out if operated by protective relays required for interconnection.
3. Capacitive tripping is unacceptable.
4. Relay Requirements
  - a. PG&E requires PS customers to install phase and ground over-current relays that trip the interrupting device at the POS. These relays must detect all phase and ground faults, and coordinate with PG&E's source side protection. All required relays must include relay targets, and have "manual reset" capability.
  - b. The PS customer must either: a) select phase and ground relays approved by PG&E or, b) have an International Electric Testing Association certified testing company test the relay as outlined in Attachment and provide the test results to PG&E for approval.
  - c. PG&E strongly recommends that PS customers submit all relay specification and setting proposals for PG&E approval before finalizing the design and ordering equipment. PS customers not submitting this information risk delaying their projects.

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### Table 1 PG&E Approved Relays

See Tables G2-4 and G2-5 located in the [Transmission Interconnection Handbook, Section G2, "Protection and Control Requirements."](#) These tables list all of the types of relays approved for load and generation interconnections on the PG&E distribution and transmission systems.

#### NOTE

PG&E's approval of the relays does not indicate the quality or reliability of a product or service. No endorsements or warranties are implied.

#### 5. Relay Redundancy Requirement

The PS customer's protection system must contain redundancy such that the failure of any one component will still allow the customer's system to isolate the PS facility from the PG&E system under a fault condition. Three single-phase over-current relays and a ground over-current relay, or two three-phase over-current relays and a ground over-current relay satisfy the redundancy requirement. PS facilities, using microprocessor-based relays as a multifunctional protective device, must have backup relays.

#### 6. Power Supply Requirements

Power supplies for PG&E-required relays and the tripping circuitry for the fault-interrupting device must be supplied from a battery and charger system. The system must include a dc under-voltage detection and alarm feature. Fuses are not allowed in the dc trip circuitry (dc breakers are acceptable).

The preferred battery type is flooded lead-acid (calcium, antimony) or nickel-cadmium (NiCd). Sealed batteries (Valve Regulated Lead Acid [VRLA]) are allowed if they meet PG&E requirements. An uninterruptible power supply (UPS) is unacceptable. See Section 11, "Battery Requirements for Interconnecting to the PG&E System," on Page 18, for more details on PG&E's battery requirements.

#### 4.2 Reclosers and Interrupters

Contact PG&E for approved reclosers and interrupters.

When a recloser is used as the customer's primary protection, do not install a bypass switch which bypasses the protective functions of the recloser.

#### 4.3 Fuse Requirements

1. Fuses are single-phase, direct-acting, sacrificial links that melt to interrupt fault current and protect the equipment.

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2. PG&E may approve the use of fuses as the fault interrupting device at the POS for load-only facilities, if the fuses coordinate with the PG&E source-side devices for both phase and ground faults. Large primary fuses that do not coordinate with PG&E's source-side protective phase and ground relays are not allowed. These fuses may cause other customers on the circuit to lose power due to a fault inside the PS customer's facility.
3. If the facility has a generation source refer to the [Distribution Interconnection Handbook](#) for limitations on when fuses may be used as the fault interrupting device.
4. The PS customer must replace the blown fuses manually after each fault before the facility can return to service. Only trained, qualified personnel should replace the primary fuses.
5. If PG&E approves the fuses, the PS customer should consider installing a negative-sequence relay and/or other devices to protect its facility against single-phase conditions (however, this is not a requirement). The PS customer is responsible for protecting their equipment against single phase conditions, if they determine or feel that it is needed.
6. Customers must keep a full set of replacement fuses (PG&E must approve the size and type) onsite.

### 5 Equipment Test Requirements

The tests in this section apply only to the PG&E-required equipment at the POS; specifically, the breaker, the relays, and the tripping circuitry.

The customer must complete the following requirements:

- The equipment must pass all the tests described below.
- The customer must submit two copies of the test reports to PG&E a minimum of 30 working days before energizing the PS facilities.
- Each test report must identify the equipment tested and that identification must match that in the single-line or three-line diagrams.

The customer must meet the above requirements and obtain PG&E approval of the test reports at least ten working days before PG&E energizes the PS. PG&E strongly recommends that the PS customer coordinate the test program with PG&E.

#### 5.1 Circuit Breaker Tests

The PS customer must perform the following circuit breaker tests:

1. Minimum-to-trip test at 70% or less of the nominal control voltage on all circuit breakers operated by PG&E-required relays.

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2. Micro-ohm test on the main circuit breaker(s) at the POS.
3. Timing test showing the time from the trip initiation to the opening of the main poles. Proving insulation tests, as described below.
4. Proving Insulation

A 1,000 or 2,500 volt (V) dc megger test, or a 1,000 V high-pot test is acceptable for the insulation tests described below.

- a. Megger circuit breaker(s) at the POS operated by PG&E require relays (see Table 2 below).

