Section L2: PROTECTION AND CONTROL REQUIREMENTS FOR LOAD-ONLY ENTITIES AND TRANSMISSION-ONLY ENTITIES

PURPOSE

This section specifies the protective and control requirements for interconnection requests from Load Entities (load-only) or Transmission Entities (transmission-only) to the PG&E Power System. If the interconnection involves both generation and load, or both generation and transmission, or transmission facilities interconnecting network that connects to generation, then Section G2 of the PG&E Interconnection Handbooks shall also apply.

APPLICABILITY

For all load-only or transmission-only interconnections: The protective standards of this section apply to all Load Entities interconnecting to any portion of the PG&E Power System. These standards, which govern the design, construction, inspection and testing of protective devices, have been developed by PG&E to assure consistency with Applicable Reliability Criteria and to include appropriate ISO consultation.

In addition, for load-only or transmission-only interconnecting directly to the ISO Controlled Grid: The ISO, in consultation with PG&E, may designate certain new or existing protective devices as ISO Grid Critical Protective Systems. Such systems have special ISO requirements, e.g., for installation and maintenance, as described in the CAISO Tariff and the TCA Section 8. In the future, the ISO may develop its own standards or requirements applicable to certain interconnections, and also will review and comment on new requests for interconnection to the ISO Controlled Grid. Refer to the Introduction of the PG&E Interconnection Handbooks.

In addition, for load-only or transmission-only connecting directly to the UDC: PG&E’s UDC must coordinate with the ISO, the PG&E TO and the Load Entity or Transmission Entity, as needed, to ensure that any ISO Controlled Grid Critical Protective Systems, including relay systems, are installed and maintained in order to function on a coordinated and complementary basis with the load’s and the PG&E Power System, in accordance with the CAISO Tariff Section 4 and the ISO-UDC Agreement.

L2.1. PROTECTIVE RELAY REQUIREMENTS

An important objective in the interconnection of facilities to the PG&E Power System is minimizing the potential hazard to life and property. A primary safety requirement is the ability to automatically disconnect immediately when a fault is detected. Refer to Electric Rule 2. Moreover, no new facility on the PG&E Power System should degrade the existing PG&E protection and control schemes or lower the levels of safety and reliability to other customers.

In view of these objectives, PG&E requires line-protective equipment to either; 1) automatically clear a fault and restore power, or 2) rapidly isolate only the faulted section so that the minimum number of customers is affected by any outage. Due to the
high energy capacity of the high-voltage transmission system, high-speed fault clearing may be required, to minimize equipment damage and potential impact to system stability. The need for high speed fault clearing shall be determined on a case-by-case basis by PG&E. As a general rule, neither party should depend on the other for the protection of their respective equipment.

**PG&E’s minimum protection requirements are designed and intended to protect the PG&E Power System only.** The Load Entity or Transmission Entity shall install at the Point of Interconnection, at a minimum, a disconnecting device or switch with load interrupting capability. Additional protective relays are typically needed to protect the Load Entity’s or Transmission Entity’s facilities adequately. It is the Load Entity’s or Transmission Entity’s responsibility to protect its own system and equipment from faults or interruptions originating on both PG&E’s side and the Load Entity’s or Transmission Entity’s side of the Interconnection. The Load Entity’s or Transmission Entity’s facilities shall be designed to isolate any fault or abnormality that would adversely affect the PG&E Power System or the electric Systems of other entities connected to the PG&E Power System.

Some of the protective relays used in the Load Entity’s or Transmission Entity’s System Protection Facilities must be PG&E approved devices and must be set to coordinate with the protective relays at the PG&E line breaker terminals for the line to which the Load Entity or Transmission Entity is connected. Typical PG&E minimum requirements would consist of three single phase overcurrent relays and would be designed and set to trip the interrupting device closest to the point interconnection with PG&E. The Load Entity or Transmission Entity shall provide, install, own, and maintain such relays, circuit breakers and all other devices necessary to promptly remove any fault contribution of the Load Entity’s or Transmission Entity’s facilities to any short circuit occurring on the electric system not otherwise isolated by PG&E equipment. Refer to Tables G2-4 for approved overcurrent relay types. Note: There may be additional protective equipment requirements, at the Load Entity’s or Transmission Entity’s cost, which PG&E will coordinate with the Load Entity (or Transmission Entity) or its representatives.

