



City of Pasadena
Water and Power Department
Power Division

DISTRIBUTED GENERATION FACILITIES INTERCONNECTION REQUIREMENTS

REGULATION 23

Adopted by Council Resolution **8304** on October 13, 2003

Revision 1: Amended by Council Resolution **9156** on November 7, 2011

Revision 2: Amended by Council Resolution XXXX on April 30, 2018



I. Additional Information and Updates

1. Website

Additional information regarding self-generation, customer interconnection and service requirements, and updates to this Regulation 23 may be found on the internet at:

www.PWPweb.com/SelfGeneration

2. Mailing List Request

To be placed on a mailing list to receive update sheets of these regulations, fill out the form below and mail to:

Regulation 23 Mailing List
Pasadena Water and Power
150 S. Los Robles Avenue, Suite 200
Pasadena, CA 91101-2437

Attn: Electric Utility Service Planning

DATE _____

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____



II. TELEPHONE NUMBERS

Utility Service Advisors (626) 744-4495

FOR OTHER INQUIRIES:

Electric Rates..... (626) 744-4005

Energy Conservation (626) 744-6970

Emergency Service (24 hour number) (626) 744-4673

Inquiries Regarding Electric Bill (626) 744-4005

Inspection by Water and Power of
Underground Conducts and Vaults (24 hour service).. (626) 744-4495

To obtain quadrant of Utility Pole for Pole Risers (626) 744-4495

Inspection by Electrical Inspector of Community Development Department
For All New Wiring..... (626) 744-4200



SCOPE AND PURPOSE

1. The Distributed Generation Facilities Interconnection Requirements constitute the Rules, Regulations and Policies of the City of Pasadena Water and Power Department (PWP) pertaining to distributed generation units connecting to the electric grid. This book is issued for the guidance and assistance of customers or Producers contemplating the installation of distributed generation, as well as electrical contractors, engineers, architects and manufacturers engaged in the installation and design of distributed generation.

Effective May 1, 2018, PWP will only accept requests to interconnect Generating Facilities that are intended to operate in parallel with PWP's Distribution System if they qualify as Renewable Generating Facilities, as defined herein. This requirement also applies to requests to replace or increase the capacity rating of existing Generation Facilities. This requirement does not apply to Generating Facilities intended as backup power sources and do not operate in parallel with PWP's Distribution System except during Momentary Parallel Operation

2. The provisions of the Distributed Generation Facilities Interconnection Requirements are intended to be in accordance with the latest revision of the following regulation, but are not intended to be a substitute for said regulations:
 - Underwriters Laboratory (UL) 1741
 - Institute of Electric and Electronic Engineers (IEEE) P1547
3. Distributed generation installation must meet the minimum requirements of the above regulations. When the requirements of Regulation 23 are more stringent than the above regulations, Regulation 23 will apply.
4. Any unusual situation or questions that are not covered in these regulations shall be referred to PWP for clarification in advance of commencing construction.



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ELECTRIC REGULATION 23 DISTRIBUTED GENERATION FACILITIES INTERCONNECTION REQUIREMENTS

A. DEFINITIONS

Definitions. Capitalized terms used in this Regulation, and not otherwise defined, shall have the meaning ascribed to such terms in this section. The definitions in this Regulation shall only apply to this Regulation and not to PWP's other regulations.

Certification Test: A test pursuant to this Regulation that verifies conformance of certain equipment with PWP-approved performance standards in order to be classified as Certified Equipment. Certification Tests are performed by NRTLs.

Certification; Certified; Certificate: The documented results of a successful Certification Testing.

Certified Equipment: Equipment that has passed all required Certification Tests.

Commissioning Test: A test performed during the commissioning of all or part of a Generating Facility to achieve one or more of the following:

- Verify specific aspects of its performance;
- Calibrate its instrumentation;
- Establish instrument or Protective Function set-points.

Customer: The entity that receives or is entitled to receive Distribution Service through PWP's Distribution System.

Dedicated Transformer; Dedicated Distribution Transformer: A transformer that provides electricity service to a single Customer. The Customer may or may not have a Generating Facility.

Distribution Service: All services required by, or provided to, a Customer pursuant to the approved rate schedules and Regulations by PWP.

Distribution System: All electrical wires, equipment, and other facilities owned or provided by PWP by which PWP provides Distribution Service to its Customers.

Emergency: An actual or imminent condition or situation, which jeopardizes the Distribution System integrity as determined by PWP.

