PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

Policy

FACILITY CONNECTION (INTERCONNECTION) REQUIREMENTS FOR DISTRIBUTION SYSTEMS (34.5 kV and below)

Author:	Paul Della
Approval:	Greg Lyons
Authoring Department:	Standards Engineering
Approved File Location:	Pdxshrn104\shr04\Eng\Publications\DIS\POL
File Number-Name:	138-Generation Interconnection for Distribution Systems.doc
Revision Number:	1
Revision Date:	2/5/2008

List of Figures

List of Tables

Appendices

FACILITY CONNECTION (INTERCONNECTION) REQUIREMENTS FOR DISTRIBUTION SYSTEMS (34.5 kV and below)

1 INTRODUCTION

This PacifiCorp Generation Interconnection Policy explains the technical requirements for interconnection of generators to PacifiCorp's distribution power systems. It is based on applicable rules and tariffs crafted by the Federal Energy Regulatory Commission (FERC) and jurisdictional state regulatory agencies. In addition to providing reliability, this policy is consistent with safety requirements for PacifiCorp employees and the general public.

Although this policy addresses certain aspects of interconnection cost responsibility, its scope is primarily technical and does not include the commercial requirements for receiving distribution service, nor does it cover generation service from PacifiCorp. Tariffs and rules filed with FERC and jurisdictional state regulatory agencies address the rates, terms and conditions under which PacifiCorp provides these services. If there are any inconsistencies between this policy and the tariffs and rules, the tariffs and rules shall retain control.

1.1 Introductory Definitions

PacifiCorp Power System: For the purposes of this policy, the PacifiCorp power system is defined as electric distribution facilities owned by PacifiCorp.

Customer Load: A person, company, or corporation interconnected to The PacifiCorp power system owning or operating only power-consuming facilities.

Interconnection Customer: A person, company, or corporation interconnected to The PacifiCorp power system owning or operating generation facilities (including back-up and emergency generation).

Any connected entity owning or operating both power-consuming and power-generating facilities shall be considered an interconnection customer for the purposes of this policy, since the technical requirements for interconnection of generation sources are most comprehensive. Any load-only entity which is interconnected to a third-party electric system having generation capabilities shall also be considered an interconnection customer for the purposes of this policy. Technical requirements for multi-interconnected and network systems (systems interconnected to the PacifiCorp power system in addition to a third-party system) will be determined by PacifiCorp on a case-by-case basis.

1.2 Applicability

This policy applies to retail and wholesale entities which are physically connected to or desire to physically connect to PacifiCorp's distribution system. Applicability is further defined by the categories below:

1.2.1 New and Decommissioned Generation Projects

All technical requirements described or referred to in this policy apply to new generation projects. New generation projects are entities which have not been and are not yet connected with the PacifiCorp power system. Additional technical requirements may apply to special business arrangements or electrical configurations of The PacifiCorp power system or the interconnection point(s). Any such technical specifications would be documented through the interconnection agreements (i.e., generation interconnection, operation and maintenance agreement, generation interconnection facilities agreement).

1.2.2 Existing Customer Loads

Retail: All applicable technical requirements described or referred to in this policy apply to existing customer loads. Existing customer loads are loads which have previously established an interconnection with the PacifiCorp power system. To the extent this policy contains more stringent requirements than were in place at the time the customer load initially connected, the existing customer load shall be responsible for adhering to the most recent requirements. The cost for such upgrading shall be borne by either the customer load or by PacifiCorp pursuant to applicable customer load and PacifiCorp.

Wholesale: Existing contracts govern the technical interconnection requirements for existing wholesale loads. Unless modified through mutual agreement or unless PacifiCorp's current or future requirements apply pursuant to the terms of existing contract, the technical provisions of these existing agreements (e.g., with municipal utilities, federal power marketing agencies, and investor-owned utilities) concerning physical interconnection remain applicable. For information concerning the interconnection and operation of loads under these agreements please contact PacifiCorp's Distribution Account Manager.

1.2.3 Existing Generation Projects

All the applicable technical requirements described or referred to in this policy may not apply to existing generation projects. Existing generation projects are entities which have previously established an interconnection with the PacifiCorp power system.

To the extent this policy contains more stringent requirements than were in place at the time the generation projects initially connected, the existing entity shall be responsible for adhering to current requirements only to the extent that the safety and reliability of the power system or the safety of utility employees would be jeopardized by not adhering to the current requirements and policies. The cost for such upgrading shall be borne by either the interconnection customer or by PacifiCorp according to applicable electric rules and/or the terms of any executed agreements between the interconnection customer and PacifiCorp.

1.2.4 Distribution Accounts

In cases where The PacifiCorp power system reliability is threatened or where compliance with national, regional, or state reliability standards is mandatory, certain technical policies outlined in this document may apply irrespective of PacifiCorp's authority to impose the interconnection requirements.

The information in this document is subject to change. Parties interconnecting to the PacifiCorp power system should verify with their PacifiCorp representative that they have the latest version of this policy. PacifiCorp will not agree to interconnect new loads or generators unless all technical and contractual requirements are met. Copies of this document will be supplied upon request. Contact the PacifiCorp Distribution Account Manager at the address below for referrals to the PacifiCorp employee who can respond to questions concerning these policies, for interconnection coordination procedures, or for additional copies of this procedure.

Distribution Account Manager
Lloyd Center Tower
825 N.E. Multnomah Blvd. Suite 1600
Portland, Oregon 97232
(503) 813-6138

1.3 Policy for Interconnection of Generation Resources

PacifiCorp has an established policy for operating, metering, and equipment protection for generators. This policy covers these requirements for all generators wishing to interconnect to the PacifiCorp power system. Additional project-specific requirements may apply. These additional requirements may vary according to the specifications of the generator and the local configuration of the PacifiCorp power system. Additional project-specific requirements, if any, will be identified by technical studies performed by PacifiCorp prior to interconnection.

The technical studies will determine whether PacifiCorp will be required to add or modify its distribution system to interconnect the requesting party. Parties requesting interconnection are responsible for the cost of these technical studies. Interconnecting entities must also pay for, as special facilities, any additions or modifications to the PacifiCorp system needed to connect the requesting party, and for those portions of the interconnection facilities owned and maintained by PacifiCorp at the requesting party's expense. Such facilities may include metering and data processing equipment. FERC jurisdictional special facilities agreements are unique to each project but follow similar principles. Please contact the PacifiCorp Distribution Account Manager for details about the study process and additional data requirements which may apply.

1.4 Interconnection Costs

All costs incurred by PacifiCorp to accommodate the interconnection customer's generation to PacifiCorp's electrical system must be borne by the customer as specified by the federal PURPA law or as mandated by state tariff . These costs include, but are not limited to, the following items:

1. Engineering studies and design work necessary to permit the interconnection of the customer's generation to the PacifiCorp electrical system. This includes any preliminary preparation and estimating costs.
2. New overhead and/or underground line extensions to interconnect the customer's generation to PacifiCorp's system.
3. Conversion of single-phase lines to three-phase construction to accommodate the generation (if necessary).
4. Increasing the capacity of PacifiCorp's distribution system to accommodate the customer's generation.
5. Alterations, modifications, or additions to PacifiCorp's distribution system protection schemes necessitated by the interconnection of the customer's generation.
6. Telemetering facilities, including the cost of equipment and communication facilities as well as maintenance costs associated with these facilities.
7. Alterations, modifications, or additions to PacifiCorp's distribution system to maintain the quality of electrical service to PacifiCorp's customers.

A detailed interconnection study report will include the details of all of these items and possibly other issues not mentioned above if the complexity of the proposed project warrents it. Contact the distribution accounts manager to discuss the process for

conducting a generation interconnection study. See Appendix M for equipment lead times.

1.5 Customer-Owned Equipment Requirements

Interconnected parties are responsible for designing, installing, operating and maintaining any interconnection equipment they own. All protective devices necessary to protect the interconnected entity's facilities are the responsibility of the interconnected entity.

PacifiCorp requirements specified in this policy are designed to protect PacifiCorp facilities and maintain grid reliability pursuant to applicable reliability criteria; they are not designed to protect the facilities of interconnected generators.

Interconnected entities must satisfy: 1) the requirements in this policy, 2) applicable rules and tariffs of jurisdictional state regulatory agencies and FERC, 3) applicable policies of the Western Electricity Coordinating Council (WECC), the North American Electric Reliability Council (NERC), or their successor organizations, and 4) PacifiCorp's project-specific requirements. PacifiCorp's review and written acceptance of the interconnected entity's equipment specifications and plans shall not be construed as confirming or endorsing the interconnected entity's design, nor as warranting the equipment's safety, durability, or in any way relieving the interconnecting entity from its responsibility to meet the above requirements. PacifiCorp shall not, by reason of such review or lack of review, be responsible for strength, details of design, adequacy, or capacity of equipment built to such specifications, nor shall PacifiCorp's acceptance be deemed an endorsement of such equipment.

1.6 General Interconnection Requirements

1.6.1 Professional Review of Drawings

All one-line diagrams and supporting material for facilities 250 KW and larger shall be stamped by a Professional Electrical Engineer in the state where the facility resides before they are submitted to PacifiCorp as part of the application. This requirement will assure that the information contained thereon is reasonable and accurate and should avoid any significant electrical engineering issues as the project proceeds to interconnection.

1.6.2 Protective Functions

The protective functions of a DG facility must further include an over/undervoltage trip function, an over/under frequency trip function, and a means for disconnecting the DG Facility from the PEDS whenever a protective function initiates a trip.

The protective functions and requirements of this document are designed to protect the PEDS and not the generating facility. The DG Facility shall be solely responsible for providing adequate protection for the DG and interconnection facilities connected to the PEDS. The protective equipment at the DG facility shall not impact the operation of other protective devices utilized on PEDS in a manner that would affect PacifiCorp's capability of providing reliable service to its customers.

1.6.3 Automatic Lockout

Protective functions shall include an automatic means to prevent the DG (Distributive Generation) facility from re-energizing a de-energized PacifiCorp Electric Distribution System (PEDS).

1.6.4 No Unintended Islanding

The DG Facility and associated protective functions shall not contribute to the formation of an unintended island.

1.6.5 Delay on Reconnections

Protective functions shall be equipped with automatic means to prevent reconnection of the generating facility with the PEDS unless the PEDS service voltage and frequency is within specified settings and is stable for at least 60 seconds.

1.6.6 Suitable Equipment

Circuit breakers or other interrupting devices located at the PCC must be certified or listed (as defined in Article 100, the definitions section of the *National Electric Code*) as suitable for their intended application. This includes being capable of interrupting the maximum available fault current expected at their location. The generating facility shall be designed so that the failure of any one device shall not potentially compromise the safety and reliability of PacifiCorp's distribution system.

1.6.7 Visible Disconnect

The DG facility shall furnish and install a manual disconnect device that has a visible break to isolate the DG Facility from the PEDS. The device must be accessible to PacifiCorp personnel and be capable of being locked in the open position. DG facilities with non-islanding inverters 1 kVA or less to be installed in the state of California are exempt from this requirement as per Rule 21.

1.6.8 Prevention of Interference

The DG facility shall not operate equipment that superimposes a voltage or current upon PacifiCorp's electric distribution system, nor which interferes with PacifiCorp operations, service to PacifiCorp customers, or PacifiCorp communication facilities. If such interference occurs, the DG facility must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by PacifiCorp. If the DG facility does not take timely corrective action, or continues to operate the equipment causing interference without restriction or limit, PacifiCorp may, without liability, disconnect the DG facility equipment from PacifiCorp's distribution system in accordance with the executed interconnection agreement. To eliminate undesirable interference caused by the operation of the generating facility, each generating unit in a generating facility shall meet the following criteria:

1.6.8.1 Normal voltage operating range

The voltage operating range for a generating unit shall be selected as a protection function that responds to abnormal distribution system conditions and not as a voltage regulation function.

1. Small systems (11 kVA or less) – generating units connected to a generating facility with a gross nameplate capacity of 11 kVA or less

shall be capable of operating within the limits normally experienced on PacifiCorp's distribution system. The operating window shall be selected in a manner that minimizes nuisance tripping and range between 106 V and 132 V (88-110 percent of nominal voltage) on a 120-volt base. Generating facilities shall cease to energize PacifiCorp lines whenever the voltage at the point of common coupling (PCC) deviates from the allowable voltage operating range.

2. Large Systems (greater than 11 kVA) – PacifiCorp may have specific operating voltage ranges for larger DGs, and may require adjustable operating voltage settings for these larger systems. In the absence of such requirements, the above principles of operating between 88 and 110 percent of the appropriate interconnection voltage should be followed.

3. Voltage Disturbances – Whenever PacifiCorp's distribution system voltage at the point of common coupling varies from normal (nominally 120 V) by predetermined amounts as set forth in Table 1, the DG facility's protective functions shall cause the generator(s) to become isolated from PacifiCorp's distribution system.

Table 1–Under/Over Voltage Trip Times

Voltage at Point of Common Coupling (assuming 120V base)	Maximum Trip Time Allowed (assuming 60 cycles per second)
< 60V	10 cycles
≥ 60V and < 106V	120 cycles
≥ 106V and ≤ 132V	Normal Operation
≥ 132V and ≤ 165V	120 cycles (30 cycles for facilities > 11kVA)
> 165V	6 cycles

1.6.8.2 Frequency

PacifiCorp's controls system frequency and the DG facility shall operate in synchronism with PacifiCorp's distribution system. Small DG facilities should have a fixed operating frequency range of 59.3 – 60.5 Hz. The DG facility must cease to energize the system in a maximum of ten cycles should PacifiCorp remain outside of the frequency limits. The purpose of the time delay is to allow the DG facility to ride through short-term disturbances to avoid excessive nuisance tripping. PacifiCorp may require adjustable operating frequency settings for DG facilities larger than 11 kVA in order to assist the system during serious capacity shortages.

1.6.8.3 Direct Current Injection

DG facilities should not inject direct current greater than 0.5 percent of rated output current into PacifiCorp's distribution system under either normal or abnormal operating conditions.

1.6.8.4 Power Factor

Each generating unit in a DG facility shall be capable of operating at some point within a range of a power factor of 0.95 (either leading or lagging). Operation outside this range is acceptable provided the reactive power of

the DG facility is used to meet the reactive power needs of on-site loads or that reactive power is otherwise provided under tariff by PacifiCorp.

1.6.8.5 Voltage Fluctuation Limits

The interconnection customer should expect a normal operating voltage range of +/- 5 percent from nominal. The interconnection customer should contact PacifiCorp to determine the normal operating voltage at their point of interconnection The plant should be capable of start-up whenever the voltage at the point of interconnection is within this range. If the auxiliary equipment within the generator cannot operate within the above range, the generator will need to provide regulation equipment to limit the station service voltage-level excursions. During system contingency or emergency operation, operating voltages may vary up to ± 10 percent from nominal.

1.6.8.6 Harmonic Limits

All interconnection customers shall comply with the voltage and current harmonic limits specified in IEEE Standard 519, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

The harmonic content of the voltage and current waveforms in the PacifiCorp system must be restricted to levels which do not cause interference or equipment operating problems for PacifiCorp or its customers.

Any harmonic problems shall be handled on a case–by-case basis. A generation facility causing harmonic interference is considered by PacifiCorp to be a serious interference with service and is subject to disconnection from the PacifiCorp system until the condition has been corrected. If the cause of the problem is traceable to the interconnection customer's facilities, all costs associated with determining and correcting problems shall be at the customer's expense.

Many methods may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the generator and the PacifiCorp system. This method significantly limits the amount of voltage and current harmonics entering the PacifiCorp system. Generation system configuration with a star-grounded generator and a two-winding (both star-grounded) transformer shall not be allowed.

1.6.8.7 Voltage Flicker Limits

All interconnection customers shall adhere to PacifiCorp’s policy on voltage fluctuation and light flicker at the PCC with PacifiCorp. This issue primarily focuses on wind turbine-based generation but may be applicable to other forms of generation. Voltage fluctuation is more pronounced with one or two wind turbines installed on distribution circuits where the X-to-R ratio of the line is high. PacifiCorp’s policy is available in the Engineering Handbook, Section 1C.5.1, which can be found on the PacifiCorp web site. This policy is based on IEEE Standard 1453 - 2004, *Voltage Flicker*. It is the generator interconnectin customer’s responsibility to determine the expected Pst flicker values caused by the addition of their generator(s). It will also be the interconnection customer's responsibility to bring the Pst flicker level into compliance with PacifiCorp’s policy at the customer's cost should the values exceed PacifiCorp’s policy limits at any time during the life of operation of the facility on PacifiCorp’s electrical system. This could occur

at the time of installation or a later date. The interconnection customer must allow for reasonable corrective contingencies if system operations or circuit modifications alter the circuit's electrical characteristics.

1.7 Technology Specific Policy Requirements

1.7.1 Three-Phase Synchronous Generating Facilities

For three-phase generating facilities, the generating facility circuit breakers shall be three-phase devices with electronic or electromechanical control. The DG facility shall be responsible for properly synchronizing its generating facility with PacifiCorp's distribution system by means of either a manual or automatic synchronizing function. Automatic synchronizing is required for all synchronous generating units, which have a short-circuit contribution ratio (SCCR) exceeding 0.05. A generating unit whose SCCR exceeds 0.05 shall be equipped with protective functions suitable for detecting loss of synchronism and rapidly disconnecting the generating facility from PacifiCorp's system. Unless otherwise agreed upon by the producer and PacifiCorp, synchronous generating units shall automatically regulate power factor, not voltage, while operating in parallel with PacifiCorp's distribution system. Power system stabilization is specifically not required for generating facilities under 10 MW gross nameplate capacity. Synchronization means that at the time of connection, the frequency difference shall be less than 0.2 Hz, the voltage difference shall be less than ten percent, and the phase angle difference shall be less than ten degrees.

1.7.2 Induction Generators

Induction generator generating units do not require separate synchronizing equipment. Starting or rapid-load fluctuations on induction generators can adversely impact PacifiCorp's distribution system voltage. Corrective step-switched capacitors or other techniques may be necessary and may cause undesirable ferroresonance. When these counter measures (e.g., additional capacitors) are installed on the producer's side of the point of common coupling, PacifiCorp must review these measures. Additional equipment may be required to resolve this problem as determined in an interconnections study.

See Appendix Q for specific information on wind turbine installations on distribution systems.

1.7.3 Inverter Systems

Utility-interactive inverters do not require separate synchronizing equipment. Non-utility-interactive or "stand-alone" inverters shall not be used for parallel operation with PacifiCorp's distribution system. Inverters shall be UL 1741 certified. No inverters will be permitted to interconnect with PacifiCorp's electrical system that are not certified; non-certified interconnections will be disconnected until they are brought into compliance with this policy.

1.7.4 Facility Monitor and Control with Interface to PacifiCorp

Prior to engineering design, the facility's monitoring and control systems (i.e., protocols and interface methods) with interface to PacifiCorp's control, monitoring, and protection schemes shall be approved by the appropriate PacifiCorp department. The appropriate PacifiCorp departments are the Metering Assets, Protection and Control, and the SCADA Engineering departments. At PacifiCorp's option, the facility's monitoring and control equipment shall be tested

in a PacifiCorp lab three months prior to the in-service date to verify the scheme meets PacifiCorp requirements.

2 OWNERSHIP POLICY

2.1 Ownership and Operation of Interconnection Facilities and Equipment

For new generation facilities, PacifiCorp shall not own, operate, nor maintain any of the interconnection facilities downstream electrically from PacifiCorp's meter. It will be assumed that this equipment is owned, operated, and maintained by the interconnection customer. This equipment includes the transformer, breaker, and relay and protection devices. Any recloser on PacifiCorp facilities shall be owned, operated, and maintained by PacifiCorp. If a recloser is installed or an existing recloser is modified due to the introduction of a generation facility on a distribution circuit, all costs (purchase of device, installation, operation, and maintenance) shall be borne by the interconnection customer as specified in the interconnection and construction agreements.

For new generation facilities, PacifiCorp will own, operate, maintain, test, and install all communication equipment including the circuit from PacifiCorp's facilities to the interconnection customer's facilities if the circuit is a technology other than land line wire. Land line-wire circuits are to be owned/leased, operated, and maintained by an entity other than PacifiCorp (either the interconnection customer or a telephone company). The protective relay(s) and all other equipment downstream from the PCC will be owned, installed, and maintained by the interconnection customer.

For existing generation facilities where circuit-loading changes mandate transfer trip, PacifiCorp will own, operate, maintain, test, and install all communication equipment necessary to perform this function as per the language of the interconnection agreement if addressed. The interconnection customer will own (upgrade if necessary) and maintain the same equipment originally installed downstream from the PCC (i.e. relay(s), breaker(s), etc.).

See Appendix C for equipment configuration and ownership of a typical distribution generation project.

2.2 Applicant Construction of PacifiCorp Facilities

When it is mutually agreed by PacifiCorp and the interconnection customer that the interconnection customer shall design and build PacifiCorp facilities, the interconnection customer shall provide PacifiCorp with design drawings prior to the start of construction and shall continue to provide PacifiCorp with the latest revisions sent to the contractor for construction. Within 30 days of the completion of construction, the interconnection customer shall provide PacifiCorp with a complete set of design drawings revised to reflect any as-builts. In addition, the interconnect customer shall be responsible for obtaining SAP numbers and equipment memorandum forms from PacifiCorp and completing the equipment memorandums for all major equipment identified by PacifiCorp as requiring setup in SAP to provide the means for scheduling future maintenance. The interconnection customer shall provide PacifiCorp with the completed equipment memorandums upon the installation of the major equipment for which they are required.

2.3 Specification/Approval of Interconnection Customer's Facilities and Equipment

PacifiCorp retains the right to electrically disconnect any generation facility that does not acquire and/or retain PacifiCorp-approved interconnection equipment of the following types: relays, disconnect devices, transformers, RTUs, and communication equipment. The specifications for this equipment is contained in this policy document. It shall be the responsibility of the interconnection customer to comply with this

requirement and submit to PacifiCorp documentation signed off by a licensed Professional Electrical Engineer for the state in which the facility resides. The PE signature shall indicate compliance with the applicable interconnection agreement. PacifiCorp will issue written notice to the interconnection customer upon knowledge of a breach in this regard and give the interconnection customer a reasonable time to correct the issues raised in the letter. Failure to comply with this notice will result in electrical disconnection as described in the disconnection notice.

3 TELECOMMUNICATION REQUIREMENTS FOR GENERATION INTERCONNECTION

3.1 Application

Before a new generation facility is to be connected to the PacifiCorp power system, PacifiCorp will specify the metering, protection, supervisory control and data acquisition (SCADA), telemetering, and telecommunications channels that will be required. Due to the highly specialized and critical nature of the protection, metering, SCADA, and telemetering equipment, PacifiCorp requires that all such equipment be owned, installed, and maintained by PacifiCorp at the generation facility's expense. Also, due to the critical protection requirements for the interconnection of the generation facility to PacifiCorp's distribution/transmission system and the varied PacifiCorp internal telecommunications systems that may be available for the specific generation facility, the telecommunication channels described below must be defined on a case-by-case basis.

3.2 General Requirements

The generation facility will be responsible for acquiring the communication lines from the local telephone company or multiple telephone companies as required to meet the telecommunications required of the new generation facility with the exception that if tele-protected (requires communications channel) relay channels are needed, PacifiCorp will provide them at the cost of the generation facility. Due to the critical nature of the protection, metering, SCADA, and telemetering requirements, PacifiCorp will define the technical requirements and may provide, at its option, all or portions of the telecommunication channels on its existing internal telecommunication network at the cost of the generation facility.

3.3 Telecommunication Circuit Requirements

3.3.1 New Generation Facilities < 3,000 kW with no Teleprotection Requirement

3.3.1.1 Business Telephone Line

A business telephone line at the location of the interconnect point metering equipment is required for remote revenue-metering reading and maintenance work.

3.3.2 New Generation Facilities ≥ 3,000 kW or New Generation Facilities < 3,000 kW with Teleprotection Requirement

3.3.2.1 Remote-Metering Business Telephone Line

A business telephone line is required at the location of the interconnect point metering equipment for remote revenue-metering reading. The generation entity must provide landline telephone access, if possible. If local telco facilities are not available, other options for providing dial-up access to the meter will be considered.

3.3.2.2 Dispatch Business Telephone Line

A business telephone line is required so that operating instructions from PacifiCorp may be given to the designated operator of the generation facility equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone.

