PACIFICORP
A BERKSHIRE HATHAWAY ENERGY COMPANY

Policy

Facility Connection Requirements for Transmission Systems
(46 kV and Higher Voltages)
T&D Planning Policy No. 139

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Policy

Facility Connection Requirements for Transmission Systems
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1 INTRODUCTION

This policy addresses the technical requirements for generation facilities, transmission facilities, and end-user facilities that are interconnected with PacifiCorp's transmission system. This policy, along with PacifiCorp's Open Access Transmission Tariff (OATT), ensures that adverse impacts on reliability of the transmission system are avoided. In addition to ensuring reliability, this policy is consistent with safety requirements for PacifiCorp employees and the general public.

This document is maintained by the transmission services group and the transmission and distribution standards engineering group, and is published on PacifiCorp's internal and external websites for transmission policies. (The external website is https://www.pcorpstandards.com.)

Although this policy addresses certain aspects of interconnection, its scope is primarily technical and does not include the commercial requirements for connecting generators or transmission facilities. 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 apply.

Technical studies will determine whether PacifiCorp will be required to modify its transmission system to interconnect the requested facilities. Parties requesting interconnection are responsible for the expense of these technical studies. Please contact the PacifiCorp account manager for details about the study process and additional data requirements that may apply.

1.1 Applicability

This standard applies to generation, transmission, and end-user facilities that are physically connected to, or desire to physically connect to, PacifiCorp's transmission system. Applicability is further defined by the categories below:

1.1.1 Generation Facilities

All requirements described or referred to in this policy apply to new, active, and decommissioned generation facilities. New generation facilities are facilities that have not been and are not yet connected to the PacifiCorp transmission system. Decommissioned generation facilities are facilities that were actively connected to PacifiCorp's electrical system in the past, but presently are not connected nor actively producing power. Additional technical requirements may apply to special business arrangements or electrical configurations of PacifiCorp's transmission system or the interconnection point(s). All decommissioned generators must comply with all requirements contained in this policy. It may be necessary to upgrade the decommissioned generator equipment to adhere to this policy.

1.1.2 Transmission Facilities

Any proposed transmission facility interconnecting into PacifiCorp's transmission system shall be coordinated and reviewed via Pacificorp's transmission planning process. The transmission facility addition shall maintain or improve the level of system reliability that existed prior to the interconnection. Real and reactive power that flows as a result of the transmission interconnection shall not overload or adversely affect PacifiCorp's transmission system or the WECC regional transmission system.

1.1.3 End-User Facilities

Any proposed load customer interconnecting into PacifiCorp's high-voltage transmission system shall be coordinated and reviewed through PacifiCorp's "Electric Service Study Agreement" (ESSA), policy for interconnection of transmission facilities.

1.2 Security Access to Facilities

With reasonable notice and supervision, the interconnection customer shall allow PacifiCorp personnel ingress and egress to equipment for operation, maintenance, repairs, tests (or witness tests), inspection, replacements or removal of facilities/equipment. PacifiCorp personnel shall be provided with an escort if necessary (rather than taking a special training course to enter the facility). If this access is not allowed, and it affects PacifiCorp's customers, including emergency incidents or other power delivery-related activities, PacifiCorp reserves the right to exercise the disconnection provision of the facility interconnection agreement.

1.3 Facility Connection Customer Equipment Requirements

Interconnected parties are responsible for designing, installing, operating, and maintaining interconnection equipment that they own (i.e., generators, transformers, switches, relays, breakers, etc). All protective devices necessary to protect the interconnected facilities are the responsibility of the customer.

PacifiCorp's 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 customers.

Interconnected customers must satisfy the requirements in 1) this policy, 2) applicable rules and tariffs of jurisdictional state regulatory agencies and the Federal Energy Regulatory Commission (FERC), 3) applicable policies of the Western Electricity Coordinating Council (WECC), the North American Electric Reliability Corporation (NERC), or their successor organizations, and 4) PacifiCorp's project-specific requirements (interconnection agreement or Electric Service Agreement (ESA) / Master Electric Service Agreement (MESA). 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, as warranting the equipment's safety and 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.

Readers should be aware that the information in this policy document is subject to change. The latest version of this document is available at https://pcorpstandards.com/www/docs/2/FPP/XMSN-FPP.html, and http://www.oasis.pacificorp.com/oasis/ppw/main.htmlx.

PacifiCorp will not agree to interconnect new facilities unless all technical and contractual requirements are met. Copies of this policy will be supplied upon request. Contact the PacifiCorp account manager for referrals to the PacifiCorp employee who can respond to questions concerning PacifiCorp's policy for facility interconnection coordination procedures or additional copies of this document:

Director, PacifiCorp Transmission Services
825 N.E. Multnomah Blvd, Ste 1600
Portland, Oregon 97232
(503) 813-7237, brian.fritz@pacificorp.com

2 OWNERSHIP POLICY AND OPERATION OF INTERCONNECTION EQUIPMENT

PacifiCorp shall own all interconnection facilities and system upgrades necessary to assure reliable service to PacifiCorp customers. This may include, but is not limited to: relaying, control systems, breakers, switches, bus work, and transmission lines. In all cases, revenue metering and communications circuits for the purpose of breaker status and transfer trip will be owned and maintained by PacifiCorp. PacifiCorp may, at its option, and under the provisions of the LGIA, contract with the interconnection customer, or a third party, for construction of any or all of these facilities.

2.1 Applicant Design and Construction of PacifiCorp Facilities

When it is mutually agreed by PacifiCorp and the facility interconnection customer, the customer shall design and build PacifiCorp facilities using an engineering firm from PacifiCorp's pre-qualified contractor list. Contact kristopher.bremer@pacificorp.com for a list of current pre-qualified engineering firms.

All equipment installed by the customer in a PacifiCorp-owned facility shall follow PacifiCorp's Material Specifications and Construction Standards, and and must be pre-approved for purchase by the relevant engineering group (i.e., meters must be approved by the metering engineer; also see PacifiCorp Policy 212, *Pre-qualified Project Equipment Supplier List*) and Appendix C (of this document), *Technical Data Sheet*.

PacifiCorp will require a design that conforms to their current standards and design process. Generally, three design reviews take place during the design process, and a final "Issue for Construction" review occurs prior to construction. These reviews take approximately 5-10 days; this time shall be included in the project schedule. Review intervals and the documentation submitted for review shall be consistent with PacifiCorp's Procedure 211, *Substation Engineering AutoCAD Review for External Consultants*.

The interconnection customer shall provide PacifiCorp with design drawings, forms, calculations, geotechnical reports, surveys, and other requirements per a pre-approved schedule for design. The customer shall allow PacifiCorp CAD review time in the project schedule; CAD reviews typically take between 10 and 20 days.

The interconnection customer shall continue to provide PacifiCorp with revisions sent to the contractor for construction. Within 120 days of the completion of construction, the interconnection customer shall provide PacifiCorp with a complete set of design drawings revised to reflect as-built conditions. In addition to drawings detailed models for

power flow, dynamics, and relay settings also need to be provided to PacifiCorp's account manager. The interconnection customer shall also be responsible for obtaining SAP numbers and equipment memorandum forms from PacifiCorp and for 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.

Unless specifically agreed to otherwise, the interconnection customer shall follow all PacifiCorp-specified installation, commissioning and testing practices as described in Section 10, and shall use PacifiCorp-provided equipment installation procedures and forms for installing and testing of any equipment in PacifiCorp facilities. The interconnection customer shall be responsible for completion of generator baseline and model validation testing and submission of test reports to PacifiCorp transmission planning per applicable WECC criteria. The interconnection customer shall provide PacifiCorp with copies of all installation forms as soon as is practical, but no later than ten days after the installation of each piece of equipment. PacifiCorp must receive all installation forms no less than 15 business days before equipment is scheduled to be energized. No equipment will be energized until PacifiCorp has reviewed the installation reports and granted approval to energize the equipment.

3 INTERCONNECTION PROCESS, STUDIES, AND REQUIREMENTS

3.1 Facility Interconnection Process Summary

FERC provides procedures which govern generation facility interconnections where a generator chooses to sell power to the bulk power market or a transmission customer/end user chooses to take unbundled or wholesale electric service from a FERC jurisdictional transmission line. A FERC jurisdictional line is defined as a line or interconnection classified as FERC transmission by the host utility. End users must follow all FERC procedures when using or interconnecting with FERC jurisdictional transmission.

1. The FERC processes and procedures have been incorporated into PacifiCorp's OATT, which may be accessed at: http://www.oasis.oati.com/ppw/index.html. If the generator, transmission line, or end user are not FERC jurisdictional, PacifiCorp applies applicable state processes, if they exist, and voluntarily applies the OATT processes and procedures for consistency and ease of processing when state rules do not exist.
2. Generators, transmission line, and end users must follow all FERC interconnection procedures and processes when they are FERC jurisdictional (specifically, LGIA and LGIP). The following FERC orders govern the interconnection processes and procedures:

    a) Generators with nameplate ratings greater than 20 MW are governed by the FERC Large Generator Interconnection Procedures and Agreements (LGIP/LGIA) process. These are incorporated into Section IV *Large Generator Interconnection Service* of PacifiCorp's OATT.

    b) Generators rated from 10 kW to 20,000 kW (20 MW) are governed by FERC Small Generator Interconnection Procedures and Agreements (SGIP/SGIA) process. These are incorporated into Section V *Small Generator Interconnection Service* of PacifiCorp's OATT.

c) Line/end users who choose to take unbundled or wholesale electric service are governed by PacifiCorp's (OATT).

3. Generators not governed by FERC procedures and agreements shall be governed by PacifiCorp procedures and agreements. Line/end users not governed by the PacifiCorp OATT shall be governed by the corresponding PacifiCorp state tariffs (bundled electric service) and procedures.

4. All interconnecting customers will be required to meet all applicable standards, which include, but are not limited to NERC Reliability Standards, WECC Reliability Standards, FERC Generator Interconnection Procedures, FERC Generator Interconnection Agreements,and PacifiCorp transmission planning criteria and facility connection requirements

3.2 Coordinated Joint Studies

3.2.1 Procedures for Coordinated Joint Studies

Unless there are conflicts with FERC or state standards (such as Critical Energy Infrastructure Information [CEII] and/or standards or code of conduct issues) PacifiCorp will form ad hoc groups (or project review group based on WECC guidelines on regional planning processes), distribute results, and facilitate any required meetings between the interconnection customer, PacifiCorp, potentially affected electric systems, and any governing authorities in accordance with the FERC Large Generation Interconnection Procedures/Agreements (LGIP/LGIA) or other applicable procedures. This includes requesting potentially-affected parties participate in joint studies and following accepted WECC regional planning practices. If a potential CEII conflict arises such as an unknown consultant requesting critical system data, PacifiCorp would require FERC approval and a confidentiality agreement. If, in the opinion of PacifiCorp, a potential standard or code of conduct issue arises that may involve parties that 1) are not FERC jurisdictional public utilities, or 2) decline to sign a confidentiality agreement, PacifiCorp will provide system criteria violations (thermal, voltage, or stability) specific to the affected system only.

Results of coordinated joint studies shall be documented along with any conclusions and recommendations. Such documentation shall be retained by PacifiCorp, and shall be made available if requested by WECC or NERC, or any other entities responsible for the reliability of the interconnected transmission system as soon as feasible.

3.2.2 Procedures for Notification of New or Modified Facilities

PacifiCorp shall disseminate notification of new or modified facilities to the WECC and NERC, as soon as feasible, in accordance with their established notification procedures.

Interconnection customers seeking to integrate new facilities with PacifiCorp should contact:

Director, PacifiCorp Transmission Services
825 N.E. Multnomah Blvd, Ste 1600
Portland, Oregon 97232
(503) 813-7237, brian.fritz@pacificorp.com

3.2.3 Additional Requirements

All transmission facilities, whether owned by PacifiCorp or the interconnection customer must be in compliance with all NERC reliability requirements. NERC reliability standards may be accessed on the internet at: http://www.nerc.com/pa/Stand/Pages/ReliabilityStandards.aspx.

1. Some specific NERC standards families that may apply are:
    - BAL Resource and Demand Balancing
    - CIP Critical Infrastructure Protection
    - COM Communications
    - EOP Emergency Preparedness and Operations
    - FAC Facilities Design, Connections and Maintenance
    - INT Interchange Scheduling and Coordination
    - IRO Interconnection Reliability Operations and Coordination
    - MOD Modeling, Data, and Analysis
    - PER Personnel Performance, Training, and Qualifications
    - PRC Protection and Control
    - TOP Transmission Operations
    - TPL Transmission Planning
    - VAR Voltage and Reactive
2. PacifiCorp may revise the technical requirements periodically to comply with new requirements from FERC, NERC, state, other governmental authorities. PacifiCorp may require that all generator, transmission line, and end-user interconnections comply with new regulations by implementing similar procedures and/or upgrades as would be expected on PacifiCorp facilities in a non-discriminatory manner. If the interconnection customer does not comply, PacifiCorp may require an upgrade of the interconnection customer's facilities as necessary to be compliant. Any such upgrades shall be executed at the customer's expense. Alternately, PacifiCorp may disconnect the interconnection customer after proper notification according to OATT requirements and procedures.
3. The Bulk Electric System (BES) is defined as the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.
4. Generators interconnecting to the PacifiCorp electric system are governed by the most current version of the PacifiCorp OATT.

5. This document complies with NERC requirements to document, maintain, and publish facility connection requirements for NERC/FERC jurisdictional generation facilities (rated at 10 – 20,000 kW), and transmission/end-user facilities to ensure compliance with:
   - NERC Reliability Standards
   - FERC Small Generator Interconnection Procedures and Agreements
   - Applicable regional reliability organization requirements
   - Sub-regional requirements (if applicable)
   - PacifiCorp requirements
6. These technical requirements specify the minimum technical requirements intended to ensure a safe, effective, and reliable interconnection. These requirements are intended to supplement, but not replace, information contained in regulatory codes, PacifiCorp's OATT, PacifiCorp electric service tariffs, and specific interconnection agreements. The requirements outlined in this document may not cover all details in specific cases.

3.3 General Requirements

1. The interconnection customer shall identify an operating voltage level (in kV) that is locally available on the PacifiCorp transmission system, as well as the expected demand (in MW and MVAr) at the point of interconnection.
2. The interconnection customer shall interconnect to the PacifiCorp electric system at the nominal voltage at the agreed-to point of interconnection. PacifiCorp, at its sole discretion, may elect to upgrade or change the voltage level of the PacifiCorp electric system serving the interconnection customer. Any expenses to upgrade or change the interconnection customer's equipment to maintain an interconnection with PacifiCorp shall be the responsibility of the interconnection customer. All facilities required to interconnect to 46 kV (or higher voltage) systems will be designed and built to PacifiCorp's avian protection standards.
3. The customer shall obtain PacifiCorp's acceptance of those portions of design documents that apply to protection and security of the PacifiCorp electric system according to OATT requirements and procedures. The customer is solely responsible for the design that affects the facility. Protection of the interconnection customer's overall electrical system, including generation and connected load, is the sole responsibility of the interconnection customer.
4. The customer will follow all FERC, NERC, and Regional Reliability Organization (RRO) requirements for review and approval of the facility interconnection and any required system changes or upgrades. This may include the development of such studies and data as a WECC subcommittee shall reasonably request.
5. PacifiCorp and/or its consultant shall conduct all electric system studies and issue reports required by FERC, NERC, RRO, PacifiCorp, and any other regulatory body for authorization and justification of the proposed interconnection to the PacifiCorp electric system. The customer shall reimburse PacifiCorp for all expenses incurred for these studies and reports according to OATT requirements and procedures.
6. An interconnection study report or a system impact study shall describe the effects on the underlying transmission system. This report must be approved by PacifiCorp's main grid planners for facilities connecting to the bulk electric system, and for any other connections, the reports must be approved by PacifiCorp's area planners.