Field Testing: Testing performed in the field to determine whether equipment meets PWP's requirements for safe and reliable Interconnection

Generating Facility: All Generators that are included in an Interconnection Agreement.

Generator: A device converting mechanical, chemical, or solar energy into electrical energy, including all of its protective and control functions and structural appurtenances. A Generating Facility is comprised of one or more Generators .

Gross Nameplate Rating: The total gross generating capacity of a Generator or Generating Facility as designated by the manufacturer of the Generator.

Host Load: Electrical power that is consumed by the Customer at the property on



which the Generating Facility is located.

Initial Review: The review by PWP, following receipt of an Application, to determine the following: (a) The Generating Facility qualifies for Simplified Interconnection; or (b) the Generating Facility can be made to qualify for Interconnection with Supplemental Review determining any potential additional requirements; or (c) if neither (a) nor (b), provides the cost estimate and schedule for performing an Interconnection Study.

In-rush Current: The current determined by the In-rush Current Test.

Interconnection; (Interconnected): The physical connection of a Generating Facility in accordance with the requirements of this Regulation so that Parallel Operation with the Distribution System can occur or has occurred.

Interconnection Agreement: An agreement between PWP and the Producer that gives certain rights and obligations to effect or end Interconnection.

Interconnection Facilities: The electrical wires, switches and related equipment that interconnect a Generating Facility to the Distribution System. Interconnection Facilities are part of their related Generating Facilities.

Interconnection Study: A study to establish the requirements for Interconnection of a Generating Facility.

Island, Islanding: A condition on the Distribution System in which one or more Generating Facilities deliver power to Customers using a portion of the Distribution System that is electrically isolated from the remainder of the Distribution System.

Line Section: That portion of the Distribution System connected to a Customer bounded by automatic sectionalizing devices or the end of the distribution line.

Momentary Parallel Operation: The interconnection of a Generating Facility to the Distribution System for one second (60 cycles) or less.

Nationally Recognized Testing Laboratory (NRTL): A laboratory accredited to perform the certification testing requirements under this Regulation.

Net Energy Metering (NEM): Metering for the receipt and delivery of electricity between the Producer and PWP pursuant to NEM service provisions of the PWP Electric Rate Schedule and/or Section 2827 of the Public Utilities Code. Over a given time frame (typically a month) the difference between these two values yields either net consumption or surplus. The meter registers are ratcheted to prevent reverse registration. If available, a single meter may be allowed to spin backward to yield the same effect as a directional, two-meter (or register) arrangement.

Net Generation Output Metering (AKA "Performance Metering"): Metering of the net electrical power output in kW or energy in kWh, from a given Generating Facility. This may also be the measurement of the difference between the total electrical energy produced by a Generator and the electrical energy consumed by the auxiliary equipment necessary to operate the Generator. For a Generator with no Host Load, metering that is located at the Point of Common Coupling. For a Generator with Host Load, metering that is located at the Generator but after the point of auxiliary load(s) and prior to serving Host Load.



Net Nameplate Rating: The Gross Nameplate Rating minus the consumption of electrical power of a Generator or Generating Facility as designated by the manufacturer(s) of the Generator(s).

Non-Export; Non-Exporting: Designed to prevent the transfer of electrical energy from the Producer to PWP.

Non-Islanding: Designed to detect and disconnect from a stable Unintended Island with matched load and generation. Reliance solely on under/over voltage and frequency trip is not considered sufficient to qualify as Non-Islanding.

Parallel Operation: The simultaneous operation of a Generator with power delivered or received by PWP while Interconnected. For the purpose of this Regulation, Parallel Operation includes only those generators that are interconnected with the Distribution System for more than one second (60 cycles).

Periodic Test: A test performed on part or all of a Generating Facility at pre-determined time or operational intervals to achieve one or more of the following:

- Verify specific aspects of its performance;
- Calibrate instrumentation; and/or,
- Verify and re-establish instrument or Protective Function set points.

Point of Common Coupling Metering: Metering located at the Point of Common Coupling. This is the same Metering as Net Generation Output Metering for Generating Facilities with no Host Load.

Point of Common Coupling: The transfer point for electricity between the electrical conductors of PWP and the electrical conductors of the Producer.

Point of Interconnection: The electrical transfer point between a Generator or a Generating Facility and the electrical system. This may or may not be coincident with the Point of Common Coupling.