3.3.2.3 Protective Relay Remote Access Business Telephone Line

A business telephone line is required at the location of the protective relay equipment for remote maintenance of the protective relay equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the Generation Entity must provide a local telephone.

3.3.2.4 Protective Relays

PacifiCorp will determine if non-pilot protective relays will be adequate for emergency tripping of the generation facility and/or protection of the distribution system or if tele-protected type protection equipment is required. PacifiCorp will design and provide telecommunications channels suitable for the protective relay package required at the cost of the generation facility. Local telephone company leased lines are not acceptable for protective relay channels. Telecommunication channels for protective relay equipment may consist of a fiber optic system, power line carrier, microwave radio, or a combination of these systems.

3.3.2.5 SCADA Remote Terminal Unit (RTU)

Real-time data and/or control via a SCADA RTU is be communicated to PacifiCorp's Control Center. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class B, Type 3, 4-wire, full-duplex communication line from the generation facility to PacifiCorp's Control Center. PacifiCorp will specify the location where the communication line will terminate. Telecommunication channels for SCADA RTU equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic system, microwave radio, other radio system, or a combination of these systems.

3.3.2.6 Analog Telemetering

Analog telemetering of the total generation facility's kW output to PacifiCorp's alternate control sites (Medford, Oregon; Yakima, Washington; Goshen, Idaho; or Sigurd, Utah) is required as an interim solution per NERC Standard EOP-008-0, *Plans for Loss of Control Center Functionality*. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the generation entity must provide a local telephone company VG36, Class B, Type 3, 2-wire, communication line from the generation facility to PacifiCorp's alternate control site. PacifiCorp will specify the location of the closest alternate control site where the communication line will terminate. Telecommunications channel for analog telemetering equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic system, power line carrier, microwave radio, or a combination of these systems. The analog telemetering channel may use the same telecommunications system as the SCADA RTU channel providing it is not routed through PacifiCorp's Control Centers.

3.4 Telephone Company Line Treatment Equipment

Proper cable and protection equipment may be required at substations and other high-voltage electric facilities for expected ground potential rise (GPR). The GPR testing required to determine the required telephone line protection may be performed by PacifiCorp at the cost of the generation facility or may be performed by generation

facility itself. The calculated GPR value will determine what grade of telephone-cable high-voltage protection equipment is required, as well as the distance from the generation facility at which the telco pedestal shall be located. The local telephone company must be informed in advance (up to six months) so outside plant facilities can be engineered to serve the generation facility location. Some independent telephone companies are not tariffed to provide protection equipment. In this case, the generation facility will be required to purchase and install the necessary telephone line protection equipment.

3.5 Communications Procedures

3.5.1 Normal Operating Conditions

The interconnection customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during routine operating conditions. This information shall be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

3.5.2 Emergency Operating Conditions

The interconnection customer shall provide to PacifiCorp the information necessary to communicate with the equipment and/or personnel at the generation facility during the loss of the primary communication medium. This would be considered the emergency operating condition. This information is also to be updated as soon as a material change becomes available for use by notifying PacifiCorp's grid operations centers in either Salt Lake City, Utah or Portland, Oregon, depending on the facility's operating area.

4 METERING POLICY FOR INTERCONNECTION CUSTOMERS

4.1 General

The purpose of this section is to assist a generation facility in accommodating PacifiCorp metering for the measurement of electricity supplied to the PacifiCorp system. This section is applicable only to those providing power to the PacifiCorp power system. The general requirements are similar to the general requirements for metering the supply of electrical service by PacifiCorp.

Usually, when a generator is installed with the intent of providing power to the PacifiCorp power system, electric service to the auxiliary load associated with the generation plant is also needed. As such, power may flow into or out of the plant at different times. Deliveries to and from the plant (bi-directional metering) must be separately recorded and treated as separate transactions under PacifiCorp's tariffs. All meters and instrument transformers shall be provided, owned, and maintained by PacifiCorp at the power producer's expense

At the Power producer's request, PacifiCorp will install net generation metering which may be used to satisfy a qualifying facility's status as outlined in Code of Federal Regulations 18 CFR 292, *Public Utility Regulatory Policies*.

4.2 Basic Metering Policy for Generators

4.2.1 Metering Requirements

The standard PacifiCorp meter used for all generation interchange projects is the Landis and Gyr, Maxsys 2510 meter. The meter will be programmed with a standardized PacifiCorp internal program that will include bidirectional kWh and kvarh energy and kW and kvar sliding 15-minute demand quantities, with instantaneous MW Mvar data. The meters will be programmed to record 15-minute interval profile demand that includes bidirectional kWh and kvarh and per-phase volt hour demand interval recording. The kWh digital or analog accumulator data will be read hourly and compiled for the monthly kWh interchange report.

Additional quantities can be added if necessary to the basic program.

Metering data collected will include working meter register reads, monthly register freeze reads, and 15-minute demand interval profile data. The meter will perform a self-freeze read at midnight each month. The meters shall be compatible with the PacifiCorp MV-90™ system and shall be interrogated daily or whenever necessary for maintenance purposes. For 3 MW and above installations, the metering design package will include two revenue-quality meters, a test switch, and all data inputs and outputs terminated at a utility interposition block. One meter will be designated a primary meter and shall be used for EMS data that includes bidirectional kWh quantities and instantaneous MW Mvar data. The second or backup meter will be used for telemetry MW data sent to the PacifiCorp Alternate Control Center.

All meters will include both analog and digital output boards following current PacifiCorp specifications. The metering design will include a test switch with all data inputs and outputs terminated at a utility interposition block.

The final metering design requirements including hardware I/O and software specifications will be written into the specific project's scoping documentation. Requests from foreign utilities for digital or analog metering outputs must be

made prior to final design. A second or backup meter will be added when needed or if there are additional metering outputs required beyond what is possible from the primary meter.

4.2.2 Metering Location

All generation connections require a policy interchange metering system design package for PacifiCorp billing and/or scheduling processes. PacifiCorp will own and maintain the revenue metering at generation interchange metering sites. When requested, PacifiCorp will supply outside parties with the design details of the policy metering system. The approved policy PacifiCorp metering package provides a three-phase, four-wire, three-element, grounded installation. Un-grounded three-wire metering systems are not approved.

Metering must be installed at the point of interconnection with the PacifiCorp power system. PacifiCorp metering is required at the point of interconnect for all interconnection customers. If it is not possible to install metering at the physical point of interconnect, PacifiCorp will require that line losses be calculated. The calculated loss algorithm may be additive or subtractive depending upon current flow through the meter. The calculated loss algorithm will be programmed within the meter(s) firmware to adjust the registers, load profile, and any digital or analog outputs. PacifiCorp requires that any applicable line loss compensation be performed in the meter, rather than calculated in the billing system.

4.2.3 Metering Structures

Unless other arrangements are made the Power producer shall provide, install, own, and maintain all mounting structures, conduits, meter sockets, meter socket enclosures, metering transformer cabinets, and switchboard service sections approved by PacifiCorp. Prior to installation of metering equipment, PacifiCorp must receive and approve meter location and enclosure dimensional drawings. Other requirements vary by the amount of power delivered to PacifiCorp. For applications below 600 V, the distance between the meter and the revenue-metering transformers must not exceed 50 feet. The intent is to not exceed the metering-transformer burdens. PacifiCorp must approve any variance from this general rule. Metering structures typically consist of primary ground-mounted, metal-clad switchgear. Physical space restrictions as well as local codes and ordinances may require variation from the above policy; in such cases Good Utility Practice shall prevail.

4.2.4 Metering Disconnects

High-side metering shall have a minimum of two gang-operated, lockable disconnect devices to facilitate establishing a visual open. Disconnect devices are necessary at the following locations:

1. At the point of interconnection with PacifiCorp (this switch is PacifiCorp-operated).
2. Between the generator side of PacifiCorp's metering and the interconnection customer's electrical facility (this switch is owned and operated by the interconnection customer).
3. If the generation facility is selling power to PacifiCorp on a surplus sale basis, a separate disconnect device (generator or host-site-owned and -operated) is required on the metering side of the load. Refer to Figure 1 for typical

interconnections. Distribution pole-top metering requires only one switch located on the load side of the metering.

4.3 Metering Policy for Existing Generators

The following sections describe the detailed requirements for metering electricity supplied by generators connected to the PacifiCorp system as per the following classifications and depending upon the contractual arrangements.

Surplus-Sale Operation: Meters shall be required to measure both the net generator output and the surplus generation delivered to the PacifiCorp system.

Net-Sale Operation: Meters shall be required at the point of interconnection.

No-Sale Operation: Metering will not be required for the measurement of power delivered into the PacifiCorp system, except that load-profile and net-generator profile metering may be required for standby service.

Wheeling Service: Wheeling Service under certain existing agreements on the PacifiCorp system require two sets of revenue-metering equipment which may be totalized to accommodate various line and switch configurations. Import metering is required to the point of import (receipt) to (on) the PacifiCorp system. Export metering is required at the point of export (delivery) from (off) the PacifiCorp system.

4.4 Interchange Metering System 600 V – 34.5kV

All generation connections require an interchange metering system design package for PacifiCorp billing and/or scheduling processes. PacifiCorp will own and maintain the revenue metering at generation interchange metering sites. When requested, PacifiCorp will supply outside parties with the design details of the metering system. The approved policy PacifiCorp metering package provides a three-phase four-wire three-element grounded installation. Un-grounded three wire metering systems are not approved.

4.5 Backup metering

For 3 MW and above facilities a backup meter is required to be installed and shall programmed and tested in an identical fashion as the primary meter. The purpose for the backup meter is to provide metering data for telemetry and to be an alternate source of data in the event of a failure to the primary meter.

4.6 Metering Communication Policy

All interchange metering will require a dedicated voice-grade data phone line for use with the PacifiCorp MV-90 meter data collection system. It will be the responsibility of the generation customer to supply both the land line and any communication protection devices necessary for PacifiCorp to remotely interrogate the meter.

For installations with limited land lines it is acceptable for a Teltone Gauntlet Gateway line switch to be used for adding data-phone connections and addressing land line communications.

4.7 General Installation Applications below 600 V

4.7.1 Self-Contained Metering (120 – 480 V)

Single phase metering of 400 amps or less and three phase metering of 200 amps or less:

All meter sockets for self-contained installations shall be furnished, installed, and wired by the generation customer. Required socket types are summarized in the PacifiCorp Electric Service Requirements (ESR) manual.

4.7.2 Single-Phase Metering > 400 amps and Three-Phase Metering > 200 amps

Current transformer (CT) metering is required when a three-phase service exceeds 200 amps or when a single-phase service exceeds 400 amps. The generation customer shall provide and install a EUSERC-approved meter socket enclosure and a current-transformer cabinet. Approved meter socket and cabinets shall be in compliance with the PacifiCorp ESR.

4.8 Primary Installation Applications (600 V – 34.5 kV)

4.8.1 Underground-Enclosed Metering

For underground primary metering customers shall meet the PacifiCorp requirements for a primary metering station as described in the ESR. The metering station shall comply with PacifiCorp Material Specification ZM 003, *Primary Metering Enclosure, Padmount*.

4.8.2 Switchgear- or Substation-Enclosed Metering

Customers shall meet the requirements of EUSERC, Section 400 whenever switchgear enclosures are required to meter medium-voltage interchange services.

The customer shall provide all necessary hardware per EUSERC, Section 400. A clear work space 78” high, 36” wide, and 48” deep in front of distribution metering equipment (per current NEC requirements) is required. A concrete mounting pad at least 4” thick is required for the switchgear metering enclosure.

The metering instrument transformers will be specified by PacifiCorp and shall be provided and installed by the manufacture of the switchgear. The meter, test switch, and any specialized hardware will be specified, ordered, and installed by PacifiCorp.

4.8.3 Primary Pole-Mounted

Customers shall install metering equipment according to PacifiCorp’s Construction Metering Standards, Section DM.

The metering instrument transformers will be specified by PacifiCorp. The cluster-mounted primary metering, including instrument transformers, meter, test switch, and any specialized hardware will be specified, ordered, and installed by PacifiCorp.

4.8.4 Indoor Panel Applications

When meter panels are required to mount meters and metering hardware, PacifiCorp will specify, order, and install all revenue panels. The meter panels will be 12” wide by 90” high and shall require a clear work space 36” wide, 90” high, and 48” deep in front and to the rear of the panel.

4.9 Outdoor Meter Enclosure Applications

When it is necessary to mount meters and metering hardware in outdoor locations, PacifiCorp will specify and order the metering box enclosure. The enclosure will be mounted and installed by the facility owner’s contractor. When outside meter enclosures are used, they typically serve both as the junction box and meter socket

enclosure. The meter enclosure box will be 3R-rated by the National Equipment Manufacturer's Association (NEMA), and shall have sealing provisions.

4.10 Sealable Junction Box

The junction box provides a means of terminating the utility's service conductors when they are required (for instance, on indoor-panel applications). The use of this junction box shall be coordinated with PacifiCorp prior to installation. The junction box will be NEMA 3R-rated, and shall have sealing provisions.

4.11 Secondary Leads and Termination

All metering secondary leads or cable (with the exception of prefabricated switchgear equipment) will be provided by PacifiCorp. The secondary leads will conform to PacifiCorp policies and color-code requirements. Lead terminations may be done by manufacturer or contractor, but all will be inspected and approved by PacifiCorp.

4.12 Conduit Substation > 600 volts

For running secondary metering leads between the connections at the meters and the instrument transformers located in the substation yard, the generation customer is to provide a minimum size of 3-inch conduit. When the distance between the revenue instrument transformers and meter panel is greater than 250 feet, it may be necessary to increase the conduit size to accommodate paralleled CT metering secondaries to reduce the burden to the current transformers. PacifiCorp shall procure all conductors and the generation customer shall install meter-wiring cable from the transformers to the revenue-metering panel located in the substation. The conduit shall be PVC, rigid steel, or IMC and must be installed with long-radius sweeps. The customer contractor is responsible for proper installation practices.

4.12.1 Requirements for a Meter within Four to 12 Inches of CT Compartment

1. 1" minimum conduit of rigid steel or IMC.
2. Proper fittings and bushings to protect metering conductors.
3. Schedule 40 PVC/ EMT may be allowed when a bonding lug is provided in both the CT cabinet and meter base.

4.12.2 Requirements for a Meter and CT Cabinet > 12 inches but < 50 feet apart

1. 1.25" minimum conduit of PVC, rigid stell, or IMC.
2. Conduit runs may not have more than three bends totaling 270 degrees. No single bend greater than 90 degrees is allowed .
3. Pull lines are required in all conduit.
4. Removable conduit fittings shall have sealing provisions. (LB connectors are not allowed outside the enclosure without prior written approval from PacifiCorp).

4.12.3 Requirements for a Meter and CT cabinet > 50 Feet Apart

1. 3" minimum conduit of PVC, rigid steel, or IMC.
2. Conduit runs may not have more than three bends totaling 270 degrees. No single bend greater than 90 degrees is allowed.
3. Pull lines are required in all conduit.

4. Removable conduit fittings shall have sealing provisions. (LB connectors are not allowed outside the enclosure without prior written approval from PacifiCorp).

4.13 Meter Testing

PacifiCorp and the generation customer agree that certification of meter system accuracy be done at least biannually or as specifically agreed upon in the interchange agreement. PacifiCorp shall give all interested parties notification of at least two weeks for the impending test. A copy of the test results shall be kept on file and shall be made available for review.

4.14 Instrument Transformers

Voltage and current instrument transformers are required to be 0.3 percent metering accuracy class for both ratio error and phase-angle error over the burden range of the installed metering circuit. Instrument transformers shall be stand-alone, located on the line at the delivery point such that the metering is not interrupted during possible switching configurations at the delivery point unless the metering is being removed for service. Paralleling CTs and internal CTs located inside breakers and power transformers for the purpose of revenue metering will not be permitted.

4.15 Loss Compensation

PacifiCorp may require that distribution system losses such as those in lines and transformers be accounted for in the revenue metering process. PacifiCorp requires that any applicable loss compensation be performed in the meter, rather than calculated in the billing system. PacifiCorp engineering will calculate the meter firmware algorithms to accommodate the transformer and/or line loss factors applicable to each site.

4.16 Station Service Power

Depending upon its electrical source and electrical location, the station service power for connecting substation facilities may also require revenue metering. It may or may not be necessary to meter station service var hours. The other requirements of this section apply to station service metering.

4.17 Instrument Transformer Verification

At least once during the life of the transformer, a documented verification of instrument transformer ratios shall be performed. This requires measurement of primary current simultaneously with secondary current to determine actual ratio to within ten percent of marked nameplate ratio. Transformer turns ratio (TTR) on voltage transformers or CT tester check shall substitute if in-service primary measuring equipment is unavailable. The objective is to ensure that the instrument transformer ratios are documented and are connected to known taps under known burden conditions. This test shall be performed during a scheduled bi-annual test if there is no record of a verification being performed and when instrument transformers are replaced.

4.17.1 Metering Generation Loads

When a generation entity sells power to PacifiCorp, electric service to the auxiliary load associated with the generator plant is also needed. Because deliveries to and from the plant must be separately recorded and treated as separate transactions under PacifiCorp's tariffs, multifunction revenue metering will be required in most cases.

For generators 100 kW or less (connected to PacifiCorp's secondary service voltage), where non-utility generators (NUG) (i.e., emergency generators, peak shaving generators, etc.) or portable plug-ins (generators not permanently wired to the outlet) are connected via an electrical outlet or automatically connected via an automatic transfer switch, a visible disconnect shall be required. A visible disconnect can be a disconnect knife switch or a combination of a manual disconnect circuit breaker, built-in switch, and red-light indicators. These fail-safe indicators shall be visible at all times and shall have at a mimumum one red light bulb per conductor indicating energized/de-energized conditions of the utility and generator source conductors on the line side of the main disconnect or circuit breaker.

4.18 Telemetering Policy for Generator Monitoring

4.18.1 For New Generation Facilities ≥ 3 MW

For generation facilities 3 MW or greater, the following real-time data is to be telemetered to PacifiCorp's Control Center for each generating unit over 3,000 kW in size:

- kW
- kvar
- status (on-line or off-line)

A telemetering circuit to the PacifiCorp Control Center is also required. Control of the breakers at the interconnection switching station may be required, depending on configuration. A minimum number of alarms to be transmitted include the following:

- breaker trip
- transfer trip receive (if applicable)
- channel/equipment fail

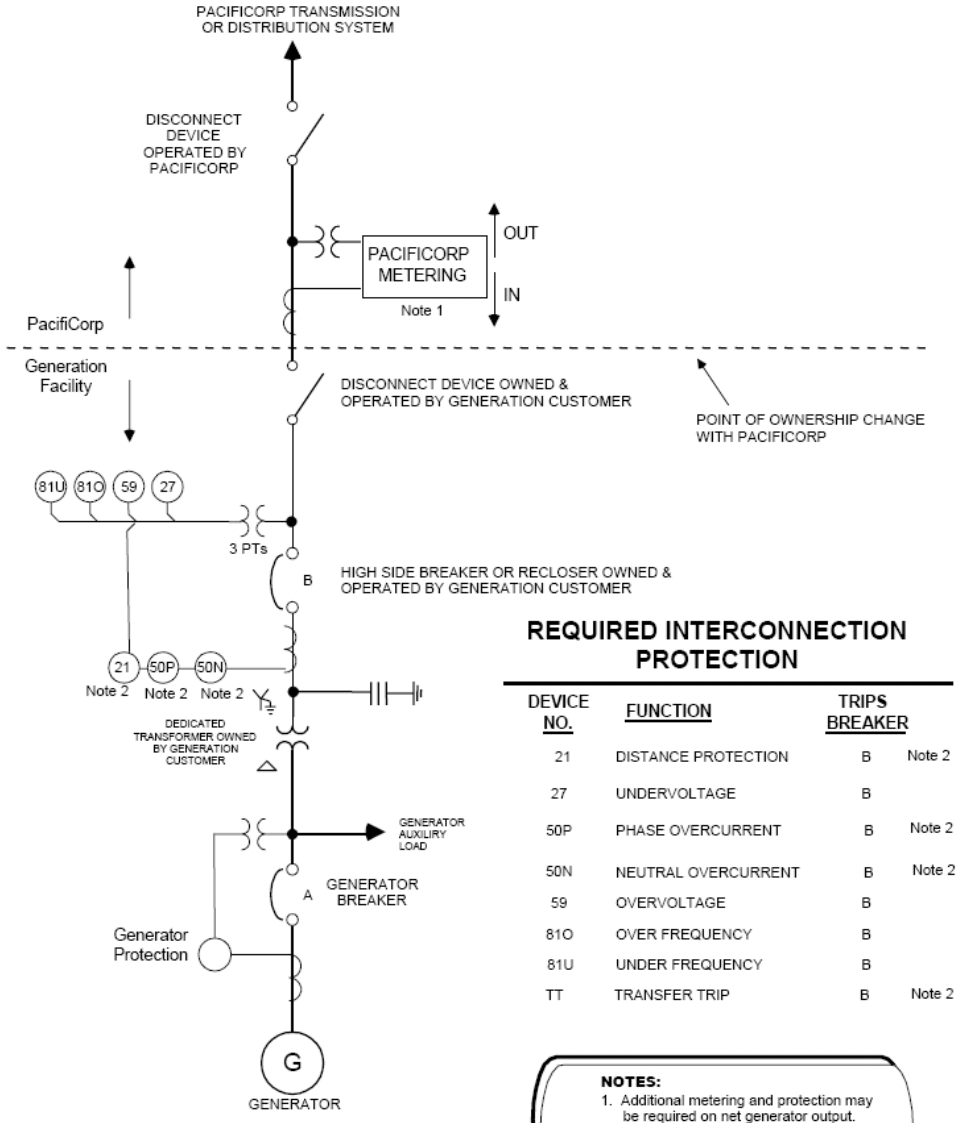
Unless other arrangements are made, the interconnection customer must provide communication lines with the following minimum specifications: VG36, Class B, Type 3, four-wire, full duplex (1200 baud).

Telemetering equipment (usually an RTU and an analog tone telemeter) shall be located in the metering enclosure. At the entity's expense, PacifiCorp will supply telemetering equipment at the interconnection customer's site, at PacifiCorp's Control Center, and at the designated PacifiCorp alternate control site.

4.18.2 For Generation Facilities < 3,000 kW

PacifiCorp will have telemetry for generators of less than 3,000 kW that were installed prior to the January 2007 revision of this document. No new facilities less than 3,000 kW proposed for interconnection after January 2007 will be required to install telemetry. PacifiCorp management reserves the right to alter this policy at any time. Please check with the PacifiCorp Distribution Account Manager to determine the most up–to-date policy.

Figure 1–Typical Metering Installation for Protection and Metering



REQUIRED INTERCONNECTION PROTECTION

DEVICE NO.	FUNCTION	TRIPS BREAKER	
21	DISTANCE PROTECTION	B	Note 2
27	UNDERVOLTAGE	B	
50P	PHASE OVERCURRENT	B	Note 2
50N	NEUTRAL OVERCURRENT	B	Note 2
59	OVERVOLTAGE	B	
81O	OVER FREQUENCY	B	
81U	UNDER FREQUENCY	B	
TT	TRANSFER TRIP	B	Note 2

NOTES:
1. Additional metering and protection may be required on net generator output.
2. Conditionally required

5 RELAY PROTECTION AND CONTROL POLICY FOR INTERCONNECTION CUSTOMERS

This section specifies the protective and control requirements for interconnection requests from interconnection customers to PacifiCorp's power system.

5.1 Applicability

The applicable protective policies of this section apply to all generators interconnecting to any portion of the PacifiCorp power system. These policies, which govern the design, construction, inspection, and testing of protective devices, have been developed by PacifiCorp to be consistent with applicable reliability criteria and policies.

5.2 Protective Relay Policy

An important objective in the interconnection of facilities to the PacifiCorp system is minimizing the potential hazard to life and property. A primary safety requirement is the ability to disconnect immediately when a fault is detected. Generating entities desiring interconnection with the PacifiCorp power system must comply with all applicable jurisdictional state regulatory agency rules in this regard.

The protection equipment for a generation facility must protect against faults within that facility and faults on the PacifiCorp system. As a general rule, a generation facility must also trip off-line (disconnect from the PacifiCorp system automatically) when PacifiCorp's power is disconnected from the line into which the unit is generating.