**Table 2. Circuit Breaker Positions and Connections**

Circuit Breaker Position	Connection
Circuit breaker open.	Each pole to ground, pole 1 to 2, pole 3 to 4, pole 5 to 6
Circuit breaker closed.	Pole 1–ground, pole 3–ground, pole 5–ground
If the poles are in a common tank or cell.	Pole 1 to 3, pole 3 to 5, pole 5 to 1

- b. Megger (phase-to-phase and phase-to-ground) all buses from the POS to the main breaker or fuses.
- c. The main circuit breaker(s) must have a dielectric test performed on the insulating medium (gas or oil). This test is not required for factory-sealed, circuit-switcher interrupters.

**5.2 Tests for Current Transformers and Current Circuits**

PS customers must perform the following tests for current transformers (CTs) and current circuits associated with PG&E-required relays:

1. Check the saturation on all CTs. If this is not possible, a manufacturer's curve is acceptable.
2. Prove the ratio of all CTs by using current (primary to secondary) or voltage (secondary to primary).
3. Check the CTs for the proper polarity.
4. Check the CT circuits for the proper connections.
5. Check the continuity of the CTs by:
  - a. Applying primary or secondary current at the CT block.

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- b. Verifying that the proper current exists in each phase relay and the ground relay.

Customers must perform each test (primary or secondary) in all combinations prove that all phase relays and ground relays have proper connections.

PS customers must also ensure that no loose wiring or parallel current paths exist, by applying or injecting the current to achieve a secondary reading of 5 amperes (A) in each relay.

Check each phase of each current circuit feeding PG&E–required relays. Megger the total circuit with the ground wire lifted (to prove that only one ground exists).

### 5.3 Relay and Fuse Tests

The testing requirements for relays/fuses include:

1. PS customers must field test the settings of PG&E-required relays to verify the following items:
  - a. The minimum operating point at which the relay picks up (minimum pickup).
  - b. Time delays at three different current-test points, in integral multiples of the minimum pickup that closely characterize the relay time-current curve.
  - c. Test results must be within the tolerances listed below:
    - (1) Current/Voltage/Time  $\pm 10\%$
    - (2) Impedance/Phase Angle  $\pm 0.05\%$
    - (3) Frequency  $\pm 0.05\text{ Hz}$
2. Check all fuses for continuity before energizing.

### 5.4 Tests Recommended (But Not Required by PG&E) for the PS Customers

#### 1. Transformer

It is recommend (but not required by PG&E) that the customer perform the following tests to prove the insulation and turns ratio on their primary service transformers.

##### a. Proving Insulation

A 1,000 or 2,500 volt (V) dc megger test or a 1,000 V, high-pot test is recommended for any of the insulation tests below.

- (1) Megger the main transformer(s) winding-to-winding and each winding-to-ground.

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- (2) Megger the buses (phase-to-phase and phase-to-ground) from the POS to the main transformer.
  - (3) Perform a dielectric test on the main transformer(s) insulating medium (gas or oil).
- b. Proving Ratios
- Prove the main transformer(s) ratio(s) using one of the following methods:
- (1) Turns-ratio tester.
  - (2) Voltage-ratio test on the final operating tap. Consult with PG&E to best match the present distribution-system voltage.

### 6 Pre-Energizing Test

6.1 Customers must meet the following requirements before PG&E will energize the PS:

1. Ensure that any inspections required by local governmental and regulatory agencies are complete and any applicable permits are obtained before PG&E energizes the PS.
2. A PG&E technical representative must witness trip checks of all PG&E-required relays. This may require injecting a signal to trigger the relay. This proves that the relay will handle the trip current of the circuit breaker. It also proves relay targeting. Jumpering the studs on the back of the relay is not acceptable.
  - a. The Primary Service Entity shall provide all test equipment and qualified 3rd party personnel to perform the required tests. PG&E recommends third party testers to be National Electrical Testing Association (NETA) certified. PG&E shall be there strictly as an observer. Form PS-1 shall be completed by the PG&E representative on site at the time of the pre- energizing test.
3. A PG&E technical representative must verify grounds are bonded per standard (switching platforms, fences, buildings, etc.) and verify signage is correct per the below requirement. All signs shall be constructed to be weather proof.
  - a. Disconnect -- The disconnect sign shall have 1 inch wide by 2 inch high, with colors venetian red (#3) lettering on a buff (#1) background (or similar). It shall be attached as shown on Engineering Design Standard 454092 (see Appendix D). If the facility has multiple feeds with multiple separate disconnect switches, then each disconnect requires a separate sign.

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- b. Location -- The location sign shall have 1 inch high venetian red (#3) lettering on a buff (#1) background. PG&E's standard location sign size is 14 inches wide by 7 inches high overall. It shall be posted at each entrance to the facility. If there are other gates or doors to go through, then each one of those shall have a sign as well. For example: One posted at the entrance to the primary service facility and one posted on the entrance to the substation within the primary service facility.
4. After energizing the PS and adding load, a PG&E technical representative must witness the reading of the load current in each phase relay and the absence of load current in the ground relay. The PG&E technical representative will then seal the relays.
5. The PS customer is responsible for providing all test equipment, and qualified personnel to conduct the tests in the presence of a PG&E technical representative.