7. The customer shall comply with PacifiCorp, industry, WECC, and NERC design, construction and operation standards and procedures.
8. The interconnection customer's installation shall meet all applicable national, state, and local construction and safety codes.
9. The interconnection design shall be capable of accommodating PacifiCorp electric system reclosing practices.
10. The interconnection design shall incorporate protection equipment to detect system abnormalities or disturbances in either the interconnection customer's system or the PacifiCorp system. This equipment shall have the capability to isolate the sources of the disturbance.
11. The interconnection customer's design and facilities shall provide all necessary equipment to protect against inadvertent rapid and repetitive tripping and reclosing of the interconnected PacifiCorp system.
12. The interconnection design shall be such that failure of the generator, transformer, and other auxiliary equipment shall result in automatic isolation of the affected equipment from PacifiCorp's transmission system.
13. The customer shall design the facility to meet all current WECC and NERC reliability standards (including the WECC System Performance Table on the WECC website), the requirements described in PacifiCorp's Engineering Handbook Section 1B.4, *Reliability Criteria for System Planning*.
14. The customer shall not cause the PacifiCorp electric system to violate WECC System Performance Criterion, PacifiCorp Engineering Handbook Section 1B.7, or the voltage criteria or voltage ranges defined in ANSI Standard C84.1, *Electric Power Systems and Equipment – Voltage Ratings*, Range A (plus or minus five percent of nominal).
15. The customer shall control the electrical real (MW) and reactive (MVAr) power output such that it will not exceed the capacity of the interconnection facilities.
16. The interconnection customer's three-phase generation shall be connected to the PacifiCorp power system with three-phase automatic disconnecting devices (circuit breakers), which are intended to significantly reduce the possibility of damaging the interconnection customer's generation equipment due to single-phase operation. These disconnecting devices shall be equipped with auxiliary contacts that indicate the actual status of the devices' main contacts.
17. An isolating device, typically a switch, must be installed to physically and visibly isolate the customer and PacifiCorp systems. The disconnect switch will serve as the point of change of ownership between the customer and PacifiCorp and will be labeled as such both on drawings and on-site signage. Disconnects located within the interconnection customer's facilities shall be installed by the customer and shall be accessible to both PacifiCorp and the customer at all times. The disconnect shall be owned and operated by PacifiCorp to provide a visible air gap with clearances for adequate grounding, maintenance, and repairs of the PacifiCorp electric system. PacifiCorp may require the capability to apply safety grounds on the PacifiCorp side of the disconnect. The customer shall not remove any PacifiCorp padlocks or safety tags as per the Occupational Safety and Health Administration (OSHA) lockout/tagout requirements. In any case the device:

- must simultaneously open all phases (gang operated) to the interconnected facilities,
- must be accessible by PacifiCorp and must be under PacifiCorp Dispatcher jurisdiction,
- must be lockable in the open position by PacifiCorp,
- shall not be operated without advance notice to affected parties, unless an emergency condition requires that the device be opened to isolate the interconnected facilities, and
- must be suitable for safe operation under all foreseeable operating conditions.

PacifiCorp personnel may lock the device in the open position and install safety grounds:

- if it is necessary for the protection of maintenance personnel when working on de-energized circuits,
- if the interconnected facilities or PacifiCorp equipment presents a hazardous condition, or
- if the interconnected facilities jeopardize the operation of PacifiCorp's system.

18. System flows as a result of the interconnection shall not overload nor adversely impact PacifiCorp's transmission system, nor neighboring transmission system. Where the interconnection customer's generation or transmission facilities supply fault currents to the PacifiCorp electric system in excess of breaker or other interrupting device maximum-rated interrupting capability, the customer shall be required to install and pay for fault-limiting equipment or pay for breaker or other interrupting-device replacements according to OATT requirements and procedures. (The interconnection study report or system impact study shall identify findings.)
19. Industry standard basic insulation level (BIL) ratings shall be used for electric system additions and electric system interface equipment. The electric equipment shall meet IEEE C62.41 or C37.90.1, V&I Withstand Requirements.
20. The harmonic content of the voltage and current wave forms of both the interconnection customer 's and PacifiCorp's systems shall comply with the latest version of the IEEE Standard 519, *Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*.
21. The customer shall be capable of withstanding electromagnetic interference environments in accordance with ANSI/IEEE Standard C37.90.2. The interconnection system and protection system shall not mis-operate due to electromagnetic interference, including hand-held communication devices.
22. PacifiCorp may install disturbance-recording equipment at the system interface according to NERC, OATT, or regional requirements and procedures.
23. The interconnection design shall incorporate adequate facilities to enable the on-site generation to be synchronized with PacifiCorp's transmission system prior to interconnection. The interconnection customer's generator protection shall incorporate elements to block out-of-sync closing of the customer's facilities. The customer shall be solely responsible for synchronizing the generator to the system. At PacifiCorp's discretion (after initial synchronization), synchronizing the generator to the system shall be preceded with advance notification of not less than one full clock hour to be provided to PacifiCorp's grid operations department.

24. All points at which the generator can be paralleled with the PacifiCorp electrical system must be clearly defined as synchronization points in the submittal documentation. A given installation may be designed such that there are several synchronization points.

25. For lightning, surge, and overvoltage protection of transmission facilities 34.5 kV and higher voltages, PacifiCorp's Engineering Handbook Section 1B.7, *Lightning and Other Overvoltage Protection*, shall govern facility design. For insulation levels, insulation coordination and basic lightning impulse insulation level (BIL), Handbook Section 1B.9, *Substation Design Criteria*, Table 1, shall be followed.

26. Determination of Equipment Rating: All series elements that together make up a line section or bulk power substation transformer circuit are reviewed to determine which facility has the most limiting rating. In the event that a line section or bulk power transformer terminates on a ring bus or a breaker-and-a-half, the facility rating will be determined assuming a closed ring bus or closed breaker-and-a-half. The most limiting facility rating of the entire ring bus or the most limiting facility rating of the breaker positions adjacent to the line section or bulk power transformer in a breaker-and-a-half scheme are considered in determining the rating of the line section or bulk power transformer. In order to account for the flow split when entering a closed-ring or a closed breaker-and-a-half, a multiplier is used to adjust the ratings of the ring bus or breaker-and-a-half facilities. The multiplier assumes a conservative split of 75/25%, meaning that 75% of the line section flow or bulk transformer flow is assumed to be transferred onto one leg of the ring bus or breaker-and-a-half. This means that an equivalent line section or bulk power transformer flow of 133% (100/75%) can be accommodated before exceeding the facility rating of the ring-bus limit or breaker-and-a-half limit. The most limiting series element facility rating, and where applicable, 133% of the most limiting ring-bus facility rating, or 133% of the most limiting facility rating of the adjacent breaker positions in a breaker-and-a-half is then used in the WECC model data submittal and in operations of PacifiCorp's system. In cases where a facility is jointly owned, the operator of the facility determines the facility rating and shares this rating information with the other joint owners. In cases where a facility is owned in segments (such as a transmission line terminal being owned by one party and the transmission line itself owned by another party), PacifiCorp coordinates with the owners of the other segments of the facility to insure that the most limiting rating is used by all parties.

3.4 Close-Out Requirements

The interconnection customer's interconnection facilities (ICIF) shall be designed and constructed in accordance with good utility practice. Within 30 calendar days of a project reaching commercial operations, the transmission provider will provide the interconnection customer with an "As-Built Documentation Checklist for Generator Interconnections."

Within 120 calendar days after the commercial operation date, unless both parties agree on another mutually acceptable deadline, the interconnection customer shall deliver to the transmission provider "as-built" drawings, information and documents for the ICIF, including:

- a one-line diagram
- a site plan showing the large generating facility and the ICIF plan
- elevation drawings showing the layout of the ICIF

- a relay functional diagram, relaying AC and DC schematic wiring diagrams, and relay settings for all facilities associated with the interconnection customer's step-up transformers, and
- the facilities connecting the large generating facility to the step-up transformers and the ICIF, and the impedances (determined by factory tests) for the associated step-up transformers and the large generating facility.

The interconnection customer shall also provide the transmission provider with specifications for the excitation system, automatic voltage regulator, large generating facility protection and control settings, transformer tap settings, communications facilities and transmission facilities, if applicable. Additionally, the interconnection customer shall provide reports documenting generating unit baseline and model validation testing, per applicable WECC criteria, to PacifiCorp transmission planning. (See Appendix B of this document for information on site documentation.)

The interconnection customer shall complete the "Closeout Checklist" posted to PacifiCorp's web page for large generation interconnections: http://www.pacificorp.com/tran/ts/gip/lgi.html. Completed forms are submitted to PacifiCorp transmission services, per the instructions in the checklist.

4 METERING POLICY FOR INTERCONNECTION CUSTOMERS

4.1 General

The purpose of this section is to assist the customer in accommodating PacifiCorp metering for the measurement of electricity supplied to the PacifiCorp transmission system. This section is applicable only to those providing power to the PacifiCorp transmission system. The general requirements are similar to, if not identical to, the general requirements for metering the supply of electrical service by PacifiCorp.

4.1.1 Interchange metering:

PacifiCorp requires revenue metering at the physical delivery point, typically at a PacifiCorp-owned transmission substation. In addition, redundant revenue metering is required for all interconnections 3 MW and greater, including dual-path communications. All metering shal be programed as bidirectional, to measure the total customer NET generation, including reverse back-feed load.

4.1.2 Net per unit generation metering (3 MW and greater):

PacifiCorp will require revenue metering for individual generators with ratings 3 MW and above. The metering shall be located on the high side of the customer-owned transformer. All metering shall be programed as bidirectional, to measure the per-unit NET generation, including reverse back-feed load.

At large wind farms with multiple collector stations, metering is required on the high side of each step-up transformer at the interconnection customer's generating facility's substation. The general requirements for the high-side collector metering are the same as the requirements for revenue metering at the point of interconnection.

For wind farms where a single step-up transformer serves multiple collector strings, the revenue metering shall be located on the low side of each collector string at the interconnection customer's collector substation.

At wind farms where future project phases are planned additional metering is required at each of the separate projects. The metering requirements for future

phases of a project shall be identical to the existing requirements, but do not prevent changes during the facility study.

Solar inverter arrays with inverters rated greater than 3 MW located on a single-circuit feeder, or identifed as separate generation projects, require individual revenue metering. Metering requirements for smaller or consolidated inverters shall be determined during the project study.

4.1.3 Consolidation of smaller generators less than 3 MW:

Individual per-unit revenue meters are not required when the total facility generation is less than 3 MW. The total NET generation shall be metered at a single location. This does not preclude Purchase Power agreements that may require additional metering for a separate generation contract or state retail tariff.

4.1.4 Generation gross and auxiliary metering:

Individual gross and auxiliary metering may be identified and installed separately to be feeders into a totalized NET generation calculation. Only those parasitic loads associated with the generator shall be metered.

Auxilliary station and facility metering may be identified and installed for customer state retail tariff loads.

All meters and instrument transformers shall be provided, owned, and maintained by PacifiCorp at the interconnection customer's expense. Unless other arrangements have been made, at customer-owned facilities, the customer will provide, own, and maintain all mounting structures, conduits, metering transformer cabinets, and switchboard service sections of the size and type approved by PacifiCorp.

Metering will be programmed such that the generators are only charged for consuming Mvars when the project is drawing MWs; i.e., not generating.

4.2 Basic Metering Requirements for Generators

4.2.1 Metering Requirements

PacifiCorp's most current standard high-end meter shall be used for all generation and transmission interchange projects. The applicable meter will be programmed bidirectionally, to measure the generation output to the PacifiCorp system, including any reverse customer retail load. The standardized PacifiCorp internal program will include bidirectional MWh and Mvarh energy, sliding demand quantities MW, and Mvar with instantaneous MW, MVAr, volt, and amp data. The meters will be programmed to record five-minute interval profile demand that includes bidirectional MWh and Mvarh and per-phase volt-hours. Additional time-of-use (TOU) quantities will be added to the basic program when required per tariff.

All programs shall include additional time-of-use bidirectional billing quantities for retail load as required on an individual, per-state tariff.

Metering data collected shall include working meter register reads, monthly register freeze reads, and five-minute demand interval profile data. Meters shall perform a self-freeze read at midnight each month. Meters shall be compatible with PacifiCorp's meter data acquisition system, and shall be interrogated daily or whenever necessary for maintenance purposes.

4.2.2 Requests from foreign utilities for metering data

Utilities may request digital DNP, Modbus and analog metering outputs, but they must be made prior to final contract agreements and final design.

Requests to remotely interrogate meters register and profile channels directly using Ethernet communications will not be approved.

At the PacifiCorp interchange point of delivery, customers may request alternate communication access, and, if approved, it will be written into the contract.

Inside the generation facility, the customer does have the option to provide a data phone line, however, it must be operational and tested prior to the installation of the revenue metering communication equipment.

4.2.3 Meter Testing

A standard meter system accuracy test shall be done with bi-annual certification (at the least), or as specifically agreed upon in the interconnection agreement. PacifiCorp will give all interested parties notification for the impending test at least two weeks in advance. A copy of the test results shall be given to PacifiCorp meter engineering for placement on file, for all parties involved to review. Net generation metering used for any PacifiCorp revenue purpose or data validation will be tested and maintained identically to the recognized interconnect revenue metering.

4.3 Metering Installations

The standard PacifiCorp metering installation is a wye-connected design. The measurement shall include a primary and backup meter located at the physical point of interchange for transmission metering, and at the high-voltage side of the generator step-up transformer for net generation applications. The equipment installation requirements will be written into the specific project's scoping documentation. 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.

4.3.1 Conduit for Revenue Metering Secondary Leads

For secondary metering leads between the connections at the meters and the instrument transformers located in the substation yard, the generation customer shall provide a minimum size of three-inch conduit. When the distance between the revenue instrument transformers and meter panel is greater than 500 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 at the generation facility, the 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. When PVC conduit is used, shielding of secondary wires will be inspected and approved by PacifiCorp.

4.3.2 Indoor Panel Applications

When indoor panels are required, adequate space shall be provided in the control building for installation of the PacifiCorp-owned and maintained equipment. To mount meters and hardware, PacifiCorp will specify and order. Panels are 12” wide by 90” high, and require a clear work space 36” wide by 90” high by 48” deep in front of and to the rear of the panel. The installation requirements will be written into the specific project’s scoping documentation.

4.3.3 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. At customer-owned generation facilities, the enclosure shall be mounted and installed by the customer/contractor at a suitable location. When outdoor meter enclosures are used, they typically serve both as the junction box and meter socket enclosure. The meter enclosure dimensions are 38” × 42”. The meter enclosure shall be NEMA 3R-rated.

4.3.4 Sealable Junction Box

PacifiCorp will specify order and supply the sealable junction box, including internal metering hardware. The enclosure at customer-owned generation facilities shall be installed by the customer/contractor. The junction box provides a means of terminating the revenue metering service conductors within the substation yard for indoor panel applications. The use of this junction box shall be coordinated with PacifiCorp prior to installation.

4.3.5 Secondary Leads and Termination

All revenue metering secondary leads or cable will be provided by PacifiCorp. Prior to ordering cable, the customer shall provide secondary wire run distances to PacifiCorp for proper wire sizing and circuit design. This is necessary to ensure that the burden rating of the instrument transformer will not be exceeded. The secondary leads shall conform to PacifiCorp’s standards and color-code requirements. Wire pulls and terminations shall be done by the contractor, and will be inspected and approved by PacifiCorp.