The protection equipment at a generation facility is divided into two categories: generator protection and interconnection protection. Generator protection is primarily concerned with detecting abnormal conditions within the generation facility. Interconnection protection is concerned with protecting other customers from abnormal conditions caused by the generation facility. It is imperative that a generation facility disconnect from the PacifiCorp power system before the feeder to which the generation facility is connected. Figure 1 is a basic diagram of a typical interconnection.

In view of these objectives, PacifiCorp requires line-protective equipment to either 1) automatically clear a fault and restore power, or 2) isolate only the faulted section so that any outages affect a minimum number of customers.

Due to the high-energy capacity of the PacifiCorp distribution system, high-speed fault clearing may be required to minimize equipment damage and potential impact to system stability. The requirement of high-speed fault clearing will be determined by PacifiCorp on a case–by-case basis. To achieve these results, relays and protective devices are needed. The requirements are outlined in the following pages. Some protection requirements can be standardized, however most line relaying depends on generator size and type, number of generators, line characteristics (i.e., voltage, impedance, ampacity), and the existing protection equipment connected to the PacifiCorp system.

PacifiCorp's minimum protection requirements are designed and intended to protect the PacifiCorp system only. As a general rule, neither party should depend on the other for the protection of its own equipment. Additional protective relays are typically needed to protect the interconnection customer's facility adequately. It is the interconnection customer's responsibility to protect its own system and equipment. PacifiCorp requires that the interconnection customer hire a PE licensed in electrical

engineering to review the electrical design of the proposed generation facility to ensure that it will be adequately protected.

The interconnection customer must provide PacifiCorp test reports for all relays outlined in Tables 1 and 2 before PacifiCorp will allow the facility to parallel. Refer to Section 8.10.6 for information regarding pre-parallel inspections. Every four years thereafter, the interconnection customer must submit written proof, by testing or other means acceptable to PacifiCorp, that the relays are operable and within calibration. PacifiCorp will not test the entity's equipment, but may witness the testing performed by a qualified testing firm retained by the entity. On-site power (typically 120 V) is required for the test equipment. Circuit breakers must be tested at least every eight years after the pre-parallel inspection. It is also in the interconnection customer's best interest to make sure all of its protective equipment is operating properly, since significant equipment damage and liability can result from failures of the entity's protective equipment.

5.3 Reliability and Redundancy

The interconnection customer shall design the protection system with sufficient redundancy or relay coordination that the failure of any one component will still permit the interconnection customer's facility to be isolated from the PacifiCorp system under a fault condition. Multi-function three-phase protective relays must have redundant relay(s) for back-up unless otherwise agreed to by PacifiCorp. The required breakers must be trip tested by the interconnection customer at least once a year.

5.4 Relay Protection Elements

The following is a desciption of the relay elements shown in Figure 1.

21 – Distance relay is a relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value. This type of relay may be required when the Generation Entity is connecting two (2) or more generators to The PacifiCorp power system. This determination is made during the System Impact Study and is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

27 – Undervoltage relay is a relay that operates when its input voltage is less than a predetermined value. PacifiCorp requires three (3) undervoltage elements with time delay. Settings will be determined during the System Impact Study.

50P – Phase instantaneous overcurrent relay is a relay that functions instantaneously on an excessive value of phase current. The requirement for this element is based on minimum peak loading of the feeder tow which the Generator Entity will connect.

59N – 3V0 overvoltage relay is a relay that functions instantaneously on an excessive value of 3V0 voltage. This element utilizes the second coil of the potential transformer wired in a broken delta. Settings will be determined during the System Impact Study.

59 – Overvoltage relay is a relay that operates when its input voltage is higher than a predetermined value. This element is utilizes a current transformer between the transformer and the high side breaker. Settings will be determined during the System Impact Study.

81O – Overfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds a predetermined value. PacifiCorp requires three (3) overfrequency elements with time

delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

81U – Underfrequency relay is a relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency is less than a predetermined value. PacifiCorp requires three (3) underfrequency elements with time delay. Settings will be determined during the System Impact Study and are based on radial or non-radial connections.

TT – Transfer Trip is a scheme that operates based on a remote signal. Transfer trip could utilize, fiber, leased line, microwave, etc. as determined by PacifiCorp. Transfer trip may be required depending on PacifiCorp circuit configuration and loading, as determined by PacifiCorp. Typically, transfer trip shall be required if PacifiCorp determines that a generation facility cannot detect and trip on PacifiCorp end-of-line faults within an acceptable time frame or if the generation facility may be capable of keeping a PacifiCorp line energized with the PacifiCorp source disconnected. It may be in the generation facility's best interest to purchase relays capable of communications in the event transfer trip is later required.

5.4.1 Relays Approved by PacifiCorp

PacifiCorp is familiar with all major utility-grade relay manufacturers. Below is a listing of major vendors; it is intended to be a sample and not an exhaustive listing.

- ABB
- Areva
- Beckwith
- Basler
- Cooper
- GE
- Schweitzer
- Siemens

PacifiCorp will accept any utility-grade relay or combination of relays from this list provided that all required relay elements are fulfilled.

PacifiCorp approval does not indicate the quality or reliability of a product or service, and endorsements or warranties shall be implied.

See Appendix B for equipment configuration and ownership of a transfer trip scheme.

5.5 Line Protection

Many factors are considered when determining the protective relaying requirements needed by interconnection customer to protect PacifiCorp facilities and the customers' equipment. Some of these factors are: the zone of protection, location of connection to the PacifiCorp system, location of customers relative to the location of connection, and the type of protection system used on the PacifiCorp power system.

The zone of protection refers to the area in PacifiCorp's system where the interconnection customer facility must provide fault protection. When a fault occurs, the interconnection customer's protective relays shall cause the isolation of the interconnection customer's facilities from PacifiCorp's or the interconnection customer's system. If there are any PacifiCorp customers connected to the system in the zone of protection, the protection system shall be designed such that the service to those customers is not diminished by the addition of the interconnection customer's

facilities. This includes the amount of delay in automatic testing of the zone of protection by PacifiCorp's equipment following a fault.

There are in many cases options for providing the protective relay system for the zone of protection. These options will effect the up-front cost and the reliability of the interconnection customer's facilities. The use of pilot relaying or direct transfer trip communication may increase the cost to the interconnection customer, however the use of these systems will limit the number of times the facility is forced offline to protect PacifiCorp's system. This is especially true when a PacifiCorp customer is connected to the system in the zone of protection. The protective relays at the interconnection customer's facility will need to be set to detect any fault in the zone of protection and shall isolate the interconnection customer's generator from PacifiCorp's system with no delay. Since the protective relays cannot be set to detect 100 percent of the faults without detecting and operating for faults outside the zone of protection, the interconnection customer's generator will be disconnected for fault conditions that normally would not require isolation of the generator. With the use of a pilot relaying system or direct transfer trip, the number of these unnecessary operations can be greatly reduced.

PacifiCorp may sometimes require installation of a distribution line protective relay at the interconnection customer's sub-site. This is commonly the case whenever three-terminal permissive overreach transfer trip (POTT) schemes are employed to protect the line. Because this line relay participates in a scheme to protect the PacifiCorp distribution system, PacifiCorp must ensure the maintenance, testing, and reliability of this particular type of relay.

The PacifiCorp required relays must be located so that a fault on any phase of the PacifiCorp line shall be detected. If transfer trip protection is required by PacifiCorp, the interconnection customer 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 that the transfer trip equipment will operate properly during fault conditions. (For a detailed description of protection requirements of the transfer trip equipment, refer to Appendix B.)

The PacifiCorp distribution network system is designed for high reliability by having multiple sources and paths to supply customers. Due to these multiple sources and paths, more complex protection schemes are required to properly detect and isolate faults. The addition of any new generation facility to the PacifiCorp system must not degrade the existing protection and control schemes or cause existing PacifiCorp customers to suffer lower levels of safety and/or reliability.

5.6 Generator Protection and Control

Single phase generators must be connected in multiple units so that an equal amount of generation capacity is applied to each phase of a three-phase circuit.

All synchronous, induction, and single-phase generators shall comply with the latest ANSI Standards (C50.10 and C50.13), dealing with waveform and telephone interference.

Synchronous generators of any size require: a) synchronizing relays (device no. 25) to supervise generator breaker closing, and b) reclose blocking at the PacifiCorp side of the line to which the generator is connected (applies to substation breaker/recloser and line reclosers). If coordinated protection is desired by the interconnection customer, policy device numbers for commonly used protective elements can be found

in Table 3. Coordinated protection will minimize the number of times the generator is forced offline without a dedicated feed.

The generator protection should appropriately protect the generation entinty's facility and trip in a reasonable time for any faults in said facility.

5.7 Dedicated Transformer

The dedicated transformer steps up the generator voltage to the interconnection level and isolates the interconnection customer from other customers.

The importance of a dedicated transformer with a delta on the PacifiCorp side and a wye-ground on the generator entity side (delta/wye-gnd) is that the delta isolates the two systems from a ground fault caused by the other system. This connection does not provide a source of zero sequence current to impact the PacifiCorp distribution system's ground relay coordination. The delta winding will also reduce the PacifiCorp system harmonics entering the generation facility, hence it reduces the potential damage to both parties.

A high-side fault-interrupting device, such as a breaker or recloser, is required for transformer protection. It is also required that the device be gang-operated so as to avoid the possibility of ferroresonance or loss of phase condition.

Lightning arrestors, if the interconnection customer chooses to install them, must be installed between the transformer and the fault-interrupting devices and shall be encompassed by the generator's relay protection zone.

5.8 Manual Disconnect Switch

A manual disconnect switch is required for a generation facility. For connections to the PacifiCorp distribution system, a tap-line switch may also be required if, in PacifiCorp's judgment, sufficient tap-line exposure exists to warrant it. Refer to Appendix K for more details on tap-line switches. The installation of line selector switches may impact the protection requirements for the interconnection, specifically the need for direct transfer trip.

A PacifiCorp-operated disconnect device must be provided as a means of electrically isolating the PacifiCorp system from the generator. This device shall be used to establish visually open working clearance for maintenance and repair work in accordance with PacifiCorp safety rules and practices. A disconnect device must be located at the point of interconnection with PacifiCorp for interconnections 2.4 kV and above. The disconnect should be a gang-operated, three-pole lockable switch. PacifiCorp shall own, operate, and maintain all disconnect switches for generation interconnection facilities. The disconnect switch shall be specified by the appropriate PacifiCorp engineers working on the interconnection project and shall come from PacifiCorp stock and be installed on PacifiCorp-owned facilities. PacifiCorp will notify the interconnection customer in advance of the operation of the disconnect switch and follow all work practices associated with this procedure. In the event of an emergency or an unanticipated urgent incident, it will be assumed that notification of the interconnection customer for operation of the disconnect switch cannot be assured. Any deviation from this policy shall be signed off by a Vice-President of Engineering at PacifiCorp along with corporate legal counsel and shall be included in the interconnection agreement between PacifiCorp and the interconnection customer with an explanation of why this policy was not followed for the specific project.

For cases in which the state or federal regulatory policy conflicts with PacifiCorp's policy, the state and/or federal regulatory policy shall prevail.

The interconnection customer may at its option install a second disconnect switch on its property to operate as its sees fit. PacifiCorp asks that the interconnection customer notify PacifiCorp dispatch center before operation of the disconnect switch.

If another disconnect switch is to be located on the interconnection customer's site, it must be furnished, installed, owned, and maintained by the interconnection customer. Only devices specifically approved by PacifiCorp may be used. PacifiCorp personnel shall inspect and approve the installation before parallel operation is permitted. If the disconnect device is in the interconnection customer's substation, it should be located on the substation dead-end structure and must have a PacifiCorp-approved operating platform.

The disconnect device must not be used to make or break parallels between the PacifiCorp system and the generator(s). The device enclosure and operating handle (when present) shall be kept locked at all times with PacifiCorp padlocks.

The disconnect device shall be physically located for ease of access and visibility to PacifiCorp personnel. When installed on the interconnection customer's side of the interconnection, the device shall normally be installed close to (i.e., within one foot of) the metering. The PacifiCorp-operated disconnect shall be identified with a PacifiCorp-designated switch number plate.

Metering is normally on the high side of the interconnection customer's dedicated transformers. Between the metering units and the circuit breaker, a second disconnect device is required; it shall not have a PacifiCorp lock and may be operated by the interconnection customer.

5.8.1 Specifications

1. Disconnect switches must be rated for the voltage and current requirements of the specific installation.
2. Disconnect switches must be gang-operated.
3. Disconnect switches must be weatherproof or designed to withstand exposure to weather.
4. Disconnect switches must be lockable in both the open/closed positions with a standard PacifiCorp lock if the switch is located at a PacifiCorp facility.

5.8.2 High-Voltage Disconnects

The interconnection customer shall submit a proposed switch specification to PacifiCorp for approval prior to ordering and installing.

5.9 Discontinuation of Operation

Producers must discontinue parallel operation when requested by PacifiCorp for the following reasons:

1. To facilitate maintenance, test, or repair PacifiCorp facilities. PacifiCorp will coordinate this with each producer.
2. During system emergencies.
3. When a generator is interfering with other PacifiCorp customers or producers on the system.
4. When an inspection of a generator reveals either conditions hazardous to the PacifiCorp system or personnel or a lack of scheduled maintenance or maintenance records for equipment necessary to protect PacifiCorp's system.

5.10 Fault-Interrupting Devices

The fault-interrupting device selected by the interconnection customer must be reviewed and approved by PacifiCorp for each particular application.

There are two basic types of fault-interrupting devices:

- Circuit Breakers
- Reclosers

The type of fault-interrupting device required for a generation facility must be determined based on the size and type of generation, the available fault duty, the local circuit configuration, and the existing PacifiCorp protection equipment.

5.10.1 Circuit Breakers

Three-phase circuit breakers at the point of interconnection automatically separate the generation facility from the PacifiCorp system upon detection of a circuit fault. Additional breakers and protective relays may be installed in the generation facility for ease in operating and protecting the facility. The interconnection breakers must have sufficient capacity to interrupt maximum available fault current at its location and shall be equipped with accessories to:

1. Trip the breaker with an external trip signal supplied through a battery (shunt trip).
2. Telemeter the breaker status when it is required.
3. Lockout if operated by protective relays required for interconnection.

Generally, a three-phase circuit breaker is the required fault-interruption device at the point of interconnection, due to its simultaneous three-phase operation and ability to coordinate with PacifiCorp line-side devices

5.10.2 Reclosers

Reclosers are a single- or three-phase protective device used on distribution circuits.

An automatic circuit recloser is designed to: 1) sense overcurrents, 2) time and interrupt the overcurrent according to a preset characteristic, and 3) reclose to test and possibly reenergize the line after a specified time interval. A recloser should operate several times (usually three or four) before isolating the source of overcurrent from the rest of the system. Since most distribution overcurrents are caused by temporary faults such as tree limb contact in a wind storm, a high probability exists that a recloser can restore service without an outage to customers.

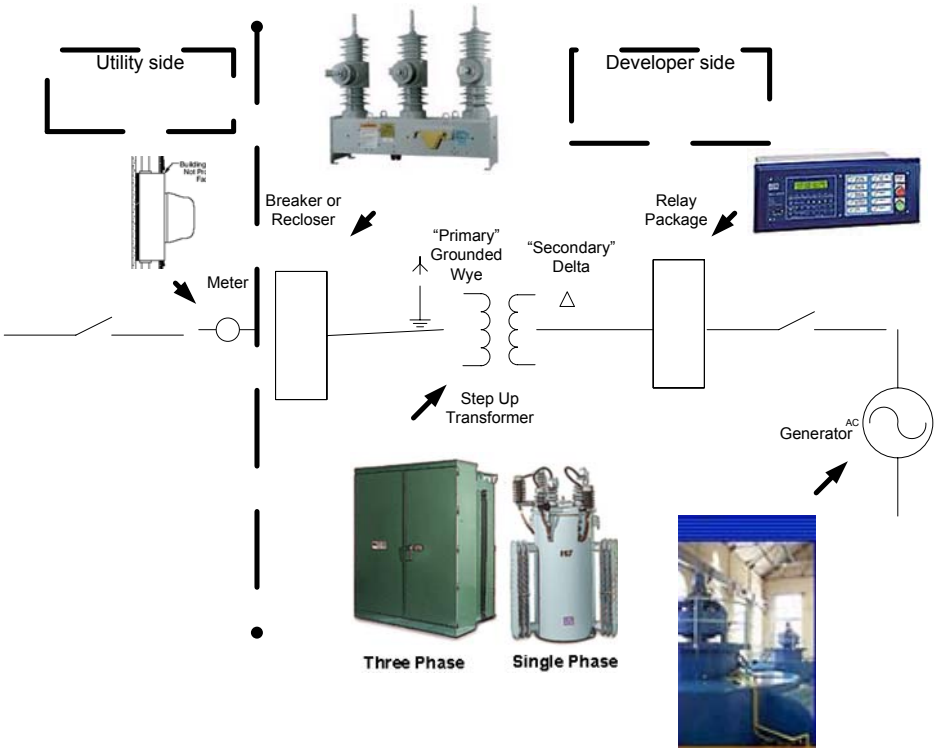
When generation is introduced into circuits that have reclosers, the following alterations may be necessary to the existing units:

1. Change the control to one that is capable of handling generation.
2. Add PTs and CTs to install a hot-line block feature.
3. Change the entire installation if both the control and recloser are too antiquated to accommodate generation. This will be determined by the Local Area Engineer.
4. The unit and control may need to be moved to a different location to better protect the circuit because of the change the added generator introduces to the circuit.

Please refer to the applicable interconnection study results for project-specific details.

For generation projects 250 kW or greater in size, PacifiCorp will require the installation of a breaker or recloser near the point of interconnection (see Figure 2).

Figure 2–Interconnection Equipment Placement and Ownership on Distribution Voltages



5.11 Synchronous Generators

The generating unit must meet all applicable American National Standard Institute (ANSI) and Institute of Electrical and Electronic Engineers (IEEE) policies. The prime mover and the generator shall also be able to operate within the full range of voltage and frequency excursions that may exist on the PacifiCorp system without damage to the equipment. The generating unit must be able to operate through the specified frequency ranges for the time durations listed in Table 6, to enhance system stability during a system disturbance.

5.11.1 Synchronizing Relays

Synchronous generators and other generators with stand alone capability must use one of the following methods to synchronize with the PacifiCorp system:

1. Automatic Synchronization with Automatic Synchronizing (Device 25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation.

The automatic synchronizing relay sends a close signal to the breaker after the above conditions are met.

2. Automatic Synchronization with Automatic Synchronizer (Device 15/25)

   The automatic synchronizing relay must have a slip frequency-matching window of 0.1 Hz or less, a voltage-matching window of ± 10 percent or less, a phase angle-acceptance window of ± 10 degrees or less, and breaker-closure time compensation. For an automatic synchronizer which does not have breaker-closure time compensation, a tighter frequency window (± 5 degrees) with a one-second time acceptance window shall be used to achieve synchronization within ± 10 degrees phase angle.

   In addition to the above characteristics, this automatic synchronizer has the ability to adjust generator voltage and frequency automatically to match system voltage and frequency.

3. Manual Synchronization with Synchroscope and Synch Check (Device 25) Relay Supervision

   The synch check relay must have a voltage-matching window of ± 10 percent or less and a phase angle-acceptance window of ± 10 degrees or less.

   Generators with greater than 1,000 kW aggregate nameplate rating must have automatic synchronizing relay or automatic synchronizer.

5.11.2 Frequency/Speed Control

Unless otherwise specified by PacifiCorp, a governor shall be required on the prime mover to enhance system stability. Governor characteristics shall be set to provide a five percent droop characteristic (a 0.15 Hz change in the generator speed shall cause a five percent change in the generator load). Governors on the prime mover must be operated unrestrained to help regulate PacifiCorp's system frequency.

5.11.3 Excitation System Requirements

An excitation system is required to regulate generator output voltage.

Static systems shall have a minimum ceiling voltage of 150 percent of rated full load field voltage with 70 percent of generator terminal voltage and a maximum response time of two cycles (0.033 seconds).

Rotating systems shall have an ANSI voltage response ratio of 2.0 or faster.

Excitation systems shall respond to system disturbances equally in both the buck and boost directions.

Under certain conditions, PacifiCorp may grant an exemption for generation facilities which have excitation systems not meeting these requirements. Requests for exemption should be sent to PacifiCorp's Distribution Account Manager.

5.11.4 Voltage Regulator Bank

The regulator bank must be able to maintain the generator voltage under steady state conditions without hunting and within ± 0.5 percent of any voltage level between 95 percent and 105 percent of the rated generator. The point of voltage sensing should be at the same point as the PacifiCorp revenue metering. As

determined by the PacifiCorp Control Center, the generator shall be operated at either a voltage or a power factor schedule.

Depending on interconnection study results, the generating facility may also be requested by the PacifiCorp Control Center to produce more or less reactive power from that indicated on the regular schedule in order to meet the system needs.

Existing regulator banks on the distribution feeder may need to have their existing controls altered or replaced to accommodate bi-directional power flow. This will be outlined in the interconnection study report.

5.11.5 Power Factor Controller

The controller must be able to maintain a power factor setting within ± 1 percent of the setting at full load at any set point between 95 percent lagging and 95 percent leading. In addition, all power factor controllers for synchronous generators greater than 1 MW must have programmable capability to vary hourly settings.

5.11.6 Data Gathering/Event Recorder

Generation facilities with capacity greater than 250 kW and with automatic- or remotely-initiated paralleling capability may, at PacifiCorp's discretion, have an event recorder utilized by a power quality consulting firm or by PacifiCorp's Engineering Department to investigate operational difficulties encountered with the generator. The event recorder shall provide PacifiCorp with sufficient information to determine the status of the generation facility during system disturbances. The event recorder must provide remote access from PacifiCorp's Control Center or engineering offices. The cost of this recorder and its utilization and operation will be borne entirely by the interconnection customer/owner. It will be assumed that data-gathering and event-recording devices are only installed to resolve specific incidents that arise relating to the generation facility, they are not intended to be installed on a permanent basis.

PacifiCorp Field Engineers may request 15-minute data for any generation facility tied to PacifiCorp circuits. This can be done by either calling or e-mailing the Rocky Mountain Power Commercial and Trading Dept. Manager at (801)220-2542. Please list the type and dates of the data needed and an electronic file will be created and sent via e-mail. If it is found that existing data is not available from the meter, it is possible that the meter can be reprogrammed to access this data. This request can be submitted by contacting Rocky Mountain Power's Metering Dept. at (801)220-2424 or Pacific Power's Metering Dept. at (503)813-5249.

5.11.7 Generator Testing

Testing of the generator and excitation system must be performed to verify proper parameters of the generator and exciter. Testing shall meet the requirements of the WECC Generator Testing Program. Copies of the test reports with appropriate power flow and stability data parameters identified shall be provided to the PacifiCorp Distribution Account Manager. If a stability model is not available, the interconnection entity will be responsible for developing a suitable model for use in PacifiCorp's transient stability program.

5.11.8 Induction Generators

Induction generators and other generators with no inherent var (reactive power) control capability shall be required to provide power to the unity point of interconnection within the range of ± 95 percent power factor as is technically feasible without risk of self-excitation. The induction generator will provide an amount of reactive power equivalent to that required for a synchronous generator and shall be controllable by voltage. Induction generators may also be required to follow a PacifiCorp-specified voltage or var schedule on an hourly, daily, or seasonal basis, depending on the location of the installation. Specific requirement instructions shall be evaluated on a case-by-case basis and shall be provided by the PacifiCorp Control Center

5.12 DC Generators

5.12.1 Inverters Capable of Stand-Alone Operation

Inverters capable of stand-alone operation are capable of islanding, operation, and shall have similar functional requirements as synchronous generators. For units less than 100 kW, it is usually acceptable to have the frequency and voltage functions built into the electronics of the inverter if the set points of these built-in protective functions are tamperproof and can be easily and reliably tested. The total harmonic distortion in the output current of the inverters must meet ANSI and IEEE Standard 519 requirements.

Inverter type generators connected to the PacifiCorp system must be pre-approved by PacifiCorp. For units over 10 kW, a dedicated transformer will be required to minimize the harmonics entering into the PacifiCorp system.