Producer: The entity that executes an Interconnection Agreement with PWP. The Producer may or may not own or operate the Generating Facility, but is responsible for the rights and obligations related to the Interconnection Agreement.

Production Test: A test performed on each device coming off the production line to verify certain aspects of its performance.

Protective Function(s): The equipment, hardware or software in a Generating Facility (whether discrete or integrated with other functions) whose purpose is to protect against Unsafe Operating Conditions.

Prudent Electrical Practices: Those practices, methods, and equipment, as changed from time to time, that are commonly used in prudent electrical engineering and operations to design and operate electric equipment lawfully and with safety, dependability, efficiency, and economy.

PWP: The City of Pasadena Water and Power Department.

PWP Electric Rate Schedule: Pasadena Municipal Code Section 13.04, the Light and Power Rate Ordinance.



Renewable Generating Facility: A Generating Facility consisting only of Generator(s) that meet the definition of "Renewable electrical generation facility" as defined in Section 25741 of the California Public Resources Code.

Simplified Interconnection: Interconnection conforming to the minimum requirements under these Regulations, as determined by Section I.

Short Circuit Contribution Ratio (SCCR): The ratio of the Generating Facility's short circuit contribution to PWP's short circuit contribution for a three-phase fault at the high voltage side of the distribution transformer connecting the Generating Facility to PWP's system.

Single Line Diagram; Single Line Drawing: A schematic drawing, showing the major electrical switchgear, protection devices, wires, generators, transformers and other devices, providing sufficient detail to communicate to a qualified engineer the essential design and safety of the system being considered.

Stabilization; Stability: The return to normalcy of the PWP Distribution System, following a disturbance. Stabilization is usually measured as a time period during which voltage and frequency are within acceptable ranges.

Starting Voltage Drop: The percentage voltage drop at a specified point resulting from In-rush Current. The Starting Voltage Drop can also be expressed in percentage on a particular base voltage, (e.g. 6 volts on a 120-volt base, yielding a 5% drop).

Supplemental Review: A process wherein PWP further reviews an Application that fails one or more of the Initial Review Process screens. The Supplemental Review may result in one of the following: a) Simplified Interconnection; b) approval of Interconnection with additional requirements; or c) cost and schedule for an Interconnection Study.

System Integrity: The condition under which a Distribution System is deemed safe and can reliably perform its intended functions in accordance with the safety and reliability Regulations of PWP.

Telemetry: The electrical or electronic transmittal of metering data in real-time to PWP.

Transfer Trip: A Protective Function that trips a Generating Facility remotely by means of an automated communications link controlled by PWP.

Type Test: A test performed on a sample of a particular model of a device to verify specific aspects of its design, construction and performance.

Unintended Island: The creation of an island, usually following a loss of a portion of the Distribution System, without the approval of PWP.

Unsafe Operating Conditions: Conditions that, if left uncorrected, could result in harm to personnel, damage to equipment, loss of System Integrity or operation outside pre-established parameters required by the Interconnection Agreement.

Visible Disconnect: An electrical switching device that can separate the Generating Facility from the Distribution System and is designed to allow visible verification that separation has been accomplished. This requirement can be met by opening the enclosure to observe the contact separation.



B. APPLICABILITY

Applicability. This Regulation describes the interconnection, operating and metering requirements for Generating Facilities to be connected to the PWP Distribution System pursuant to the PWP Electric Rate Schedule.

Effective May 1, 2018, PWP will only accept requests to interconnect Generating Facilities that are intended to operate in parallel with PWP's Distribution System if they qualify as Renewable Generating Facilities. This requirement also applies to requests to replace or increase the capacity rating of existing Generation Facilities. This requirement does not apply to Generating Facilities intended as backup power sources and do not operate in parallel with PWP's Distribution System except during Momentary Parallel Operation.