### 7 General Notes

- The PG&E system has an A-C-B counterclockwise rotation.
- Before making changes to PG&E-required protection equipment, the customer must submit the proposed changes to PG&E for review and approval.
- The customer is responsible for maintaining PG&E-required protection equipment in accordance with PG&E maintenance and test practices. After completing such tests, the customer must submit maintenance and test report documentation to PG&E for review and approval. A PG&E technical representative will reseal PG&E-required relays following setting changes and routine maintenance.
- Contact the local PG&E representative with any questions.

### 8 Alternate Source

- 8.1 A PS customer may request an alternate primary voltage source installed at customer expense. Requests for an alternate source are handled on a case-by-case basis. This section describes some of the technical requirements associated with installing and operating a PS with an alternate source. Technical requirements may change depending on location and a variety of other factors. PG&E strongly recommends that customers contact the Company early in the design phase to ensure a successful project. The PS customer and PG&E must work together to ensure that an alternate source system fulfills the customer's needs while not degrading PG&E protection schemes, operating flexibility or cause interference with another customer's service.
- 8.2 When a PS load is transferred from the primary source to the alternate source or vice versa, a momentary outage ("drop-and-pickup" operation) occurs.

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- 8.3 When the PS is fed from the alternate source and the PS customer wants to transfer back to the primary source with a parallel operation (“make-before-break” method), the PS customer must meet the following requirements:
1. The ratios and electrical connections of the transformers on both sources must be well matched to minimize circulating currents.
  2. The impedance of the transformers and the relative phase angles of the sources must be such that any “through load” (i.e., flowing of power through the PS customer’s electrical system to other customers) does not cause overloads.
  3. The parallel transfer operation must not degrade protection, inhibit PG&E’s operating flexibility, or overstress equipment (customer or PG&E equipment).
  4. The transfer switches, one on each side of the PS load, require an automatic interlock control scheme to minimize the time the two systems are paralleled. The transfer switches must be circuit breakers or other suitably rated, automatically controlled switches.

### NOTE

The parallel period must be less than one second because the presence of two parallel circuits will increase the fault duty and may overstress the PS customer’s equipment.

5. In some cases, PG&E may require additional protective devices and/or special operating procedures to ensure safe and reliable service for the PS customer and other PG&E customers.
6. Each parallel transfer operation can only proceed after PG&E’s specific approval. The PS customer must obtain PG&E’s approval before performing the parallel transfer operation. PG&E may withhold approval if, in its sole judgment, the above requirements have not been met, or if a previously unforeseen factor or change in conditions is deemed to jeopardize the operator, public safety, or reliability to customers.
7. The PS customer must assume all liability for any problems or damage resulting from any parallel transfer operation.

## 9 Revenue-metering Requirements

This section addresses direct access (DA) and bundled–service PS customers connected at distribution voltages (34.5 kV and below), as described in Rule 2. Customers must satisfy PG&E’s revenue–metering requirements and those of other applicable governing authorities (i.e., California Public Utilities Commission [CPUC], California Independent System Operator [CAISO], etc.).

For customers exporting power, loads connected at distribution voltages must satisfy the metering protocols established by PG&E and CAISO. Exceptions are handled on a case-by–

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case basis with approval from PG&E's Customer Metering Services in close coordination with Field Metering Services.

Other arrangements that affect the required metering installation may also require a "Generation Special Facilities Agreement."

There are two types of distribution services:

- Wholesale
- Retail (i.e., end-users)

### 9.1 Wholesale Service

1. For wholesale-service interconnections, the PS customers must provide, install, own, and maintain all revenue-metering-related equipment, including all the items provided and maintained by PG&E or a Meter Service Provider (MSP) listed under "Retail Service" below.
2. PS customers requesting wholesale service must meet the following criteria:
  - a. CAISO metering standards
  - b. CPUC-approved metering standards
  - c. PG&E's requirements
  - d. Enter into a Meter Service Agreement (MSA) with the CAISO and, in certain cases, with PG&E. The MSA specifies requirements regarding the retrieval of load data and accessibility by CAISO.
3. The wholesale PS customer is responsible for ensuring that the meters comply with CAISO's meter standards and accuracy requirements.
4. All PS customers must contact PG&E's local account services representative for PG&E's revenue-metering requirements.

### 9.2 Retail Service (End Users)

Electric Rule 22 "[Direct Access](http://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_22.pdf)" governs the interconnection and operating requirements for DA customers. Please use the following link to access the document, [http://www.pge.com/tariffs/tm2/pdf/ELEC\\_RULES\\_22.pdf](http://www.pge.com/tariffs/tm2/pdf/ELEC_RULES_22.pdf).