5.12.2 Inverters Incapable of Stand-Alone Operation

Inverters, rated 10 kW or less, that have been tested and certified by Underwriter Laboratories (UL-1741) to be non-islanding, and which meet IEEE Standard 519 harmonic requirements, may be interconnected to the PacifiCorp system as is. Certified non islanding inverters over 10 kW will require a dedicated transformer and may have other requirements depending on the installation location and local generation penetration.

5.13 Emergency Generator Requirement

There are two major methods of transferring electric power supply between the PacifiCorp source and the emergency generator system: open transition (break-before-make) and closed transition (make-before-break). The open transition method can be accomplished via a double-throw transfer switch or an interlock scheme which prevents the two systems from operating in parallel. The interconnection customer's main breaker shall not be allowed to close until the generator breaker opens. This open transition method does not require any additional protection equipment, however it does cause the interconnection customer's load to experience an outage while transferring back to PacifiCorp. The length of this transfer outage depends on the transfer equipment involved.

Emergency systems are routinely tested by the interconnection customer under load, usually once a month. With a break-before-make system, the interconnection customer's load, or most often a portion of it, is removed from the PacifiCorp system and the emergency generator is tested under load conditions. After successful completion of the test, the generator is taken offline and the interconnection customer is transferred back to PacifiCorp. This testing procedure results in the test load

experiencing two outages (when bringing the emergency generator online and when taking it offline) whenever the system is tested.

For generation facilities that cannot tolerate this momentary loss of power, the closed transition (make-before-break) method is intended to provide transfer without interruption. For the closed-transition method, the maximum parallel time with the PacifiCorp system shall be less than 0.5 seconds, both to and from the emergency generator source. The protection requirements for synchronous generators will also apply to emergency generators any time a parallel is to be made with the PacifiCorp system. These would include, but are not limited to, a dedicated transformer and automatic synchronizing.

PacifiCorp may, at its discretion, allow installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE1-32R) for emergency generator installations, as an alternative to the normally required voltage, frequency, and ground relays. The reverse power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. The reverse power relay, in this case, will protect PacifiCorp personnel and the general public by preventing the generator from keeping the PacifiCorp system energized in the event the PacifiCorp source substation(s) have tripped for a fault while the generator is paralleled. The relay output shall trip the circuit breaker on the PacifiCorp side of the transfer switch. This application can be used when the interconnection customer's emergency generator output is expected to be less than the entity's load.

5.14 Notification/Documentation

The interconnection customer must notify its local PacifiCorp representative in writing of all new proposed emergency generator installations, or proposed changes to the existing schemes, regardless of method of interconnection or transfer.

Required documentation includes a description of generation and control system operation, one-line diagrams, identification of all interlocks, sequence of events description for transfer operation, and specifications for any PacifiCorp-required protective devices. PacifiCorp may request additional documentation should it deem it necessary. Depending on the complexity of the installation, PacifiCorp may require a professional engineering review by an electrical engineer from the state in which the generator is to reside. Please consult with the Distribution Account Manager with any questions.

All documentation must be approved by PacifiCorp Engineering prior to installation.

5.15 Operation/Clearances

For the safety of PacifiCorp personnel and to ensure the proper operation of the PacifiCorp system, it is essential that the interconnection customer notify the PacifiCorp Control Center of all emergency generator installations prior to paralleling. For operation and clearance purposes, emergency generator installations should be treated the same as any independent generation facility interconnected to the PacifiCorp system. A satisfactory visible open point shall be approved by PacifiCorp.

For all line work and clearances, the emergency generator shall be treated as a power source.

Interconnection customers using make-before-break transfer schemes are required to notify the PacifiCorp Control Center of their intent to transfer to their emergency generator and then back to the PacifiCorp source before any transfers are attempted. The notification of the make-before-break transfer scheme is necessary because such

actions put another generation source in parallel with the PacifiCorp system. This notification is not essential on break-before-make schemes, but may be desirable in some instances.

5.16 Parallel-Only (No-Sale) Generator Policy

Parallel-only generators shall have similar requirements as that of any other standard synchronous generator interconnection except that PacifiCorp may at its discretion allow the installation of three very sensitive, single-phase, reverse-power relays (such as the Basler BE 1 32R) along with the dedicated transformer as an alternative to the normally required interconnection protection relays. The reverse power relays shall be set to pick up on transformer magnetizing current with a time delay not to exceed 0.5 second. This option may not be feasible on generating systems with a slow load-rejection response since they may be tripped offline frequently for in-plant disturbances.

Owners of parallel-only generators must execute a parallel-only (no-sale) operating agreement with PacifiCorp prior to operation by the interconnection customer.

5.17 Interconnection Customer-Owned Primary or Distribution Voltage Tap Lines (2.4 kV and Above)

If the interconnection customer constructs, owns, and maintains a primary level or distribution-level voltage tap-line extension, the entity shall also install, own, and maintain the following equipment at the point of interconnection with PacifiCorp:

- Fault-interrupting protection device (i.e., breaker or recloser, as specified by PacifiCorp).
- Manual isolating disconnects (gang-operated).
- High-side metering installation as outlined in Section 4.

5.18 PacifiCorp Protection and Control System Changes

At the interconnection customer's expense, PacifiCorp will perform a detailed interconnection study to identify the cost of any required modifications to PacifiCorp's protection and control systems to interconnect a new generation source. A Generation Special Facilities Agreement shall be executed to recover the costs to PacifiCorp associated with any protection and control system modifications which are directly assigned to the interconnection customer. These protection and control system modifications are in addition to any distribution system upgrades identified in the system impact or facilities studies for interconnection of the new generation facility.

Following is a partial list of protection system modifications which may be required:

- PacifiCorp's automatic restoration equipment shall be prevented from operating until the generator is below 25 percent of nominal voltage as measured at the restoration equipment. Generator damage and system disturbances may result from the restoration of power by automatically re-energizing PacifiCorp's facilities. This modification shall be required when the generator has the capability of energizing a line while the PacifiCorp system is disconnected. PacifiCorp will not allow the interconnection customer's generator to automatically re-energize PacifiCorp facilities.
- For generation facilities greater than 1,000 kW aggregate nameplate rating, all existing single-phase fault-interrupting devices (fuses) located in series between the generator and PacifiCorp's substation shall be replaced with three-phase interrupting devices to prevent possible single-phasing of other customers.
- PacifiCorp substation transformer high-side fuses must be replaced with a three-phase interrupting device when the generator is on a distribution circuit fed from a

fused PacifiCorp substation transformer bank, and the bank's minimum load is equal to or less than 200 percent of the generator's nameplate rating.

- Installation of transfer trip from the high-side circuit breaker/circuit switcher, as well as the distribution breaker and any line reclosers, to the generator may be required if deemed necessary by circuit conditions. An associated alarm circuit is required between the interconnection customer's site and the PacifiCorp Control Center.

These ride through and trip settings are required for the protection of PacifiCorp's system. The required devices and settings will be installed at the Point of Interconnection (POI). The protection devices at the POI will send trip signals to the generator breakers (or to the wind turbine feeder breakers if a wind plant). The interconnection customer may also have frequency and voltage protection at its generating facility. The interconnection customer's local protection settings must be compatible with the voltage and frequency ride-through requirements in Table 2

Table 2–Ride-Through and Trip Voltage/Frequency Relay Settings

Frequency Ride-Through Required (see Note 1)	Trip Required	Voltage Ride-Through Required (see Note 1)	Trip Required
(Hz, delay(sec))	(Hz, delay(sec))	(pu, delay(sec))	(pu, delay(sec))
	> 61.6, 0.0		> 1.500, 0.1
	> 60.5-61.6, 0.5		1.10-1.49, 2.0
60.5-59.5, infinite	< 59.5-58.4, 0.5	.950-1.05, infinite	1.099-1.051, 120.0
	< 58.4, 0.0		0.949-0.901, 120.0
			0.900-0.671, 2.0
			< 0.671, 0.1

Notes:

1. Outside of range/time delay, trip permitted but not required

Table 3–WECC Disturbance-Performance Table of Allowable Effects on Other Systems

NERC and WECC Categories	Outage Frequency Associated with Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard (see Note 2)
A	Not Applicable	Nothing in addition to NERC		
B	≥ 0.33	Not to exceed 25% at load buses or 30% at non-load buses Not to exceed 20% for more than 20 cycles at load buses	Not below 59.6 Hz for 6 cycles or more at a load bus	Not to exceed 5% at any bus
C	0.033 - 0.33	Not to exceed 30% at any bus Not to exceed 20% for more than 40 cycles at load buses	Not below 59.0 Hz for 6 cycles or more at a load bus	Not to exceed 10% at any bus
D	< 0.033	Nothing in addition to NERC		

Notes:

1. The WECC Disturbance-Performance Table applies equally to either a system with all elements in service, or a system with one element removed and the system adjusted.

2. As an example in applying the WECC Disturbance-Performance Table, a Category B disturbance in one system shall not cause a transient voltage dip in another system that is greater than 20% for more than 20 cycles at load buses, or exceed 25% at load buses or 30% at non-load buses at any time other than during the fault.

3. Additional voltage requirements associated with voltage stability are specified in WECC Standard I-D. If it can be demonstrated that post-transient voltage deviations that are less than the values in the table will result in voltage instability, the system in which the disturbance originated and the affected system(s) should cooperate in mutually resolving the problem.

5.19 Telemetry and SCADA Requirements

In order to fully comply with NERC Reliability Standards TOP-005-1, *Operational Reliability Information* and FAC-001-0, *Facility Connection Requirements*, Grid Ops will need the following SCADA and tone-telemetered generator data for 3 MW and higher plants connected to PacifiCorp system:

1. Status (of breakers).
2. MW and MVAR capability.
3. MW and MVAR net output.

4. Status of automatic voltage control facilities (i.e., capacitors, reactors, dynamic VAR devices).

   The same standard requires that key voltages be metered (and that PacifiCorp's voltage requirements adequately address this need).

5. Tone telemetry.

5.20 Digital Control (DDC)

Dispatchable generators larger than 3,000 kW are required to have real-time direct digital control of unit output from PacifiCorp's Control Center. This allows generation units to respond to power system load/frequency changes.

5.21 Warning Label for Protective Relays

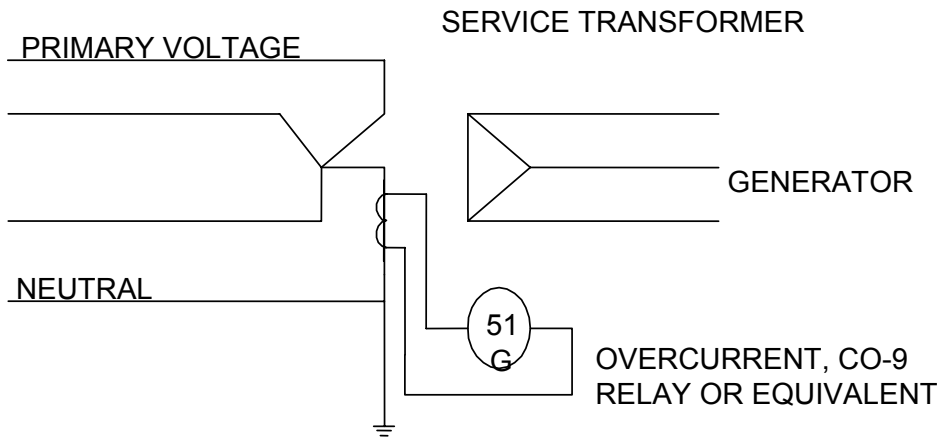
A warning label shall be affixed within 6 inches of any relay in the interconnection customer's control house (or similiar enclosure containing protective relays) **which affects the operation of PacifiCorp's electrical circuits**. The warning label shall state the following:

> ***Warning !!!*** *Do not alter or change any settings on this relay without first receiving approval from PacifiCorp's Protection and Control Engineering Dept. in Portland, Oregon. Failure to give notification to PacifiCorp of this action may result in damaged or destroyed electrical equipment, possible physical injury or fatality, facility disconnection, and/or legal action.*

A stock item number is available from Pacificorp to acquire this item. Please contact PacifiCorp's Local Area Engineer and/or a Distribution Account Manager to acquire this label.

Figure 3–Recommended Ground Detection Schemes on Primary Voltage Circuits

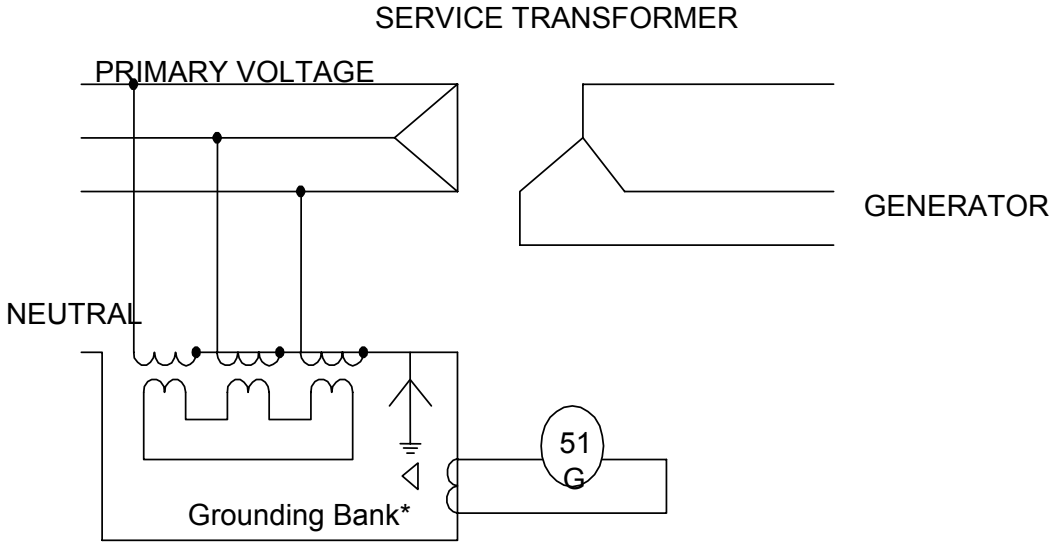
Wire System, Service Transformer Connected Ground Wye on Primary Voltage Side



Notes:

1. CT ratio to be selected according to ground fault currents for the location.

Wire System, Service Transformer Connected Delta on Primary Voltage Side



Notes:

1. Grounding Bank to be sized to limit overvoltages to 1.15 times normal voltage.

6 GENERATOR REACTIVE AND VOLTAGE POLICY

The purpose of this section is to help all generation facilities satisfy applicable PacifiCorp policies and procedures.

The policies and procedures of this section apply to all generators interconnecting with the PacifiCorp power system. All generators must meet applicable WECC (Western Electricity Coordinating Council) policies.

Generation facilities are required to schedule energy or ancillary services through a designated scheduling coordinator unless other arrangements have been made with PacifiCorp.

6.1 Reactive and Voltage Control Policy for Generators

Reactive power (var) and voltage control are vital components of desired PacifiCorp system operation. It is essential that PacifiCorp receive both real and reactive power from interconnected generators. Where a generator is unable to furnish reactive power support due to interconnection limitations, type of generator, generator loading, or other reasons, the interconnection customer shall install equivalent reactive support at the customer's expense or make other arrangements with PacifiCorp.

How a generator meets PacifiCorp's reactive requirements depends on its type and size. Synchronous generators have an inherent reactive flexibility that allows them to operate within a range to either produce or absorb vars. Unless they have installed corrective equipment, induction generators operate at a power factor absorbing vars and require reactive support from the interconnected system.

Interconnection customers must provide reactive supply sufficient to operate at as near unity power factor as can be safely achieved without risk of self excitation. Typically the power factor should range from 97 percent leading power factor (absorbing vars) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing vars) to 95 percent lagging power factor (producing vars) within an operating range of ± 5 percent of rated generator terminal voltage and full load. This is typical if the induction generators shall be equipped and operated to control voltage. If the facility is not capable of providing positive reactive support (supplying reactive power to the system) immediately following the removal of a fault or other transient low-voltage perturbations, the facility may be required to add dynamic voltage support equipment.

6.1.1 Generator Control

6.1.1.1 Voltage Control

Voltage regulators are required for all generators larger than 100 kW. In some cases, particularly for small units connected to the distribution system, a power factor controller will also be required to provide operational flexibility.

Voltage regulators must be capable of maintaining the interconnection reactive interchange between 0.95 leading/lagging power factor measured at the point of interconnection. For synchronous machines, the regulators and exciters will be required to react during faults (i.e., within cycles). For wind farms that will have induction machines installed, PacifiCorp may accept slower adjustments to voltage regulation on a case-by-case basis.

The generator shall normally be operated with the generator automatic voltage regulator in a constant voltage regulation mode. The voltage regulator shall be adjusted periodically throughout each day to maintain reactive output within a range defined by PacifiCorp and consistent with the reactive requirements for the local transmission system. This may be a voltage that minimizes the reactive interchange between PacifiCorp's system and the generation facility, or, at PacifCorp's discretion, the PacifiCorp dispatcher may ask the plant operator to hold a higher or lower voltage so as to cause the facility to supply or absorb reactive power in support of specific system control objectives. It is the owner's responsibility to insure that the transformer tap position and all other equipment are compatible with this objective.

In the event that the generator by itself is not capable of providing sufficient reactive power at the point of interconnection so as to supply reactive power to the system sufficient to meet the 0.95 leading/lagging power factor requirement, switched shunt capacitors or dynamic var equipment may be required (as determined by the interconnection study). The generating facility's operation shall limit abrupt voltage changes on PacifiCorp's system to ± 3 percent.

Special considerations may require the use of line-drop compensation to partially compensate for reactive losses of the generator step-up transformer and/or other impedances between the generator and the point of interconnection. If required, the control system should allow for up to 50 percent compensation of said losses. The need for line-drop compensation will be at the sole discretion of PacifiCorp

6.1.1.2 Power Factor Control

For units smaller than 100 kW and/or in special cases as mutually agreed, a power factor controller shall be utilized to maintain a constant power factor at the point of interconnection by controlling the voltage regulator or other relevant equipment. The controller must be capable of maintaining a power factor within ± 1 percent at full load at any set point between 95 percent lagging (producing vars) and 95 percent leading (absorbing vars) measured at the point of interconnection. In addition, all power factor controllers for generators larger than 1,000 kW must have programmable capability to vary hourly settings. The PacifiCorp Control Center shall specify required settings for voltage or power factor. Generally, as noted above, a voltage will be specified that minimizes the reactive interchange between PacifiCorp's system and the generating facility.

In the event that the generator by itself is not capable of providing sufficient reactive power at the point of interconnection so as to supply reactive power to the system sufficient to meet the 0.95 leading/lagging power factor requirement, switched shunt compensation or dynamic var equipment may be required

The programmable controller for units larger than 1,000 kW is normally obtained by combining a non-programmable controller and a general-purpose programmable device.

Control over the var production associated with the delivery of power to PacifiCorp falls under the following general classifications, depending upon the contractual arrangements:

6.1.1.2.1 Surplus-Sale Operation

When an interconnection customer dedicates its generator to serving plant needs first, selling only the surplus to PacifiCorp, treatment differs depending on whether excess power is being *sold to* PacifiCorp or supplemental power (no-sale mode) is being *purchased from* PacifiCorp. In a no-sale mode, the interconnection customer has sole control over var production, however the customer shall meet the power factor requirements for its overall facility as described by the applicable tariff(s). When surplus power is being sold, PacifiCorp has operational control of the power factor at which the power is delivered.

6.1.1.2.2 Net-Sale Operation

All electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of var production within the generator operating range.

6.1.1.2.3 No-Sale Operation

When an interconnection customer uses generation exclusively to offset load, the customer has sole control of the generator power factor, however the customer shall meet the power factor requirements for its overall facility as described by the applicable tariff(s).

6.1.1.2.4 Generation Connected to the PacifiCorp Power System (< 1 MW and Total Output Sold to PacifiCorp):

All electricity produced, excluding station load, isvar production within the generator operating range.

6.2 Synchronous Generator Frequency/Speed Control

To enhance system stability, a governor is required on the prime mover, set to provide a 5 percent droop characteristic (a change of 0.15 Hz in the generator speed will cause a 5 percent change in the generator load). Exceptions must be approved by PacifiCorp. Governors shall be operated unrestrained to regulate system frequency.

6.2.1 Non-Synchronous Generator Control (without Var Control)

Induction generators or other generators without var control absorb vars and therefore require reactive power support from PacifiCorp's system. For facilities larger than 40 kW, PacifiCorp will require power factor correction. Power factor correction or capacitors must be installed either by the interconnection customer or as part of the special facilities installed by PacifiCorp at customer expense. Care must be exercised by the interconnection customer in connecting capacitors directly to the generator terminals to avoid self-excitation. Stand-alone switched capacitors supplied by the interconnection customer which are not an integral part of the generator control system shall be switched on and off at the request of PacifiCorp.

When the generator is located at a remote location on an existing distribution line, severe circuit voltage regulation problems may result if all the interconnection customer's capacitors are located at the generator terminals. In such cases, the generator can be operated at a power factor less than unity (absorbing vars) with part of the generator reactive supply furnished from

capacitors located elsewhere on the PacifiCorp system. If this solution is adopted, the interconnection customer will bear the cost of the capacitor installation(s) as well as the maintenance of these units. The maintanence charges will be included in the interconnection agreement for the interconnection customer.

6.2.2 Induction Generators

Switched capacitors may be required by PacifiCorp in areas where severe reactive limitations exist. The need for the capacitors as well as the specifics of their size, location, and operational limitations will be outlined in the interconnection study report results. The interconnection customer must provide reactive supply sufficient to operate at as near unity power factor as can be safely achieved without risk of self-excitation. Typically the power factor should range from 97 percent leading power factor (absorbing vars) and 1.0 (unity). PacifiCorp may further require the provision of reactive support equivalent to that provided by operating a synchronous generator anywhere within the range from 95 percent leading power factor (absorbing vars) to 95 percent lagging power factor (producing vars) within an operating range of ± 5 percent of rated generator terminal voltage and full load. (This is typical if the induction project is greater than 1,000 kW.)

6.2.3 Generator Step-Up Transformer

The available voltage taps of an interconnection customer's step-up transformer must be reviewed by PacifiCorp for their suitability with PacifiCorp's system. The Interconnection customer is expected to request this review before acquiring the transformer.

PacifiCorp shall determine which voltage taps would be suitable for a step-up transformer for the interconnection customer's proposed project. Suitable taps are required in order to give the transformer the essential capacity for the generator to:

- Deliver maximum reactive power to PacifiCorp's system at the point of interconnection (generator operating at 95 percent lagging power factor) and,
- Absorb maximum reactive power from PacifiCorp system (generator operating at 95 percent leading power factor).

The interconnection customer's transformer, with correct voltage taps, helps maintain a specified voltage profile on PacifiCorp's system for varying operating conditions. Actual voltage tap settings can be different for transformers connected at the same voltage level, depending upon their geographic location.

The interconnection customer is responsible for ensuring that the available voltage taps of each interconnection customer’s step-up transformer are adequate to best match current distribution system operating voltages provided by PacifiCorp. In addition, suitable taps are required to support a 95 percent power factor at the point of interconnection by delivering or absorbing reactive power as needed. Before acquiring the transformer, the interconnection customer should consult PacifiCorp for assistance in this matter.

6.2.4 Grid Operations

All generation interconnections on distribution level voltages will require as policy a standard breaker-status indication for PacifiCorp’s grid operations utilization for day-to-day power system activities. The standard PacifiCorp scheme for reading

breaker status of small generating facilities on distribution systems less than 3 MW as of this date is the “ibox.” PacifiCorp reserves the right to alter this scheme in the future should technological advances in this arena render this method obsolete and/or more costly. Check with the Distribution Account Manager to see the present system in use for this activity. If this alteration should occur, the ibox method will be grandfathered for each facility where it is utilized by the account manager through amendments to existing agreements/contracts. The “ibox” system will be used with the following communications methods:

1. MAS radio (if a master site is available).
2. Leased telephone line.
3. Other radio systems or set of radios used to bring the SCADA info back to the collection location station.

The following data will be gathered by PacifiCorp in order to fully comply with NERC Reliability Standard TOP-005-1, *Operational Reliability Information* and FAC-001-0, *Facility Connection Requirements*. Grid Ops will need the following SCADA and tone-telemetered generator data for 3 MW and higher plants connected to the PacifiCorp system:

1. Status (of breakers).
2. MW and Mvar capability.
3. MW and Mvar net output.
4. Status of automatic voltage control facilities (capacitors, reactors, dynamic VAR devices).