C. GENERAL REGULATIONS, RIGHTS AND OBLIGATIONS

- 1. Authorization Required to Operate.** Producer must comply with this Regulation, execute an Interconnection Agreement with PWP, and take electrical energy service pursuant to the PWP Electric Rate Schedule. Other than for momentary testing, Generating Facility shall not be interconnected to PWP's Distribution System prior to receiving permission to operate in writing from PWP.
- 2. Transmission Service Not Provided with Interconnection.** Interconnection with PWP's Distribution System under this Regulation does not provide a Producer any rights to utilize PWP's Distribution System for the transmission or distribution, or wheeling of electric power.
- 3. Compliance with Laws, Regulations, and Tariffs.** Producer shall ascertain and comply with PWP Regulations, rate schedules, and applicable California Public Utilities Commission approved Regulations, tariffs, and regulations; and any local, state or federal law, statute or regulation which applies to the design, siting, construction, installation, operation, or any other aspect of the Producer's Generating Facility and Interconnection Facilities.
- 4. Design Reviews and Inspections.** PWP shall review the design of a Producer's Generating Facility and Interconnection Facilities and to inspect a Producer's Generating and Interconnection Facilities prior to the commencement of Parallel Operation with PWP's Distribution System. PWP may require a Producer to make modifications as necessary to comply with the requirements of this Regulation. PWP's review and authorization for Parallel Operation shall not be construed as confirming or endorsing the Producer's design or as warranting the Generating or Interconnection Facilities' safety, durability or reliability. PWP shall not, by reason of such review or lack of review, be responsible for the strength, adequacy, or capacity of such equipment.
- 5. Right to Access.** Producer's Generating Facility and Interconnection Facilities shall be reasonably accessible to PWP personnel as necessary for PWP to perform its duties and exercise its rights under its rate schedules and



Regulations, and any Interconnection Agreement between PWP and the Producer.

6. **Prudent Operation and Maintenance Required.** Producer shall operate and maintain its Generating Facility and Interconnection Facilities in accordance with Prudent Electrical Practices and shall maintain compliance with this Regulation.
7. **Renewable Generating Facility Biomethane Certification/Attestation:** For any Generating Facility using biomethane to qualify as a Renewable Generating Facility, Producer shall provide an attestation, signed by a duly authorized representative, with sufficient documentation and information for PWP to determine that: (i) any biomethane used meets the Renewable energy resource requirements established by the California Energy Commission ("CEC"); and, (ii) the Generating Facility consumes no other fuel than biomethane. Such attestation shall be provided prior to Interconnection and annually thereafter. At any time, PWP may request documentation providing evidence of CEC certification of biomethane used at the Generation Facility. If PWP determines in its reasonable judgment that Producer either failed to provide evidence or that it provided insufficient evidence that the Generating Facility does not or will not meet the eligibility requirements, then the Generating Facility shall be deemed to be out of compliance with this Regulation until such time as Producer demonstrates to PWP's reasonable satisfaction that the Generating Facility meets the requirements of a Renewable Generating Facility.
8. **Curtailement or Disconnection. If Producer or Generating Facility fails to comply with any provision of this Regulation, PWP may lockout or require the disconnection of a Producer's Generating Facility from PWP's Distribution System until such condition is remedied.** PWP may limit the operation or disconnect or require the disconnection of a Producer's Generating Facility from PWP's Distribution System at any time, with or without notice, in the event of an Emergency, or to correct Unsafe Operating Conditions. However, PWP must provide written notice as soon as possible following such disconnect. PWP may also limit the operation or disconnect or require the disconnection of Producer's Generating Facility from PWP's Distribution System upon the provision of reasonable written notice: 1) to allow for routine maintenance, repairs or modifications to PWP's Distribution System; 2) upon PWP's determination that Producer's Generating Facility is not in compliance with this Regulation; or, 3) upon termination of the Interconnection Agreement. Upon the Producer's written request PWP shall provide a written explanation of the reason for such curtailement or disconnection.

D. APPLICATION AND INTERCONNECTION PROCESS

1. Application Process

- a. **Applicant Initiates Contact with PWP.** Upon request, PWP will provide information and documents (such as sample agreements, the Application,



technical information, listing of Certified Equipment, application fee information, applicable rate schedules and metering requirements) in response to a potential applicant's inquiry. PWP will establish an individual representative as the single point of contact for an applicant, but may allocate responsibilities among its staff to best coordinate the Interconnection of an applicant's Generating Facility.

- b. Applicant Completes and Files an Application.** All applicants shall be required to complete and file an Application and supply any relevant additional information requested by PWP. The filing must include the completed Application and a fee for processing the application and performing the Initial Review to be completed by PWP pursuant to Section D.1.c. The application fee shall vary with the type of the proposed Generating Facility as follows:

Type of Service	Initial Review	Supplemental Review
Net Energy Metering (per Public Utilities Code Section 2827)	None	None
All others	\$800	\$600 (additional)

Fifty percent of the fees associated with the Initial Review will be returned to the applicant if the Application is rejected by PWP or the applicant retracts the Application.