#### 1. Customer Service Elections

According to Rule 22, customers have the opportunity to acquire their electric power needs under the following two options:

- a. Bundled Utility Services – traditional service from PG&E

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### (1) Bundled Services

For bundled (full-service) utility services, PG&E, in most cases, continues to provide the following services:

- Own, provide, and maintain metering equipment, including the meter
- Meter reading

Customers returning to bundled service may own the meter, if the meter is supported by PG&E. In the event that the customer's meter becomes nonfunctional, PG&E will replace the meter with an equivalent meter and return the former meter to the customer (end-user).

- b. DA – customers purchase energy from various suppliers and related services from Energy Service Providers (ESPs)

### 2. Customer Meter Options

Customer metering options include:

- a. DA customers, PG&E, or the ESP may own the hourly meter.
- b. The ESP may act as its own MSP or hire an MSP to maintain metering equipment compliance.
- c. The ESP may also act as its own Meter Data Management Agent (MDMA) or hire an MDMA to read the meter and maintain the meter data.
- d. Contracting with PG&E to perform metering services or meter-data management.
- e. PG&E retains the right to physically access any hourly or monthly meter data.
- f. PG&E continues to read, test, and inspect the meters on PG&E's system.

### 3. PG&E Is The MSP

PG&E, as the MSP, continues to provide, install, maintain, and test the following:

- a. Revenue-metering instrument transformers (voltage transformers and current transformers), which are considered part of the distribution system per CPUC decision D.97-10-087, dated October 30, 1997. PG&E Engineering Document 058779, "Pole Top Primary Metering Installation, Cluster Mounted (12 or 21 kV Line)," shows a typical, distribution, pole-type metering.

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- b. Secondary wiring from the base of the metering transformers to the revenue meter in a customer-supplied dedicated raceway (conduits) used solely for revenue-metering.
    - c. Meters and associated metering devices such as isolation relays, test switches, etc.
  4. PG&E Is the MDMA
5. Customer Responsibilities

PG&E, as the MDMA, continues to provide the following services:

- a. Reading raw meter data from the interval meter.
- b. Validating, editing, and estimating the data of a settlement-quality form.
- c. Placing the settlement-quality data on the MDMA server and, if necessary, performing a usage adjustment.

The customer (end-user) maintains the following:

- a. The Meter Enclosure

To maintain the required metering accuracy, the distance between the meter enclosure and the revenue-metering transformers must not exceed 50 feet.

PG&E must approve any variance from this general rule. The enclosure must be grounded and located within the substation ground grid. Access must be readily available for PG&E employees to read and maintain the metering equipment.

The enclosure must be equipped with the following items:

- (1) Auxiliary 120 V duplex plug
- (2) Overhead light
- (3) Light switch adjacent to the door
- (4) Ground bus connected to the ground and mounted near the bottom of the wall where the meters are located

Please refer to PG&E's [Electric and Gas Services Requirements \(Greenbook\)](#) and [Engineering Document 058779, "Pole-Top Primary Metering Installation, \(12 or 21 kV Line\)."](#)

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b. PG&E-Approved Meter Panels

Please refer to PG&E's [Electric and Gas Services Requirements](http://www.pge.com/greenbook) (<http://www.pge.com/greenbook>)

c. The Pull Lines

The customer must install a pull line in the conduit between the metering enclosure and the junction box at the base of the metering-unit support structure to facilitate the MSP's installation of the metering-unit secondary wires.

Only install the MSP's secondary revenue metering wires in the conduit between the meter enclosure and the PT/CT units. Conduits may be metallic or nonmetallic.

d. Telephone Lines into the Metering Enclosure

If a telephone line is required to read the meter, the customer may be responsible for installing the line into the metering enclosure and establishing telephone service. If a land-line is unavailable and cellular signal levels are acceptable, the use of a cellular telephone is acceptable.

If the meter's telephone line is not dedicated to the meter, the customer, with prior approval from PG&E's local metering group, may arrange to use a line-sharing switch.

The customer must ensure that the telephone line terminations in switchboards, panels, pole-mounted meters, and pedestals meet the following requirements:

- (1) Located within five circuit-feet of the centerline of the meter.
- (2) Located between a minimum of 18 inches and a maximum of 72 inches above the finished grade.

When cellular telephones are used, the same location requirements apply to the power supply, as measured from the load side of the meter. Locate the power supply outside PG&E's sealable section.

### 10 Communication Circuits

PG&E may require communications circuits between PG&E and the customer's PS facilities for the following purposes:

- Protection
- Revenue Metering

## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

- Energy Management System (EMS)
- Supervisory Control and Data Acquisition (SCADA)
- Generation
- Voice communications

When external communication circuits are installed, the responsible party must ensure that the high-voltage protection (HVP) equipment on these circuits meets all applicable standards.