PG&E assumes no liability for damage to Load Entity-owned or Transmission Entity-owned facilities resulting from mis-coordination between the Entity’s protective device(s) and PG&E’s protective devices. PG&E recommends that the Load Entity or Transmission Entity acquire the services of a qualified electrical engineer to review its plans. The Load Entity or Transmission Entity shall, at its expense, install, operate, and maintain System Protection Facilities in accordance with applicable ISO, WECC and NERC requirements and in accordance this Handbook.

The protective devices shown in Table L2-1 may or may not be required for Load Entities as determined by PG&E on a case-by-case basis. Typically, a 230 kV Ring or Breaker-and-a-Half (BAAH) substation bus service may require all of the relays listed, while a 60 kV radial service may require only phase and ground overcurrent relays. Most line relaying depends on the existing system configuration, the existing protection,

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1 Refer to Appendix F for a description of pilot protection requirements, the associated transfer trip equipment, communications circuits monitoring, and commissioning test requirement.

2 These facilities in addition to other protection facilities are termed System Protection Facilities.
and line characteristics such as impedance, voltage, ampacity and available fault duty, at the location in question.

Fault-interrupting equipment should usually be located at the point of interconnection to PG&E, or as close to the interconnection point as practicable—typically within one span of overhead line or 200 feet of unspliced underground cable for transmission interconnection and 50 feet of overhead line or 100 feet of unspliced underground cable for distribution interconnections. Neither party should depend on the other for the protection of its own equipment. Refer to Section 6 of PG&E’s Distribution Interconnection Handbook (DIH) for the detailed distribution primary service requirements.

For all relays required for the particular installation, a test report (see Form G2-2, Section G2) is mandatory, prior to energizing and every four years. The Load Entity or Transmission Entity shall provide test reports to PG&E, from a qualified testing firm obtained by the entity, a minimum of ten (10) working days prior to energizing. Refer to Section L5 for information regarding the pre-parallel inspections. On-site power (120 volts ac typically) is required for the test equipment. Circuit breakers must be tested every eight years after the pre-parallel inspection. Facilities that fail to meet the above testing requirements are subject either to a delay in service or to being disconnected from the PG&E Power System.

L2.2. RELIABILITY AND REDUNDANCY

The protection system must be designed with enough redundancy that failure of any one component still allows the facility to be isolated from the PG&E system under a fault condition.

L2.3. RELAY SPECIFICATIONS RELIABILITY AND REDUNDANCY

All load facilities or transmission facilities interconnected to PG&E’s transmission system shall use utility grade relays, which are much more accurate and reliable than industrial grade relays. Utility grade relays also have targets to facilitate testing/troubleshooting and typically have draw-out cases.

Utility grade auxiliary relays must be used in the tripping circuits of utility grade protection relays. All such relays must include manually resettable relay targets. Their power supplies must be powered by station battery DC voltage and must include a DC under-voltage detection device and alarm.

All proposed relay specifications and settings, for those relays which impact PG&E reliability and/or safety, shall be submitted to PG&E for approval prior to ordering (see Tables G2-4, G2-5, and G2-6 in Section G2). Load Entities or Transmission Entities who fail to submit relay specifications for approval shall risk the possibility of not being able to interconnect with PG&E (refer to Electric Rule 2). In some cases where PG&E may be unfamiliar with a specific proposed relay, PG&E may perform tests on relays provided by the Load Entity or Transmission Entity for approval, or request that test and supporting data from the manufacturer be supplied by the Load Entity or Transmission Entity. Such tests shall be performed at the Load Entity’s or Transmission Entity’s
expense and prior to PG&E approval of the relay for interconnection use. Approval of relays shall not indicate the quality or reliability of a product or service. No endorsements or warranties shall be implied.

**L2.4. LINE PROTECTION**

Line-protection relays must coordinate with the protective relays at the PG&E breakers for the line on which the facility is connected. The typical protective zone is a two-terminal line section with a breaker on each end. In the simplest case of a load on a radial line, current can flow in one direction only, so protective relays need to be coordinated in one direction and do not need directional elements. However, on the typical transmission system, where current may flow in either direction depending on system conditions, relays must be directional.