The applicant may propose and PWP may negotiate specific costs for processing non-standard applications such as multi-units, multi-sites, or otherwise as conditions warrant. The costs for the Initial Review and the Supplemental Review contained in this Section, as well as the language provided in Sections D.1.c and D.1.d, do not apply under these circumstances.

If deficiencies in the application are noted, PWP and applicant shall cooperate in a timely manner to establish a satisfactory Application.

The information submitted in the Application will remain active and valid for a period of twelve months from the date the Application is accepted by PWP as a "completed" Application. If the project has not received authorization to operate per Section D.1.h of this regulation, the Application will expire. The PWP General Manager may authorize a twelve month extension if construction of the Generation Facility is at a substantially advanced stage, in the sole discretion of PWP.



- c. PWP Performs an Initial Review and Develops Preliminary Cost Estimates and Interconnection Requirements.**
- 1) Upon receipt of a satisfactorily completed Application and any additional information necessary to evaluate the Interconnection of a Generating Facility, PWP shall perform an Initial Review using the process defined in Section I. The Initial Review determines if (a) the Generating Facility qualifies for Simplified Interconnection, (b) the Generating Facility can qualify for Interconnection subject to additional requirements, or (c) it will be necessary for PWP to perform an Interconnection Study to determine the Interconnection Requirements.
 - 2) PWP shall complete its Initial Review, absent any extraordinary circumstances, upon determination that the Application is complete, if the Generating Facility qualifies for Simplified Interconnection. If the Initial Review determines that the proposed facility can be interconnected by means of a Simplified Interconnection, PWP will provide the applicant with a written description of the requirements for interconnection and a draft Interconnection Agreement pursuant to Section D.1.e.
 - 3) If the Generating Facility does not qualify for Simplified Interconnection as proposed, PWP will notify the applicant and perform a Supplemental Review as described in Section I. The Supplemental Review will provide either (a) Interconnection Requirements beyond those for Simplified Interconnection, and a draft Interconnection Agreement, or (b) a cost estimate and schedule for an Interconnection Study.
- d. When Required, Applicant and PWP Commit to Additional Interconnection Study Steps.** When an Initial Review reveals that the proposed facility cannot be interconnected to PWP's Distribution System by means of a Simplified Interconnection, or that significant PWP Interconnection Facilities or Distribution System improvements must be installed or made to PWP's Distribution System to accommodate the interconnection of an applicant's Generating Facility, PWP and applicant shall sign the "City of Pasadena Utility Services Contract" for PWP to perform additional studies, facility design, and engineering and to provide detailed cost estimates for fixed price or actual cost billing, to the applicant at the applicant's expense. The Contract shall set forth PWP's schedule for completing such work and the estimated or fixed price costs of such studies and engineering. Upon completion of an Interconnection Study, PWP shall provide the applicant with the specific requirements, costs and schedule for interconnecting the Generating Facility to accommodate execution of agreements pursuant to Section D.1.e
- e. Applicant and PWP Enter Into an Interconnection Agreement.** The applicant shall sign the applicable form of Interconnection Agreement. Current standard Interconnection Agreement forms are posted on the



internet at www.PWPweb.com/SelfGeneration or may be obtained by contacting PWP Utility Services Planning division.

- f. **Where Applicable, PWP or Producer Installs Required Interconnection Facilities or Modifies PWP's Distribution System.** After signing the Interconnection Agreement, Producer will commence construction/installation of the modifications or metering and monitoring requirements identified in the Interconnection agreement. The parties will use good faith efforts to meet the schedules and cost estimates.
- g. **Producer Arranges for and Completes Commissioning Testing of Generating Facility and, Where Applicable, Producer Installed Interconnection Facilities.** The Producer shall successfully demonstrate to PWP's satisfaction that Generating Facilities and associated Interconnection Facilities, comply with the safety and reliability provisions of this Regulation, and PWP Regulations and regulations prior to being operated in parallel with PWP's Distribution System.
- h. **PWP Authorizes Parallel Operation or Momentary Parallel Operation.** The Producer's Generating Facility shall be allowed to operate in Parallel Operation or Momentary Parallel Operation, as applicable, with PWP's Distribution System upon satisfactory compliance with the terms of all applicable agreements. Compliance may include, but not be limited to, provision of any required documentation and satisfactorily completing any required inspections or tests as described herein or in the Interconnection Agreement formed between the Producer and PWP.

E. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS

1. General Interconnection and Protection Requirements

- a. **Protective Functions Required.** The Protective Functions for Generating Facilities operating in parallel with PWP's Distribution System shall include:
 - 1) Over and under voltage trip functions and over and under frequency trip functions;
 - 2) A means for disconnecting the Generating Facility from PWP's Distribution System when a protective function initiates a trip;
 - 3) An automatic means to prevent the Generating Facility from energizing a de-energized Distribution System circuit and to prevent the Generating Facility from reconnecting with the Distribution System unless the Distribution System service voltage and frequency is of specified settings and is stable for at least 60 seconds;
 - 4) A means to prevent the Generating Facility from contributing to the formation of an Unintended Island.



- b. **Momentary Paralleling Generating Facilities.** With PWP's approval, the transfer switch or system used to transfer the Producer's loads from PWP's Distribution System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.
- c. **Purpose of Protective Functions.** The Protective Functions and requirements of this Regulation are designed to protect PWP's Distribution System and not the Generating Facility. A Producer shall be solely responsible for providing adequate protection for its Generating Facility and Interconnection Facilities. The Producer's protective equipment shall not impact the operation of other protective devices utilized on the Distribution System in a manner that would affect PWP's capability of providing reliable service to its Producers.
- d. **Suitable Equipment Required.** Circuit breakers or other interrupting devices located at the Point of Common Coupling must be Certified or "Listed" (as defined in Article 100, the Definitions Section of the National Electrical Code) as suitable for their intended application. This includes being capable of interrupting the maximum available fault current expected at their location. Producer's Generating Facility and Interconnection Facilities shall be designed so that the failure of any one device shall not potentially compromise the safety and reliability of PWP's Distribution System.
- e. **Visible Disconnect Required.** The Producer shall furnish and install a manual disconnect device that has a Visible Disconnect to isolate the Generating Facility from PWP's Distribution System. The device must be accessible to PWP personnel and be capable of being locked in the open position. Generating Facilities with Non-Islanding inverters totaling 1 kVA or less are exempt from this requirement.
- f. **Single-Phase Generators.** For single-phase Generators connected to a shared single-phase secondary system, the maximum Net Nameplate Rating of the Generating Facilities shall be 20 kVA. Generators applied on a center-tapped neutral 240-volt service must be installed such that no more than 6 kVA of imbalance in capacity exists between the two sides of the 240-volt service. For Dedicated Distribution Transformer services, the maximum Net Nameplate Rating of a single-phase Generating Facility shall be the transformer nameplate rating.
- g. **Drawings Required.** PWP, prior to Parallel Operation or Momentary Parallel Operation of the Generating Facility, shall approve the Producer's protection and control diagrams of the Generating Facility. Generating Facilities equipped with a protection and control scheme previously approved by PWP for system-wide application or with Certified Equipment only may satisfy this requirement by reference to previously approved drawings and diagrams.



- h. **Generating Facility Conditions Not Identified.** In the event this Regulation does not address the interconnection requirements for a particular Generating Facility, PWP and Producer may agree upon other requirements.

2. Prevention of Interference.

The Producer shall not operate equipment that superimposes upon PWP's Distribution System a voltage or current that interferes with PWP operations, service to PWP Producers, or PWP communication facilities. If such interference occurs, the Producer must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by PWP. If the Producer does not take timely corrective action, or continues to operate the equipment causing interference without restriction or limit, PWP may, without liability, disconnect the Producer's equipment from the Distribution System, in accordance with Section C.7 of this Regulation.

To eliminate undesirable interference caused by operation of the Generating Facility, each Generating Facility shall meet the following criteria:

- a. **Normal Voltage Operating Range.** The voltage operating range limits for Generating Facilities shall be selected as a protection function that responds to abnormal Distribution System conditions and not as a voltage regulation function.
 - 1) **Generating Facilities (11 kVA or less).** Generating Facilities with a Gross Nameplate Rating 11 kVA or less shall be capable of operating within the limits normally experienced on the Distribution System. The operating range shall be selected in a manner that minimizes nuisance tripping between 106 volts and 132 volts (88-110% of nominal voltage) on a 120-volt base. Generating Facilities shall cease to energize PWP circuits whenever the voltage at the Point of Common Coupling deviates from the allowable voltage operating range.
 - 2) **Generating Facilities (Greater than 11 kVA).** PWP may have specific operating voltage ranges for Generating Facilities with Gross Nameplate Ratings greater than 11 kVA and may require adjustable operating voltage settings. In the absence of such requirements, the Generating Facility shall operate at a range between 88% and 110% of the applicable interconnection voltage.
 - 3) **Voltage Disturbances.** System voltage assumes a nominal 120 V base. The Generator should sense abnormal voltage and respond accordingly. The following conditions should be met, with voltages in root mean square and measured at the Point of Common Coupling, as described in Table D-1.