### 11 Battery Requirements for Interconnecting to the PG&E System

- 11.1 This section describes PG&E's process for ensuring safety and reliability of for customers who connect to Company systems. The recommendations made here will ensure that the system operates as designed.
- 11.2 Because of serious reliability, safety and reduced life concerns with sealed (also called Valve Regulated Lead Acid [VRLA]) batteries industry wide, PG&E has decided to completely stop the use of sealed batteries in our Substation or any switchgear installations or interconnection using these batteries. Flooded lead acid (calcium, antimony) and Nickel-Cadmium (NiCd) are the only batteries acceptable in these installations. Switchgear compartments typically see very high temperatures, and if sealed batteries are used they will dry out in less than a few years causing safety and reliability concerns along with not having the capability to trip breakers.

Refer to the side by side comparison of IEEE Standard 450-2002 Section 5.2.3 (IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented lead acid batteries for Stationary applications –also referred as Flooded batteries) and IEEE Standard 1188-1996 Section 5.2.2 Subsections a, b & c.

- 11.3 IEEE Recommended Practice for Maintenance, Testing and Replacement of Valve-regulated batteries for Stationary application. Also referred as VRLA) clearly demonstrates that VRLA requires Quarterly ohmic resistance testing compare to yearly ohmic testing for flooded batteries. Experience industry wide indicates problem with doing ohmic tests on VRLA because of the design of battery and trying to make connections to the terminals and interconnecting hardware. Even if ohmic resistance reading is not done on flooded battery, the failure modes can be detected by other means whereas with VRLA eliminating this test could cause dryout condition and ultimately catastrophic failure. In hot environment VRLA would require charger compensation as well as monitoring which is expensive and still not proven to be adequate. In the telecommunication industry there are presently trials under way for system wide replacements of VRLA with Flooded or NiCd batteries. PG&E recommends use of NiCd batteries in switchgear cubicle because of better performance under extreme temperatures. Flooded batteries can also be used in switchgear.

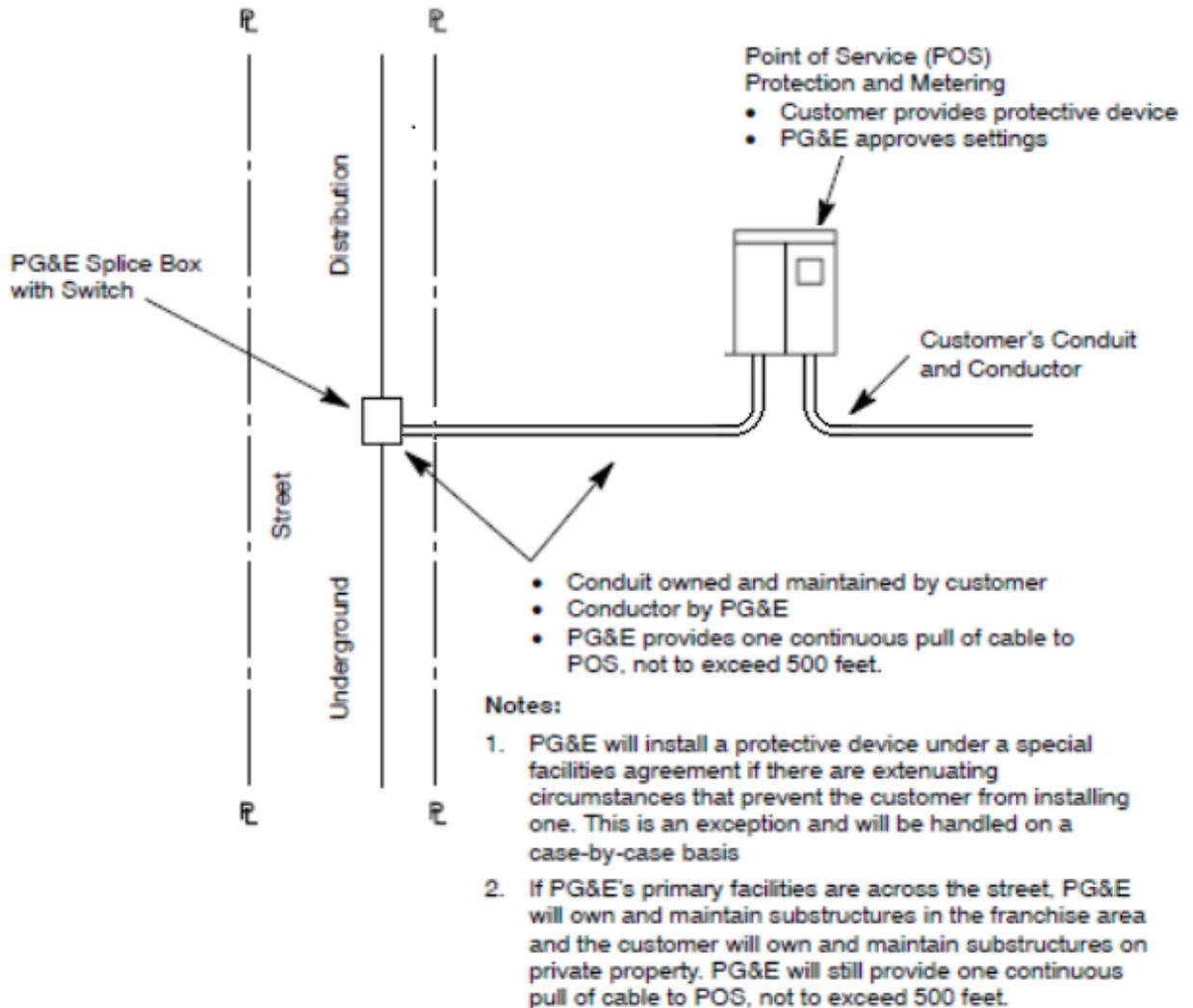
## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