4.3.6 Metering Bypass Switch

PacifiCorp will specify and own, and the customer shall purchase and install switches which will isolate and bypass the metering transformers when necessary, to allow for maintenance. The specific requirements for metering bypass switches shall be written into the documentation during the facility study.

1. A metering bypass switch is required at the point of interconnection for all co-generation customers (these are typically customers who have large internal loads that could be served by PacifiCorp on a transmission tariff, including internal generation paralelled or supplied to the system). The metering bypass switch shall be owned and operated by PacifiCorp.
2. For customers only selling net-generation, it is recommended the interconnection customer install meter bypass switches to reduce operational disruption. If the customer elects not to install metering bypass switches, the customer generator will need to be taken off line for metering testing, repair and service. This switch is owned and operated by the interconnection customer.

4.3.7 Primary Metering Structures

The high-side primary metering structure must be designed to accommodate the standard PacifiCorp wye-connected instrument transformers. The physical location will be determined during the design phase of the project. When requested by the customer, PacifiCorp will supply outside parties with design details of the standard metering instrument transformer system.

4.4 Metering Installations Less than 5 MW

For 46 kV and higher voltages with a total net generation or interconnect less than five MW, it is acceptable for the revenue metering to be located on the low-side of the step-up transformer and loss compensated to the high-side. All low-side metering must be wye-connected and installed on the unregulated side of the voltage regulator. For this application, the metering installation is normally inside the customer facility and PacifiCorp-approved metering enclosures are required. Instrument transformers shall be located inside an approved PacifiCorp metering enclosure. It is not acceptable for meters, metering transformers, and accessories to be located on outside structures. In order to meter medium voltages, interconnection customers shall meet the requirements of the Electric Utility Service Equipment Requirements Code (EUSERC) Section 400.

4.5 Metering for Station-Service Power

Depending upon the generation facility's electrical sources, the station service power for connecting substation facilities may also require revenue metering. The same metering requirements as generation meters apply to station-service metering.

4.6 Meter Communication Requirements

All generation metering will require an Ethernet connection for use with the PacifiCorp MV-90 remote meter data collection system. If an Ethernet connection is not possible, a land line or other data communication connection shall be required to remotely interrogate the meter.

4.7 Instrument Transformers

Voltage and current instrument transformers are required to be combined CT/VT wye-connected and wire-wound. The revenue metering current transformers are to be classed at extended-range designated at 0.15 percent metering accuracy using three standard types (1 - 3). The instrument transformers will maintain their accuracy ranging from one (1) amp to 4,000 amps (type 1), 0.5 amp to 2,000 amps (type 2) and from 0.25 amps to 750 amps (type 3) primary current. The voltage transformers shall be 0.3 percent metering accuracy class. The accuracy class addresses 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.

4.8 Instrument Transformers, Low-Side

For low-side metering applications, it is not required for the metering transformer's accuracy to be extended-range. Voltage instrument transformers are required to be 0.3 percent and current 0.15 percent standard metering accuracy class for both ratio error and phase-angle error over the burden range of the installed metering circuit. Instrument transformers shall be of an approved PacifiCorp design and shall be located within the metering switchboard or switchgear enclosures.

4.9 Instrument Transformer Verification

Documented verification of instrument transformer turns (TTR) ratio, polarity, burden and insulation tests shall be performed. The objective is to ensure that the instrument transformer performance is documented and connected to known taps under known burden conditions.

4.10 Real Time Control Center(s) Meter Data

4.10.1 Facilities ≥ 3 MW

For interchange interconnects, including generating facilities totaling three (3) MW or greater, the following DNP real-time digital data is to be delivered to PacifiCorp Control, including (Alternate Control) Centers. Each generating facility shall have each generating unit metered. The only exceptions are conditions in which the generation facility is a consolidation of many smaller generators, each less than 10% of the total. In these cases, the generator real-time data requirements will be limited to quantities from the collector lines. Otherwise, the following real-time data for each generating unit shall be delivered: Real Power MW (+/-) and Reactive Power Mvar(+/-)

The following real-time data for the total plant shall be delivered:

- Real Power MW (+/-)., Reactive Power Mvar(+/-)
- Volts (A,B,C)
- Energy MWh (del), MWh (rec), MVarh (del) MVarh (rec)
- Wind speed (wind farms)
- Real-time status of circuit breakers and circuit switchers that complete the electrical path from PacifiCorp's system to the generators (except for the consolidation of the outputs of many small generators, in which case the status of collector line circuit breakers will be adequate).
- Status of alarms from PacifiCorp's relay and transfer trip equipment.

In addition to the above data requirements, refer to PacifiCorp's grid operations Document GCR-001, *Generation Control Requirement: Generation/Wind Farm / Substation Data* for creating a points list for the implementation of data into PacifiCorp's EMS SCADA database. GCR-001 addresses PacifiCorp's EMS SCADA data requirements and recommendations for generation facilities (including wind farms) and associated substations.) The current version of GCR-001 must be obtained from PacifiCorp's System Operations Department. Customers may view a sample of document GCR-001 here.

PacifiCorp will design, procure, own, and maintain all communication equipment used for revenue metering. The communication requirements will be written into the specific project's scoping documentation. The communication equipment shall be located near the metering. Typically the primary meter will supply a DNP output to the local RTU. The backup meter will be designated for the PacifiCorp Alternate Control Center(s) and typically feeds DNP directly into Ranger.

4.10.2 Wheeling Service

Wheeling service, under certain existing agreements on PacifiCorp's system, requires 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 (received) to (on) the PacifiCorp system. Export metering is required at the point of export (delivery) from (off) the PacifiCorp system.

All generators must meet applicable standards of the Western Electric Coordinating Council (WECC)

5 TELECOMMUNICATION REQUIREMENTS FOR FACILITY INTERCONNECTION

5.1 Application

Before a new facility is interconnected to the PacifiCorp power system, PacifiCorp will specify the associated telecommunications-related equipment required. This involves multiple critical systems on the power grid including metering and telemetering, protective relaying and interrupting devices, supervisory control and data acquisition (SCADA), and other data channels to support integration of the new facility. Due to the safety and reliability considerations involved, PacifiCorp requires that all such telecommunications-related equipment be owned, installed, and maintained by PacifiCorp at the generation facility's expense. For the protective relaying component, this requirement is limited to equipment installed to protect PacifiCorp's system, or to the tie line into PacifiCorp's system (if pilot line relay systems are required). The protective relays intended for protection of the interconnected generation facility are owned, installed, and maintained by the interconnection customer. When telecommunication channels are required as part of a protection and/or metering scheme, the general requirements below are to be followed.

Typical SCADA points required include but are not limited to:

From the point of interconnection substation:

Analogs:

- Net generation MW
- Net generator MVAR

Accumulator Pulses:

- Interchange metering kWh

From the interconnection customer's substation:

Status:

- All voltages of breakers (34.5 kV and above)
- Line relay alarm

Analogs:

- Real power flow through each of the line feeder breakers
- Reactive power flow through each of the line feeder breakers
- Reactive power flow from each of the shunt capacitor banks
- A phase transmission voltage
- B phase transmission voltage
- C phase transmission voltage

Additional SCADA points required for solar generation projects

Analogs:

- Total farm generation (MW)
- Average farm atmospheric pressure (Bar)
- Average farm temperature (Celsius)
- Irradiance (W/m2)

Additional SCADA points required for wind generation projects

Analogs:

- Total wind farm generation (MW)
- Average wind farm wind speed (m/s)
- Average wind farm atmospheric pressure (Bar)
- Average wind farm temperature (Celsius)
- Wind direction

5.2 General Requirements

The interconnection customer 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 for the alternate metering data circuit. Due to the critical nature of the protection, metering, and SCADA, PacifiCorp will own the communication facilities providing these circuits. The only exception to this is if no communication is required for protective relaying, in which case the SCADA may be on a leased commication circuit.

5.3 Telecommunication Circuit Requirements

5.3.1 New Generation Facilities < 3 MW with No Teleprotection Requirement

Metering requires a cell phone or other data communication connection for use with the PacifiCorp MV-90 remote meter data collection system. An Ethernet connection is approved, but not required.

5.3.2 New Generation Facilities ≥ 3 MW or New Generation Facilities < 3 MW with Teleprotection Requirement

An Ethernet connection for use with the PacifiCorp MV-90 remote meter data collection system is required. If an Ethernet connection is not possible, a land line or other data communication connection is required to remotely interrogate the meter.

5.3.2.1 Dispatch Business Telephone Line

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

5.3.2.2 Protective Relay Remote Access Business Telephone Line

A business telephone line is required at the location of the protective relay equipment for remote access to the protective relay equipment. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the interconnection customer must provide a local telephone line. Relevant CIP standards apply.

5.3.2.3 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 or transmission 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 expense 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 fiber optic system, power line carrier, microwave radio, or a combination of these systems.

5.3.2.4 SCADA Remote Terminal Unit (RTU)

Real-time data and/or control via a SCADA RTU is to be communicated to PacifiCorp's Control Center(s). Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the interconnection customer must provide either a local telephone company VG36, Class B, Type-3, 4-wire, full-duplex communication line or an MPLS T1 from the generation facility to PacifiCorp's location where the communication line terminates. 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.

5.3.2.5 Alternate Telemetry

An alternate-meter telemetering of the total generation facility's kW output is to be communicated on a separate channel, but in a manner similar to the SCADA channel, to meet requirements for NERC Standard EOP-008-0, *Plans for Loss of Control Center(s) Functionality*. Unless other arrangements are made to use PacifiCorp's existing telecommunications network, the interconnection customer must provide either a local telephone company VG36, Class-B, Type-3, 4-wire, communication line or an MPLS T1 from the generation facility to PacifiCorp's Control Center(s). PacifiCorp will specify the location of PacifiCorp's closest communications facilities where the communication line will terminate. Telecommunications channel for the alternate-meter telemetering equipment, when using PacifiCorp's telecommunications network, may consist of fiber optic cable, microwave radio, or a combination of these systems. The alternate-meter telemetering channel may use the same telecommunications system as the SCADA RTU channel providing it is not routed through PacifiCorp's Control Center(s).

5.4 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 expense of the generation facility or may be performed by the 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 facility at which the telephone company pedestal will 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

generating facility will be required to purchase and install the necessary telephone line protection equipment.

5.5 Communication Operating Conditions

5.5.1 Normal Operating Conditions

The 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 department.

5.5.2 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 department.

6 PROTECTION AND CONTROL POLICY

This section specifies the protection and control requirements for interconnection customers.

6.1 Applicability

The applicable protective standards of this section apply to all facilities interconnecting to any portion of PacifiCorp's transmission 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.

6.2 Protective Requirements

An important objective in the interconnection of facilities to PacifiCorp's 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.

The protection equipment for an interconnection facility must protect against faults within that facility and faults on the PacifiCorp system. As a general rule, an interconnection facility must also trip off-line (disconnect from the PacifiCorp system automatically) when PacifiCorp's transmission system is disconnected from the line onto which the facility is connected.

The interconnection customer must declare their operating intention as outlined below; then the protection requirements for the facility will be determined. Starting with the less complex protection scheme to the most complex protection scheme that would permit the most flexibility in the operation of the generation facility.

- **Emergency-only operation:** The onsite generation will operate isolated from PacifiCorp's network carrying only the customer's load. If the generation is paralleled with the network during transitions, the duration for which PacifiCorp's network is in parallel with the generation is limited, by design, to be less than 0.5 seconds. For this configuration, no protective relays for the protection of PacifiCorp's facilities are required.

- **Parallel operation but without power fed into the PacifiCorp transmission network:** The generator will operate in parallel with PacifiCorp's network longer than 0.5 seconds, but will not feed power into the PacifiCorp transmission network. This parallel operation can be continuous. Under this configuration, the protective relaying for the protection of PacifiCorp's transmission network will be limited to a device with a three-phase power function. This device will monitor the current and voltage on the interconnection customer's side of the step-up transformation. The function will be set to operate if real power in excess of the power losses of the transformation flows back toward PacifiCorp's transmission network for greater than 0.5 seconds. If this occurs, either the generator breakers or the main tie breakers will be tripped. This is to accomplish a separation of the generators from the PacifiCorp transmission network. The interconnection customer may decide the side of separation on which their load will reside.
- **Parallel operation with restriction only by the physical and contractual limitations of the PacifiCorp transmission network:** The generator will operate in parallel with the PacifiCorp transmission network greater than 0.5 seconds, and the power fed into the PacifiCorp transmission network is limited only by the physical and/or contractual limitations. Under this configuration, the protective relaying requirements will depend on the following issues:
  - The rated AC power output of the electrical equipment at the generation facility
  - The minimum load with which the generation facility could be isolated, upon the operation of fault-interrupting equipment
  - The configuration and voltage level of the network at the point of interconnection
  - The line protection and communication system in use on the network prior to the installation of the generation facility

At a minimum, voltage magnitude and frequency protection, monitored at the point of interconnection, is required. If conditions are outside the tolerance for the specified duration, the generator facility will be disconnected. More sensitive detection levels (over or under) will have longer time delays to detect problems in the operation of the controls at the generation facility.

For farther out-of-tolerance conditions, short time delays will be used. These short time delays are to disconnect the generation for transmission network problems that the normal fault detecting protection has not operated for. The settings for the voltage magnitude protection are listed in Tables 1A and 1B. The settings for the voltage frequency protection are listed in Tables 2A and 2B. The only exceptions to the values in Tables 2A and 2B are for generation facilities that are determined by PacifiCorp to be connected in a fashion that has integrated the facility into PacifiCorp's main transmission system in that region (by the presence of multiple transmission lines to major load substations; for these facilities, no over- or under-frequency relay functions will be implemented).

Table 1A – Voltage Relay Settings
(for relays with only three overvoltage elements and three undervoltage elements)

Pickup (per unit)	Time Delay (seconds)
1.20	0
1.15	0.5
1.10	1.0
0.90	3.0
0.75	2.0
0.65	0.3

Table 1B – Voltage Relay Settings
(for relays capacity for four overvoltage elements and four undervoltage elements)

Pickup (per unit)	Time Delay (seconds)
1.20	0
1.175	0.2
1.15	0.5
1.10	1.0
0.90	3.0
0.75	2.0
0.65	0.3
0.45	0.15

Table 2A – Frequency Relay Settings
(for relays with only three overfrequency elements and three underfrequency elements)

Pickup (hertz)	Time Delay (seconds)
61.7	0
61.6	30
60.6	180
59.4	180
57.8	7.5
57.3	0.75

Table 2B – Frequency Relay Settings
(for relays with capacity for three overvoltage elements and four underfrequency elements)

Pickup (hertz)	Time Delay (seconds)
61.7	0
61.6	30
60.6	180
59.4	180
57.8	7.5
57.3	0.75
57	0

Due to the high-energy capacity of the PacifiCorp transmission 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, specific 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, and ampacity), and the existing protection equipment connected to the PacifiCorp system.

PacifiCorp's minimum protection requirements are designed and intended to protect PacifiCorp's system only. As a general rule, neither party should depend on the other for the protection of its own equipment. Interconnected facilities are required to provide their own protection for all facilities on the customer-side of the point of interconnection. It is the interconnection customer's responsibility to protect their own system and equipment.

The interconnection customer shall design their protection system with sufficient redundancy such that the failure of any one component will still permit the interconnection customer’s facility to be isolated from PacifiCorp’s system under a fault condition.

6.3 Line Protection

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

The zone of protection refers to the area in PacifiCorp’s system where the interconnection customer’s facility must provide fault protection. When a fault occurs, protective relays are to cause the isolation of the interconnection customer’s facilities from PacifiCorp’s system. If there are any PacifiCorp customers connected to the system in the zone of protection, the protection system is designed so 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 by PacifiCorp’s equipment following a fault.