Table D-1: Voltage Trip Setting

Voltage at Point of Common Coupling (Assuming 120V base)	Maximum Trip Setting (Assuming 60 cycles per Second)
Less than 60 Volts	10 cycles
Greater than or equal to 60 Volts but less than 106 Volts	120 cycles
Greater than or equal to 106 volts but less than or equal to 132 Volts	Normal Operation
Greater than 132 volts but less than or equal to 165 Volts	120 cycles (30 cycles for facilities greater than 11 kVA)
Greater than 165 Volts	6 cycles

**"Maximum Trip time" refers to the time between the onset of the abnormal condition and the Generating Facility ceasing to energize the Distribution System. Protective Function sensing devices and circuits may remain connected to the Distribution System to allow sensing of electrical conditions for use by the "reconnect" feature. The purpose of the time delay is to allow a Generating Facility to "ride through" short-term disturbances to avoid nuisance tripping. For Generating Facilities with a Gross Nameplate Rating of 11 kVA or less, the set points are to be non-user adjustable. For Generating Facilities with a Gross Nameplate Rating greater than 11 kVA, different voltage set points and trip times from those in Table D-1 may be negotiated with PWP.*

- b. **Flicker.** Any voltage flicker at the Point of Common Coupling caused by the Generating Facility should not exceed the limits defined by the "Maximum Borderline of Irritation Curve" identified in IEEE 519 (IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, IEEE STD 519-1992, Institute of Electrical and Electronic Engineers, Piscataway, NJ. April 1992.) This requirement is necessary to minimize the adverse voltage effects experienced by other customers on PWP's Distribution System. Induction Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.
- c. **Frequency.** PWP controls system frequency, and the Generating Facility shall operate in synchronism with the Distribution System. Generating Facilities with a Gross Nameplate Rating of 11 kVA or less shall have a fixed operating frequency range of 59.3-60.5 Hertz. The Generating Facility must cease to energize PWP's Distribution System in a maximum of ten cycles should Distribution System remain outside of the frequency limits. The purpose of the time delay is to allow the Generating Facility to ride through short-term disturbances to avoid nuisance tripping. PWP may require adjustable operating frequency settings for Generating Facilities with a Gross Nameplate Rating greater than 11 kVA.



- d. **Harmonics.** Harmonic distortion shall be in compliance with IEEE 519. Exception: The harmonic distortion of a Generating Facility located at a Producer's site shall be evaluated using the same criteria as for the loads at that site.
- e. **Direct Current Injection.** Generating Facilities should not inject Direct Current greater than 0.5% of rated output current into PWP's Distribution System.
- f. **Power Factor.** Each Generator in a Generating Facility shall be capable of operating at some point within a power factor range of 0.9 leading and 0.9 lagging. To the extent technically feasible, a Generating Facility shall be operated in a manner that meets the reactive power needs of on-site loads in order to maintain a power factor at the Point of Common Coupling in the range of 0.9 leading and 0.9 lagging. The Producer shall notify PWP if it is using the Generating Facility for power factor correction.

3. Control, Protection and Safety Equipment Requirements

a. Technology Specific Requirements

- 1) **Three-Phase Synchronous Generators.** For three-phase Generators, the circuit breakers shall be three-phase devices with electronic or electromechanical control. Producer shall be responsible for properly synchronizing its Generating Facility with the Distribution System by means of either a manual or automatic synchronizing function. Automatic synchronizing is required for all synchronous generators, which have a Short Circuit Contribution Ratio (SCCR) exceeding 0.05. A Generating Facility whose SCCR exceeds 0.05 shall be equipped with Protective Functions suitable for detecting loss of synchronism and rapidly disconnecting the Generating Facility from the Distribution System. Unless otherwise agreed to between the Producer and PWP, synchronous generators shall automatically regulate power factor, not voltage, while operating in parallel with the Distribution System. Power system stabilization functions are specifically not required for Generating Facilities under 10 MW Net Nameplate Rating. Synchronization means that at the time of connection, the frequency difference shall be less than 0.2 Hz, the voltage difference shall be less than 10%, and the phase angle difference shall be less than 10 degrees.
- 2) **Induction Generators.** Induction Generators do not require a synchronizing function. Starting or Rapid fluctuations on induction generators can adversely impact the Distribution System's voltage. Corrective step-switched capacitors or other techniques may be necessary and may cause undesirable ferro-resonance. When these counter measures (e.g. additional capacitors) are installed on the Producer's side of the Point of Common Coupling, PWP must review



these measures. Additional equipment may be required as determined in a Supplemental Review or an Interconnection Study.