The complexity and the required number of protective devices increase dramatically as the number of terminals increases in each protective zone. With two terminals in a protective zone, there are two paths of current flow. With three terminals there are six paths of current flow, and so on. In coordinating a multi-terminal protective relay scheme, PG&E may require the installation of a transmission line protective relay at the Load Entity’s or Transmission Entity’s substation site particularly if a three-terminal permissive overreach transfer trip (POTT) scheme or a carrier blocking scheme is employed to protect the line. This line relay would be installed at the Load Entity’s or Transmission Entity’s expense as part of a Special Facilities Agreement according to applicable tariffs. Because this line relay is part of a scheme which is designed to protect the PG&E transmission system, PG&E must ensure the maintenance, testing and reliability of this particular type of relay.

In addition, the breaker’s relays must be set to have overlapping zones of protection in case a breaker within any given zone fails to clear. The line protection schemes must be able to distinguish between load, inrush and fault currents. Multiple terminal lines become even more complex to protect. Existing relay schemes may have to be reset, replaced, or augmented with additional relays at the Load Entity’s or Transmission Entity’s expense, to coordinate with the Load Entity’s or Transmission Entity’s new facility.

The PG&E required relays must be located so that a fault on any phase of the PG&E line shall be detected. If transfer trip protection is required by PG&E, the Load Entity or Transmission Entity shall provide at its expense a voice-grade communications circuit. This circuit may be a communication line from the telephone company or a dedicated cable. The line must have high-voltage protection equipment on the entrance cable so the transfer trip equipment will operate properly during fault conditions. (For detailed description of protection requirements of the transfer trip equipment, refer to Appendix F).

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3 There are additional system tests associated with communication-assisted protection. These tests (also referred to as end-to-end satellite tests) require all terminals of a transmission line to be tested as a system and include the protection, communication equipment and medium between the interconnected terminals. Refer to Appendix F for more information.
Table L2-1 below lists the minimum protection that PG&E typically uses on its own installations. Higher voltage interconnections require additional protection due to the greater potential for adverse impact to system stability, and the greater number of customers who would be affected. Special cases such as distribution-level network interconnections, if acceptable, may have additional requirements. The acceptability and additional requirements of these interconnection proposals shall be determined by PG&E on a case-by-case basis.

L2.4.1. Fault-Interrupting Devices

The fault-interrupting device selected by the Load Entity or Transmission Entity must be reviewed and approved by PG&E for each particular application. There are three basic types of fault-interrupting devices:

- Circuit Breakers
- Circuit Switchers
- Fuses

PG&E will determine the type of fault-interrupting device required for a load facility, based on the available fault duty at the interconnection point, size of load, the local circuit configuration and the existing PG&E protection equipment

<table>
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Table L2-1 Notes:

1. May be required by PG&E depending on local circuit configurations.
Transfer trip may be required on load transmission interconnections depending on PG&E circuit configuration and loading, as determined by PG&E. Typically, transfer trip is required on multi-terminal lines.

Refer to Table G2-1 (Section G2) for device number definitions and functions.

Power failure tripping may be required on load transmission interconnections to facilitate restoration of customer load after a transmission line or area outage.

**L2.4.1.1. Circuit Breakers**

A three-phase circuit breaker at the point of interconnection automatically separates the Load Entity’s or Transmission Entity’s equipment from the PG&E system upon detection of a circuit fault. Additional breakers may be installed in the Load Entity’s or Transmission Entity’s equipment to facilitate operating and protecting the facility, but they are not required by PG&E. The interconnection breaker must have sufficient capacity to interrupt the maximum available fault current at its location. It must be equipped with accessories to:

- Trip the breaker with an external trip signal supplied through a battery (shunt trip);
- Telemeter the breaker status when it is required; and
- Lock out if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the recommended fault-interruption device at the point of interconnection. It is typically required due to its simultaneous three-phase operation and its ability to coordinate with PG&E line-side devices.

**L2.4.1.2. Circuit Switchers**

A circuit switcher is a three-phase fault-interrupter with limited fault interrupting capability. These devices have typically been used at voltages of 115 kV and below, and may be substituted for circuit breakers if the fault duty is within the interrupting rating of the circuit switcher, and if the protective relays that trip the circuit switcher for customer transformer faults are connected to CTs on the customer's transformer.