There are many options for providing the protective relay system for the zone of protection. These options will affect the up-front expense and the reliability of the interconnection customer's facilities. The use of pilot relaying or direct transfer trip communication may increase the expense to the interconnection customer, but 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 to 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 customer's interconnection facilities will be disconnected for fault conditions that normally would not require isolation of the facilities. With the use of a pilot relaying system or direct transfer trip, the number of these unnecessary operations can be greatly reduced.

If it is determined that pilot relaying is required to maintain the speed and selectivity of line fault detection, the protective relay system installed at the interconnection customer's facility that communicates with the protective relays at PacifiCorp's facility will be owned and maintained by PacifiCorp.

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

If transfer trip protection is required by PacifiCorp, the communications circuits for the protection system shall be a radio or optical fiber communication link. If the point of interconnection is to a power system 345 kV or higher, redundant and independently routed communication systems for the redundant line relaying are required. This can also be the case for selective interconnections at 230 kV. If the transient stablity of the 230 kV network is dependent on the high-speed clearing of all line faults, redundant communication systems will be required. The need for redundant communication systems for interconnections at 230 kV will be determined by PacifiCorp.

The PacifiCorp transmission system is designed for high reliability via multiple sources and paths to supply customers. Due to the 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.

Higher voltage interconnections require additional protection due to the greater potential for adverse impact to system stability, and the greater number of customers who would be affected. The acceptability and additional requirements of these interconnection proposals shall be determined by PacifiCorp on a case-by-case basis.

6.4 PacifiCorp Protection and Control System Changes

PacifiCorp will perform an interconnection study to identify the expense of any required modifications to PacifiCorp's protection and control systems that are required to interconnect a new facility. These protection and control system modifications are in addition to any identified transmission and distribution system upgrades.

Modifications shall include, but are not limited to, the addition of equipment to delay restoration of the circuit to which the generator is connected, until voltage is no longer detectable on the line. This is to prevent damage to the generator and to other customers' equipment that may result from the restoration of PacifiCorp's source to the circuit before the generator has disconnected.

6.5 Manual Disconnect Switch Requirements

A manual load-break disconnect switch is required for all interconnected facilities. For connections to the PacifiCorp transmission grid, a tap line switch may also be required if, in PacifiCorp's judgment, sufficient tap line exposure exists to warrant it. Refer to Appendix D for more details on tap line switches. For transmission line taps, two additional line switches, one on each side of the tap, are required to provide the facility better service and operating flexibility. Note that the installation of line 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 transmission system from the interconnected facilities. 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. 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 urgent incident or emergency, PacifiCorp may not be able to notify the developer in a timely fashion that it intends to operate a switch.

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

The interconnection customer may at its option install other disconnect switch(es) on its property to operate as its sees fit. PacifiCorp asks that the developer notify a PacifiCorp Control Center before operation of their disconnect switch(es).

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 deadend 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 (within one foot) to the metering. The PacifiCorp-operated disconnect shall be identified with a PacifiCorp-designated switch number plate.

For transmission voltage interconnections, metering is normally on the high side of the interconnection customer's step-up 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.

Notes:

1. Disconnect switches must be rated for the voltage and current requirements of the particular installation.
2. Disconnect switches must be gang-operated unless otherwise agreed to by PacifiCorp.
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 unless otherwise agreed to by PacfiCorp.

6.5.1 High-Voltage Disconnects

The interconnection customer shall submit a proposed switch specification to PacifiCorp. It shall be reviewed and approved in writting by a PacifiCorp engineering manager prior to its purchase and installation.

6.5.2 Conditions for Manual Disconnection

The interconnection customer must discontinue parallel operation when requested by PacifiCorp under the following conditions:

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

6.6 Fault-Interrupting Devices

6.6.1 PacifiCorp-Owned Facilities

Fault-interrupting devices will be installed at the point of interconnection in a facility owned and operated by PacifiCorp. In most cases, this facility will be a substation with a minimum of three circuit breakers configured in a ring bus. The only exceptions to this are if the point of interconnection is an existing PacifiCorp-owned substation, or if the transmission line at the point of interconnection is currently (and for the foreseeable future) operated normally, with only one connection to the transmission network.

If the point of interconnection is to an existing substation, the interconnection will be accomplished with the expansion of the existing bus configuration, if feasible. If the existing bus arrangement is a main/bypass or double operating bus arrangement, the addition of a single circuit breaker may be adequate. If the existing bus arrangement is a ring bus, and there are less than six breakers in the ring, the addition of a single circuit breaker in the ring bus configuration may be adequate. If the ring bus already has six breakers, or for system reliability due to the potential for a breaker failure, the ring bus may need to be reconfigured to a breaker and a half-bus arrangement, to accommodate the interconnection; then the number of additional circuit breakers needed will be in excess of three.

If the transmission line at the point of interconnection is currently (and for the foreseeable future) operated radially, then a single circuit breaker in the new point of interconnection substation may be adequate for the interconnection.

6.6.2 Interconnection Customer-Owned Facilities

The interconnection customer shall own any facilities dedicated to the moving or transforming of energy from the generation facility, unless PacifiCorp has potential plans for using the facilities to interconnect other customers. If the interconnection customer's transformation facility is adjacent to the point of interconnection substation, the interconnection voltage is less than 230 kV, and the top rating of the power transformer is less than 20 MVA, then PacifiCorp's circuit breaker in the adjacent point of interconnection substation can be used for clearing faults in the interconnection customer's transformer. The ground mats of the adjacent substations must be tied together. If these conditions are not met, the interconnection customer will be required to install their own ganged three-phase fault-interrupting device for their transformer. Fuses will not be acceptable.

If the transformer for the generation facility is remote from the point of interconnection, regardless of the size or voltage, the Interconnection customer will need a ganged three phase fault-interrupting device for transformer protection. The relay systems for fault detection for the tie-line between the two facilities will be determined by PacifiCorp, and will trip the circuit breakers at the point of interconnection and at the interconnection customer's facility.

7 GENERATION FACILITY PROTECTION AND CONTROL

All generating sources shall comply with all PacifiCorp design requirements and applicable WECC and/or NERC policies, criteria, and standards, including:

- NERC TPL Planning Standards TPL−001 through TPL−004, current versions
- WECC and NERC Modeling, Data and Analysis (MOD) Standards
- FERC Order no. 661-A
- Standard VAR-002-1.1b., *Generator Operation for Maintaining Network Voltage Schedules*
- ANSI Standards C50.10 and C50.13, regarding waveform and telephone interference

  WECC TPL-001-WECC-CRT-2, *System Performance Criterion, current version*
- WECC Standard VAR-501-WECC-1, *Power System Stabilizer*

All generating plants are required to remain in-service during three-phase faults with normal clearing and single line-to-ground faults with delayed clearing, as well as during the subsequent post-contingency period unless clearing the fault effectively clears the generator from the system. The clearing time will be determined by and documented by PacifiCorp on a location by location basis. If determined necessary by PacifiCorp, generating plants may be tripped after the fault period if this action is intended as part of a special protection system. Specific requirements will be determined during the Generator Interconnection Process.

In general, facilities capable of operating under voltage control are required to do so with the voltage sensed electrically at the point of interconnection; exceptions are determined by PacifiCorp during the interconnection study. Synchronous generators are required to be capable of delivering deliver 100% of rated power to the point of interconnection at a +/- 0.95

power factor (see Article 9.6.1 and 9.6.2 in PacifiCorp's OATT). PacifiCorp will provide a voltage or, in special cases, a reactive power schedule at the Point of Interconnection. Non-synchronous generating facilities are required, as a minimum, to have sufficient reactive capacity to enable the delivery of 100 percent of the plant output to the point of interconnection at unity power factor measured at 1.0 per unit voltage under steady state conditions.

See Appendix A of this document for more information on power system stabilizers.

7.1 Generators

The generating unit must meet all applicable American National Standards Institute (ANSI) and Institute of Electrical and Electronic Engineers (IEEE) standards. The prime mover, generator, and plant auxilliary equipment should also be able to operate within the full range of voltage and frequency excursions that may exist on the PacifiCorp system without damage. To enhance system stability during a system disturbance, the generating unit must be able to operate through the specified frequency ranges for the time durations listed in Tables 2A and 2B of this document.

7.1.1 Synchronous Generators

7.1.1.1 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.

7.1.1.2 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.

7.1.1.3 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 be capable of responding to the full generator reactive capability 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 account manager.

7.1.1.4 Voltage Regulator

The regulator 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(s), the generator shall be operated at either a voltage or a power factor schedule.

At various times, the generating facility may also be requested by the PacifiCorp Control Center(s) to produce more or less reactive power from that indicated on the regular schedule in order to meet the system needs.

7.1.1.5 Power-Factor Controller

The controller must be able to maintain a power-factor setting within ± 5 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.

7.1.1.6 Power-System Stabilizer (PSS)

Generators with properly tuned and calibrated PSS provide damping to electric power oscillations. Such damping improves stability in the electrical system and may also prevent an individual generator from unnecessary tripping. The current WECC policy requires that the PSS be an integral part of the voltage regulator and be incorporated into the excitation systems for all new generating units with suitable excitation systems. PacifiCorp can help determine, at the interconnection customer's expense, the suitability of an excitation system for PSS.

The PSS must be calibrated and operated in accordance with the latest standard procedures for calibration, testing, and operation of such equipment. These procedures are available from PacifiCorp. In addition, the calibration and test reports must be submitted to PacifiCorp's account manager and PacifiCorp transmission planning.

The generating facility shall not be considered operational until the PSS has been calibrated to PacifiCorp's satisfaction. A copy of the PSS calibration and operation procedures, as well as the suitability requirements, may be obtained from the PacifiCorp account manager. Additional information on PSS can be found in Appendix A.

The following criteria shall be used to determine when a PSS shall be installed on a synchronous generator, regardless of ownership, connected to the transmission system (by generator step-up transformer to 60 kV or higher voltage):

1. A PSS shall be installed on every existing synchronous generator that is larger than 75 MVA and is equipped with a suitable excitation system as defined in the WECC report, *Criteria to Determine Excitation System Suitability for PSS* available from the WECC web site.
2. A PSS shall be installed on every existing synchronous generator larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, or if the excitation system is updated so that it becomes a suitable excitation system as defined in the report mentioned in 1 above. This section applies to all machines whose excitation system is updated at any time after November 18, 1993.
3. A PSS shall be installed on every synchronous generator that is larger than 30 MVA or part of a complex that has an aggregate capacity larger than 75 MVA, and is equipped with suitable excitation systems as defined in paragraph 1 and is commissioned after November 18, 1993.
4. A PSS is not required on a station service generator.

When a generator equipped with a functional PSS is online, the PSS shall be in operation except for the following reasons:

1. Maintenance and testing.
2. PSS exhibits instability due to nonstandard transmission line configuration.
3. PSS does not operate properly due to a failed component.
4. Unit is operating in the synchronous condenser mode (very near zero power level).
5. When a unit is generating less power than its design limit for effective PSS operation.
6. When a unit is passing through a range of output that is a known "rough zone."

The aggregate MVA of the synchronous machines tonline and equipped with a functioning PSS shall not fall below the level identified in the most recent power system stabilizer study commissioned by the WECC.

When a synchronous generator equipped with a PSS is operating in the pump mode (P/G unit), and is connected to a transmission system such that the PSS does not produce negative damping, the PSS should be in service.

PSS equipment shall be tested and calibrated in conjunction with AVR testing and calibration. This will be done as often as is necessary to maintain reliable PSS performance in accordance with WECC *PSS Tuning Criteria*. PSS recalibration must be performed if AVR response parameters are modified. When a PSS is taken out of service because of a failed component, the party responsible will be expected to perform the needed repairs (or replacement) in a responsible and timely manner.

A PSS is not required for a synchronous condenser.

7.1.1.7 Power-Quality Analysis

At the discretion of the PacifiCorp transmission planning engineer, unattended generation facilities with capacity greater than 250 kW and with automatic or remotely-initiated paralleling capability may require a power-quality investigation analysis performed by PacifiCorp or a power-quality consulting firm. The analysis shall provide PacifiCorp with sufficient information to determine the status of the generation facility during system disturbances. The analyzer may provide remote access from PacifiCorp's Control Center(s) or engineering offices.

7.1.1.8 Generator Testing

Testing of the governor, generator and excitation system including the power system stabilizer shall be performed to verify proper parameters of the generator and exciter. Testing shall meet the WECC Generating Unit Baseline and Model Validation Test Requirements. Copies of the test reports with appropriate powerflow and stability data parameters identified shall be provided to the PacifiCorp account manager and PacifiCorp transmission planning. 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, which currently uses the Power Technologies, Inc. Power System Simulator for Engineering (PSSE) program.

7.1.1.9 Direct Digital Control (DDC)

Dispatchable generators larger than 10,000 kW are required to have real-time direct digital control of unit output from PacifiCorp's Control Center(s). This allows generation units to respond to power system load/frequency changes.

7.1.2 Induction Generators

Induction generators, and other generators with no inherent VAR (reactive power) control capability are required to provide power to the point of interconnection at unity. Such generators shall operate in as near a range of ± 0.95 power factor as is technically feasible without risk of self-excitation to provide an amount of reactive power equivalent to that required for a synchronous generator. They 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 instructions shall be provided on a case-by-case basis by the PacifiCorp Control Center(s).

7.1.3 Inverters

Inverters capable of stand-alone operation are capable of islanding operation and shall have similar functional requirements as synchronous generators. The total harmonic distortion in the output current of the inverters must meet IEEE Standard 519, *Harmonics 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.

7.2 Dedicated Step-Up Transformer

The dedicated transformer matches the generator voltage to the utility voltage and steps up the generator voltage to the interconnection level. It also serves to isolate the interconnection customer from other customers to a small degree.

The impedance of a dedicated transformer limits fault currents on the generator bus from the PacifiCorp system and also limits fault currents on the PacifiCorp system from the generator. Hence, it reduces the potential damage to both parties due to faults. The transformer must have a delta winding to reduce the generator harmonics entering the PacifiCorp system unless otherwise agreed to by PacifiCorp. The delta winding will also reduce the PacifiCorp system harmonics entering the generation facility.

The interconnection customer's generation facility shall be a zero-sequence current source to the transmission network. It is preferred that this source is provided with the step-up transformer, but the application of a separate grounding transformer will be considered. If a grounding transformer is used, the power size and impedance of the grounding transformer must create an effectively grounded system when the generation source is isolated.

A high-side, fault-interrupting device such as a circuit breaker or circuit switcher 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. (See Section 6.6.2.)

Lightning arresters, 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.

7.3 Special Protection Scheme (SPS) Participation Requirement for Generation Facilities

A SPS is a special protection system that automatically initiates one or more pre-planned corrective measures to restore acceptable power system performance following a disturbance. Application of SPS mitigates the impact of system disturbances and improves system reliability.

The operation of the electric generators may have an impact on the entire interconnected transmission system. A generation facility is therefore required to participate in remedial action schemes to protect local transmission lines and the entire system as PacifiCorp determines necessary.

A typical disturbance, as it is considered in the planning and design of the electric transmission system, is the sudden loss of one or more critical transmission lines or transformers. A widely-applied corrective measure is to instantaneously drop a sufficient amount of generation on the sending end of the lost transmission facility. This is known as generation dropping, and a participating generation facility may be disconnected from the transmission by the automatic SPS controller in much the same way as by a transfer trip scheme. A generation facility should therefore have full load rejection capability as

needed both for local line protection and SPS. The SPS design must be such that any single-point failure will not prevent the effective operation of the scheme.