- 11.4 Additional reasoning for not using VRLA in substation as pointed out by IEEE Battery working group Chairman in the recent paper published in IEEE. "Summarizing the issue for VRLA batteries, there is a considerable risk involved in installing a single VRLA string in a substation. If parallel strings are installed, to operate reliably, they must be redundant, either by design or by a sufficient degree of conservatism in the sizing calculation. In building in redundancy, however, the main aim of reducing battery costs is compromised. Despite the early claims of maintenance-free operation, VRLA batteries require considerable surveillance and testing to maintain a high degree of reliability, IEEE 1188-1996 [2] recommends quarterly internal ohmic measurements and annual discharge testing of VRLA. These measures are largely ignored by the telephone operating companies because of their low loads and use of parallel strings, as detailed above. In substation operation, however, these practices are doubly important because of the higher currents involved".
- 11.5 It is required for the third party customer to provide the following documentation to PG&E for review and acceptance by the Substation Engineering Department:
1. Type of Battery (Vented Lead Acid-VLA or NiCd). Monoblock (multiples cells in a jar) batteries from C & D, EnerSys or other vendors will be acceptable. Battery racks must be designed to withstand loading based on IEEE 693 (High Seismic).
  2. Detail information of load including continuous and momentary. No minimum load requirement- Smallest flooded acid may be the limitation
  3. Battery sizing calculation based on IEEE Standard 485-2010 (IEEE recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations) or IEEE Standard 1115-2014 (IEEE recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary application) and minimum 8 hours discharge rate using manufacturer software (to ensure proper discharge curve is used) using aging factor of 1.25 and design margin of 1.1 to be clearly shown on the calculation. Charger sizing calculation based on battery size with recharge time of 12 hours assuming charger will support the continuous load as well as recharges the battery at the same time.
  4. When battery is installed proof of three (3) hour discharge testing to ensure battery has the capacity to support the load and trip; per IEEE Standard 450-2010 (Voltage measurements should be taken every 15 minutes throughout the testing).
  5. Documentation showing what kind of maintenance will be done (Monthly, Quarterly, and Yearly etc).
  6. Monitoring of minimum battery low voltage by separate voltage relay or through charger and provide critical alarm to scada or monitoring system.
  7. Along with documentation of items 1-5; See Attachment 1, Third Party Interconnection Battery Information Sheet And Acceptance Document, located on pages 23 and 24. This information must be completed and submitted by the customer to Substation Project Engineering Department for approval.

## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

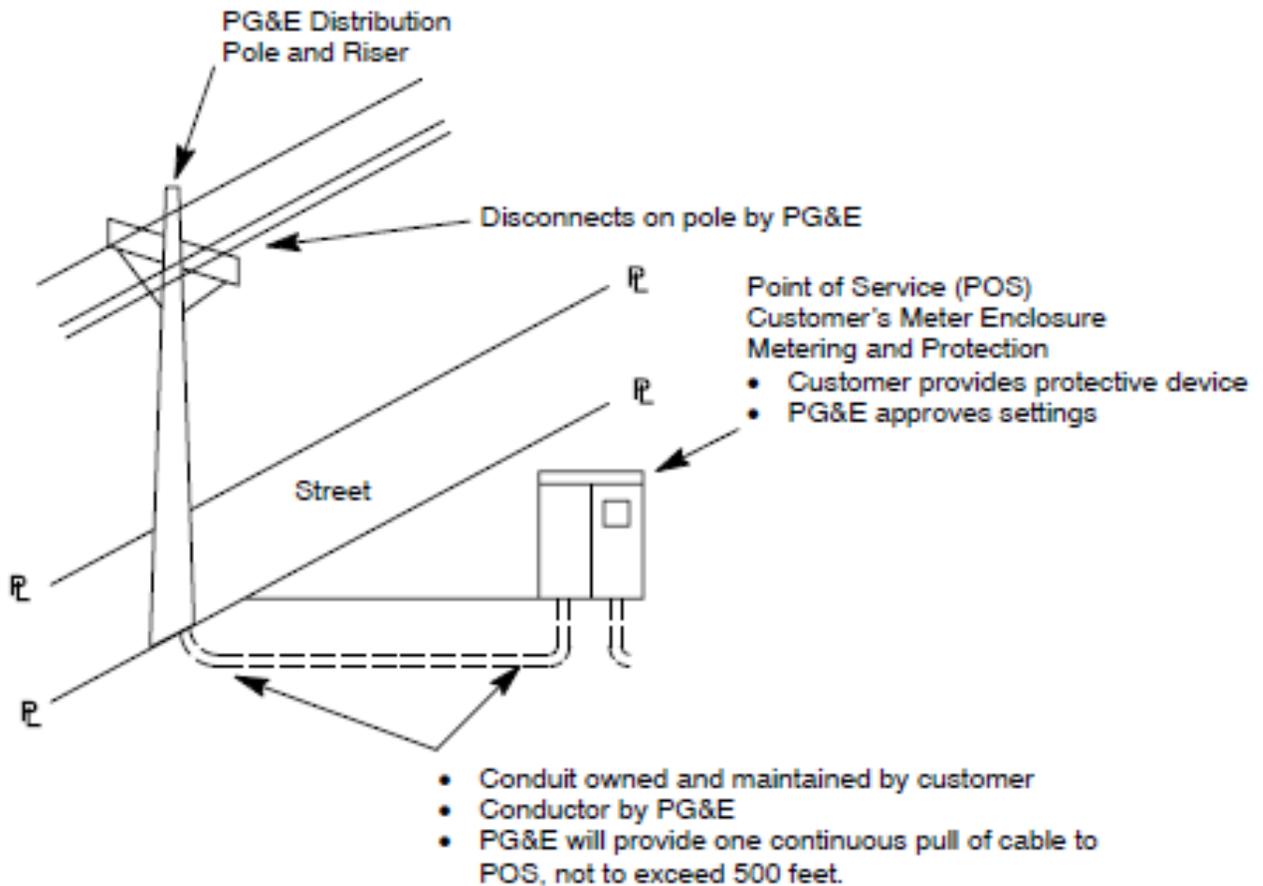
### 12 Preferred Service Arrangement Figures

The following pages provide figures showing the preferred service arrangements for overhead and underground primary services.



**Figure A3-1**  
**Underground Primary Service from Underground Distribution**  
**Preferred Service Arrangement**  
**POS ≤ 500 Feet From PG&E Splice Box**

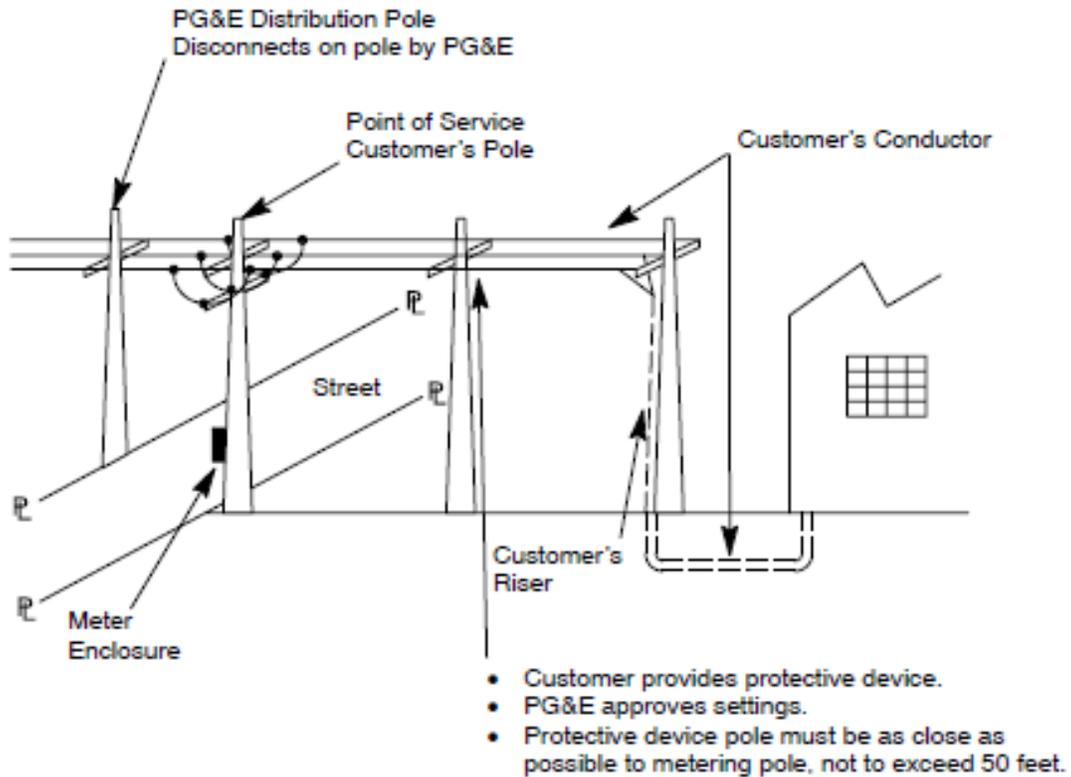
**Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages**



