

Section L3: SUBSTATION DESIGN FOR LOAD-ONLY ENTITIES AND TRANSMISSION-ONLY ENTITIES

PURPOSE

This section provides substation design information for Load Entities interconnected at transmission voltage and Transmission Entities. Supplemental information is provided in the Planning Guide for Single Customer Substations Served from Transmission Lines (Refer to [Appendix D](#)). Design information for interconnecting at a distribution voltage will be provided by PG&E, upon request.

L3.1. DEAD-END STRUCTURE

The Load Entity or Transmission Entity shall supply the structure at which PG&E shall dead-end or terminate its transmission conductors. PG&E shall supply the insulators at the entity’s expense. The entity shall supply the associated hardware for the transmission connection and the conductor up to the first device. The entity’s dead-end structure shall meet the specifications of Table L3-1 below.

Table L3-1

DEAD-END STRUCTURE SPECIFICATIONS

VOLTAGE	MINIMUM PHASE SEPARATION	MINIMUM CLEARANCE (live part to structure)	MINIMUM CLEARANCE phase-to- ground (per GO 95)*	MINIMUM CONDUCTOR SIZE	TENSION PER PHASE IN FT•LB.
60 kV	7 ft.	2 ft. 6 in.	32 ft.	#4/0 al	1520
				715 kcmil al	2700
70 kV	7 ft.	2 ft. 6 in.	32 ft.	#4/0 al	1520
				715 kcmil al	2700
115 kV	10 ft.	3 ft. 9 in.	34 ft.	#4/0 al	1520
				715 kcmil al	2700
230 kV	18 ft.	7 ft. 3 in.	34 ft.	954 kcmil ACSR	2700-6800
				1113 kcmil AACC	2700-6800

* The actual minimum height at which the conductor lands on the structure shall be such that the conductor height at mid span meets these requirements.

L3.2. TRANSFORMERS

Before ordering the transformer, the Load Entity or Transmission Entity shall submit the transformer nameplate data to PG&E for approval, because the normal operating voltage in some parts of the system may deviate slightly from the nominal voltages. Approval by PG&E does not imply warranties or endorsement. Load Entities or Transmission Entities interconnecting to 60 kV, 70 kV or 115 kV facilities should be aware that at some future date PG&E may convert those facilities to a higher voltage. It would then be the entity’s responsibility to maintain, at the entity’s expense, compatibility between the entity’s and PG&E’s facility.

PG&E recommends a high-side delta, low-side grounded wye transformer bank for interconnection. Any other connections may require additional protection, as determined by PG&E. The use of a delta connection also helps to suppress harmonics, helping to keep power quality at acceptable levels.

If the entity chooses to install lightning arrestors, the arrestors must be on the transformer side of the fault-interrupting devices.

L3.3. VOLTAGE REGULATION

PG&E maintains transmission voltages at levels required for economic and reliable transmission of electricity. Regulation to keep voltage variations within limits acceptable to end-use entities is provided typically on distribution. An entity interconnecting at transmission voltage needs to understand that voltage regulation at transmission voltage levels is different from distribution voltage. For this reason, Load Entities or Transmission Entities are strongly urged to install their own voltage regulation equipment. The entity should contact PG&E regarding the typical range of operating voltages in the area. PG&E usually purchases transformers with a high-side, nominal center tap as shown in Table L3-2, and with two taps above and two taps below, each at 2.5 percent of the nominal voltage.

PG&E’s nominal voltages are shown in Table L3-2.

Table L3-2

CENTER TAPS FOR SUBSTATION TRANSFORMERS

Nominal Voltage (per ANSI C84.1)	Center Tap
500,000	525,000
230,000	230,000
115,000	117,500
69,000	69,580
60,000	60,000

The nominal PG&E voltages are 60 kV, 70 kV, 115 kV and 230 kV, but in some areas of the PG&E system, voltages may run significantly higher or lower. The Load Entity or Transmission Entity is advised to contact PG&E before ordering its transformer. PG&E transformers are usually equipped with a low-side regulator or load tap changer (± 7.5 percent or ± 10 percent).