Whether SPS shall be required will depend on the overall location and size of the generation facility and the load on the transmission system, the nature, consequences, and expected frequency of disturbances as well as the nature of potential alternative transmission reinforcements.

If PacifiCorp requires SPS participation for a particular generation facility, the interconnection customer shall be responsible for all related expenses.

7.4 Emergency Generator Operation

7.4.1 Notification/Documentation

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

Required documentation includes a description of generation and control system operation, single 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.

All documentation must be approved by PacifiCorp Engineering prior to installation. See Section 6.2, *Protective Requirements*.

7.4.2 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(s) 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(s) of their intent to transfer to their emergency generator and then again 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.

8 REACTIVE AND VOLTAGE RESTRICTIONS FOR INTERCONNECTION CUSTOMERS

The purpose of this section is to help all customers satisfy applicable PacifiCorp policies and procedures with regard to voltage and reactive power flow.

The policies and procedures of this section apply to all facilities interconnecting with PacifiCorp's system. All facilities must meet applicable WECC standards.

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

8.1 Reactive and Voltage Control Requirements

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, the generator loading, or other reasons, the interconnection customer shall install equivalent reactive support at the interconnection 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. Induction generators operate at a power factor absorbing VARs and require reactive support from the interconnected system unless they have installed corrective equipment.

Generators 10 MVA and larger shall be equipped with automatic voltage-control equipment. All generating units with automatic voltage-control equipment shall normally be operated in the automatic voltage regulation control mode. These generating units shall not be operated in other control modes (e.g., constant power factor control) unless authorized in writing to do so by the host control area. The control mode of generating units shall be accurately represented in operating studies. The previous statements in this paragraph are consistent with the Western Electricity Coordinating Council (WECC)’s minimum operating reliability criteria.

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 additional reactive support equipment that allows the operation of a generating unit within the range of 95% leading power factor (absorbing VARs) to 95% lagging power factor (producing VARs) measured at the point of interconnection and within an operating range of ± 5 percent of rated generator terminal voltage at full load. This is typical of induction generators. Generators shall be equipped and operated to control voltage. If the facility is not capable of providing positive reactive support (i.e., 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. The general control requirements are discussed below.

8.1.1 Generator Control

8.1.1.1 Voltage Control

Voltage regulators are required for all generators larger than 10 MVA unless otherwise agreed. 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 unless otherwise agreed. 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 excitation controller regulating the generator stator terminal voltage in automatic 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 generating 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.

8.1.2 Power Factor Control

In special cases with small units, as mutually agreed, a power factor controller could 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(s) will 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 meet the 0.95 leading/lagging power factor requirement, switched shunt compensation or dynamic reactive support equipment may be required.

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

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 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 applicable tariff(s). When surplus power is being sold, PacifiCorp has operational control of the power factor at which the power is delivered.

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.

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 applicable tariff(s).

For generation connected to the PacifiCorp transmission system at less than 1 MW, with the total output being sold to PacifiCorp, all electricity produced, excluding station load, is sold to PacifiCorp. PacifiCorp therefore has operational control of VAR production within the generator operating range.

8.1.3 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 that are not an integral part of the generator control system shall be switched on and off at the request of PacifiCorp.

8.1.4 Induction Generators

Switched capacitors may be required by PacifiCorp in areas where severe reactive limitations exist. 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.)

8.2 Synchronous Generator Frequency/Speed Control

A governor is required on the prime mover, set to provide a five (5) percent droop characteristic as specified by WECC criteria. Exceptions must be approved by PacifiCorp. Governors shall be operated unrestrained to regulate system frequency.

8.3 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 have this information reviewed before procuring 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 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 the 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.

8.4 Direct Digital Control

Dispatchable generator units larger than 10,000 kW are required to have real-time direct-digital control of unit output from the PacifiCorp Control Center(s). This will allow generation units to respond to system load/frequency changes.

8.5 Power System Stabilizer Operating Requirements for Generators

If a power system stabilizer (PSS) is a required part of the generator's voltage regulator, it must be operated and maintained in accordance with the standard procedures developed by WECC. Recalibration and testing of the PSS is required at least every five years, with data submitted for approval to PacifiCorp's account manager

PacifiCorp is responsible for the safe and reliable operation of the electric system. Because failure of the interconnection customer to recalibrate and test its PSS could adversely impact system operation, PacifiCorp reserves the right either to disconnect from, or refuse to parallel with, any interconnection customer which does not operate and maintain its generator control systems in accordance with applicable reliability criteria or standards. Any sanctions or penalties assessed due to failure to meet WECC Reliability Management System (RMS) operating requirements (available from the WECC website at *http://www.wecc.biz*) for units equipped with PSS shall be the sole responsibility of the interconnection customer.

8.6 Power Quality Policy

8.6.1 Voltage Fluctuation and Light Flicker Limits

A customer connected to the PacifiCorp system must not cause harmful voltage fluctuations or interference with service and communication facilities. Any generation facility that does so is subject to being disconnected from the PacifiCorp system until the condition has been corrected. Specific limits are in PacifiCorp's Engineering Handbook section 1C.5.1 and available on the company's website. This is consistent with IEEE Std. 1453.

8.6.2 Harmonic Limits

All customers 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*. These same limits are also listed in PacifiCorp's Engineering Handbook Document 1C.4.1, *Harmonic Distortion*, available on the company's external websites: http://www.rockymountainpower.net/con/pqs.html and http://www.pacificpower.net/con/pqs.html.

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 customer 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 expenses 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 interconnected facility 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.

9 OPERATING REQUIREMENTS

1. The interconnection customer shall not commence parallel operation of interconnected facility(s) until final written acceptance has been given by PacifiCorp. PacifiCorp reserves the right to inspect the interconnection customer's facility and witness testing of any equipment or devices associated with the interconnection. The interconnection customer shall submit a written, detailed procedure with specific requirements for initial commissioning of the interconnection customer's generation and interconnecting facilities for PacifiCorp approval. PacifiCorp and the interconnection customer shall each identify one representative to serve as a coordination contact to be the initial point of contact and coordinate communications between the parties for both normal and emergency conditions. PacifiCorp and the interconnection customer shall notify each other in writing of the personnel appointed as coordination contacts. PacifiCorp and the interconnection customer shall abide by their respective switching and tagging rules for obtaining clearances for work or for switching operations on equipment. Such switching and tagging rules shall be developed in accordance with OSHA standards. PacifiCorp and the

interconnection customer shall develop mutually acceptable switching and tagging rules for PacifiCorp's and the interconnection customer's facilities that involve common clearance requirements. The interconnection customer shall follow PacifiCorp directives with regard to emergencies on the PacifiCorp system.

2. The following items are required before the Customer is given permission for each operational milestone:
   a. Backfeed requires that protection and metering be complete and operational.
   b. First synchronization requires that all protection, metering, *and communications* be complete and operational. Power is delivered to the system after first synchronization, but prior to commercial operations' energy test.
   c. Commercial operations requires that all testing is complete, verifying that the customer is ready to deliver commercial power.
3. The interconnection customer is not permitted to energize a de-energized PacifiCorp circuit, and shall follow lockout/tagout procedures.
4. The operation of the interconnection customer's on-site generation shall not cause the service voltage for other PacifiCorp customers to go outside the requirements of ANSI C84.1, Range A.
5. The operation of the interconnection customer's on-site generation shall be conducted in a manner that minimizes reactive flow from the on-site generation to the PacifiCorp system, except when requested to assist in voltage control on the PacifiCorp system.
6. The interconnection customer shall design a large generating facility to maintain composite power delivery at continuous-rated power output measured at the generator terminals, at a power factor (measured at the point of interconnection) within the range of 0.95 leading to 0.95 lagging, unless the transmission provider has established different requirements that apply to all generators in the control area on a comparable basis. This applies to all units, unless specifically exempted by FERC, NERC, or PacifiCorp. The interconnection customer's voltage regulation equipment shall be designed and operated to limit VAR flow to a power factor between 0.95 leading and 0.95 lagging, except for units connected to the PacifiCorp distribution system rated at 15 kV and less. These generators are to maintain unity power factor and shall not regulate distribution system voltage unless requested or required to do so by PacifiCorp per IEEE 1547 Standards.
7. The operation of the interconnection customer's on-site induction machines or other non-synchronous generation shall be required to provide the same VAR support as synchronous machines unless specifically exempted by FERC or other governmental authority.
8. Operation of the interconnection customer's on-site generation and equipment shall not adversely affect the voltage regulation of the PacifiCorp system. The interconnection customer shall minimize the reactive flow, except when requested to assist in voltage control on the PacifiCorp system. The interconnection customer shall provide adequate voltage control to minimize voltage regulation on the PacifiCorp system caused by generator loading conditions.
9. In cases where starting or load-changing on induction generators will have an adverse impact on PacifiCorp system voltage, step-switched capacitors or other techniques may be required to attenuate the voltage changes to acceptable levels.

10. For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the PacifiCorp system. The generator voltage-VAR schedule, voltage regulator, and transformer ratio settings will be jointly determined by PacifiCorp and the interconnection customer to ensure proper coordination of voltages and regulator action. The interconnection customer is encouraged to generate their own VAR requirements to minimize power factor adjustment charges and enhance generator stability.
11. Induction or other non-synchronous generating installations shall provide the same voltage and VAR support as synchronous installations, except where specifically exempted by FERC or other governmental authorities.
    a) Where the interconnection customer's installation does not comply with this requirement, and the existing PacifiCorp system can reliably supply the VARs for voltage support without installations of reactive compensation, the interconnection customer may either purchase the reactive requirements for voltage support from PacifiCorp, or supply such requirements with its own compensation. The reactive supply obtained from PacifiCorp shall be billed on a tariff, to be determined during contract discussions.
    b) Where the interconnection customer's installation does not comply with this requirement and the existing PacifiCorp system cannot reliably supply the VARs for voltage support, PacifiCorp shall install apparatus on the PacifiCorp system to supply the required VARs. The expense of the apparatus, controls, installation, and operation shall be paid according to OATT requirements and procedures.
12. Reactive power supply requirements for inverter systems are similar to those for induction generators, except where specifically exempted by FERC or other governmental authorities.
13. To avoid self-excitation, care shall be exercised in applying power factor correction capacitors directly to or electrically near induction generator terminals.
14. The interconnection customer shall discontinue parallel operation when requested by PacifiCorp for the following purposes:
    a) To facilitate maintenance, tests, or repairs of the PacifiCorp electric system.
    b) During emergencies on the PacifiCorp system.
    c) When the interconnection customer's generating equipment is interfering with other customers on the PacifiCorp system.
    d) When an inspection of the interconnection customer reveals a condition hazardous to the PacifiCorp system or a lack of scheduled maintenance records is found.
15. WECC requires all members to share in an operating reserve or Generation Reserve Sharing Pool. PacifiCorp requires a specific agreement to supply operating reserve to cover the interconnection customer 's generation to load at that site. The generator will provide or contract for adequate generation to meet WECC or power pool generation reserve, spinning reserve, and load-following requirements.
16. The interconnection customer shall comply with all NERC, WECC, and PacifiCorp Underfrequency Load Shedding requirements. During any underfrequency situation, the interconnection customer shall agree to immediately make available to PacifiCorp any spinning or operating reserves that exist on their generation.

17. The interconnection customer shall adhere to WECC Operating Standards, any PacifiCorp operating guides, and any additional operating requirements either stated herein or mutually agreed to elsewhere. The latest revision of all applicable documents shall serve as the minimum requirements for system operation. These documents are available at the publishing organizations respective website. Contact the account manager for further details.
18. PacifiCorp and the interconnection customer may, in accordance with good utility practice, remove from service facilities or network upgrades as necessary to perform maintenance and to test, install, or replace equipment. PacifiCorp and the interconnection customer shall make reasonable efforts to coordinate outages for maintenance, with dates and times acceptable to both parties.
19. The interconnection customer shall compensate PacifiCorp for any incremental energy or reactive losses, and for incremental demand charges resulting from changes in system power flow caused by the interconnection customer's system addition, in accordance with OATT requirements and procedures.
20. The interconnection customer shall operate the interconnection facilities in compliance with the latest revision of the National Electric Safety Code, applicable state codes, PacifiCorp Engineering Handbooks referenced in this document, and IEEE Std 519. Failure to comply with these policies and standards will result in the interconnection being opened. The interconnection will not be re-established until compliance has been determined.
21. The interconnection customer shall maintain its interconnection facilities and any generating equipment that could negatively impact the PacifiCorp system in good order. PacifiCorp reserves the right to inspect the interconnection customer's facilities on a periodic basis or whenever it appears that the interconnection customer is operating in a manner hazardous to PacifiCorp's system integrity.

9.1 Specific Generator Interconnection Requirements

The following requirements apply specifically to generation interconnections. The equipment associated with the interconnection customer's generation equipment should be protected in accordance with the practices described in the latest revision of the following ANSI/IEEE standards or guides. There may be special requirements imposed by PacifiCorp due to the specific project or application.

ANSI C50.10-1990, *Rotating Electrical Machinery - Synchronous Machines*

ANSI 50.12-1982, *Requirements for Salient Pole Synchronous Generators and Condensers*

ANSI C50.13-1989, *Requirements for Cylindrical-Rotor Synchronous Generators*

ANSI C50.14-1977, *Requirements for Combustion Gas Turbine Driven Cylindrical-Rotor Synchronous Generators*

ANSI/IEEE C37.101, *Guide for Generator Ground Protection*

ANSI/IEEE C37.102, *Guide for AC Generator Protection*

ANSI/IEEE C37.106, *Guide for Abnormal Frequency Protection for Power Generating Plants*

ANSI/IEEE Std 1001, *Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems*

IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems*

In addition to the above-listed requirements, the following standards apply:

1. Any generating unit or line/end-user interconnection to the PacifiCorp electric system with its output purchased by PacifiCorp or another network customer shall be considered a “Network Resource” under the terms of Part III of the OATT.
2. Generator installations requesting WECC accreditation must meet all NERC, WECC, and PacifiCorp requirements, including WECC Generation Reserve Sharing Pool requirements, URGE testing, and any reactive testing requirements.
3. The generator step-up (GSU) transformer connection will be determined by the system impact study. In general, the GSU must be effectively grounded on the utility side providing an adequate ground reference and will isolate the generator’s zero sequence current from the PacifiCorp system through the use of an ungrounded connection on the generator side.
4. Induction generators may use a speed-matching relay (Device 15) as a means of synchronization and to limit the magnetizing inrush current/voltage drop. The speed matching must keep voltage flicker at the point of interconnection within PacifiCorp voltage flicker requirement and within IEEE 519 requirements.
5. Generation operated in parallel with the PacifiCorp electric system may supply additional fault current energy which shall be disconnected in case of a disturbance on PacifiCorp's system. The existence of parallel generation may alter the operation of protective devices normally used by PacifiCorp to protect the system.
6. Equipment shall be provided to detect system abnormalities in the interconnection customer 's or PacifiCorp's system, and shall have the capability to isolate the sources of the disturbance. At a minimum, the interconnection customer shall provide adequate protective devices to:
   a) Detect and clear the generator(s) from short circuits on PacifiCorp facilities serving the interconnecting facilities.
   b) Detect the voltage and frequency changes which can occur if PacifiCorp facilities serving the interconnecting facilities are disconnected from the main system, and clear any interconnection customer generation/load from the isolated system if necessary.
   c) Prevent reclosing the interconnection customer’s generation to PacifiCorp after an incident of trouble, until authorized to reclose by PacifiCorp’s Portland or Salt Lake City Control Center.
   d) Isolate interconnection customer’s generation from the PacifiCorp electric system upon:
      - Receipt of a direct trip signal from an upstream PacifiCorp substation.
      - Failure of the communications channel used for direct tripping.
      - Receipt of a trip command from the Portland or Salt Lake City Control Center via SCADA.
7. PacifiCorp, at its discretion, may require out-of-step protection and/or loss of excitation protection and/or overexcitation protection to trip or block-trip the interconnection customer's interconnection. The requirement for this protection will be determined during system studies.