   The same standard requires that key voltages be metered (and that PacifiCorp's voltage requirements adequately address this need).
5. Tone telemetry.

Note that in WECC units, 10 MVA and above should have automatic voltage regulation (AVR) installed on them.

For installations less than 3 MW, it shall be the policy of PacifiCorp to gather data on breaker status, MW, and Mvar values when the cumulative total generation connected to a feeder breaker or transformer exceeds 3 MW. The generation project proposed which by its interconnection and insertion to the circuit exceeds this threshold shall be responsible for installing a system to acquire the aforementioned data points for its project and transmitting them to the regional dispatcher monitoring distribution circuits. If the addition of the proposed project does not exceed the circuit’s total connected generation nameplate level above 3 MW, no additional equipment will be required.

7 POWER QUALITY POLICY

7.1 Voltage Fluctuation Limits

The interconnection customer should expect a normal operating voltage range of ± 5 percent from nominal. The interconnection customer should contact PacifiCorp to determine the normal operating voltage at their point of interconnection The plant shall be capable of start-up whenever the voltage at the point of interconnection is within this range. If the auxiliary equipment within the generator cannot operate within the above range, the generator will need to provide regulation equipment to limit the station service voltage-level excursions. During system contingency or emergency operation, operating voltages may vary up to ± 10 percent from nominal.

7.1.1 Harmonic Limits

All generators shall comply with the voltage and current harmonic limits specified in IEEE Standard 519 -1992, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

The harmonic content of the voltage and current waveforms in the PacifiCorp system must be restricted to levels which do not cause interference or equipment operating problems for PacifiCorp or its customers.

Any harmonic problems shall be handled on a case-by-case basis. A generation facility causing harmonic interference is considered by PacifiCorp as a serious interference with service and is subject to disconnection from the PacifiCorp system until the condition has been corrected. If the cause of the problem is traceable to the interconnection customer's facilities, all costs associated with determining and correcting problems shall be at the customer's expense.

Many methods may be used to restrict harmonics. The preferred method is to install a transformer with at least one delta connection between the generator and the PacifiCorp system. This method significantly limits the amount of voltage and current harmonics entering the PacifiCorp system. Generation system configuration with a star-grounded generator and a two-winding (both star-grounded) transformer shall not be allowed.

7.1.2 Voltage Flicker Limits

All generating units shall adhere to PacifiCorp's policy on voltage fluctuation and light flicker at the PCC with PacifiCorp. This issue primarily focuses on wind turbine based generation but may be applicable to other forms of generation. Voltage fluctuation is more pronounced with one or two wind turbines installed on distribution circuits where the X-to-R ratio of the line is high. PacifiCorp's policy is available in the Engineering Handbook, Section 1C.5.1 which can be found on the PacifiCorp website. This policy is based on IEEE Standard 1453 - 2004. It is the interconnection customer's responsibility to determine the expected Pst flicker values caused by the addition of their generator. It will also be the interconnection customer's responsibility to bring the Pst flicker level into compliance with PacifiCorp's policy at the customer's cost should the values exceed PacifiCorp's policy limits at any time during the life of operation of the facility on PacifiCorp's electrical system. This could occur at the time of installation or at a later date. The interconnection customer must allow for reasonable corrective contingencies if system operations or circuit modifications alter the circuit's electrical characteristics.

8 COMMISSIONING POLICY AND INSPECTION PROCEDURE FOR INTERCONNECTION CUSTOMERS

A PacifiCorp meter/relay technician will be the only person allowed to test the meter installed for the generation facility since this equipment is owned by PacifiCorp. Coordination between the interconnection customer and PacifiCorp's project manager is recommended to take place at least two months before the start-up date.

PacifiCorp will either utilize its own qualified employees or a contractor from its approved contractor list. Commissioning of any relays which tie with the PacifiCorp system and affect PacifiCorp's customer must be certified by a Professional Engineer licensed in the state in which the interconnection project is located.

It will be the interconnection customer's responsibility to provide adequate time for commissioning activities. The interconnection customer will provide unrestricted access for PacifiCorp's employees or vendor employees (whichever are utilized) to the equipment to be commissioned. It shall be the interconnection customer's responsibility to pay for all commissioning costs

Commissioning testing, where required on either PacifiCorp-owned equipment or equipment that affects the operational integrity of the electrical circuit, will be performed on site to verify protective settings and functionality. Upon initial parallel operation of a generating facility, or any time interface hardware or software is changed that may affect the functions listed below, a commissioning test must be performed. An individual qualified in testing protective equipment (a Professional Engineer, factory-certified technician, or licensed electrician with verifiable experience in testing protective equipment) must perform commissioning testing in accordance with the manufacturer's recommended test procedure to prove that the settings and requirements of PacifiCorp's interconnection study report are met. PacifiCorp reserves the right to witness commissioning tests listed below and requires written certification stamped by a Professional Engineer from the state the in which project resides describing which tests were performed and their accompanying results.

It is preferred but not required for PacifiCorp to perform the commissioning on the customer-owned relay on distribution generators that affects PacifiCorp's customers. This preference is to provide PacifiCorp with greater assurance that the relay was set properly and functions as intended to protect PacifiCorp's customers on the electrical circuit.

Functions to be tested during commissioning will consist of the following:

- Over and undervoltage
- Over and underfrequency
- Anti-islanding function (if applicable)
- Non-export function (if applicable)
- Inability to energize dead line (dead line check)
- Time delay on restart after a utility source is stable
- Utility system fault detection (if used)
- Synchronizing controls (if applicable)
- Other interconnection protective functions that may be required as part of the interconnection agreement.
- Verify final protective relay settings
- Trip test
- In-service test

8.1 Certified Equipment

Generating facilities qualifying for simplified interconnection incorporate certified equipment that have, at a minimum, passed the type test and production tests described in this document and are judged to have little or no potential impact on PacifiCorp's distribution system. For such generating facilities, it is necessary to perform only the following tests:

- Over and undervoltage
- Over and underfrequency
- Anti-islanding function (if applicable)

Protection settings that have been changed after factory testing will require field verification. Tests will be performed using injected secondary quantities, applied waveforms. A test connection using a generator to simulate abnormal utility voltage or frequency, or by varying the set points to show that the device trips at the measured (actual) utility voltage or frequency, will be conducted.

The non-islanding function will be checked by operating a load break disconnect switch to verify that the interconnection equipment ceases to energize the line and does not re-energize for the required time delay after the switch is closed.

The non-export function will be checked using secondary injection techniques. This function may also be tested by adjusting the generating facility output and local loads to verify that the applicable non-export criteria (i.e., reverse power or under power) are met. The supplemental review or interconnection study may impose additional components or additional testing.

8.2 Non-Certified Equipment

Non-certified equipment shall be subjected to the appropriate tests described in Sections 8.1 and 8.9. With PacifiCorp's approval, these tests may be performed in the factory, in the field as part of commissioning, or a combination of both. PacifiCorp, at its discretion, may also approve a reduced set of tests for a particular application or, for example, if it determines it has sufficient experience with the equipment.

8.3 Verification of Settings

If the testing is part of the commissioning process, then, at the completion of such testing, the producer's third-party Professional Engineer shall confirm that all devices are set to PacifiCorp-approved settings. This step shall be documented in the commissioning test certification.

8.4 Trip Tests

Interconnection protective devices (e.g., reverse-power relays) which have not previously been tested as part of the interconnection system with their associated interrupting devices (e.g., contactor or circuit breaker) shall be trip-tested during commissioning. The trip test shall be adequate to prove that the associated interrupting devices open when the protective devices operate. Interlocking circuits between protective devices or between interrupting devices shall be similarly tested unless they are part of a system that has been tested and approved during manufacture.

8.5 In-Service Tests

Interconnection protective devices which have not previously been tested as part of the interconnection system with their associated instrument transformers, or that are wired in the field, shall be given an in-service test during commissioning. This test will

verify proper wiring, polarity, CT/PT ratios, and proper operation of the measuring circuits. The in-service test shall be made with the power system energized and carrying a known level of current. A measurement shall be made of the magnitude and phase angle of each AC voltage and current connected to the protective device and the results shall be compared to expected values. For protective devices with built-in metering functions that report current and voltage magnitudes and phase angles, or magnitudes of current, voltage, and real and reactive power, the metered values may be used for in-service testing. Otherwise, portable ammeters, voltmeters, and phase-angle meters shall be used.

8.6 Periodic Testing

Periodic testing of interconnection-related protective functions shall be performed as specified by the manufacturer, or at least every five years. All periodic tests prescribed by the manufacturer shall be performed. The producer shall maintain periodic test reports or a log available for inspection by PacifiCorp. Periodic testing conforming to PacifiCorp test intervals for the particular line section may be specified by PacifiCorp under special circumstances, such as in high fire-hazard areas. A system that depends upon a battery for trip power shall be checked and logged once per month for proper voltage. Once every five years, the battery must be either replaced or a discharge test performed.

8.7 Supplemental Testing Procedures

This section describes the additional type tests necessary to qualify a device as certified for use on PacifiCorp distribution systems. These type tests are not contained in UL 1741, *Standard Inverters, Converters and Controllers for Use in Independent Power Systems*, nor other referenced standards, but are considered necessary for Certification by PacifiCorp.

8.7.1 Non-Exporting Test Procedures

The non-exporting test is intended to verify the operation of relays, controllers, and inverters designed to limit the export of power and certify the equipment as meeting the requirements that power not be exported across the PCC to the PacifiCorp distribution system. Tests are provided for discrete relay packages and for controllers and inverters that include the intended function.

8.7.2 Reverse-Power Relay Test

This version of the non-exporting test procedure is intended for stand-alone reverse power and under-power relay packages provided to block the export of power across the PCC to PacifiCorp's system. It should be understood that in the reverse power application, the relay will provide a trip output with power in the export (toward the PacifiCorp distribution system) direction.

Step 1: Power Flow Test at Minimum, Midpoint, and Maximum Pickup Level Settings

Determine the appropriate secondary pickup current for the desired export power flow of 0.5 secondary watts (the agreed-upon minimum pickup setting, assumes 5 amp and 120V CT/PT secondary). Apply nominal voltage with minimum current setting at zero degrees in the trip direction. Increase the current to pickup level. Observe the relay trip's (LCD or computer display) indication of power values. Note the indicated power level at which the relay trips. The power indication should be within two percent of the expected power. For relays with adjustable settings, repeat this test at the midpoint and maximum settings. Repeat at phase

angles of 90, 180, and 270 degrees and verify that the relay does not operate (measured watts will be zero or negative).

Step 2: Leading Power Factor Test

Apply rated voltage with a minimum pickup current setting (calculated value for system application) and apply a leading power factor load current in the non-trip direction (current lagging voltage by 135 degrees). Increase the current to relay rated current and verify that the relay does not operate. For relays with adjustable settings, this test should be repeated at the minimum, midpoint, and maximum settings.

Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Increase the current level to pickup (about ten times higher than at 0 degrees) and verify that the relay operates. Repeat for phase angles of 90, 180, and 270 degrees and verify that the relay does not operate.

Step 4: Negative Sequence Voltage Test

Using the pickup settings determined in Step 1, apply rated relay voltage and current at 180 degrees from tripping direction, to simulate normal load conditions (for three-phase relays, use Ia at 180, Ib at 60, and Ic at 300 degrees). Remove phase-one voltage and observe that the relay does not operate. Repeat for phases two and three.

Step 5: Load Current Test

Using the pickup settings determined in Step 1, apply rated voltage and current at 180 degrees from the tripping direction, to simulate normal load conditions (use Ia at 180, Ib at 300, and Ic at 60 degrees). Observe that the relay does not operate.

Step 6: Unbalanced Fault Test

Using the pickup settings determined in Step 1, apply rated voltage and two times rated current, to simulate an unbalanced fault in the non-trip direction (use Va at 0 degrees, Vb and Vc at 180 degrees, Ia at 180 degrees, Ib at 0 degrees, and Ic at 180 degrees). Observe that the relay, especially single-phase, does not mis-operate.

Step 7: Time Delay Settings Test

Apply Step 1 settings and set time delay to minimum setting. Adjust the current source to the appropriate level to determine operating time, and compare against calculated values. Verify that the timer stops when the relay trips. Repeat at midpoint and maximum delay settings.

Step 8: Dielectric Test

Perform the dielectric test described in IEC 414 using 2 kV RMS for one minute.

Step 9: Surge Withstand Test

Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand test described in Section 8.9.6 of this policy.

8.7.3 Under-Power Relay Test

In the under-power application, the relay will provide a trip output when import power (toward the producer's generating facility) drops below the specified power level.

For an underpower relay, pickup is defined as the highest power level at which the relay indicates that the power is less than the set setting.

Step 1: Power Flow Test at Minimum, Midpoint, and Maximum Pickup Level Settings

Determine the appropriate secondary pickup current for the desired power flow pickup level of five percent of peak load (the agreed-upon minimum pickup setting). Apply rated voltage and current setting at zero degrees in the direction of normal load current. Decrease the current to pickup level. Observe the relay's (LCD or computer display) indication of power values. Note the indicated power level at which the relay trips. The power indication should be within two percent of the expected power. For relays with adjustable settings, repeat the test at the midpoint and maximum settings. Repeat at phase angles of 90, 180, and 270 degrees and verify that the relay operates (measured watts will be zero or negative).

Step 2: Leading Power Factor Test

Using the pickup current setting determined in Step 1, apply rated voltage and rated leading power factor load current in the normal load direction (current leading voltage by 45 degrees). Decrease the current to 145 percent of the pickup level determined in Step 1 and verify that the relay does not operate. For relays with adjustable settings, repeat the test at the minimum, midpoint, and maximum settings.

Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Decrease the current level to pickup (about ten percent of the value at 0 degrees) and verify that the relay operates. Repeat for angles 90, 180, and 270 degrees and verify that the relay operates for any current less than rated current.

Step 4: Negative Sequence Voltage Test

Using the pickup settings determined in Step 1, apply rated relay voltage and 25 percent of rated current in the normal load direction, to simulate light load conditions. Remove phase-one voltage and observe that the relay does not operate, repeat for phases two and three.

Step 5: Unbalanced Fault Test

Using the pickup settings determined in Step 1, apply rated voltage and two times rated current to simulate an unbalanced fault in the normal load direction (use Va at 0 degrees, Vb and Vc at 180 degrees, Ia at 0 degrees, Ib at 180 degrees, and Ic at 0 degrees). Observe that the relay, especially single-phase, operates properly.

Step 6: Time Delay Settings Test

Apply Step 1 settings and set time delay to minimum setting. Adjust the current source to the appropriate level to determine operating time, and compare against

calculated values. Verify that the timer stops when the relay trips. Repeat at midpoint and maximum delay settings.

Step 7: Dielectric Test

Perform the test described in IEC 414 using 2 kV RMS for one minute.

Step 8: Surge Withstand

Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand test described in Section 8.9.6 of this policy.

8.7.4 Functional Tests for Inverters and Controllers

Inverters and controllers designed to provide reverse or under-power functions shall be tested to certify the intended operation of this function. Two methods are provided:

Method 1: If the controller utilizes external current/voltage measurement to determine the reverse or under-power condition, then the controller shall be functionally tested by application of appropriate secondary currents and potentials as described in Section 8.7.2, Reverse Power Relay Test.

Method 2: If external secondary current or potential signals are not used, then unit-specific tests must be conducted to verify that power cannot be exported across the PCC for a period exceeding two seconds. These tests may be factory tests if the measurement and control points are part of a single unit, or may be provided for in the field.

8.8 In-Rush Current Tests

This test will determine the maximum in-rush current drawn by the unit.

8.8.1 Locked-Rotor Method

Use the test procedure defined in NEMA MG-1 (manufacturer's data is acceptable if available).

8.8.2 Start-Up Method

Install and setup the generating facility equipment as specified by the manufacturer. Using a calibrated oscilloscope or data acquisition equipment with appropriate speed and accuracy, measure the current draw at the point of interconnection as the generating facility starts up and parallels with PacifiCorp's distribution system. Startup shall follow the normal, manufacturer-specified procedure. Sufficient time and current resolution and accuracy shall be used to capture the maximum current draw within five percent. In-rush current is defined as the maximum current draw from PacifiCorp during the startup process, using a ten-cycle moving average. During the test, the utility source, real or simulated, must be capable of maintaining voltage within ± 5 percent of rated at the connection to the unit under test. Repeat this test five times. Report the highest ten-cycle current as the in-rush current. A graphical representation of the time-current characteristic along with the certified in-rush current must be included in the test report and made available to PacifiCorp.

8.9 Type Testing

8.9.1 Inverters

Static power inverters shall meet all of the type tests and requirements appropriate for a utility interactive inverter as specified in UL 1741, *Static*

Inverters and Charge Controllers for Use in Photovoltaic Power Systems. These requirements may be applied to inverters used with electric energy sources other than photovoltaic systems.

A description of key aspects of these procedures is provided in the testing procedures section of this document. Separate test procedures are provided to certify non-islanding functions and non-export functions, to determine the in-rush current tolerance of the distribution system, to subject the device to voltage surge conditions, and to verify the inverter's ability to synchronize with the distribution system.

8.9.2 Synchronous Generators

Until a standardized test procedure written specifically for synchronous generators is identified, PacifiCorp shall determine which of the tests described in this section are appropriate and necessary to certify the performance of the control and protection system functions of the synchronous machine, and how to perform them. The tests listed in Table 4 below and defined in UL 1741 shall be performed as applicable to a synchronous generator.

Table 4–Type Tests and Requirements Appropriate for Synchronous Generators

Section Number	Section Title
39.1	Utility Disconnect Switch
39.2	Field Adjustable Trip-points
39.3	Field Adjustable Trip-points
39.4	Field Adjustable Trip-points
39.5	Field Adjustable Trip-points, Marking
44	Dielectric Voltage Withstand Test
45.2.2	Power Factor
45.4	Harmonic Distortion
46.2	Utility Voltage and Frequency Variation Test
46.2.3	Rest Delay
46.4	Loss of Control Circuit
47.3	Short-circuit Test

A description of key aspects of these procedures is provided in the testing procedures section of this document. Separate test procedures are provided to certify non-islanding functions and non-export functions to determine the in-rush current tolerance of the distribution system to subject the device to voltage surge conditions and to verify the inverter's ability to synchronize with the distribution system.

8.9.2.1 Induction Generators

Until a standardized test procedure written specifically for induction generators is identified, PacifiCorp shall determine which of the tests described in this section are appropriate and necessary to certify the performance of the control and protection system functions of the induction generator, and how to perform them. The tests listed in Table 5 below and defined in UL 1741 shall be performed as applicable to a induction generator.

Table 5–Type Tests and Requirements Appropriate for Induction Generators

Section Number	Section Title
39.1	Utility Disconnect Switch
39.2	Field Adjustable Trip-points
39.3	Field Adjustable Trip-points
39.4	Field Adjustable Trip-points
39.5	Field Adjustable Trip-points, Marking
44	Dielectric Voltage Withstand Test
45.2.2	Power Factor
45.4	Harmonic Distortion
46.2	Utility Voltage and Frequency Variation Test
46.2.3	Rest Delay
46.4	Loss of Control Circuit
47.3	Short-circuit Test
47.7	Load Transfer Test

8.9.3 Anti-Islanding Test

In addition to the above type tests, devices that pass the anti-islanding test procedure described in this document will be considered non-islanding for the purposes of PacifiCorp's interconnection requirements.

8.9.4 Non-Export Test

In addition to the above type tests, devices that pass the non-export test procedure described earlier will be considered non-exporting for the purposes of PacifiCorp's interconnection requirements.

8.9.5 In-rush Current Test

Generation equipment that utilizes PacifiCorp power to motor-up to speed will be tested using the procedure defined earlier to determine the maximum current drawn during this startup process. The resulting in-rush current is used to estimate the starting voltage drop.

8.9.6 Surge Withstand Capability Test

Interconnection equipment shall be tested for surge withstand capability, both oscillatory and fast transient, in accordance with the test procedure defined in IEEE/ANSI C62.45 using the peak values defined IEEE/ANSI C62.41 Tables 1 and 2 for location category B3. An acceptable result occurs even if the device is damaged by the surge, but is unable to operate or energize PacifiCorp's distribution system. If the device remains operable after being subject to the surge conditions, previous type tests related to PacifiCorp's protection and power quality will need to be repeated to ensure the unit will still pass those tests following the surge test.

8.9.7 Synchronization Test

This test verifies that the unit synchronizes within the specified voltage/frequency/phase-angle requirements. It is applied to synchronous generators and inverters capable of operating as voltage-sources while connected to the PacifiCorp system. This test is not necessary for induction

generators or current-source inverters. The test will start with only one of the three parameters: 1) voltage difference between generating facility and PacifiCorp's distribution system, 2) frequency difference, or 3) phase-angle outside of the synchronization specification. Initiate the synchronization routine and verify that the generating facility is brought within specification prior to synchronization. Repeat the test five times for each of the three parameters. For manual synchronization with synch check or manual control with auto synchronization, the test must verify that paralleling does not occur until the parameters are brought within specifications.

8.10 Production Testing

As a minimum, the utility voltage and frequency variation test procedure described in UL1741 Section 68, *Manufacturing and Production Tests*, shall be performed as part of routine production (100 percent) on all equipment used to interconnect generating facilities to PacifiCorp's distribution system. This testing may be performed in the factory or as part of a commissioning test.

The following is PacifiCorp's procedure for performing commissioning. All time requirements must be met for PacifiCorp to provide the interconnection customer with timely service. Any inspections required by local government agencies must be completed and permits signed off prior to the pre-parallel date.

8.10.1 Test Results

All tests outlined below must be complete and two copies of the test reports submitted to a PacifiCorp representative a minimum of 15 working days before the requested energize date unless otherwise agreed to by PacifiCorp. All test reports require header information reflecting the equipment identification matching the one- or three-line diagrams. One-line and three-line diagrams of the facility are required to be submitted with test reports. All requirements must be met and test reports approved at least three working days before the requested pre-parallel date.

8.10.1.1 Proving Insulation

For any of the megger tests referred to below, a 2,500 volt DC megger or a hi-pot is preferred, but a 1,000 volt DC megger is acceptable.

1. All transformers connected to the primary bus and the main transformer must be meggered winding-to-winding and each winding to ground. For purposes of this document, "primary bus" is defined as the source-side bus or conductor from the primary interrupting device to the generating plant.
2. All circuit breakers and circuit switchers connected to the primary bus and at the interconnection point must be meggered in the following manner: breaker open each pole to ground, pole 1 2, pole 3 4, pole 5 6; breaker closed pole 1 ground, pole 3 ground, pole 5 ground, and if the poles are in common tank or cell, pole 1 3, pole 3 5, pole 5 1.
3. All buses and cables shall be meggered phas- to-phase and phase-to-ground.
4. The main transformer(s) and breaker(s) shall have a dielectric test performed on the insulating medium (gas or oil). This does not apply to factory-sealed circuit switcher interrupters.

5. The generator(s) must be meggered or hi-pot-tested phase-to-phase and phase-to-ground.

8.10.1.2 Proving Ratios

All ratios of transformers connected to the primary bus must be proven using either a turns ratio tester or a voltage ratios test. The main transformer must be tested on the final operating tap. This tap shall be recommended by PacifiCorp to best match transmission system operating voltages.

8.10.2 Circuit Breakers and Circuit Switchers

1. A minimum-to-trip at 70 percent or less of the nominal DC control voltage must be performed on all circuit breakers and/or circuit switchers that are operated by PacifiCorp-required relays.
2. A micro-ohm test must be performed on all circuit breakers and circuit switchers.
3. A timing test showing the time from trip initiation to main poles opening is required.
4. A timing test showing the time from close initiation to main poles closing is required.

8.10.3 Current Transformers and Current Circuits

1. A saturation check should be made on all current transformers (CTs) associated with the required PacifiCorp relays. If this is not possible, a manufacturer's curve is acceptable.
2. The ratio of all CTs must be proven either by using current (primary to secondary) or voltage (secondary to primary).
3. CT circuits must be checked for proper connections and continuity by applying primary or secondary current and reading in the relays. Each test (primary or secondary) must be performed in all combinations to prove proper connections to all phase and ground relays. Current must be applied or injected to achieve a secondary reading of five amps in each relay to ensure that no loose wiring or parallel current paths exists.
4. A single-phase burden check must be made on each phase of each current circuit feeding PacifiCorp-required relays.
5. A megger check of the total circuit with the ground wire lifted must be done to prove that only one ground exists.