L3.4. POWER FACTOR

The [CAISO Tariff](#), effective on March 31, 1998, specifies that all loads connected directly to the ISO grid are to maintain a power factor between 0.97 lag and 0.99 lead, as measured at the point where the retail facilities interconnect with the ISO-controlled facilities; i.e., the high voltage side of the distribution and entity-owned transformer banks. The ISO is currently developing penalties, which, subject to any required regulatory approvals, will be applied to the Scheduling Coordinators for Load Entities' non-compliance to this power factor requirement.”

Many PG&E Load Entities with a transmission connection receive Traditional Bundled Service under electric tariffs that provide for a billing adjustment using a reference power factor of 0.85. Those entities with power factors less than 0.85 incur a penalty and those with power factors greater than 0.85 receive a credit. Receiving service under these electric tariffs does not negate the need to meet the provisions of the [CAISO Tariff](#). However, PG&E would continue to apply the power factor provisions contained in the existing tariffs to all transmission-connected Load-only Entities. Thus, an entity whose power factor is within, or corrects its power factor to be within, the ISO-acceptable range would receive a billing credit to the extent it exceeds the 0.85 reference power factor.

L3.5. CIRCUIT BREAKER OR OTHER FAULT INTERRUPTING DEVICES

See [Section L2](#), Protection and Control Requirements.

L3.6. RULES FOR TAPPING TRANSMISSION LINES

Effective January 1, 2016, tapping a transmission line, on PG&E owned lines, for new load and generation interconnections is not permitted on the PG&E system for 100 kV and above. The required method of interconnecting new load/generation is via a new or existing substation. If a new transition switching station is required in-lieu of a tap, on a PG&E owned line, then the new station must be owned, operated and maintained by PG&E. Effective January 1, 2019, tapping 3rd party transmission lines owned, operated and maintained by a 3rd party are restricted, and exceptions may or may not be allowed upon review of standby load agreements being served through non-PG&E facilities and installation of PG&E interconnection requirements required to safely and reliably interconnect the project.

The Table L3-3 summarizes the rules for tapping transmission lines for load or generation.

Table L3-3

RULES FOR TAPPING TRANSMISSION LINES

Above 100 kV	Below 100 kV
<p>Tapping not permitted. All new connections for above 100 kV must be to a new or existing substation.</p>	<p>Interconnections are preferred to new or existing substations. Exceptions are allowed on a restricted basis with PG&E's written approval as determined by PG&E standards.</p>
<p>Existing taps are "grandfathered" in</p>	<p>Existing taps are "grandfathered" in</p>

L3.7. SWITCHES

Manual disconnect switches, tap switches and line selector switches are required as described below:

L.3.7.1. Manual Disconnects

For a transmission interconnection, there shall be manually operated disconnects on both sides of the metering PT/CTs. The first manual disconnect device must be at the point of interconnection with PG&E. This device would be operated by PG&E, at PG&E's discretion, and is used to establish a visually open working clearance for maintenance and repair work in accordance with PG&E safety rules and practices. The disconnect device must not be used to make or break parallels between the PG&E system and the Load Entity's or Transmission Entity's substation. It shall be a gang-operated, three-pole switch. The device enclosure and operating handle (when present) shall be kept locked at all times with a PG&E lock.

If the disconnect device is PG&E-owned, it shall be installed by PG&E at the Load Entity's or Transmission Entity's expense. If the device is to be located in the entity's substation, it must be owned, furnished and installed by the entity. Only devices specifically approved by PG&E may be used. PG&E personnel must inspect and approve the installation before service is energized.

The device shall be physically located for ease of access and visibility to PG&E personnel. When installed in the entity's substation, the device shall normally be located close to the metering. The PG&E-operated disconnect shall be identified with a PG&E-designated switch number plate.

The second manual disconnect device is required between the metering units and the circuit breaker or fault-interrupting device. This device may be operated

by the entity and need not have a PG&E lock. This device would be owned, furnished and installed by the entity.

Disconnect devices shall have the following specifications:

- Must be rated for the voltage and current requirements of the particular installation.
- Must be gang-operated.
- Must be weatherproof.
- The first disconnect switch, at the point of ownership change, must be lockable in both the open and closed positions with a standard PG&E lock.
- Proposed switch specifications must be submitted to PG&E for approval, preferably prior to ordering. For coastal environments, it's preferable to have copper blade switches, and/or non-wash insulators.