8. The interconnection customer should be aware that certain conditions on PacifiCorp's system can cause negative sequence currents to flow in the generator. It is the sole responsibility of the interconnection customer to protect the interconnection customer's equipment from excessive negative sequence currents.
9. The interconnection customer shall design its facilities (generation or otherwise) to avoid causing dynamic voltage excursions above 1.2 and below 0.7 pu according to WECC performance design standards (see the WECC Reliability Handbook for NERC/WECC Planning Standards, Guidelines, and System Performance Table W-1 of TPL-001-WECC-CRT-2). The WECC Reliability Handbook may be accessed via the WECC website or may be obtained upon request from the account manager.
10. The interconnection customer shall design its generation to remain online for faults and any resulting low voltages to maintain system reliability. Generation must remain online for the duration of a normally-cleared (single- or three-phase) fault on the electric system up to a maximum of nine cycles, as well as for the recovery from such a normally-cleared fault even where the voltage drops to zero during the clearing of the fault.
11. Generators must be designed to remain online for normal clearing system faults within close proximity to the plant switchyard. Voltage may approach zero at the switchyard bus for nine cycles for some types of faults. Control systems, contactors, motors, and auxiliary loads which are critical to the operation of the plant must not drop out under these conditions. Critical 480 V supply contactors must be provided with ride-through capability where required. Additionally, generator protection systems such as the Load Drop Anticipator, Early Valve Actuator, or Power Load Unbalance should not be designed to trip a generator for normal clearing external faults or stable swings.
12. The interconnection customer shall design its generation to remain online for off-nominal frequency operation according to IEEE C.37.106.
13. Only solid state microprocessor underfrequency relays shall be used on generators to provide off-nominal frequency protection.
14. Synchronous generators with an individual unit nameplate rating greater than 10 MVA or a facility aggregate rating greater than 20.0 MVA shall have generator protection set such that it does not result in tripping of the generator for the following conditions:
    a) Generator terminal voltages that are within five percent of the rated nominal design voltage.
    b) Generator terminal voltage deviations that exceed five percent but are within 10 percent of the rated nominal design voltage and persist for less than 10 seconds.
    c) Generator volts per hertz conditions that are less than 116 percent (of generator nominal voltage) that last for less than 1.5 seconds.
    d) Generator overexcited stator currents (or generator apparent impedance) less than 150 percent of nameplate rating persisting for less than five seconds.
15. Documentation of the generator protection and controls that could respond to these conditions by tripping the generator shall be provided to PacifiCorp. In the event the generating equipment owner cannot correct or mitigate these potential generator trip conditions, a request for a waiver may be made to PacifiCorp. A waiver may be justified in certain special circumstances such as low adverse reliability consequences from generator tripping.

16. The generator step-up and auxiliary transformer tap settings shall be coordinated with PacifiCorp transmission systems voltage requirements. Generating equipment owners shall provide PacifiCorp with generator step-up and auxiliary transformer tap settings and available ranges.
17. The AVR control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. The generating equipment owner shall provide PacifiCorp with the AVR control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions.
18. All new synchronous generators connected to the PacifiCorp transmission system with a nameplate rating greater than an individual unit nameplate rating greater than 10 MVA or a facility aggregate rating greater than 20.0 MVA shall be equipped with a speed/load governing control that has a speed droop characteristic in the three to six percent range. The preferred droop characteristic setting is five percent. Notification of changes in the status of the speed/load governing controls must be provided to the PacifiCorp Control Center.
19. Prior to commercial operation, the generating equipment owner shall provide PacifiCorp with open circuit, step-in voltage reference step test results. Recording of generator terminal voltage and field voltage shall be clearly labeled so that initial and final values can be identified in physical units.
20. Generating equipment owners shall annually test the gross and net dependable summer and winter capability of their units. These test results shall be provided to PacifiCorp.
21. Generating equipment owners shall test the gross and net reactive capability of their units at least every five years. These test results shall be provided to PacifiCorp.
22. Generating equipment owners shall test the AVR control and limit functions of their units at least every five years. An initial test result shall be provided to PacifiCorp prior to commercial operation and every five years thereafter. The initial test results shall include documentation of the settings AVR control and limit functions. Typical AVR limit functions are maximum and minimum excitation limiters and volts per hertz limiters. Documentation of the generator protection that coordinates with these limit functions shall also be provided. Typical generator protection of this type includes overexcitation protection and loss of field protection.
23. The interconnection customer generator shall meet all WECC requirements for providing an appropriate high-response excitation system and shall make provisions for a Power System Stabilizer (PSS) on all units / facilities that meet the capacity size criteria identified in the WECC Policy Statement on Power System Stabilizers. The exciter shall meet the following requirements:
    e) The response ratio less is less than 2.0 as demonstrated through calculations consistent with IEEE Standard 421.2-2014.
    f) The response time is less than 0.1 second as demonstrated through the completion of a response ratio test.
    g) The open circuit step-response test is satisfactory; where satisfactory means that the response is not oscillatory in nature.
24. The interconnection customer shall demonstrate that they have the appropriate exciter model by providing plots of the model output in PSSE or other modeling software compared with plots of the generator response ratio tests and open-circuit step tests. The interconnection customer shall complete generating unit baseline and

model validation testing per WECC's Generating Unit Model Validation Test Policy, and shall provide the test results to PacifiCorp, comparing model performance with test results.

25. The interconnection customer's generator shall meet all WECC requirements for the installation and tuning of a PSS.
26. Where stabilizing equipment is installed on generating equipment for the purpose of maintaining generator or transmission system stability, the generating equipment owner is responsible for maintaining the stabilizing equipment in good working order and promptly reporting any problems interfering with its proper operation to PacifiCorp grid operations.
27. PacifiCorp will maintain a contact list of all interconnection customers tied to PacifiCorp's transmission circuits for routine and emergency grid operation use. This list will compile the normal and emergency phone numbers for the interconnection customer's facilities and an e-mail address if available. It will be the responsibility of the interconnection customer to notify PacifiCorp in a timely fashion when any of this information is altered or changed for whatever reason.

    To keep the list current, the new updated information will be supplied to:

    PacifiCorp Transmission Interconnection Manager
    825 N.E. Multnomah Blvd, Ste 1600
    Portland, Oregon 97232
    (503) 813-6496

10 COMMISSIONING FOR FACILITY INTERCONNECTIONS

The following outlines PacifiCorp's procedure for performing commissioning activities. 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. It is the interconnection customer's responsibility to provide adequate notification through the PacifiCorp project manager for commissioning activities, and to pay all commissioning expenses.

For equipment owned by the interconnection customer, the interconnection customer shall meet the (initial and ongoing) testing and maintenance requirements of the currently effective version of NERC PRC-005 for protective systems, and shall provide PacifiCorp with all test reports before PacifiCorp will allow the facility to parallel. It is 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. The interconnection customer shall report any problems to PacifiCorp, and shall resolve problems in a reasonable time (within one year at a minimum). If this places PacifiCorp or the interconnection customer in a compromised position of liability, the generation shall be disconnected until the relay issue(s) is/are resolved to PacifiCorp's satisfaction. (Also see Section 6.2, *Protective Requirements*.)

For equipment installed in PacifiCorp-owned facilities, or PacifiCorp-owned equipment located in an interconnection customer's facilities, the interconnection customer shall follow all installation and equipment testing and commissioning requirements as specified in PacifiCorp's EPC Exhibit A-1, Section 16, *Substation Testing & Commissioning*. PacifiCorp will either utilize its own qualified employees or a contractor from its approved contractor list for relay commissioning testing.

Upon initial parallel operation of a generating facility, or any time interface hardware or software is changed which may affect the functions listed below, a commissioning test must be performed. PacifiCorp reserves the right to witness any commissioning tests performed by the interconnection customer.

10.1 Interconnection Metering

PacifiCorp-owned, metering equipment shall be tested by authorized PacifiCorp personnel.

Coordination between the developer and PacifiCorp's project manager is recommended at least two months before the backfeed date to assure that timelines for project completion are met. The interconnection customer will provide unrestricted access for PacifiCorp's employees or vendor employees (whichever are utilized) to the equipment to be commissioned.

10.2 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 by either a current (primary-to-secondary) or voltage (secondary-to-primary) test, or by the use of test equipment desinged specifically for CT testing as approved by PacifiCorp.
3. CT circuits must be checked for proper connections and continuity.
4. A single-phase burden check must be made on each phase of each current circuit feeding PacifiCorp required relays. This requirement may be waived in cases where all of the devices in the current circuit are low-input impedance devices such as microprocessor-type relays.
5. A megger check of the total circuit with the ground wire lifted must be done to prove that only one ground exists.

10.2.1 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. Relays shall meet the manufacturer's specified tolerances and shall never exceed the tolerances are listed below:

Table 3–PacifiCorp Relay Tolerances

Relay Type	Tolerance
Current / Voltage / Time	± 10.0 percent
Impedance / Phase Angle	± 6.0 percent
Frequency	± 5.0 percent

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

10.2.2 Primary Disconnect Switch

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

10.2.3 Checklists and Forms for Equipment Commissioning

The project manager will have available, for both internal and external use, checklists and forms for all relevant facility interconnection equipment to be commissioned for the interconnection customer.

The commissioning process will be coordinated with other PacifiCorp employees in the field through the project manager.

10.3 Pre-Parallel Test for Generator Developers

Where generation has a rated output in excess of 100 kW, the entity shall reimburse PacifiCorp for the expense 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.

When possible, 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. The appropriate commissioning form shall be completed by the PacifiCorp representative on site at the time of the pre-parallel inspection.

10.3.1 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 test will require isolating the generator to prevent motoring, typically by

opening the generator leads, and enegizing the facilty generator bus from the point of interconnection back to the point of isolation. The energized portion of the bus must include the generator potential transformers used for synchronizing for the test to be valid. The equipment must show an "in-phase" condition.

4. Check the generator phase rotation. (PacifiCorp's phase rotation is A B C counterclockwise).
5. 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.

10.3.2 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.

10.3.3 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 by PacifiCorp dispatch.
4. Verify operation of the generator at 95 percent lagging and 95 percent leading power factors at rated output. Coordination with a PacifiCorp Control Center will be required during this test to monitor and control system voltage during the test.
5. Verify operation of the generator at 95 percent and 105 percent of per unit terminal voltage while delivering rated output. Coordination with a PacifiCorp Control Center will be required during this test to monitor and control system voltage during the test.
6. Typically, pre-parallel inspections can be performed within a normal working day. PacifiCorp shall dedicate one full work day to observe the tests. If a test cannot be completed by 6 p.m., the PacifiCorp representative may elect to reschedule it.

10.4 Parallel Operation for Generator Developers

10.4.1 Clearance for Parallel Operation (For Testing Purposes Only)

The PacifiCorp project manager shall contact the PacifiCorp Control Center(s) at least 72 hours (three days) before the pre-parallel test and obtain a clearance for parallel operation. The PacifiCorp project manager shall provide the Control Center(s) 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 this testing only permission is granted, the generator may operate in accordance with a previously executed interconnection agreement or Master Electric Service Agreement.

10.4.2 Power System Stabilizer

During the 14-day testing period, the Power System Stabalizer (PSS) shall be calibrated and tested in accordance with the latest applicable WECC calibration requirements and test procedures. The test report shall be submitted for approval to PacifiCorp's project manager and PacifiCorp transmisison planning. Adequate testing of the PSS can only occur on the generating unit(s) after pre-parallel inspection has been satisfactorily completed and the units are paralleled and supplying load. The generation facility shall not be considered officially operational until this PSS calibration and testing has been completed to PacifiCorp's satisfaction.

10.4.3 Permission for Parallel Operation

At the end of this period, if the interconnection customer has not received written permission from PacifiCorp to operate in parallel, the interconnection customer must isolate from PacifiCorp until written permission is received. 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. PSS tests and calibration have been completed.
4. All other outstanding issues have been resolved, including rights-of-way, deeds of conveyance, insurance verification, and operating agreements.
5. 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.
6. If applicable, firm capacity performance testing of new generators cannot begin until the interconnection customer receives written permission from PacifiCorp to parallel.

10.5 Reliability and Redundancy

The interconnection customer shall design the protection system with sufficient redundancy or relay coordination such 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 backup unless otherwise agreed to by PacifiCorp.

10.6 General Notes

The PacifiCorp system has ABC counterclockwise rotation.

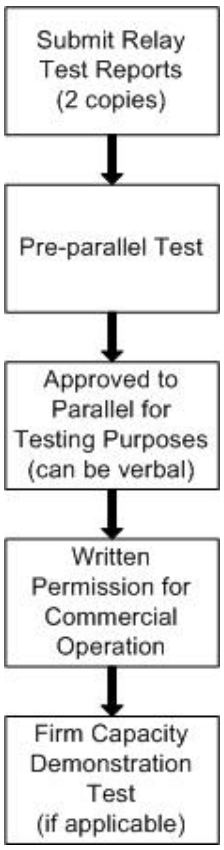
Any changes to PacifiCorp-required protection equipment or major substation equipment (transformers, breakers, etc.) must be submitted to the PacifiCorp representative for review and approval by the appropriate PacifiCorp engineer prior to the changes being made.

Maintenance and testing of customer-owned, PacifiCorp-required protective relays and the breaker(s) must meet PacifiCorp, NERC and WECC standards.

Questions should be directed to the PacifiCorp account manager.

10.7 Simplified Flow of Pre-Parallel/Parallel Test Procedure

Figure 2–Pre-Parallel/Parallel Test Procedure



11 GLOSSARIES

Several industry and regulatory agency glossaries define the terms that apply to interconnection:

PacifiCorp's Open Access Transmission Tariff (OATT)

Current version can be found on PacifiCorp's OASIS page at the following link:

http://www.oasis.oati.com/ppw/index.html
(*See page 511.*)

NERC Glossary:
http://www.nerc.com/files/glossary_of_terms.pdf

WECC Glossary:
https://www.wecc.biz/Reliability/WECC%20Glossary%20of%20Terms%20and%20Naming%20Conventions%20Updated%203-10-2015.pdf

Appendix A Power System Stabilizer Operation and Performance Requirements

The Power System Stabilizer (PSS) aids overall electric system stability by providing additional machine damping. It will supplement the proportional voltage control used on the excitation system.

There are several types of PSS. Each type uses a different input signal, such as frequency, shaft slip, or accelerating power. The most common type of PSS uses frequency as its input signal; it consists of a source-signal transducer providing frequency deviation of the generator bus from 60 Hz and derivative and lead-lag networks to provide proper phase advance. Generator excitation is controlled by a composite of voltage and frequency.

Figure H1 provides a mathematical control block diagram of a conventional excitation system which includes a PSS that uses frequency as its input signal. The transducer provides translation of bus frequency deviation into an appropriately noise-free electrical signal to serve as input to the derivative network.