8.10.4 Relays

All relays must be field tested on site to their specified settings to verify the following:

1. Minimum operating point at which relay picks up (minimum pickup).
2. Time delay at three different current test points, in integral multiples of minimum pickup that closely characterize the relay time current curve.
3. Phase angle characteristic of the directional relay.
4. Pickup points at maximum torque angle (MTA) and ± 30 degrees of MTA on impedance relays using the approved settings.

5. Slip frequency, voltage matching, phase-angle acceptance, and breaker compensation time on synchronizing relays.
6. PacifiCorp tolerances are listed below:

Table 6– PacifiCorp Relay Tolerance

Relay Type	Tolerance
Current / Voltage / Time	± 10.0 percent
Impedance / Phase Angle	± 0.05 percent
Frequency	± 0.05 percent

If a pilot relay system is required by PacifiCorp, signal level checks must be performed to PacifiCorp standards.

8.10.5 Primary Disconnect Switch

The primary disconnect switch at the point of interconnection shall be assigned a PacifiCorp number by PacifiCorp. The switch, platform, and switch number plate bracket must be constructed to PacifiCorp Engineering Standards. A switch number plate bracket shall be furnished by PacifiCorp.

8.10.6 Pre-Parallel Test Policy

Where generation has a rated output in excess of 100 kW, the entity shall reimburse PacifiCorp for the cost of performing the pre-parallel inspection.

The interconnection customer is responsible for ensuring that all relays and other protective devices are adjusted and working properly prior to the pre-parallel inspection. If problems arise with equipment during testing, the PacifiCorp protection representative may elect to cancel the test and reschedule.

All pre-parallel tests should be scheduled to begin at 9 a.m., Monday through Friday only. Functional tests shall be performed by the interconnection customer and all tests shall be observed by PacifiCorp as outlined below. The interconnection customer shall provide all test equipment and qualified personnel to perform the required tests. PacifiCorp shall be there strictly as an observer. Commissioning test forms shall be completed by the PacifiCorp representative on site at the time of the pre parallel inspection.

8.10.7 Functional Tests

The following functional tests shall be performed after the equipment has been energized, but before the generator is paralleled with PacifiCorp's system:

1. Check that each protective relay trips the appropriate generator breaker and/or main breaker. This may require injecting a signal. **Jumpering across contact on the back of the relay is not acceptable.**
2. When first energized, check that proper secondary potential is applied to all voltage and frequency relays.
3. Check the synchronizing meter, synchronizing equipment and phasing panel (if used) with the paralleling breaker closed and the generator offline. This typically requires lifting the generator leads. The equipment should show an "in-phase" condition.
4. Check the generator phase rotation. (PacifiCorp's phase rotation is A C B counterclockwise). All three phases must be checked using hot sticks with a

phasing tool or a phasing panel provided by the interconnection customer. The synchronizing equipment typically checks one phase only. Phase rotation varies by area within the PacifiCorp system. Interconnection customers shall consult PacifiCorp for the correct rotation.

8.10.8 Impedance and Directional Relay Tests

Direction check all impedance and directional relays by doing the following:

1. Bring up load on the plant and/or generator.
2. Verify direction of power flow.
3. Measure the phase angle between the current and potential applied to the relay.
4. Observe the current action of the directional contacts according to the direction of power flow. Reverse either the potentials or current to prove contact operation for reverse power flow.

8.10.9 Generator Load Tests

For generators, the following load tests shall be performed after the generator picks up load:

1. Load-check all PacifiCorp required differential relays. The load current must balance to zero in all differential relays.
2. Load-check voltage restraint overcurrent relays to prove correct connection of currents and potentials.
3. The generator(s) may have to be paralleled temporarily with PacifiCorp's system to run the load tests. Permission to do this shall be given by the PacifiCorp operations representative observing the test.
4. Verify operation of the generator at 95 percent lagging power factor and at 95 percent leading power factor at rated output.
5. Verify operation of the generator at 95 percent and 105 percent of per unit voltage while delivering rated output.
6. Verify metering and telemetering to the PacifiCorp Control Center to demonstrate proper calibration and accuracy. The communication channel must be in place to verify the telemetering.

Typically, pre-parallel inspections can be performed within a normal working day. PacifiCorp shall dedicate one full work day to observe the test. If a test cannot be completed by 6 p.m., the PacifiCorp representative may cancel the remainder of the test and reschedule it. In this case the interconnection customer shall be charged another pre-parallel inspection fee.

8.11 Design Changes after Commercial Operation

Any modifications to the generator requiring PacifiCorp protective relaying and interlocks after the date of commercial operation must be reviewed and approved by PacifiCorp prior to implementing any changes. Demonstration of relay calibration, trip tests, and online tests may be required depending on the extent of the design change. Setting changes of any interconnection protection or synchronizing device must be approved by PacifiCorp with a hard copy of the changes forwarded to the designated PacifiCorp representative. Any field modification or as-built AC/DC protection and

synchronizing schematics associated with any PacifiCorp-required interconnection device must be forwarded to the designated PacifiCorp representative.

8.12 Operational Log

Producers must maintain an operating log at each generating facility indicating changes in operating status (available or unavailable), maintenance outages, trip indications, or other unusual conditions found upon inspection.

8.13 Communication with PacifiCorp Grid and Field Operations

The PacifiCorp representative will provide the generation facility with the names and telephone numbers of the PacifiCorp Control Center and operations coordination personnel responsible for the PacifiCorp system at the interconnection. The generation facility will provide PacifiCorp with the names and telephone numbers of the personnel with responsibility for operating the generator.

Generation facility contacts should include at least one telephone number which can be used 24 hours a day, seven days a week. Contacts should be able to provide information on equipment status, explanation of events on the equipment, and relay target and alarm information when asked to do so by PacifiCorp personnel. PacifiCorp may choose to waive some of the communications requirements for smaller generating facilities. In addition, the generation facility should contact PacifiCorp whenever:

1. Problems with the generator are detected that could result in mis-operation of generator protection or other generator equipment.
2. The generator has tripped offline during parallel operation with the PacifiCorp system.
3. Generator equipment problems result in an outage to a portion of the PacifiCorp system.
4. The generation facility intends to initiate switching to parallel the generator(s) and the PacifiCorp system.
5. The generation facility intends to initiate switching to break the parallel interconnection between generator(s) and the PacifiCorp system.

8.14 Parallel Operation Policy

The PacifiCorp representative shall contact the PacifiCorp Control Center at least 72 hours before the pre-parallel test and shall obtain a clearance for parallel operation. The PacifiCorp representative shall provide the Control Center a drawing indicating which PacifiCorp circuit the generation facility will be connected to and which PacifiCorp-operated disconnect will be identified with a PacifiCorp-designated number. When the pre-parallel test is passed, the generator may, at PacifiCorp's discretion, be allowed to operate in parallel with PacifiCorp for testing purposes only. This should not be mistaken as an official release for parallel operation. Once testing-only permission is granted, the generator may operate in accordance with the generation operating agreement or procedures developed by the Local Area Engineer. Please review the project-specific generation interconnection and operation and maintenance agreement for details.

At the end of this period, if the interconnection customer has not received written permission from PacifiCorp to operate in parallel, the entity must isolate from PacifiCorp until written permission is received. A request for written permission to parallel shall be sent to the interconnection customer via U.S. First Class mail or via

electronic mail to the distribution accounts manager (see Section 1.2.4). This shall be done after PacifiCorp has verified the following:

1. All proper contracts and documents have been executed and are in place.
2. The pre-parallel test has been passed.
3. All other outstanding issues have been resolved, including rights-of-way, deeds of conveyance, insurance verification, and operating agreements.
4. PacifiCorp has received final copies of the one-line diagram and elementary diagrams that show as-built changes made during construction, as well as a completed finalized generator data sheet (Appendix J).
5. If applicable, firm capacity performance testing of new generators cannot begin until the interconnection customer receives written permission from PacifiCorp to parallel.

8.15 General Notes

The PacifiCorp system has A C B counterclockwise rotation in most locations. The interconnection customer shall verify correct rotation with PacifiCorp.

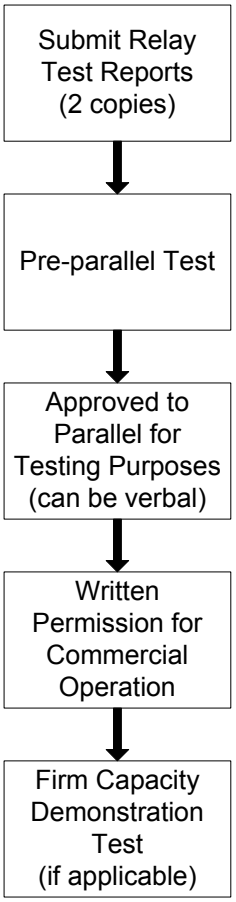
Any changes to PacifiCorp-required protection equipment or major substation equipment (transformer, breaker, etc.) must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp engineer prior to the changes being made.

Routine maintenance on PacifiCorp-required protective relays and the breaker(s) must meet PacifiCorp's maintenance and test practices. After completion of these tests, test reports must be submitted to the PacifiCorp representative for review and approval by the Local Area Engineer. A PacifiCorp technical representative shall then come to the customer's facilities and reseal the PacifiCorp-required relays.

Questions shall be directed to the PacifiCorp Distribution Account Manager (see Section 1.2.4).

8.16 Simplified Flow of Pre Parallel / Parallel Test Procedure

Figure 4–Pre-Parallel / Parallel Test Procedure



9 SPOT AND GRID NETWORK SYSTEM INTERCONNECTION POLICY

The interconnection of distribution-class voltage generators on networked electrical systems within PacifiCorp's service territory will comply with the most recent version of IEEE Standard 1547, *Distributed Resources*. Special attention should be paid to IEEE Standard 1547, Section 6, *Network Systems*.

Figure 5–Spot Network System

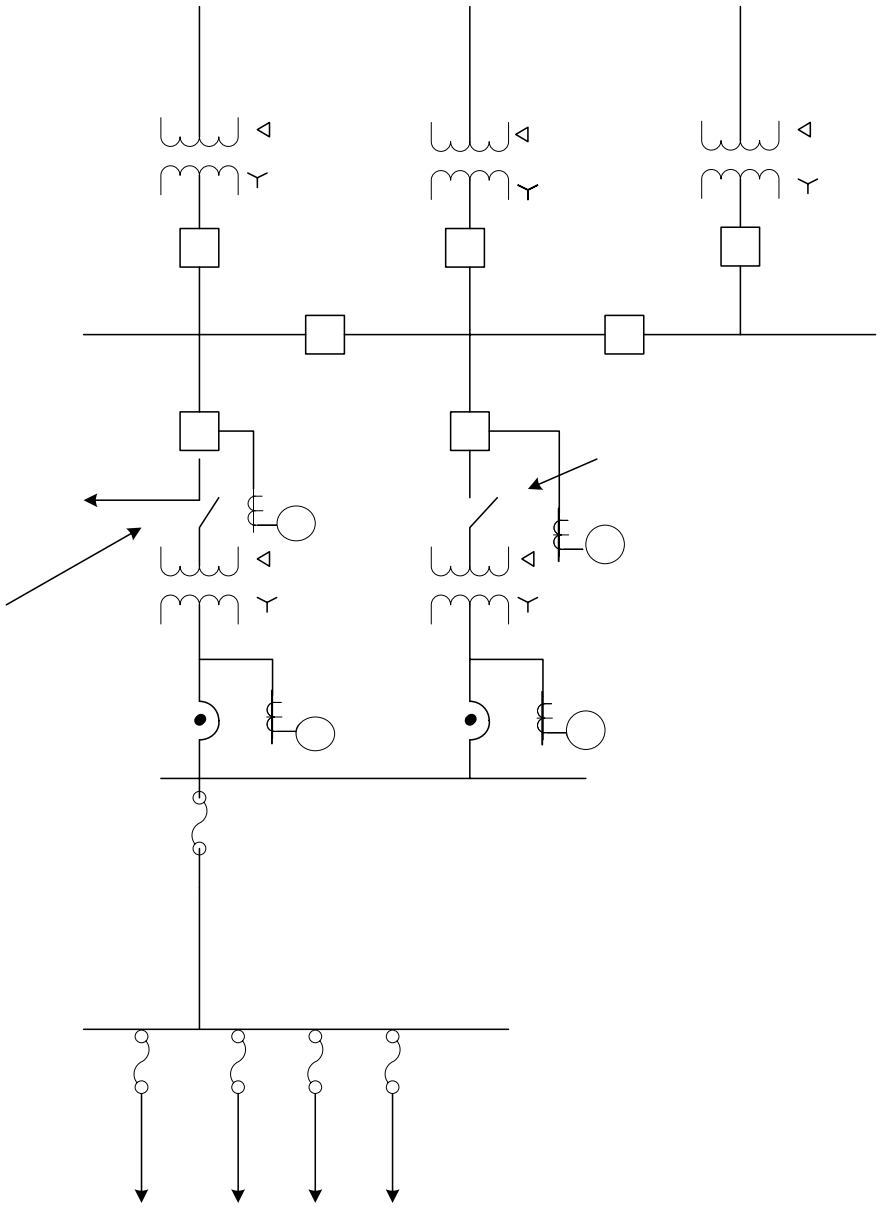


Figure 5 depicts the configuration of a typical spot network electrical system. It consists of five major components: network transformers, network protectors, network reverse power relays,

high voltage transformer disconnect switch, and network protector fuse. PacifiCorp's network distribution system is 11.7KV and it is only located in Portland, Oregon.

Figure 6–Grid Network System Diagram

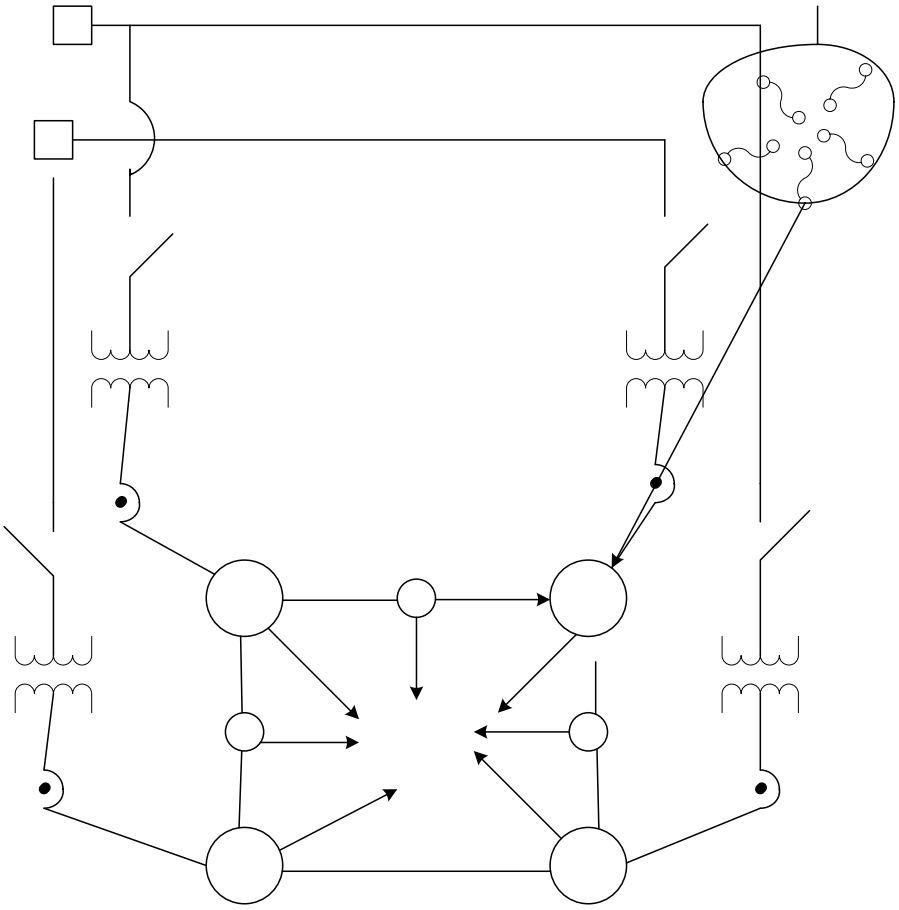
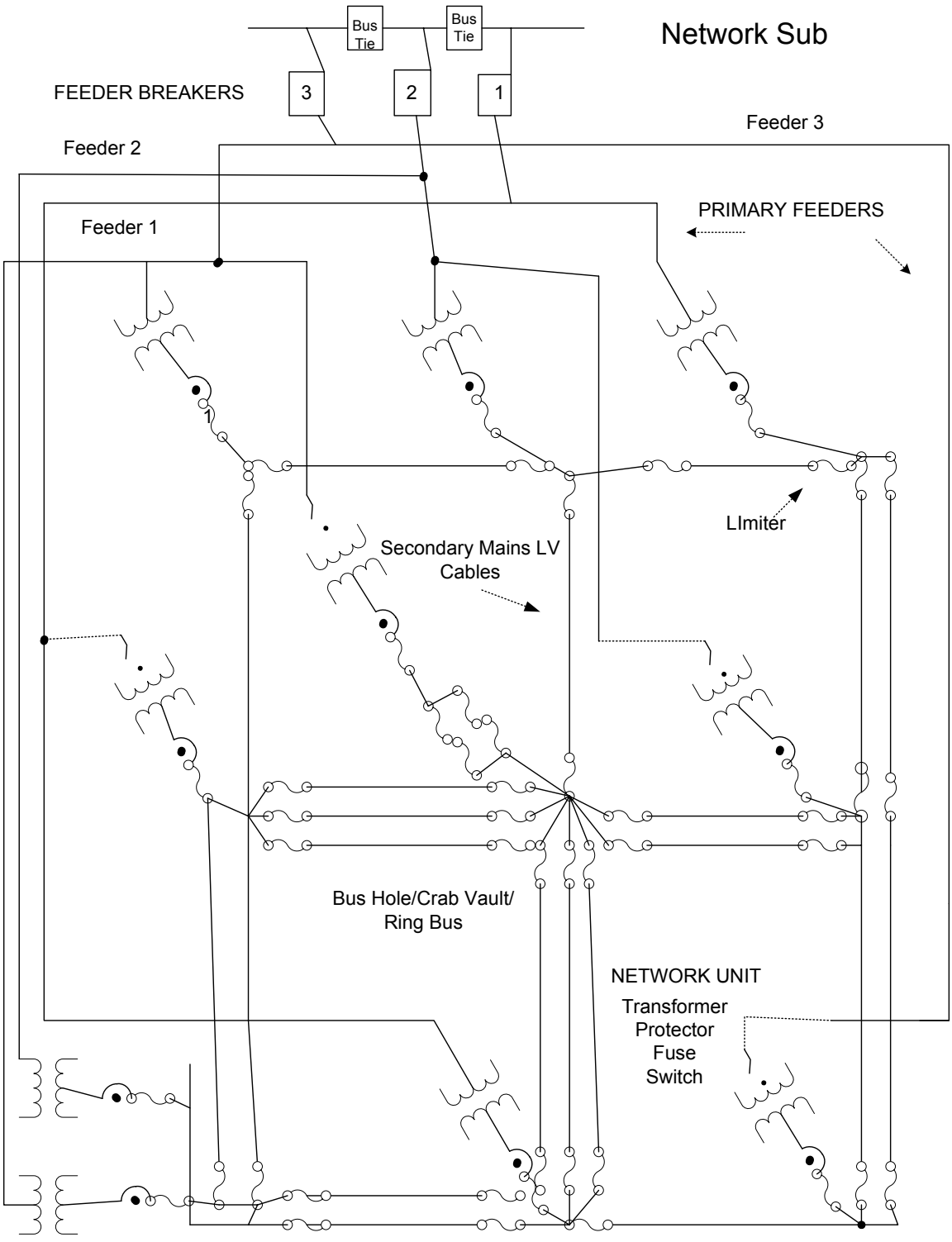


Figure 6 depicts the typical protective and control devices on a grid network system. The primary components of a grid network are as follows: network transformers, network protector reverse power relays, network protector fuses, network protectors, transformer disconnect switch, and street main secondary cable.

BREAKER

Figure 7–Typical Protective and Control Devices on a Grid Network System



Network distribution systems are the most complex distribution systems in existence. When they were designed early in the 20th century, they were intended to improve the reliability of electrical service to densely-populated urban areas. They were designed with the goal of

connecting several feeders to transformers such that when one feeder goes out of service, the remaining feeders still serve the load. **Network Distribution Systems from their inception were not designed for interconnection with generators** and consequently, this presents a challenge for any applicant who wants to introduce generation into this type of electrical system.

To date, equipment manufacturers of the components of the network electrical system (shown in Figures 6 and 7) are developing and testing modifications to the equipment such that generation can be introduced into this type of circuit. The existing network system electrical components are very expensive compared to the conventional radial distribution system components which comprise the predominant portion of electrical circuits. The cost of the revised network system units will be even more expensive (likely the most expensive of any kind of electrical system components available on the market) than the conventional radial units. This means **the cost of the generation interconnection for the customer will likely be substantially more than that of a radial electrical system**.

The following are the main components of the network system:

Network Protectors: A specially designed low-voltage air circuit breaker that is controlled by its internal reverse-power network relays. With the introduction of generation, reverse current becomes more likely and thus any interconnected generation must not cause reverse current to flow through the network protector, resulting in the operation of the protector.

Network Relay: This is a relay that contains a master and a phasing relay that work in conjunction to trip the protector upon a reverse power-flow condition and to close the protector when the power flow will be into the network. No provision or arrangement has been incorporated into the design to accommodate generation.

Network Transformers: This basic building block of electrical circuits was designed in this scenario to provide for significantly enhanced circuit reliability with several three-phase circuits tied to the unit rather than the conventional technique of a single, radial, three-phase circuit. With the introduction of generation into the distribution circuits, the design of the transformer may need review and subsequent revision and alteration.

Transformer High Voltage Disconnect Switch: A three-position (open-close-ground) oil switch that connects the primary feeder to the network transformer. This is a non-load-break switch used in part to isolate the transformer from the primary distribution system.

Network Protector Fuses: The sole purpose of these fuses is to serve as a last line of protection during a fault condition. The fuses are designed to operate if the network protector fails to open during a fault. Fuses are sized at the nameplate rating of the network protector.

With the introduction of generation in the network system, the following issues may arise:

1. “Pumping” or “chattering” of network protectors. This is when the protector opens and closes repeatedly, exhibiting traits of a pump.
2. Increase of X-to-R ratios (on newer transformers) to 12 to 14 from a traditional value of 5 will necessitate at a minimum the review of relay settings and in the worst case scenario a changeout of the relay (on older models). It will be unable to be set within an acceptable value to trip on watts since those values are not present on the device to address this condition.
3. Increasing the transformer size could alter the impedance and cause the network relay to search for values which are not present on the device. This renders it ineffective as a protective unit.

4. Phase-to-ground faults on delta-wye transformers will be harder to detect by the relays because of the impedance change. This in and of itself may necessitate a changeout of the relay. Using a different configuration transformer (wye-wye network transformer) could solve this issue, however PacifiCorp prefers not to implement this option since it is not a standard transformer connection for generation installations and would require replacing all of PacifiCorp's network transformers to wye-wye transformers. It would also reintroduce zero sequence fault currents which create difficulties for the relay protection schemes.
5. Older model network protectors do not have the fault closing capability of the newer models. In some cases, this feature will be needed, thus necessitating a changeout of the protector.
6. Low-level faults from adjacent feeders, if not cleared by the protector, could develop to become multi-phase faults. If the protector is not capable of detecting these faults because of the introduction of a DG which alters the impedance of the circuit, it will necessitate a changeout to a newer unit.
7. Network protector relays are not designed for frequency detection, thus synchronizing will not be possible until new technology is developed and the device is upgraded.
8. The introduction of DG affects the detection of arc faults thus necessitating a review of the settings for this condition. **While workers are in the vaults, sensitive ground fault protection settings must be activated.** It is possible that a changeout of the relay will be required if the settings are not available on the unit to detect and trip under arc fault scenarios.

These and other issues are addressed in detail in IEEE Standard 1547.6.