Switch operating platforms should be installed with disconnect devices. [Appendix D](#) (Document 034851, "Steel Grating Type Switch Operating Platforms") contains information on the:

- Size and hold weight of platform
- Size of foundation
- Method of bonding to the ground grid.

L3.7.2. Tap Switch

When allowed on the PG&E system (e.g. below 100 kV) tapped connections to the Grid may also require a switch at the tap. The purpose of this switch would be to disconnect the tap line from the main line in the event the tap line needs to be de-energized while keeping the main line in service. Thus the switch would provide a way to isolate trouble or to perform maintenance on the tap line without a long-term service interruption on the main line.

The need for a tap switch depends on several factors including the length of the tap line, the exposure of the tap line to potentially adverse elements and the criticality of the main line. PG&E will evaluate these factors and will determine whether such a switch is needed. If needed, this switch would be in addition to the disconnect switches described above.

The tap switch would be owned, furnished and installed by PG&E under a Special Facilities Agreement in accordance with applicable electric tariffs.

L3.7.3. Line Selector Switches

When allowed on the PG&E system below 100 kV, line selector switches are installed on one or both sides of a single-tap in order to provide operational flexibility in providing service to customers on the tap line. They are used to reduce the duration of customer outages for planned maintenance in the main line and to restore service in the case of an unplanned interruption of the main

line. At PG&E's discretion, a selector switch may not be required if the distance from the new single-tap interconnection to either end of the transmission line or to an existing selector switch on the line is relatively short (one mile or less), and have minimal exposure to causes of outages (trees, traffic, etc.).

The selector switches would be owned, furnished and installed by PG&E under a Special Facilities Agreement in accordance with applicable tariffs.

L3.8. INTERCONNECTION OF LOAD ENTITY'S OR TRANSMISSION ENTITY'S SUBSTATION WITH PG&E'S SYSTEM

For reliable transmission-level interconnection, PG&E will usually provide a substation bus connection from a nearby transmission line. Sometimes a line position can be available at the nearest existing substation. To accommodate an entity's request for improved reliability, PG&E can provide an additional source at the entity's expense in accordance with [Electric Rule 2](#). The interconnection facilities and any additional facilities needed to accommodate improved service reliability shall be covered by a Load Special Facilities Agreement (refer to [Appendix K](#) for a CPUC jurisdictional example).

L3.9. POINT OF CHANGE OF OWNERSHIP WITH PARTICIPATING TRANSMISSION OWNERS WITHIN OR ADJACENT TO THE PG&E TRANSMISSION SYSTEM

Identifying transmission interconnection points between PG&E and other Participating Transmission Owners (PTO's) is required to determine the demarcation and thus establishes the separation of ownership responsibilities of each entity's transmission assets. PG&E will collaborate with the other PTO(s) to define these boundaries outside of the entities new facility or transmission line asset(s).

A typical demarcation point for example would be the last Transmission Tower or Tubular Steel Pole adjacent to the new PTO's facility which would be defined as the Point of Change of Ownership (PCO). The PCO location would typically require a disconnect switch (230 kV or lower transmission voltages) or a wire jumper depending on the physical location and subject to PG&E approval.

L3.10. LOAD ENTITY OR TRANSMISSION ENTITY INTERFERENCE WITH POWER QUALITY

Under [Electric Rule 2](#), the Load Entity or Transmission Entity is responsible for providing facilities and equipment to avoid unacceptable interference which may adversely affect PG&E's operations or service provided to other customers, whether by

voltage fluctuations, harmonics, or inductive interference. The Load Entity or Transmission Entity is responsible for the costs of mitigating interference it causes.

Phase Unbalance: Also as outlined in [Electric Rule 2](#), the Load Entity or Transmission Entity is responsible to maintain their demand load balance to which the difference in amperes between any two phases at the Load Entity's peak load should not be greater than 10% or 50 amperes at the service delivery entrance, whichever is greater.

Harmonics: In regards to harmonic issues, it is advised for the Load Entity or Transmission Entity to follow [IEEE 519-1992](#), Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems as a guide to address acceptable limits of voltage and current distortions.