The associated filtering and wave-shaping shall be designed to emit the following signal requirements:

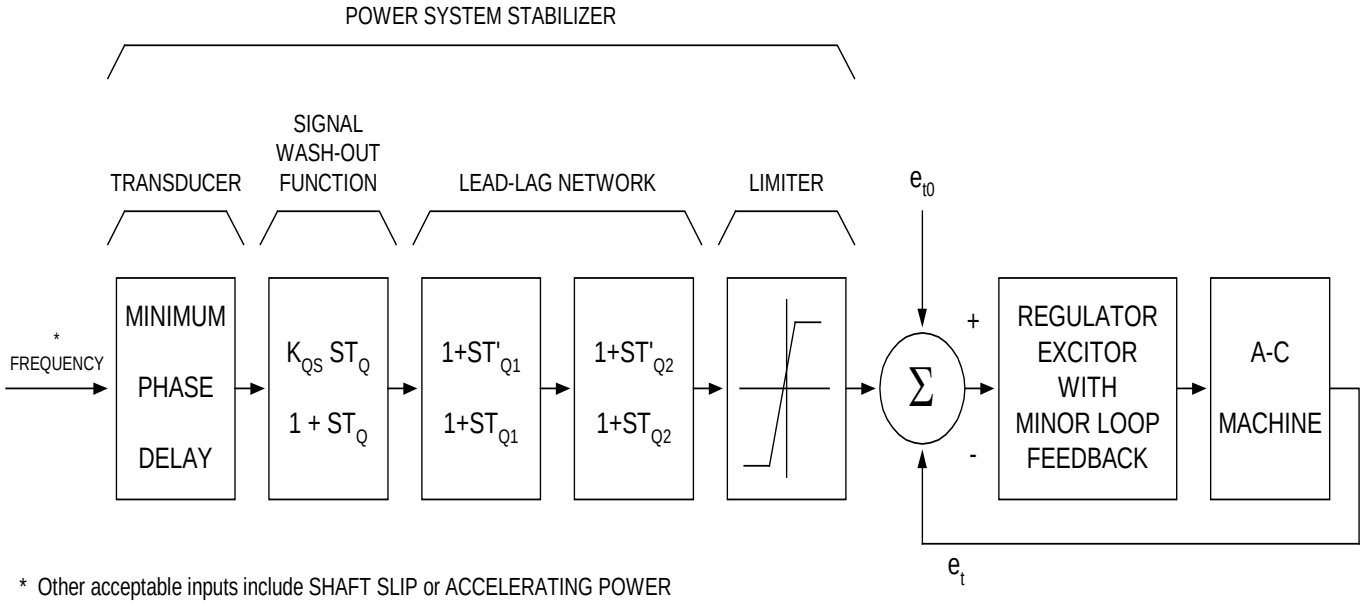
- Linearity between 59.5 and 60.5 Hz.
- Filtering and noise suppression to provide ripple shall not exceed one percent and a time constant less than 0.02 second.
- Large variations of power-supply voltage and frequency resulting from external or internal causes shall not affect performance of the PSS.

To provide the required phase lead, the PSS parameters shall be adjustable by calibrated dial settings. The parameter ranges shall be as follows:

KQs	0. 1 to 50 per unit
TQ	0. 1 to 60 seconds
T4QJ	0. 1 to 1. 5 seconds
TQi	0. 02 to 0. 1 second
T'Q2	0. 1 to 1. 5 seconds
TQ2	0.02 to 0. 1 second

FIGURE A-1

Block Diagram of Regulator-Exciter System with Power System Stabilizer



* Other acceptable inputs include SHAFT SLIP or ACCELERATING POWER

Appendix B Site Documentation

PacifiCorp requires system drawings and relay instruction books from the dispersed generation facility. Sets of preliminary drawings are needed first. Sets of final drawings and equipment instruction books are required according to the timetable outlined below.

I. Provide one set of preliminary drawings one year prior to energizing the plant. The required drawings include:

   A. Station location plot plan

   B. Station one-line

II. Provide a set of final drawings and instruction books four months prior to energizing the plant.

   A. Provide three sets of the following:

      1. Station one-line

      2. Tie breaker schematics, including

         a. control schematics

         b. current schematics

         c. potential schematics

      3. Diagram of the relay panel arrangements

One copy each of these drawings shall be routed to the Area Engineer, Relay and Protection Department, and the Transmission/Distribution Account Manager.

It is preferred that the copies be provided in paper format. Electronic files are acceptable if they are convertible to paper format in the size acceptable to the engineer assigned to the project. Please send all of these documents to the following address:

PacifiCorp Transmission Services
825 NE Multnomah Blvd, Ste 1600
Portland, Oregon 97232
(503) 813-7237
brian.fritz@pacificorp.com

Appendix C Technical Data Sheet

TECHNICAL DATA SHEET

FOR

SYNCHRONOUS MACHINES

ON THE

PACIFICORP SYSTEM

FOR POWER FLOW, TRANSIENT STABILITY, AND FAULT ANALYSIS

Questions regarding this Technical Data Sheet should be directed to:

Director, PacifiCorp Transmission Services
825 NE Multnomah Blvd, Ste 1600
Portland, Oregon 97232
(503) 813-7237
brian.fritz@pacificorp.com

NOTE 1: Please complete a separate data sheet for each generator that normally operates interconnected with PacifiCorp's Transmission System.

NOTE 2: This data sheet is for synchronous machines only, not induction machines

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Project Name _____Unit Number _____Log Number _____

Name of Person Completing Data Sheet _____

Telephone _____ FAX _____ Email _____

GENERATOR DATA

1. Generator Manufacturer _____
2. Year Generator was Manufactured _____
3. Rated Generator MVA _____MVA
4. Rated Generator Terminal Voltage _____kV
5. Rated Generator Speed _____RPM
6. Number of Poles _____
7. Rated Generator Power Factor _____
8. Generator Efficiency at Rated Load _____%
9. Moment of Inertia (Turbine plus Generator) ωR^2: _____$lb\text{-}ft^2$
10. Inertia Time Constant (on machine base) H: _____sec. (MJ/MVA)
11. SCR (Short-Circuit Ratio - the ratio of the field current required for rated open-circuit voltage to the field current required for rated short-circuit current) _____
12. Typical Generator Auxiliary Load _____MW
13. Maximum Power Output _____MW
14. Please attach generator reactive capability curves. If these curves are not available give the maximum and minimum reactive limits. Q_{MAX} _____MVAR, lagging; Q_{MIN}: _____MVAR, leading
15. Rated Hydrogen Coating Pressure (Steam Units) _____psig
16. Please attach a simple one-line diagram that includes the generator step-up transformer bark plant load, meter, and transmission-level bus.

GENERATOR DATA (continued)

All impedance data should be based on MVA given in (3) and on kV given in (4) a previous page.

17. X_d	direct-axis unsaturated synchronous reactance	_____pu
18. X_q	quadrature-axis unsaturated synchronous reactance	_____pu
19. X'_d	direct-axis unsaturated transient reactance	_____pu
20. X'_{ds}	direct-aids saturated transient reactance	_____pu
21. X'_q	quadrature-Axis unsaturated transient reactance	_____pu
22. X'_{qs}	quadrature-axis saturated transient reactance	_____pu
23. X''_d	direct-axis unsaturated subtransient reactance	_____pu
24. X''_{ds}	direct-axis saturated subtransient reactance	_____pu
25. X''_q	quadrature-axis unsaturated subtransient reactance	_____pu
26. X''_{qs}	quadrature-axis saturated subtransient reactance	_____pu
27. X_L	stator leakage reactance or Potier reactance	_____pu
28. R_a	armature resistance	_____pu
29. T_{q0}	direct-axis transient open-circuit tin,* constant	_____sec
30. T_{q0}	quadrature-axis open-circuit time constant	_____sec
31. T'_{q0}	direct-axis subtransient open-circuit time Constant	_____sec
32. T'_{q0}	quadrature-axis subtransient open-circuit time constant	_____sec
33. TA_{GEN}	armature short-circuit time constant	_____sec
34. T_D	direct-axis transient short-circuit time constant	_____sec
35. T_Q	quadrature-axis transient short-circuit time constant	_____sec
36. T'_D	direct-axis subtransient short-circuit fine constant	_____sec
37. T'_Q	quadrature-exis subtransient short-circuit time constant	_____sec
38. X_2	negative sequence reactance (sat./unsat.)	_____/_____pu
39. X_0	zero sequence reactance (sat/unsat)	_____/_____pu

40. Please attach a plot of generator terminal voltage versus field current that shows the air gap line, the open-circuit saturation curve, and the saturation curve at full load and rated power factor.

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

EXCITATION SYSTEM INFORMATION

Listed below are the most common excitation systems used for voltage regulation of large synchronous generators. Each type of excitation system has been specified according to its manufacturer and name. In addition, the different excitation systems have been grouped together according to common characteristics.

Please indicate, in the space provided on the left, the excitation system used for your generator. if your type of excitation system is not listed, please write the manufacturer and exciter type under the category that most accurately describes your excitation system.

A. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is independent of the generator terminal voltage and current.

_____1. Allis Chalmers, Regulex regulator
_____2. General Electric, Amplidyne regulator - NA101
_____3. General Electric, Amplidyne regulator - NA108
_____4 General Electric, Amplidyne regulator - NA143
_____5. General Electric, GDA regulator
_____6. Westinghouse, Mag-A-Stat regulator
_____7. Westinghouse, Rototrol regulator
_____8. Westinghouse, Silverstat regulator
_____9. Westinghouse, TRA regulator
_____10. Brown Boveri, Type AB or Type ABC regulator
_____11. Brown Boveri, Type DC regulator
_____12. Other. Manufacturer/Type: _____/_____

B. Rotating DC commutator exciter with continuously acting regulator. The regulator power source is bus fed from the generator terminal voltage

_____1. Westinghouse, PRX-400 regulator
_____ 2. Other. Manufacturer/Type _____/_____

C Rotating DC commutator exciter with non-continuously acting regulator (i.e., regulator adjustments are made in discrete increments

_____1. General Electric, GFA4 regulator
_____2. Westinghouse, BJ30 regulator
_____3. Other. Manufacturer/Type _____/_____

EXCITATION SYSTEM INFORMATION (Continued)

D. Rotating AC Altemator Exciter with non-controlled (diode) rectifiers. The regulator power source is independent of the generator terminal voltage and current (not bus-fed).
_____1. Westinghouse Brushless
_____2. Westinghouse High Initial Response Brushless
_____3. Other: Manufacturer/Type_____/_____

E. Rotating AC Alternator Exciter with controlled (thrysistor) rectifiers. The regulator power source is fed from the exciter output voltage.
_____1. General Electric Alterrex
_____2. Other: Manufacturer/Type_____/_____

F. Rotating AC Alternator Exciter with controlled (thyristor) rectifiers.
_____1. General Electric Alterrex
_____2. Other: Manufacturer/Type_____/_____

G. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from the generator terminal voltage.
_____1. Canadian General Electric Silcomatic
_____2. Westinghouse Canada Solid State Thyristor System
_____3. Westinghouse Type PS Static System, Type WTA, WHS, WTA-300 regulators
_____4. ASEA Static System
_____5. Brown Boveri Static System
_____6. Reyrolle-Parsons Static System
_____7. GEC-Elliott Static System
_____8. Toshiba Static System
_____9. Mitsubishi Static System
_____10. General Electric Potential Source Static System
_____11. Hitachi Static System
_____12. Other: Manufacturer/Type_____/_____

H. Static Exciter with controlled (thyristor) rectifiers. The regulator power source is bus-fed from a combination of generator terminal voltage and current (compound-source controlled rectifiers system).
_____1. General Electric SCT-PPT or SCPT System
_____2. Other: Manufacturer/Type_____/_____

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

Other Excitation System Information

I. Please attach a *copy of* the instruction manual for your excitation system. Make sure that a block diagram or schematic of the excitation system is included in the manual. The diagram should show the input, output, and all feedback loops of the excitation system.

J. If the manufacturer's data *for* the excitation system (i.e., time constants, gains, and saturation curves) are available, please attach these also.

K. What is the excitation system response ratio (ASA)?
(See *Power System Control and Stability* by Anderson and Fouad, 1st ed., 1977, pg 456, Fig E.1, for a precise definition of ASA.)

L. What is the rated exciter output voltage at *full* load? _____Volts

M. What is the maximum exciter output voltage (ceiling voltage)? _____Volts

N. Other comments regarding the excitation system?

_____

_____

_____

_____

_____

_____

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_____

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

POWER SYSTEM STANTLTZER INFORMATION (supplementary excitation system)

(Note: Complete this section only if your machine has PSS control.)

A. Manufacturer.
_____1. General Electric
_____2. Westinghouse
_____3. Toshiba
_____4. TTI
_____5. Alsthom
_____6. Other: Manufacturer _____

B. Is your PSS digital or analog? _____

C. What is the actuating signal (the input signal) for your PSS?

___ Bus frequency ___ Shaft slip ___Accelerating power ___Other

If "Other", indicate signal: _____

D. Please attach the instruction manual for your PSS. The manual should include a block diagram or schematic of the PSS and the correspondence between dial settings and the time constants or PSS gain.

E. Please attach a copy of the test report for your PSS. This report should contain the dial settings or time constants and TISS gain. If this report is not available, write the dial settings below:

1. T_1 washout or reset time constant dial setting _____
2. T_2 first lead time constant dial setting _____
3. T_3 first lag time constant dial setting _____
4. T_4 second lead time constant dial setting _____
5. T5 second lag time constant dial setting _____
6. K MS gain dial setting _____
7. V_{max} maximum PSS output dial setting _____
8. V_{cut} dial setting for which PSS is set to zero when generator terminal voltage deviation is too large _____
9. Other _____ / _____
10. Other _____ / _____

F. Who installed your PSS?

Name: _____
Company: _____
City, State: _____
Phone/Fax: _____/_____

POWER SYSTEM STABILIZER INFORMATION (continued)

C. Other comments regarding the PSS?

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

TURBINE-GOVERNOR INFORMATION

Please complete part A for steam, gas or combined-cycle turbines, part B for hydro turbines, and part C for both.

A. Steam, gas or combined-cycle turbines

1. Steam turbine, Gas turbine, or Combined-cycle: _____

2. If steam or combined-cycle, does the turbine system have a reheat process (i.e., both high and low pressure turbines) ? _____

3. If steam with reheat process, or if combined-cycle, indicate, in the space provided, the percent of full load power produced by each turbine:

   by low pressure turbine or gas turbine _____%

   by high pressure turbine or steam turbine _____%

B. Hydro turbines

1 What is the turbine efficiency at rated load _____%

2. What is the length of the penstock? _____ft

3. What is the average cross-sectional area of the penstock _____ft^2

4. What is the typical maximum head (vertical distance from the bottom of penstock, at the gate, to the water level)? _____ft

5. Is the water supply run-of-the-river or reservoir? _____

6. What is the water flow rate at the typical maximum head? _____ft^3/sec

7. What is the average energy rate? _____kW-hrs/acre-ft

8. What is the estimated yearly energy production? _____kW-hrs

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

C. Complete this section for each machine, independent of the turbine type.

1. Turbine manufacturer _____

2. Maximum turbine power output _____MW

3. Minimum turbine power-output (while on line) _____MW

4. Governor information:

   a. Droop setting (speed regulation) _____

   b. Is the governor mechanical-hydraulic or Electro-hydraulic? (Electro-hydraulic governors have an electronic speed sensor and transducer.) _____

   c. Please provide below any time constants you have from the manufacturer describing the speed of response of the governor. Be sure to identify each time constant.

_____ _____sec

_____ _____sec

_____ _____sec

_____ _____sec

d. Other comments regarding the turbine governor system?