With PG&E approval, some circuit switchers with blades can double as the visual open disconnect switch between the metering transformers and the main transformer of the Load-only Entity. Since circuit switchers do not have integral current transformers, they must be installed within 50 feet of the associated current transformers to minimize the length of the unprotected line/bus section; otherwise free-standing CTs are required.
L2.4.1.3. Fuses

PG&E may approve the use of fuses for load-only facilities if they coordinate with the PG&E line-side devices for both phase and ground faults. In limited cases, fuses may be used as a primary protective device (e.g. rural, 60 kV, 70 kV and 115 kV lines, where the Load Entity’s substation is 12 MVA or less). However, if fuses are approved by PG&E, the Load Entity should consider installing a negative sequence relay and/or other devices to protect its facility against single-phase conditions.

Fuses are single-phase, direct-acting, sacrificial links that melt to interrupt fault current and protect the equipment. The blown fuses must be replaced manually after each fault before the facility can return to service. Overhead primary fuses must be replaced by trained, qualified personnel. Since fuses are single-phase devices, they may not all melt during a fault and thus may not automatically separate the Load Entity’s system from PG&E.

Large primary fuses which do not coordinate with the PG&E substation breaker ground relays shall not be allowed. Otherwise, this could cause all the customers on the circuit to lose power due to a fault inside the Load Entity’s facility.

L2.4.1.4. Relay Class Current Transformers (CT)

Metering class PT/CTs (including dual winding devices) shall not be used for relaying purposes in PG&E’s system. In particular, combination PT/CTs that are installed by PG&E for revenue metering purposes (including available taps) shall not be connected to customer relays and used to provide protection of customer-owned equipment.

A combination PT/CT is a device that is installed at the customer’s point of connection to facilitate revenue metering of the power flow to or from PG&E’s grid.

A dual winding metering PT/CT is a particular type of combination PT/CT that is constructed with a separate second CT core winding. Dual winding units are a non-standard device that is not stocked by PG&E.

Prior to 2001, there may be grandfathered cases where the customer installed a circuit switcher rather than a circuit breaker as an interrupting device, and dual winding PT/CTs were installed to provide protection for the customer’s equipment. This practice was discontinued because the CTs in the metering unit do not meet relaying accuracy class standards. Also, if the dual winding unit should fail, PG&E should not be liable for protecting the customer’s equipment.
L2.5. STANDBY/BACKUP SOURCE

L2.5.1. Standby Source

In cases where the Load Entity’s load or a load served by the Transmission Entity requires a high level of reliability, the Load Entity can request both a transmission source and a back-up distribution or transmission source, at the Entity’s expense. Normally, when the Entity’s load is transferred from the primary source to the standby source or from the standby source to the primary source, a momentary outage (drop-and-pickup operation) is required.

When the Load Entity or the load supplied by the Transmission Entity is being fed from the back-up source and wants to transfer the load back to the primary source with a parallel operation (make-before-break), the following requirements must be met:

- Ratios and electrical connections of the transformers on both sources must be well matched to minimize circulating currents.

- Impedance of the transformers and the relative phase angles of the sources must be such that any “through load” (i.e. load flowing through the Load Entity’s or Transmission Entity’s electrical system to other customers) does not cause overloads.

- Protection must not be degraded during the parallel transfer operation, and neither PG&E’s nor the Load Entity’s or Transmission Entity’s equipment must become over-stressed.

- The transfer switches, one on each side of the Load Entity’s load (or the load served by the Transmission Entity), must be controlled by an automatic interlock scheme to minimize the time the parallel is in effect. Thus the transfer switches must be circuit breakers or other suitably rated, automatically controlled switches. Note that the available fault duty will be increased and the Load Entity’s or Transmission Entity’s equipment may be overstressed while the two circuits are paralleled so it is very important to make the parallel period as short as possible, typically one second or less.

- Each parallel transfer operation can only proceed after specific approval has been given by PG&E. In some cases, additional protective devices and special operating procedures may be required to avoid endangering customers and/or PG&E facilities. PG&E’s approval must be obtained prior to 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 operator or public safety or reliability to customers.

- The Load Entity or Transmission Entity must assume all liability for any problems or damage resulting from any parallel transfer operation.

L2.5.2. Backup Generators

Refer to Section G2 for a discussion of back-up/emergency generators.