10 ACCOUNTING POLICY AND PROCEDURE

PacifiCorp will have on file within the transmission business unit (or subsequent transferee department(s)) copies of each interconnection customer's interconnection agreement and maintenance agreement for use by PacifiCorp's field personnel and accounts receivable department. These agreements will be used to create work orders with associated invoices for work performed by PacifiCorp with outside interconnection customers. These work orders and invoices will bill all entities as required by the governing FERC rules concerning generation interconnection projects.

11 GLOSSARY

A

ANSI: American National Standards Institute.

Alternating Current (AC): That form of electric current that alternates or changes in magnitude and polarity (direction) in what is normally a regular pattern for a given time period called frequency.

Ampere: The unit of current flow of electricity. This is analogous to quantity per unit of time when referring to the flow of water. One ampere is equal to a flow of one coulomb per second.

Applicable Reliability Criteria: The reliability policies established by NERC, WECC, and local reliability criteria as amended from time to time, including any requirements of the NRC which are applicable to the particular type of generator and prime mover.

Automatic: Self-acting, operated by its own mechanism when actuated by some impersonal influence as, for example, a change in current strength; not manual; without personal intervention.

Automatic Control: An arrangement of electrical controls which provide for opening and/or closing in an automatic sequence and under predetermined conditions; the switches which then maintain the required character of service and provide adequate protection against all usual operating emergencies.

Automatic Generation Control (AGC): Generation equipment that automatically responds to signals from the EMS control in real time to control the power output of electric generators within a prescribed area in response to a change in system frequency, tie-line loading, or the relation of these to each other, so as to maintain the target system frequency and/or the established interchange with other areas within the predetermined limits.

Automatic Reclosing: A feature of some circuit breakers which allows them to reclose automatically after being tripped under abnormal conditions.

Automatic Tripping or Automatic Opening: The opening of a circuit breaker under predetermined conditions without the intervention of an operator.

Automatic Voltage Regulation (AVR): Generation equipment which automatically responds to signals from the EMS control in real time to control voltage.

B

Balanced Load: An equal distribution of load on all phases of an alternating current circuit.

Boost: To increase voltage.

Bundled Service or Bundled Utility Service: Traditional PacifiCorp service: transmission and distribution capacity for delivery, energy, and ancillary services.

Breaker: A switch which can open a circuit, usually designed for automatic operation.

C

Capacitance: Capacitance is developed when two charged or energized conductors are separated by a dielectric. An excess or deficiency of electrons is maintained on opposite plates

of a charged capacitor. It may be said to be the property of an electrical circuit which opposes any change of voltage.

Capacity: The number of amperes of electric current a wire will carry without becoming unduly heated; the capacity of a machine, apparatus, or devices is the maximum of which it is capable under existing service conditions; the load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

Capacity Factor: The ratio of average load on a generating resource to its capacity rating during a specified period of time, expressed in percentages.

Circuit: A conducting part through which an electric current is intended to flow.

Circuit Breaker: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Circuit Switcher: A device for interrupting a circuit between separable contacts under normal or fault conditions.

Class A Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before, during, and after a power fault condition.

Class B Telephone Circuit: Service performance objective classification for a circuit which is non-interruptible before and after a power fault condition exists.

Clearance: Permission to contact or to come in close proximity to wires, conductors, switches, or other equipment which normally might be energized at electrical, hydraulic, or pneumatic potential dangerous to human life. Conditions which must prevail before such permission can be granted are, in general, that the equipment or lines be completely isolated from all possible power sources and be tagged with properly filled out “man on line” tags.

Cogeneration: The sequential production of electricity and heat, steam, or useful work from the same fuel source.

Conductor: Material that can be used as a carrier of an electric current.

Control, Supervisory: A system for selecting control and automatic indication of remotely located units by electrical means, over a relatively small number of common transmission channels.

Control Switch: A switch controlling the circuit through circuit breakers or other switches which are magnetically operated.

Current: The part of a fluid (air, water, etc.) flowing in a certain direction. A flow of electric charge measured in amperes.

Current Transformer (CT): A transformer intended for metering, protective, or control purposes which is designed to have its primary winding connected in series with a circuit carrying the current to be measured or controlled. A current transformer normally steps down current values to safer levels. A CT secondary circuit must never be open-circuited while energized.

D

Dead-End Structure: The structure on which the last span of PacifiCorp-owned conductors terminates. Also called a landing structure. From the interconnection requester's point of view, it is sometimes called the take-off structure.

Delta-Connected Circuit: A three-phase circuit with three source windings connected in a closed delta (triangle). A closed delta is a connection in which each winding terminal is connected to the end (terminal) of another winding.

Demand: The rate at which electric energy is delivered to or by a system; normally expressed in kilowatts, megawatts, or kilovolt amperes.

Direct Access: Service election allows customers to purchase electric power and, at the customer's election, additional related services from non-utility entities known as ESPs.

Direct Current (DC): A unidirectional current in which the changes in value are either zero or so small that they may be neglected. (As ordinarily used, the term designates a practically non-pulsating current, such as the output of an electric battery.)

Disconnect: (noun) A device used to isolate a piece of equipment. A disconnect may be gang-operated (three operated together) or individually operated.

Dispatchability: Ability and availability of a generating facility to operate so that a utility can call upon it to increase or decrease deliveries of capacity to any level up to contract capacity.

Distribution Control Center: This center directs, coordinates, and implements routine and emergency switching activities on the PacifiCorp distribution system within its geographical jurisdiction.

Disturbance: Trouble (e.g., fault, sudden loss of load or generation, breaker operations, etc.) on the PacifiCorp power system resulting in abnormal performance of the system. See also System Emergency.

Droop: The slope of the prime mover's speed power characteristic curve. The speed droop, typically 5 percent, enables interconnected generators to operate in parallel with stable load division.

E

Electric Circuit: A path or group of interconnected paths capable of carrying electric current.

Electric Generator: See Generator.

Electric Substation: An assemblage of equipment for purposes other than generation or utilization, through which bulk electric energy is passed for the purpose of switching or modifying its characteristics. Service equipment, distribution transformer installations, and transmission equipment are not classified as substations.

End-Use Customer or End User: A purchaser of electric power who purchases such power to satisfy a load directly connected to the Electrical Power Grid and who does not resell the power.

Energize: To apply voltage to a circuit or piece of equipment; to connect a de-energized circuit or piece of equipment to a source of electric energy.

F

Fault Indicator: A device attached to lines which target when the current through the line exceeds the device setting.

Feeder: A circuit having as its primary purpose the distribution of electric energy.

FERC: Federal Energy Regulatory Commission.

Firm Capacity: Power committed to be available at all times during the period covered, except for forced outages and scheduled maintenance.

Forced Outage: Any unplanned outage resulting from a design defect, inadequate construction, operator error, or a breakdown of the mechanical or electrical equipment that fully or partially curtails the delivery of electricity between a load or interconnection customer's facility and the PacifiCorp power system.

Frequency: The number of cycles occurring in a given interval of time (usually one second) in an electric current. Frequency is commonly expressed in Hertz (Hz).

Fuse: A short piece of conducting material of low melting point which is inserted in a circuit and will melt and open the circuit when the current reaches a certain value.

G

Generation Facility: A plant in which electric energy is produced from some other form of energy by means of suitable converting apparatus. The term includes the generation apparatus and all associated equipment owned, maintained, and operated by the interconnection customer.

Generator: The physical electrical equipment that produces electric power. Sometimes used as a brief reference to an interconnection customer.

Grid-Critical Protective Systems: Protective relay systems and Remedial Action Schemes that the may have a direct impact on the ability to maintain system security.

Good Utility Practice: Any of the practices, methods, and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods, and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety, and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region.

Ground: A term used to refer to the earth as a conductor or as the zero of potential. For safety purposes, circuits are grounded while any work is being done on or near a circuit or piece of equipment in the circuit; this is usually called protective grounding.

Ground Bank: A secondary transformer bank installed on delta-connected winding to provide a path to ground for relaying purposes.

Ground Fault: An unintentional electric current flow between one or more energized conductors and the ground.

Ground Potential Rise: A calculated value of the highest expected voltage due to a line-to-ground fault at or near the station (power switchyard). The value is calculated as follows:

GPR = 1.2 (DC Transient Factor) x 1.4. x Ground Fault Return Current (rms) x Ground Resistance

H

Hertz (Hz): The term denoting cycles per second or frequency; named after Heinrich Hertz, the pioneering German scientist who performed research on electrical power.

I

IEC: International Engineering Consortium.

IEEE: Institute of Electrical and Electronic Engineers.

Inductance: The property of an electric circuit which produces a voltage by electromagnetic induction when the current in the circuit changes or varies. It opposes any change of circuit current.

Induction Generator: Typically an induction motor that is being driven by a prime mover at a speed which is faster than the synchronous mechanical speed to generate electric power. It typically depends on the host system for its excitation and speed regulation.

Interconnection Agreement (IA): An agreement between the utility and the interconnection customer specifying and outlining the terms and conditions of the interconnection of the generators to PacifiCorp's electrical system.

Interconnection Customer: An entity interconnected to the PacifiCorp power system which has generation facilities (including back-up generation in parallel) on its side of the point of interconnection with the PacifiCorp power system.

Interconnection Facilities: All means required and apparatus installed to interconnect and deliver power from a load or interconnection customer facility to the PacifiCorp power system including, but not limited to, connection, transformation, switching, metering, communications, and safety equipment, such as equipment required to protect: 1) the PacifiCorp power system and the load or interconnection customer from faults occurring at the load or generation, and 2) the load or generation facility from faults occurring on the PacifiCorp power system or on the systems of others to which the PacifiCorp power system is directly or indirectly connected. Interconnected facilities also include any necessary additions and reinforcements by PacifiCorp to its system required as a result of the interconnection of a facility to the PacifiCorp power system.

Interconnection Study Agreement (ISA): An agreement between the interconnection customer and PacifiCorp specifying what is to be done in the engineering interconnection study to interconnect the generator to PacifiCorp's system. This agreement specifies not only the items to be studied but the timeframe in which the study will be completed and the report results submitted to the applicant.

Interconnection Study: Those studies performed in conjunction with an interconnection request to determine the facilities needed to interconnect the load or interconnection customer in accordance with applicable reliability requirements.

Interrupting Capacity: The amount of current a switch or circuit breaker can safely interrupt.

Interruption: A temporary discontinuance of the supply of electrical power.

K

Kilovolt (kV): 1,000 volts.

Kilovolt Ampere (kVa): The product of kilovolts times amperes. Used to refer to high voltage alternating current systems.

Kilovolt Ampere Reactive (kVar): A measure of reactive power which is required to regulate system voltage.

Kilowatt (kW): An electrical unit of power which equals 1,000 watts.

Kilowatthour (kWh): 1,000 watts of energy supplied for I hour. A basic unit of electric energy equal to the use of I kilowatt for a period of I hour.

L

Lagging Power Factor: Occurs when reactive power flows in the same direction as real power. Stated with respect to the generator, lagging power factor occurs when the generator is producing vars.

Leading Power Factor: Occurs when reactive power flows in the opposite direction to real power. Stated with respect to the generator, leading power factor occurs when the generator is absorbing vars.

Line Losses: Electrical energy converted to heat in the resistance of all transmission and/or distribution lines and other electrical equipment (i.e., transformers) on the system.

Load-Only Entity or Customer Load: An entity interconnected to the PacifiCorp power system at a transmission or distribution voltage level which does not have generation of its own in parallel with the PacifiCorp power system and is not interconnected with any source of generation other than PacifiCorp's.

Log: A computer file, book, or loose leaf sheets for recording all station operations, clearances, readings, ratio reports, and other pertinent active daily data.

M

Maximum Torque Angle (MTA): The phase angle between the relay measured quantities at which the relay is the most sensitive.

Metering Services: Consists of removal, ensuring of meter design specifications, installation, calibration, and ongoing testing and maintenance of meters.

Meter Service Agreement (MSA): The agreement issued by PacifiCorp concerning meter services.

Megawatt (MW): 1 million watts.

Megger: An ohm meter device used to measure the ability of insulation to withstand voltage, as well as measuring the insulation resistance. A poor megger test would mean that the insulation is breaking down.

N

Nameplate Rating, Facility: Output rating information appearing on a generator nameplate or other electrical device, in accordance with applicable industry policies.

NEMA: National Electrical Manufacturers Association.

NERC: North American Electric Reliability Council or its successor.

Net Energy Output: The generation facility's gross output in kilowatt hours, less station use, to the point of delivery into the PacifiCorp power system.

Net Sale: The generation facility's gross output, in kW and kWh, less station use, to the point of delivery into the PacifiCorp power system.

Network System: An electrical distribution system designed with special transformers and protection devices such that more than one radial three-phase circuit can be connected to serve load.

Network Protector: A special electrical device connected to a network transformer which trips load on reverse flowing current.

Network Transformer: A special transformer designed to accommodate the connection of more than one three-phase circuit to allow for enhanced reliability.

Network Relay: A special relay connected to a network transformer designed to trip the unit of line for excess fault currents.

Neutral: The common point of a star-connected transformer bank, a point which normally is at zero potential with reference to the earth.

No-Sale: The interconnection customer desires to operate in parallel and not sell power to PacifiCorp.

O

Ohm: The unit of resistance of an electric circuit.

One-Line Diagram: A diagram in which several conductors are represented by a single line and various devices or pieces of equipment are denoted by simplified symbols. The purpose of such a diagram is to present an electrical circuit in a simple way so that its function and configuration can be readily grasped.

Operating Procedures: Policies and procedures governing the operation of the transmission grid as PacifiCorp, the WSCC, or the NERC may from time to time develop as applicable to the particular type of generator and prime mover.

Operational Control: The rights of PacifiCorp to operate their transmission lines, facilities, and other electric plant equipment affecting the reliability of those lines and facilities for the purpose of affording comparable non-discriminatory transmission access and meeting applicable reliability criteria and policies.

Outage: A condition existing when a line or a substation is de-energized.

Output: The energy delivered by a generation facility during its operation.

Overload: A load in amperes greater than an electric device or circuit is designed to carry.

Overvoltage: Voltage higher than that desired or higher than that for which the equipment in question is designed.

P

PacifiCorp Control Center: The PacifiCorp location, manned 24 hours a day, which has been assigned operational jurisdiction over a load or interconnection customer's substation.

Parallel: (verb) To connect electrically a generator or energized source, operating at an acceptable frequency and voltage, with an adjacent generator or energized system, after matching frequency, voltage, and phase angle.

Parallel Operation: As used in this manual, the operation of a non-utility owned generator while connected to the utility's grid. Parallel operation may be required solely for the interconnection customer’s operating convenience or for the purpose of delivering power to the utility's grid.

Peaking: Operation of generating facilities to meet maximum instantaneous electrical demands.

Permissive Overreach Transfer Trip Scheme (POTTS): A very secure line protection scheme for insuring that a fault is within the protected line section. It requires the presence of both a trip signal from a remote terminal and a trip signal from the local relay before tripping the local breaker.

PacifiCorp Power System: The electric transmission and distribution wires, and their related facilities owned by PacifiCorp.

Point of Interconnection (POI): The point where the load or interconnection customer's conductors or those of their respective agents meet the PacifiCorp power system (point-of-ownership change).

Potential Transformer (PT): A transformer intended to reproduce in its secondary circuit, in a known proportion, the voltage of the primary circuit; also known as a voltage transformer.

Power: The time rate of transferring or transforming energy.

Power Factor (PF): The ratio of real (MW) power to apparent power (MVA). Power factor is the cosine of the phase angle difference between the current and voltage of a given phase.

Power Purchase Agreement (PPA): An agreement/contract between the utility and interconnection customer whereby the amount for the purchase of power has been determined and is contractually binding on both parties.

Primary: Normally considered as the high-voltage winding of a substation or distribution transformer; any voltage used for transmission of electric power in reasonably good-sized blocks and for some distance, as contrasted with low voltage for the immediate supply of power and light locally, such as the distribution within a building. The lowest voltage considered as a primary voltage is 2.4 kV although this is also used for some heavy-power requirements over short distances.

Primary System: A system of alternating current distribution for supplying the primaries of transformers from the generating station or distribution substation.

Protection: All of the relays and other equipment used to open the necessary circuit breakers to clear lines or equipment when trouble develops.

Protective Relay: A device whose function is to detect defective lines or apparatus, or other power system conditions of an abnormal or dangerous nature, and to initiate appropriate control circuit action.

Protocol: A specification that describes the rules and procedures products should follow to perform activities on a network, such as transmitting data.

Pumping: A condition present on a network protector whereby the device turns on and off very quickly due to deviant circuit conditions. These conditions can be introduced with the interconnection of generation on the circuit. Pumping is to be avoided on the protector so that it can properly perform its protective function.

R

Reactance: In an alternating current circuit, the opposition to the flow of current attributable to the inductance and capacitance of the circuit.

Reactive Component of Current: That part of a current that does no useful work because its phase is 90 degrees leading or lagging the voltage.

Reactive Load: In alternating current work, a load whose current is not in phase with the voltage across the load.

Reactor: A coil with no secondary winding provided. The primary use is to introduce inductance into the circuit for purposes such as starting motors, paralleling transformers, and controlling current. A current limiting reactor is a reactor for limiting the current that can flow in a circuit under short circuit conditions.

Reclose: To again close a circuit breaker after it has opened by relay action.

Recloser: A protective device designed to: 1) sense overcurrents, 2) time and interrupt the overcurrent according to a preset characteristic, and 3) reclose to test and possibly reenergize the line after a specified time interval.

Remedial Action Scheme (RAS): Protective systems that typically utilize a combination of conventional protective relays, computer based processors, and telecommunications to accomplish rapid, automated response to unplanned power system events; also refers to details of RAS logic and any special requirements for arming of RAS schemes or changes in RAS programming that may be required.

Remote Station Alarms: Alarms received at an attended location from unattended stations or plants.

Remote Terminal Unit (RTU): Remotely located equipment used for collecting data and/or for supervisory control via communication channel.

Residual Current: The current which flows in the neutral or wye-connected current transformers when the current in the three phases of a line are unbalanced.

Resistance: Anything placed or already located in an electric circuit which opposes the flow of electric current.

Resistor: A device whose primary purpose is to introduce resistance into an electric circuit. An adjustable resistor is one so constructed that its amount of resistance can be readily changed.

Retail Service: Electric sales to PacifiCorp's end-use or retail customers. Such service is regulated by the jurisdictional state regulatory agencies.

S

Schematic: A diagram showing the essential features of a piece of equipment or a control system.

Secondary: The winding of a transformer which is normally operated at a lower voltage than the primary winding.

Secondary Distribution System: A low-voltage alternating current system which connects the secondaries of distribution transformers to the consumer's services.

Self-Excited: A term to describe an electric machine in which the field current is secured from its own armature current. In the case of induction generators, it refers to the condition in which the induction generator is separated from its normal excitation source and is unintentionally excited by the power factor correction capacitors in the vicinity.

Separately-Excited: Use of an exciter for sending current through the field windings of an electric machine in place of taking the field current from its own armature current.

Service Reliability: The time an entity or group of entities is served compared to the amount of time the entity or entities are without service over a given time period.

Service Restoration: The switching procedure a system operator directs or executes to restore services to entities following an outage.

Setting: The values of current, voltage, or time at which a relay is adjusted.

Single-Phase Circuit: A circuit in which all current can be represented by only one regular sine-wave pattern. Differs from a three-phase circuit, where when all circuit current is plotted, it produces three regular sine-wave patterns 120 electrical degrees apart.

Special Facilities: Those additions and reinforcements to the PacifiCorp power system which are needed to accommodate the receipt and/or delivery of energy and capacity from and/or to the entity's facility(ies), and those parts of the interconnection facilities which are owned and maintained by PacifiCorp at the entity's request, including metering and data processing equipment.

Standby Capacity: The lesser of: 1) net generation capacity, 2) connected loads to generator, or 3) 80 percent of main switch rating.

Star-Connected Circuit (Wye-Connected Circuit): A term applied to the manner in which a motor's windings or a transformer's windings are connected, (i.e., star-connected armature having one end of each of the coils connected to a common junction). A star-connected transformer is one in which the primaries and secondaries are connected in a star grouping.

Station Use: Energy used to operate the generating facility's auxiliary equipment. Auxiliary equipment includes, but is not limited to: forced and induced draft fans, cooling towers, boiler feed pumps, lubricating oil systems, power plant lighting, fuel handling systems, control systems, and sump pumps.

Step-Down Transformer: A transformer in which the secondary winding has fewer turns than the primary, so that the secondary delivers a lower voltage than is supplied to the primary.

Step-Up Transformer: A transformer in which the secondary winding has more turns than the primary, so that the secondary delivers a higher voltage than is applied to the primary.

Supervisory Control: A system by which equipment is operated by remote control at a distance using some type of code transmitted by wire or electronic means.

Surplus Sale: The generator's gross output, in kW and kWh, less any plant load and transformation and transmission losses, delivered to the PacifiCorp system.

Switch: A device for making, breaking, or changing the connections in an electric circuit.

Switch, Air: A switch in which the arc interruption of the circuit occurs in the air.

Switch, Alarm: A form of auxiliary switch which closes the circuit to a bell or other audible signaling device upon automatic opening of the circuit breaker or other apparatus with which it is associated.

Switch, Auxiliary: A switch actuated by some main device such as a circuit breaker for signaling, interlocking, or other purpose.

Synchronism: The condition across an open circuit wherein the voltage sine wave on one side matches the voltage sine wave on the other side in frequency and without phase angle difference.

System: The entire generating, transmitting, and distributing facilities of an electric utility.

System Emergency: Conditions beyond the normal control that affect the ability of the control area to function normally, including any abnormal system condition which requires immediate manual or automatic action to prevent loss of load, equipment damage, or tripping of system

elements which might result in cascading outages or to restore system operation to meet the minimum operating reliability criteria.

System Protection Facilities: The equipment required by the utility to protect: 1) the PacifiCorp power system from faults occurring at a load or interconnection customer' facility, and 2) the load or interconnection customer's generating facility from faults occurring on the PacifiCorp power system or on the system of others to which it is directly or indirectly connected.

T

Telephone Working Limit: A voltage potential of 300 V or less, so personnel can work on the telephone cable without rubber gloves.

Telemetering: Measurement with the aid of a communication channel that permits power metering measurements to be interpreted at a distance from the primary detector.

Transfer Trip (TT): A form of remote trip in which a communication channel is used to transmit the trip signal from the relay location to a remote location.

Transformer: An electric device without continuously moving parts in which electromagnetic induction transforms electric energy from one or more other circuits at the same frequency, usually with changes in value of voltage and current.

Transformer Efficiency: Ratio of the electric power of the current going into a transformer to the power of the secondary circuit from the transformer.

Transformer Loss: The difference between the input power to a transformer and the output power of the transformer.

Transformer Ratio: The ratio of the voltage secured from a transformer to the voltage supplied to that transformer.

Transmission Line: A line used for electric power transmission. Distinguished from a distribution line by voltage. Lines rated 46 kV and higher are transmission lines.

Transmission Control Center: This center implements switching operations on the PacifiCorp transmission system within a specific geographical area.

U

UL: Underwriters Laboratories.

Undervoltage Protection: Upon failure or reduction of voltage, the protection device interrupts power to the main circuit and maintains the interruption.

Undervoltage Release: Upon failure or reduction of voltage, the protective device interrupts power to the main circuit but does not prevent again completing the main circuit upon return to voltage.

Unity Power Factor: A power factor of 1.000 which exists in a circuit wherein the voltage and current are in phase. There are no vars in this condition, only watts.

V

Var: A unit of measurement of reactive power. It is an expression of the difference between current and voltage sine waves in a given circuit; short for volt amps reactive.

VA2 = (Watts)2 + (Vars)2

Volt: The unit of electrical pressure similar to the pounds per square inch pressure on a steam gauge.

Volt Ampere: A unit of apparent power in an alternating current circuit. Equal to the product of volts and amperes without reference to the phase difference, if any. At unity power factor, a volt ampere equals a watt. Whenever there is any phase difference between voltage and current, the true power in watts is less than the apparent power in volt amperes.

Voltage Drop: The difference in voltage level between one point and another in a circuit (see line voltage drop).

Voltage Loss: The drop of potential in an electric circuit due to the resistance and reactance of the conductor. This loss exists in every circuit.

Voltage Ratio of Transformer: The ratio of the effective primary voltage to the effective secondary voltage of a transformer.