_____

_____

_____

_____

_____

_____

_____

_____

_____

Technical Data Sheet for Synchronous Machines on the PacifiCorp System

STEP-UP TRANSFORMER DATA

1. Transformer Bank No._____

2. Rated MVA _____MVA

3. Available H.V. Taps _____ kV, _____ kV, _____ kV, _____ kV, _____ kV, _____ kV
   Available L.V. Taps _____ kV, _____ kV, _____ kV, _____ kV, _____ kV, _____ kV

4. Please indicate present tap settings: H.V. Tap: _____kV
   L.V. Tap: _____kV

5. Does transformer have tap changing under load? _____

6. Is transformer a regulating-type transformer? _____

   If yes, please indicate regulating voltage range and the number of steps.
   _____kV to _____kV Number of steps: _____

7. Please indicate how the transformer windings are connected.

H.V. Side:		LV. Side:	
_____	Wye	_____	Wye
_____	Gumnded Wye	_____	Grounded Wye
_____	Delta	_____	Delta

8. Please attach a copy of the transformer test report, if available.

9. If the transformer test report is not available, please provide the "lowing impedances using the IAVA base given in (2) above:

R_T	per unit resistance	_____PU
X_T	per unit reactance	_____PU
B_T	per unit magnetizing susceptance	_____PU
C_T	per unit core loss conductance	_____PU

10. Other comments regarding the transformer?

_____

_____

_____

_____

OF OPERATING PRACTICE QUESTIONNAIRE
SYNCHRONOUS GENERATORS

NOTE: The information on this survey is used to improve transmission models used in engineering studies.

A. Generation and Plant Load (served by own generation) Pattern:

1. Generator Size _____MVA

2. Please indicate typical peak generation level (in MW). If generator serves plant load on the same side of the PacifiCorp meter, also indicate typical load level. (Metered power equals peak generation level minus corresponding plant load).

   a. Peak Generation Level _____MW

   b. Corresponding Plant Load _____MW

3. Please indicate typical planned seasonal and time period variations as percentage of levels specified in (2) above. Approximate a percentage in Increments; of 25% (0%, 25%,50%,75%, 100%)

	Summer April thru October		Winter November thru March	
Time of Day (24-Hr format)	Generation	Load	Generation	Load
06:00 - 12:00				
12:00 -18:00				
18:00 - 22:00				
22:00 - 06:00.				

B. Type of Regulation (Complete either Section 1 or 2)

1. Maintain Voltage _____

Typical Voltage Range ____kV to _____kV
Generator Rated Terminal Voltage _____kV

Standard PacifiCorp operation bandwidth is 0.90 lagging (producing vars) to 0.95 leading (absorbing vars). If actual operation (not capability) is typically narrower than these limits, please indicate range.

_____Lagging (producing vars) to _____Leading (absorbing vars)

Do you ever operate with manual voltage control (excitation system bypassed)? _____

If yes, what percent of the time? _____

Under what conditions?

_____

_____

_____

_____

2. Maintain Power Factor _____

Typical Machine Power Factor Range _____
To _____

Is this automatically controlled? _____

If so, approximately how fast can the controller respond to a change in power factor?

_____0 - 20 seconds
_____20 seconds - 3 minutes
_____greater than 3 minutes

Standard PacifiCorp bandwidth is 95 to 105% of rated voltage. If actual operation (not capability) is typically narrower than these limits please indicate range.

_____ to _____ % of rated voltage

C. Governor Control

Do you operate with an automatic turbine speed controller (governor)? _____

If yes, do you operate with it blocked? _____

If yes, what percent of the time? _____%

Under what conditions?

_____

_____

_____

D. Other comments regarding operation of your generator?

_____

_____

_____

_____

_____

_____

_____

_____

Appendix D Requirements for Transmission Line Selector Switches and Associated Cost Responsibilities

Purpose

The purpose of this guideline is to: 1) ensure service availability can be maintained to single-tapped customers, 2) ensure system-wide consistency in the installation of selector switches on transmission lines, and 3) provide a clear understanding of the associated cost responsibilities wherever transmission lines are single-tapped.

Definition of Selector Switches

Line selector switches are installed on one or both sides of a single-tap in order to provide operational flexibility in service to customers on the tap line. Selector switches are operated to avoid customer outages for planned maintenance in the main line and to restore service in the case of an unplanned interruption of the main line (see Figure 1). Selector switches do not reduce the number of outages to the customer, but they do provide a relatively inexpensive way of reducing the duration of a sustained outage[1] by allowing the transmission line to be sectionalized. Selector switches cannot reduce the frequency of maintenance or unplanned outages on the single-tap line to the customer.

Applicability

Effective immediately, selector switches are a standard service requirement for all new single-tap interconnections to PacifiCorp's transmission system. This is applicable where a single-tap configuration is to be used to interconnect a new load or generation customer to a PacifiCorp-owned transmission line (46 kV and above) or when a change in service is requested by an existing load or generation customer. This guideline will also be incorporated into PacifiCorp's transmission interconnection requirements.

At PacifiCorp's discretion, a selector switch may not be required should the distance from the new single-tap interconnection to either end of the transmission line or to an existing selector switch on the line be approximately one mile or less, with minimal exposure to causes of outages (trees, traffic, etc.). Refer to Attachment 1 for a list of criteria in determining the need for selector switches.

[1] A sustained outage is an outage to a customer extending more than two minutes.

Single-Tap Configuration

For standard transmission tap interconnection to a customer-owned substation, a single-tap is provided from the most feasible transmission line to the customer's facility. With standard service, the customer will experience interruptions to their facility during a transmission line outage unless the customer has adequate on-site back-up generation.

The installation of selector switches reduces the duration of a sustained outage, but it does not eliminate momentary outages to a customer. For a sustained outage on the transmission line, service to the customer will be interrupted for the duration of time[2] it takes PacifiCorp to open the appropriate selector switch to isolate the faulted line section and close the breaker on the non-faulted line section. As an example, for a sustained outage between Station "B" and the tap point, selector switch "B" would be opened to isolate the problem and service to the customer would be restored by closing the circuit breaker at Station "A".

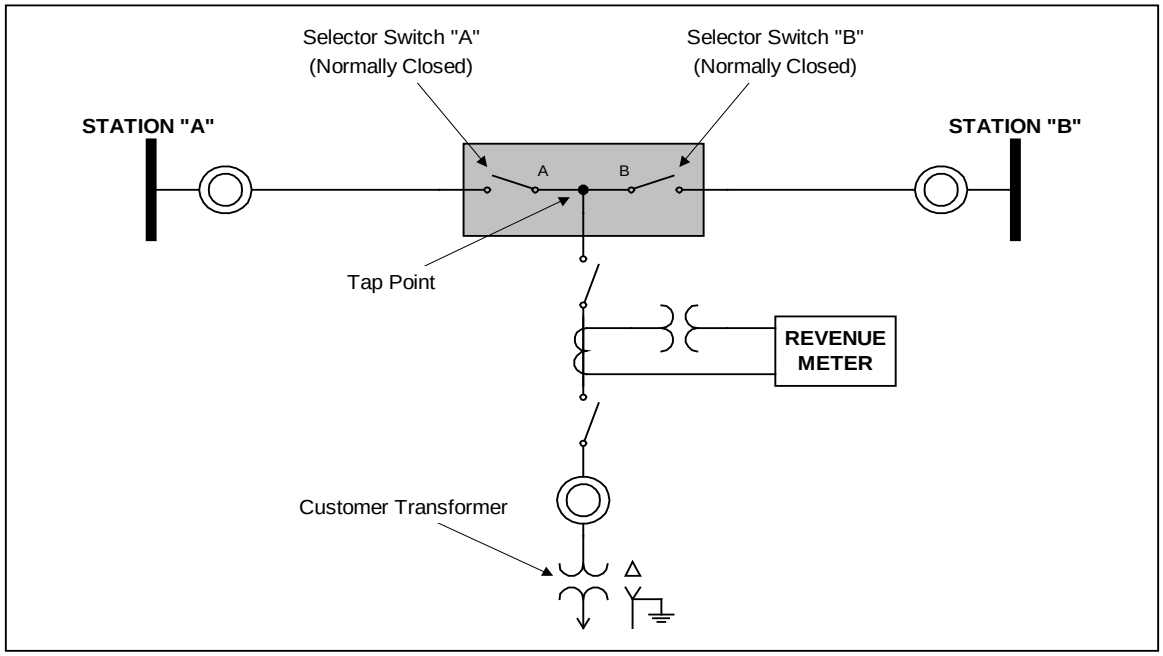


Figure 1–Typical Single-Tap Configuration with Selector Switches

Ownership and Accessibility

- Pacificorp shall own, operate, and maintain all selector switches in the system to serve customer-owned substations or customer load.
- PacifiCorp's personnel must be able to access all selector switches installation 24 hours a day.

[2] Duration of time refers to the time it takes a Pacificorp operator to manually operate the selector switches from the time Pacificorp was notified of an outage. This time could vary from about a half hour to several hours depending on the nature of the outage. Should the outage be such that the customer could be energized from one end of the transmission line, the appropriate selector switch would be opened.

Cost Responsibilities for New Single-Tap Interconnections[3]

Effective immediately, with the exception allowed in Attachment 1, line selector switches are a PacifiCorp requirement for all new single-tap interconnections to the transmission system as a means of providing adequate level of service availability. In accordance with PacifiCorp's electric tariff, if line selector switches are considered special facilities, the installation cost of the switches will be determined by the application of relevant jurisdictional state commision rules as appropriate[4].

For existing single-tap interconnections, refer to Attachment 2 for the need and installation cost responsibilities for line selector switches.

Selector Switches Capability

- PacifiCorp will determine on a case-by-case basis whether selector switches should be capable of line dropping and/or loop splitting and would specify the capabilities of the selector switches and any associated interrupting devices.

- PacifiCorp will identify locations with access difficulties, such as mountainous terrain, and may recommend that the selector switches be motor-operated and remotely controlled.

Selector Switches Installation

Selector switches must be located in close proximity (within one pole or tower structure) on either side of the single-tap on the transmission line. All structures used for mounting the selector switches will be determined and designed by PacifiCorp.

[3] New Single-Tap Interconnections: A customer requesting PacifiCorp's service who is not currently interconnected to PacifiCorp's transmission system.

[4] Unbundling of electric and transmission services may reqire the cost responsibilities be revised.

Appendix D, Attachment 1

Criteria for Determining When One or No Selector Switch Is Required

- Radial Transmission Line

  At PacifiCorp's discretion, only one selector switch may be required on the non-source side of the tapped transmission line.

- When One Selector Switch Is Sufficient

  At PacifiCorp's discretion, PacifiCorp may elect to install only one selector switch on one side of the single-tap provided that the line section without the selector switch is: 1) approximately one mile or less from the tap point to the end of the transmission line, with minimal exposure to causes of outages (trees, traffic, etc.), or 2) approximately one mile or less from the interconnection tap point of another customer with line selector switches, with minimal exposure to causes of outages.

- When No Selector Switches Are Required

  At PacifiCorp's discretion, selector switches may not be required on the transmission line if the distances on either side of the tap to the ends of the transmission line or other selector switches on the line are approximately one mile or less, with minimal exposure to causes of outages.

Criteria for Determining When Selector Switches Are Required

- Length of Transmission Line

  Long transmission lines have more exposure and have a greater frequency of being forced out of service for maintenance. Long lines are also at greater risk of experiencing sustained faults due to increased exposure to adverse elements.

- Location and Route of Transmission Line

  Geographic and environmental conditions affect the total exposure of the line to adverse elements. For example, transmission lines that traverse mountainous areas are subject to a greater number of outages due to exposure to trees and inclement weather.

- Multiple Customers on Transmission Line

  At PacifiCorp's discretion, PacifiCorp may require selector switches on a transmission line where multiple customers are tapped as a means of maintaining service availability.

Appendix D, Attachment 2
Need and Installation Cost Responsibilities for Existing Single-Tap Interconnections

This guideline is not intended for retroactive application to existing single-tap interconnections, however the installation of line selector switches on existing single-tap interconnections will be considered on a case-by-case basis based on the following:

Existing Single-Tap Customer's Request for Selector Switches

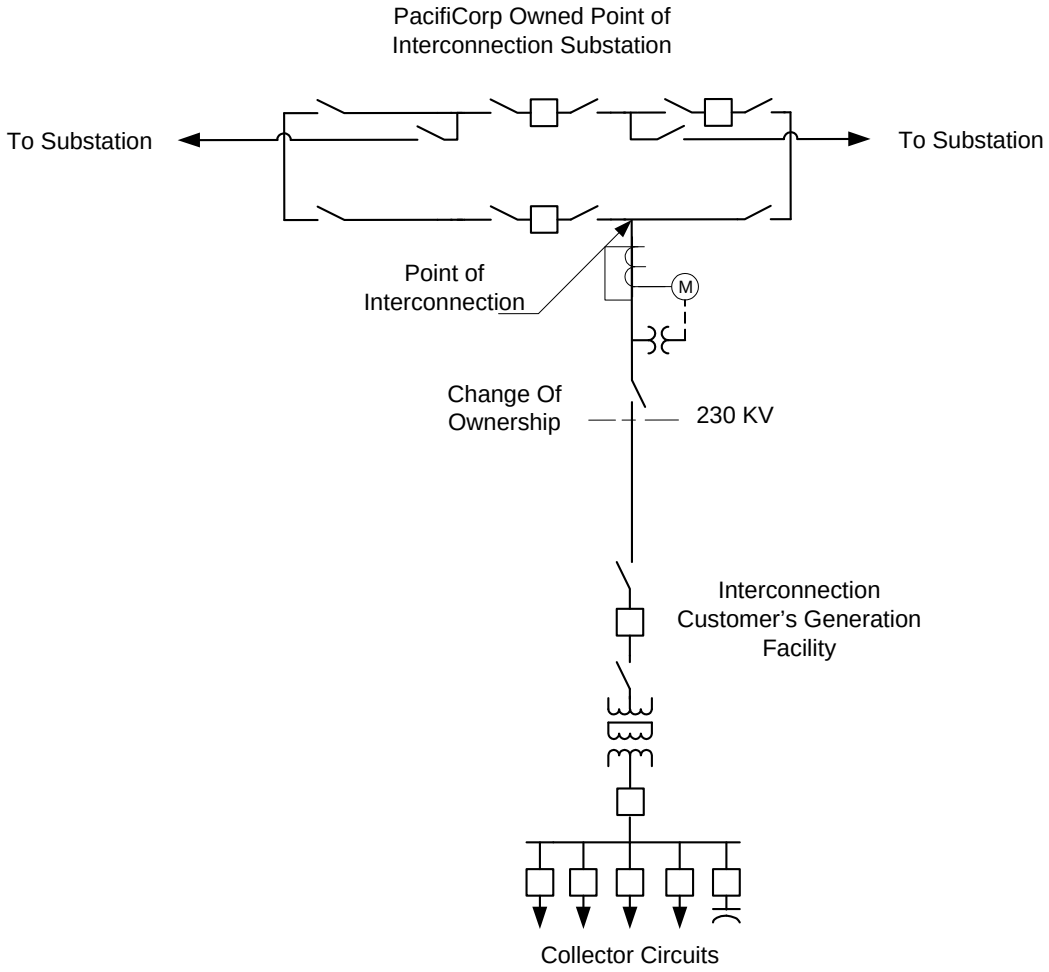
When an existing single-tap customer requests selector switches as a means of minimizing down time to his/her facility, the selector switches will be treated as Special Facilities and shall be paid for by the customer in accordance with applicable jurisdictional state utility commission rules.

PacifiCorp Determines When Selector Switches Are Necessary

When line selector switches are determined by PacifiCorp to be needed for system benefits, the installed cost of the selector switches will be borne by PacifiCorp. System benefits include but are not limited to: 1) minimizing sustained outages to multiple customers on a single-tap line, and 2) avoiding difficult clearance coordination with multiple customers.

On existing single-tap interconnections, should the need for selector switches be identified, then the criteria outlined in Attachment I also applies.

Appendix E Typical One-Line Generator Interconnection ≥ 230 kV



Appendix F Typical One-Line Generator Interconnection < 230 kV