**Notes:**

1. PG&E will install a protective device under a special facilities agreement if there are extenuating circumstances that prevent the customer from installing one. This is an exception and will be handled on a case-by-case basis
2. If PG&E's primary facilities are across the street, PG&E will own and maintain substructures in the franchise area and the customer will own and maintain substructures on private property. PG&E will still provide one continuous pull of cable to POS, not to exceed 500 feet.

**Figure A3-2**  
**Underground Primary Service from Overhead Distribution**  
**Preferred Service Arrangement**  
**POS ≤ 500 Feet From PG&E Pole**

**Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages**

**Note:**

PG&E will install a protective device under a special facilities agreement if there are extenuating circumstances that prevent the customer from installing one. This is an exception and will be handled on a case-by-case basis.

**Figure A3-3  
Overhead Primary Service from Overhead Distribution  
Preferred Service Arrangement**

**Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages**

**Attachment 1, Third Party Interconnection Battery Information Sheet And Acceptance Document**

Section 1: To be completed by Customer while providing all pertinent information and documentation for review based on Appendix T of the TIH or PG&E document TD-2999B.

Project Name: \_\_\_\_\_ Site: \_\_\_\_\_

Type of Interconnection/project: \_\_\_\_\_ Date: \_\_\_\_\_  
 (Transmission, Distribution, Primary Service, Relay Replacement, etc.)

-----

1A) - Battery

Is Battery Flooded type or Sealed Type	
Battery Manufacturer	
Battery Size.	
Battery Model No.	

1B) Charger

Charger Size	
Charger Model No.	

1C) Rack

Is Rack Certified for IEEE 693, High Seismic Zone (UBC Certification is not accepted) –	
Rack Manufacturer and Model No.	

2- List of DC Loads

Is list and quantity of DC Loads included with the Submittal?	
---	--

3-Battery Sizing Calculation

Is Battery sizing sheet based on IEEE 485-1997 or IEEE 1115-2000 included with the Submittal.	
---	--

4 –Proof of Discharge Testing

Is proof of Discharge Testing included with this Submittal	
--	--

5 –Maintenance

Are maintenance schedule and procedure included with this Submittal	
---	--

6 – Battery Low Voltage Monitoring

Are details included with this submittal for 24/7 monitoring of Low DC Voltage. – Please specify Yes or No Remote monitoring is required for unmanned Sites	
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## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

### Section 2: To be completed by PG&E Substation Engineering Department

## Third Party Interconnection Battery Acceptance Document

Date: \_\_/\_\_/\_\_\_\_

**Name of Customer:**

**JO#:**

**Distribution engineer or PM:**

**Reviewed by:**

**Item 1: Type of Utility Grade Battery –**

Battery Type:

Rack Type:

Charger Type:

**Item 2. Detailed Load Information –**

**Item 3. Battery & Charger Sizing Calculations –**

**Item 4. Proof of 3hr-Discharge Testing –**

**Item 5. Maintenance Procedures –**

**Item 6. Monitoring of Minimum Battery Voltage –**

(Ensure battery DC low voltage is monitored as this will be verified during the Pre-Parallel inspection).

Thank you,

(Engineer who reviewed Info)

Substation Project Engineering

## Technical Requirements for Electric Service Interconnection at Primary Distribution Voltages

### DOCUMENT APPROVER

Connie Pascua Taylor, Supervising Standards Engineer, Electric Distribution Standards  
 Roozbeh Movafagh, Senior Manager, Distribution Standards Engineering

### DOCUMENT CONTACT

Daniel Jantz, Engineering Standards Technical Specialist Expert, Electric Distribution Standards

### INCLUSION PLAN

There is no set inclusion plan at this time for this bulletin.

### REVISION NOTES

Where?	What Changed?
What you need to know	<ul style="list-style-type: none"> <li>• Updated the information in Table 1 that out list of approved relays are for load and generation interconnections.</li> <li>• Added to 4 and 4.2, that customers must not install a bypass switch with the recloser.</li> <li>• Removed the example (i.e., no generation is interconnected), from section 4.3.2 about fuses and coordination.</li> <li>• Added new section 4.3.3, If the facility has a generation source refer to the <a href="#">Distribution Interconnection Handbook</a> for limitations on when fuses may be used as the fault interrupting device.</li> <li>• Updated Figure A3-1</li> <li>• Removed Zone 4 from section 11.5.</li> </ul>