Voltage Transformer: See potential transformer.

W

Watt: A unit of electric power.

Watts AC = volts x amperes x power factor (single phase circuits).

Watt Hour: A measure of electric power. The power of one watt used for one hour.

Watt Hour Meter: An electrical measuring instrument which indicates power in watt hours.

WECC: Western Systems Coordinating Council or its successor.

Wholesale Customer: A person wishing to purchase energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Sales: The sale of energy and ancillary services at a bulk supply point or a scheduling point for resale.

Wholesale Service: Electric sales to wholesale customers for resale. Such service is regulated by FERC.

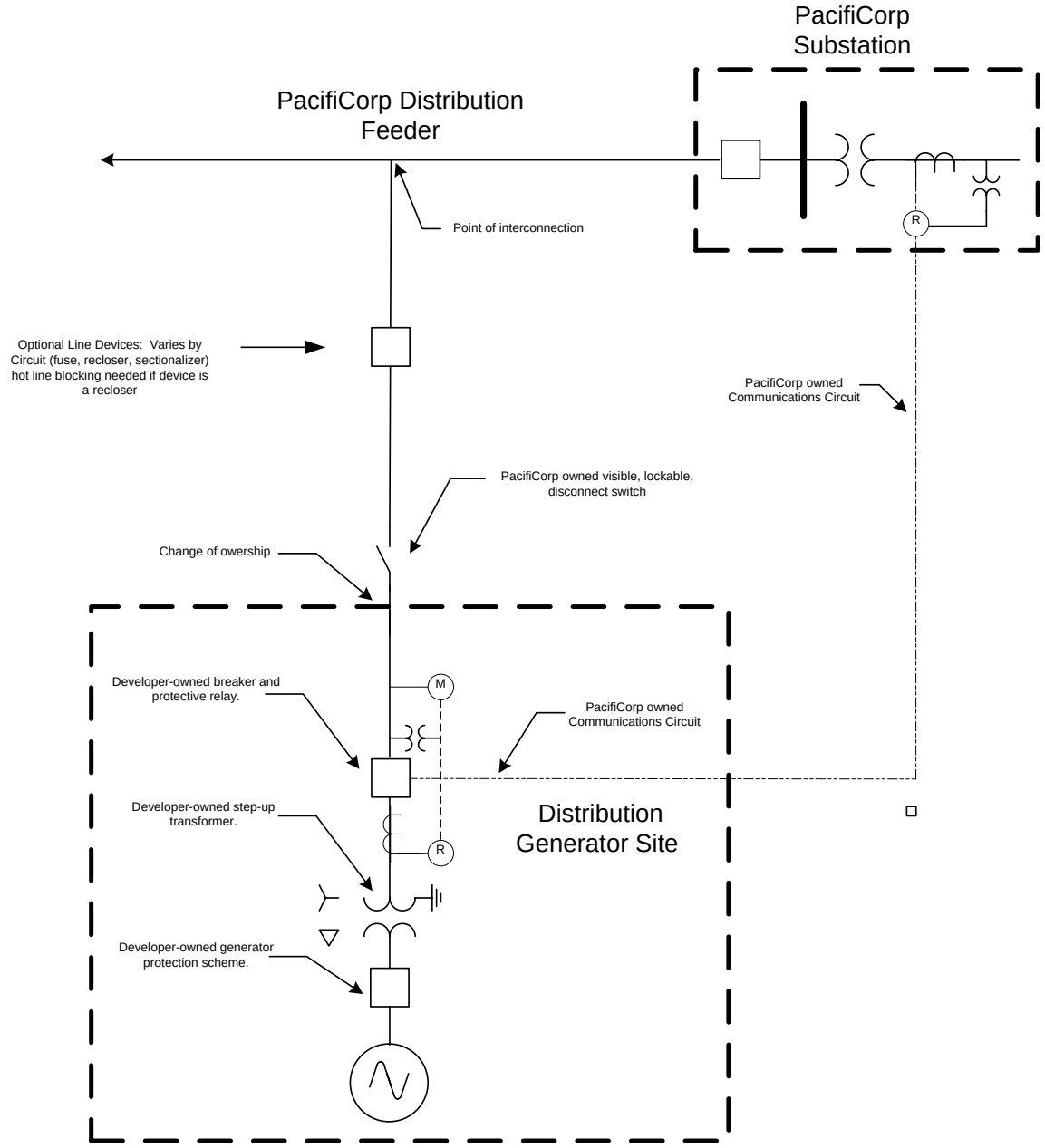
"Wye"-Connected Circuit: A three-phase circuit which is star-connected, meaning the windings of all three phases have one common connection which may be connected to ground.

CONTACTS
For Reference Documents and Information

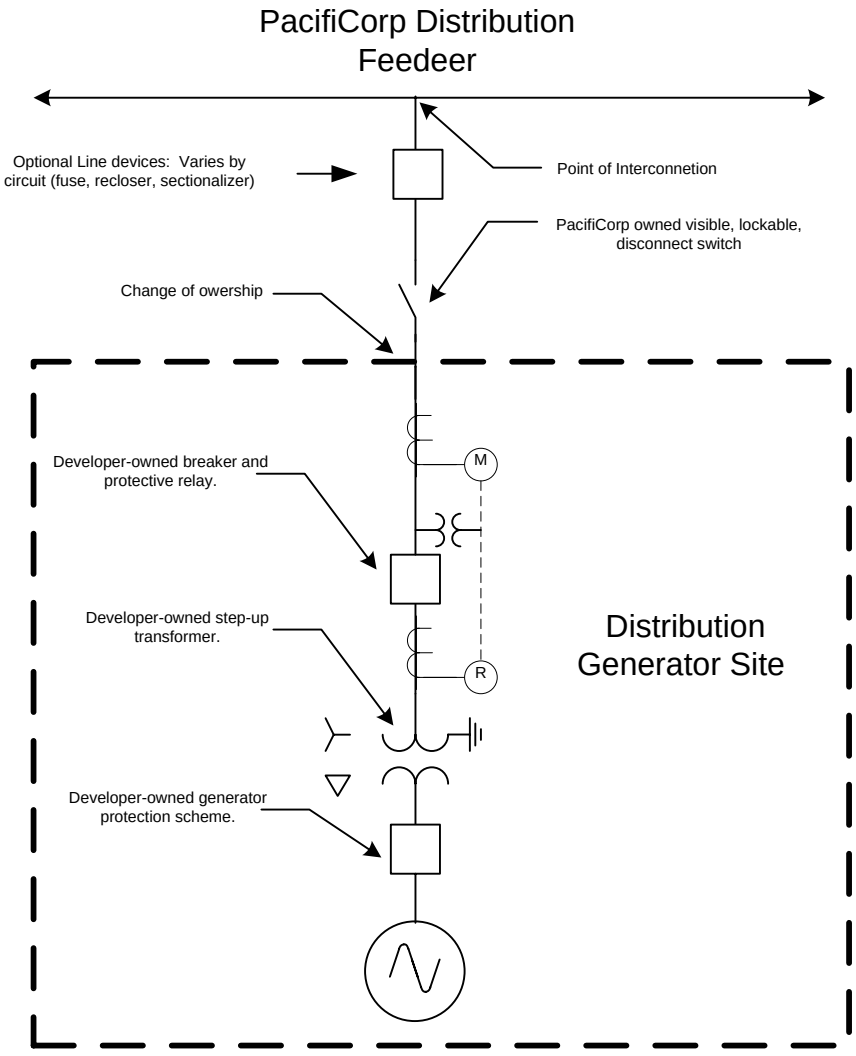
Entity	Example Documents	Who To Contact
California Public Utilities Commission (CPUC)	Retail Tariffs Electric Rules	Energy Division California Public Utilities Commission 505 Van Ness Avenue San Francisco, CA 94102 (415) 703-2782 http://nic.cpuc.ca.gov/
Idaho Public Utilities Commission (IPUC)	Retail Tariffs Electric Rules	Idaho Public Utilities Commission P.O. Box 83720 Boise, ID 83720-0074 (208) 334-0300 http://www.puc.state.id.us
Oregon Public Utilities Commission (OPUC)	Retail Tariffs Electric Rules	Oregon Public Utilities Commission 550 Capitol St. NE Salem, Oregon 97310-1380 (503) 378-6611 http://www.puc.state.or.us/
Utah Public Service Commission (UPSC)	Retail Tariffs Electric Rules	Utah Public Service Commission Heber M. Wells Building, 4th Floor P.O. Box 160 East 300 South Salt Lake City, UT 84111 http://www.psc.state.ut.us
Washington Utilities and Transportation Commission (WUTC)	Retail Tariffs Electric Rules	Washington Utilities & Transportation Commission P.O. Box 47520, Mail Stop: FY-11/7250 Olympia, WA 98504-7250 (360) 753-6423 http://www.wutc.wa.gov
Wyoming Public Service Commission (WPSC)	Retail Tariffs Electric Rules	Wyoming Public Service Commission 2515 Warren Avenue Hansen Bldg., Suite 300 Cheyenne, WY 82002 (307) 777-7427 http://www.psc.state.wy.us/index.html
Federal Energy Regulatory Commission (FERC)	Code of Federal Regulation Orders	Federal Energy Regulatory Commission Public Reference & Files Maintenance Branch 888 First Street, NE. Room 2-A Washington, DC 20426 (202) 208-1371 http://www.ferc.fed.us/
North American Electric Reliablilty Council (NERC)	National Reliability Standards	North American Electric Reliability Council Princeton Forrestal Village, 116-390 Village Boulevard Princeton, New Jersey 08540 (609) 452-9060 http://www.nerc.com
PacifiCorp (PPW)	Tariffs Standards Interconnection Handbook	Pacificorp, Inc. 825 NE Multnomah Portland, Oregon 97232 (503) 813-5731 http://www.pacificorp.com
Western Systems Coordinating Council (WSCC)	Western Reliability Standards	Western Systems Coordinating Council 540 Arapeen Drive. Suite 203 Salt Lake City, UT 84108 (801) 582-0353 http://www.wscc.com

NOTE: This list is modified periodically. Consult your local PacifiCorp representative for the most current version.

Distribution Generator Template with Transfer Trip



Distribution Generator Template



Electric Primary Service Requirements

PURPOSE

The purpose of this standard is to provide the requirements for the interconnection of electric customers served directly via the PacifiCorp distribution system. This standard is to be used for all existing primary service customers as well as all new customers.

DEFINITION OF TERMS

Primary Protective Device: That device that will detect faults within the customer's facilities and automatically operate to separate the customer from the PacifiCorp distribution grid.

Primary Service (PS) Customer: A customer receiving primary services voltage from PacifiCorp at a distribution voltage level (2.4 kV through 21 kV).

Coordination: The ability of the appropriate protective device to detect and operate to a clear fault on the electric system prior to another protective device operating.

CUSTOMER RESPONSIBILITIES

The PS Customer must not have an adverse impact upon the service reliability of the other PacifiCorp customers that are served via the same distribution system. It is the responsibility of **all** PS customers to install a satisfactory primary protective device and adequately coordinate with the appropriate PacifiCorp source-side protective device. Satisfactory coordination is defined as that which meets the criteria outlined in PacifiCorp's protection standards. The PS is responsible for owning, operating, and maintaining all required protective equipment.

PROCEDURES

Before the specific primary service installation can be approved, the customer is responsible for providing all the information necessary for PacifiCorp to determine the interconnection requirements. This includes, but is not limited to:

- One-line diagrams, meter and relay diagrams, control diagrams, and equipment specifications illustrating the interconnection design.
- All relay information (if applicable) including manufacturer, style, types, ranges, and settings for PacifiCorp-required relays.
- Projected electrical demand information.

Prior to energizing the applicant's new facility, the following activities must be completed:

- Test reports for the device and relays must be provided to PacifiCorp 10 days prior to the scheduled energization date so that there is sufficient time for review and the completion of any needed modification, including PacifiCorp approval.
- The customer must have a documented maintenance program for the protective devices and relays.
- Protective relay settings or fuse sizes must be approved by PacifiCorp.
- A pre-energization by PacifiCorp personnel must be performed to verify the proper operations of the customer's equipment.

PROTECTIVE DEVICE REQUIREMENTS

Fused cutouts are acceptable as long as satisfactory coordination can be obtained between the fuse and the PacifiCorp source-side protective device for both ground and phase faults. It becomes the customer's responsibility to protect their facility against single-phasing problems that arise due to the operation of one fuse.

If satisfactory coordination cannot be obtained using fuses, a three-phase interrupting device will be required. Reclosers, interrupters, or breakers are acceptable devices for this application. If a protective device is required to be installed on the customer's service by PacifiCorp because the customer's protective device will not coordinate with the PacifiCorp source-side device, it will be installed as Special Facilities. If the protective device is installed on the distribution circuit serving the customer for reasons other than those stated above, it will be at PacifiCorp's expense.

> **Note:** Sectionalizers are not an acceptable substitute for either fuses or a three-phase protective device because their operation inherently subjects other PacifiCorp customers to an outage for problems in the PS customer's facilities.

If electrically operated breakers and protective relays are used, it is preferable that the customer install a battery system. For economic reasons, the customer may prefer to use capacitive tripping. This may be allowed but the customer must install an alarm system to identify when the capacitor voltage falls below a predetermined set level. Spare capacitors must also be kept on hand for immediate exchange.

PROTECTIVE RELAYS

If relays are installed by the customer as part of the primary protection, they must meet the following criteria:

- Relays installed must be approved by PacifiCorp prior to their installation. If the relay being presented for approval is one not currently on the approved relay list, complete relay information, including instruction books and operating characteristics, should be provided to the PacifiCorp Transmission Account Manager.
- Phase and ground relays must be installed to protect against both three-phase and line-to-ground faults within the customer's facilities.

- If microprocessor-based three-phase devices are used, multiple units of other backup devices will be required so that the ability for the customer to detect a fault is not dependent on a single relay.

EXISTING FACILITIES

The requirement for the customer to maintain coordination and provide complete protection of their facilities refers to existing PS customers as well as new or upgraded installations. The coordination of these customers should be reviewed when performing a protection review on the circuit feeding the PS customer.

A common issue that arises when a customer owns facilities that were previously purchased from PacifiCorp is the requirement to provide both phase and ground coordination that differs from what existed when PacifiCorp owned the facilities. This is required because:

1. Jurisdictional state utility commissions typically require that a PS customer is responsible for ensuring that other PacifiCorp customers are not exposed to unnecessary service interruptions due to problems in the PS customer's facility. If both phase and ground coordination is not maintained, problems on the customer's equipment has a higher probability of affecting other PacifiCorp customers.
2. The customer assumed the responsibility of maintaining adequate coordination in order to qualify for the primary rate.
3. When PacifiCorp owned the system, the company accepted the exposure risk in exchange for the lower cost fuse installation. This cost savings was spread among all of PacifiCorp's ratepayers. When the PS customer purchases the system, all cost savings of a fused installation would be captured by the PS customer while other PacifiCorp customers would inappropriately continue to bear the risks associated with additional exposure.

NEW FACILITIES

Occasionally, the customer may indicate that it will not be possible to coordinate their main protective device with the current PacifiCorp source-side device. PacifiCorp should review the source-side device settings to determine if they can be increased. It may be possible to modify the settings with little work and no reduction in reliability and thereby provide increased coordination margin for the PS customers. This will be determined by PacifiCorp on a case-by-case basis.

If the PacifiCorp source-side device settings cannot be modified or the customer still cannot coordinate, it remains the customer's responsibility to coordinate with the PacifiCorp source-side device, with the costs involved completely borne by the PS customer. Costs should include all equipment modifications and will include Special Facility charges with the appropriate Cost of Ownership payment. In addition, any changes to the distribution system's protection must not be detrimental to the other customers on the system.

LOCATION OF PRIMARY PROTECTION

The customer's primary protective device should ideally be installed at the service delivery point designated by PacifiCorp. The service delivery point for PS customers is at or near the customer's property line. Due to the design of the customer's facility, it may not be cost effective for the customer to install the equipment right at the property line. The customer's facility design will most often have the main protective device located adjacent to the main transformer or distribution switchgear. Any additional PacifiCorp facilities installed to allow for this alternative placement will be installed as Special Facilities.

Under some circumstances, the customer can be permitted to install the primary protective device in a location which places some exposure from the customer facilities onto the PacifiCorp system. While it is difficult to determine how much exposure is acceptable, the following guidelines provide a uniform approach with some flexibility for addressing unique situations:

Overhead: Approximately 50 feet of conductor between the change-of-ownership point and the PS customer's primary protective device is acceptable if the route is free of potential hazards (especially trees).

Underground: The PS customer may be required to install a splice box with load-break elbows at the property line. This arrangement will allow the customer's facilities to be disconnected from the PacifiCorp system without necessitating a shutdown affecting other PacifiCorp customers. Approximately 100 feet of underground conductor between the point-of-ownership change and the customer's main protective device is acceptable. Since the main exposure on underground projects is due to splices and terminations, continuous runs of cable of lengths slightly in excess of 100 feet may be acceptable. This will be determined on a case-by-case basis with the intent to minimize the exposure to the PacifiCorp distribution system.

If the design of the customer's facility is such that the aforementioned coordination and location criteria cannot be met, PacifiCorp will install, own, and maintain an appropriate protective device at or near the change-of-ownership point. The cost of this installation will be borne by the PS customer under a Special Facilities Agreement. This option is only acceptable after every attempt has been made to work with the customer to find a solution which does not require this additional device.

MAINTENANCE REQUIREMENTS

The customer is responsible for maintaining the protective equipment in a serviceable and generally accepted manner. PacifiCorp has the right to request that the customer provide proof of maintenance activities upon request. If the PS customer does not perform appropriate maintenance or fails to provide records to PacifiCorp which documents appropriate maintenance activities, PacifiCorp may terminate service pursuant to applicable state commission rules and regulations. Moreover, if a problem with the PS customer's facilities has a detrimental affect on PacifiCorp or other customers, the PS customer will be considered liable.

In the event that there is a failure or problem with any of the interconnecting equipment, the PS customer must make any corrections or repairs to their facility deemed necessary by PacifiCorp to maintain adequate reliability. The PS customer may be required to take such actions as PacifiCorp deems necessary or appropriate to prevent any recurrence of the problem.

The PS customer must contact PacifiCorp prior to making any changes to their primary protective device. PacifiCorp must approve all changes before they are made to ensure that adequate coordination is maintained.

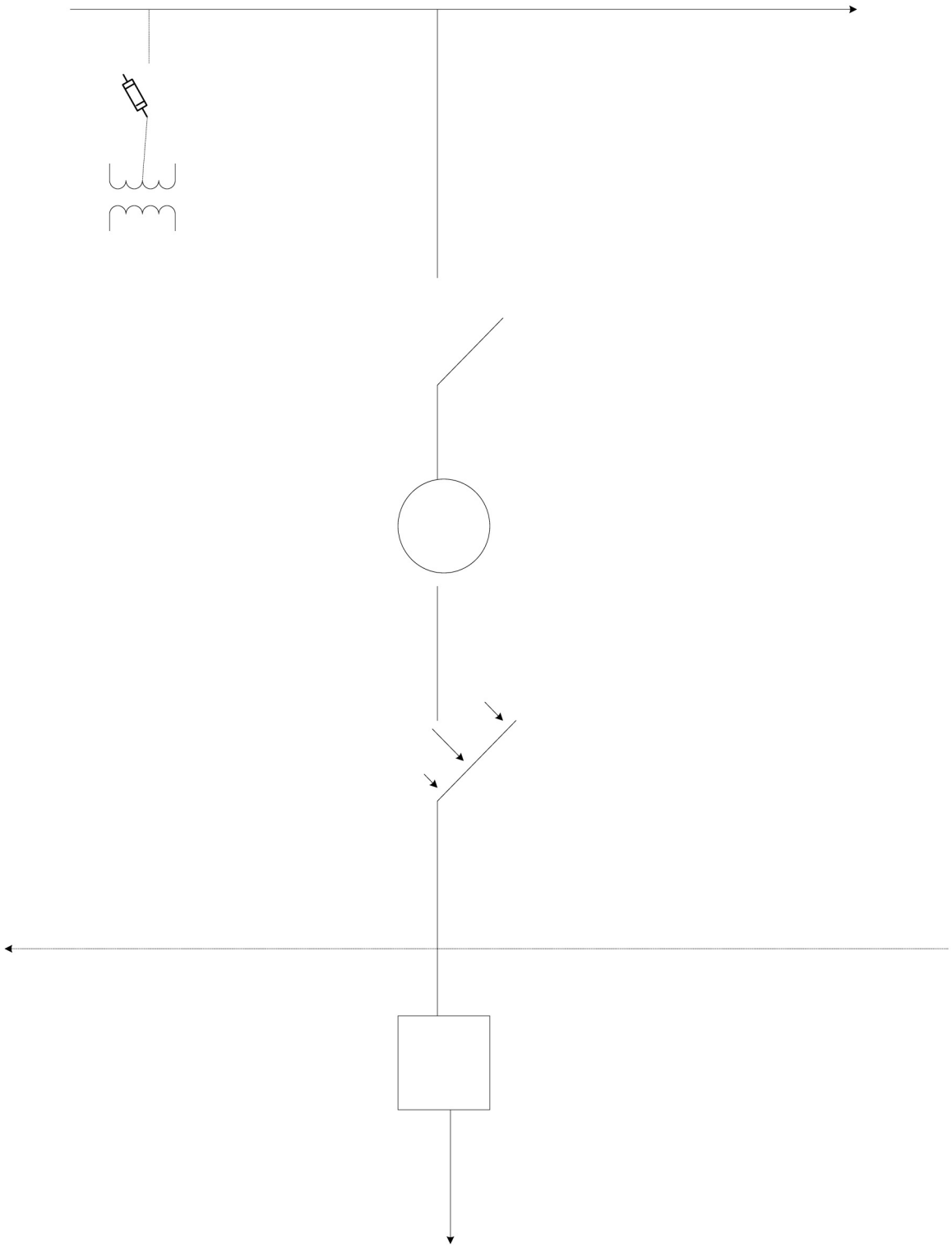
Equipment Lead Times

Typical Expected Range

- Step-Up Transformer (developer-owned, not in PacifiCorp stock, 1MVA and above) – 10 to 12 months
- Relays – 8 to 12 weeks
- Meter – 8 to 12 weeks
- Padmounted Metering Enclosure – 8 to 12 weeks
- Communication circuit – 2 months
- Recloser – 8 to 12 weeks
- Breaker – 14 to 52 weeks (1 year)
- Gang-Operated Switch – 10 to 12 weeks
- Voltage Regulator – 12 to 15 weeks
- Capacitor (substation) – 35 weeks
- RTU – 8 to 12 weeks
- Power System Stabilizer – 26 weeks (6 months)

Lead times are subject to change due to industry and market conditions of raw materials.

Generator Interconnection One-Line for Dedicated 34.5 kV Wind-Collector Feeders with Recloser or Breaker Protection



In addition to the requirements of the main document, this appendix contains additional requirements specific to PacifiCorp-owned Wind Collector Feeders (34.5 kV).

FAULT CLEARING REQUIREMENTS

All interconnections located less than six conductor miles from the originating PacifiCorp substation shall be protected with either a fuse, or a recloser (or breaker) with instantaneous tripping enabled. Faults located in this region must be cleared quickly to minimize the impact to PacifiCorp's system. For the available fault-current levels at the six-mile point on the feeder, the customer's fuse or recloser must clear the fault in a maximum clearing time of five cycles. If the customer's fuse cannot meet this requirement, the customer must install a recloser with protective relays to meet the five-cycle maximum clearing time requirement.

Interconnections located past the six-mile point on the feeder will be allowed to have fuses or re-closers that clear faults within 15 cycles at the available fault current level at the tail-end of the customer's collector system.

PacifiCorp reserves the right to modify the future configuration of these collector feeders. Future re-configurations which result in an interconnection being located within six conductor miles of the originating substation will require the customer to meet the fault-clearing requirements listed above.

Customers that have a recloser as their fault-clearing device must, upon request from PacifiCorp, provide fault records in a timely manner. If these fault records are required to troubleshoot an operating problem, these records will be needed within 48 hours of being requested.

AUTOMATIC RECLOSING

PacifiCorp's substation feeder breaker will be set to issue one automatic reclose approximately 15 to 30 seconds after it opens. The customer's equipment must be designed to handle this automatic reclose without incurring damage to the wind generators.