- 3) **Inverter Systems.** Utility-interactive inverters do not require separate synchronizing equipment. Non-utility-interactive or "stand-alone" inverters shall not be used for parallel operation with the Distribution System.

b. Supplemental Generating Facility Requirements

- 1) **Unintended Islanding For Generating Facilities that fail the Export Screen (Section J.3.b).** Generating Facilities must mitigate their potential contribution to an Unintended Island. This can be accomplished by one of the following options: (1) incorporating certified Non-Islanding control functions into the Protective Functions, or (2) verifying that local loads sufficiently exceed the Net Nameplate Rating of the Generating Facility, or (3) incorporating a transfer trip or an equivalent Protective Function.
- 2) **Fault Detection.** A Generating Facility with an SCCR exceeding 0.1 or that does not meet any one of the options for mitigating Unintended Islands in D.3.b.1 shall be equipped with Protective Functions designed to detect Distribution System faults, both line-to-line and line-to-ground, and promptly cease to energize the Distribution System in the event of a fault. For a Generating Facility that cannot detect these faults within two seconds, a transfer trip or equivalent function may be required. Reclose-blocking of PWP's affected recloser(s) may also be required by PWP for generators that exceed 15% of the peak load on the Line Section.

F. INTERCONNECTION FACILITY OWNERSHIP

1. Scope and Ownership of Interconnection Facilities

- a. **Scope.** The interconnection of a Producer's Generating Facility with PWP's Distribution System is made through the use of Interconnection Facilities. Such interconnection may also require Distribution System improvements. The type, extent and costs of Interconnection Facilities and Distribution System Improvements shall be consistent with this Regulation and determined through the Initial Review and Interconnection Study described in Section D.
- b. **Ownership.** Interconnection Facilities installed on Producer's side of the Point of Common Coupling may be owned, operated and maintained by the Producer or PWP. Interconnection Facilities installed on PWP's side of the Point of Common Coupling and Distribution System improvements shall be owned operated and maintained by PWP.



2. Responsibility for Costs of Interconnecting a Generating Facility

- a. **Study and Review Costs.** Producer shall be responsible for the reasonably incurred costs of the reviews and studies conducted pursuant to Section D.1 of this Regulation.
- b. **Facility Costs.** Producer shall be responsible for all costs associated with Interconnection Facilities owned by the Producer. The Producer shall also be responsible for any costs reasonably incurred by PWP in providing, operating, or maintaining Interconnection Facilities and Distribution System improvements required solely for the interconnection of the Producer's Generating Facility with PWP's Distribution System, unless otherwise prohibited by law.
- c. **Separation of Costs.** Should PWP combine the installation of Interconnection Facilities, or Distribution System Improvements with modifications or additions to PWP's Distribution System to serve other Customers, PWP shall not include the costs of such separate or incremental facilities in the amounts billed to the Producer for the Interconnection Facilities or Distribution System Improvements required pursuant to this Regulation.

G. METERING, MONITORING AND TELEMETRY

1. **General Requirements.** All Generating Facilities shall be metered in accordance with this Section and shall meet all applicable standards of PWP's applicable rate schedules, Regulations, and published PWP Regulations dealing with metering specifications.
2. **Metering.** The ownership, installation, operation, reading, and testing of metering for Generating Facilities shall be by PWP.
 - a. **Net Generation Output Metering.** For purposes of monitoring Generating Facility operation for determination of standby charges and applicable non-bypassable charges as defined in the PWP Electric Rate Schedule, to satisfy applicable California Independent System Operator (CAISO) reliability requirements, and for Distribution System planning and operations, consistent with Section C.3 of these Regulations, PWP shall specify the type, and require the installation of, Net Generation Output Metering. PWP shall require the provision of generator output data to the extent reasonably necessary to provide information for the utility to administer its tariffs or to operate and plan its system.
3. **Point of Common Coupling Metering.** For purposes of assessing PWP charges for retail service, the Producer's Point of Common Coupling Metering shall be a bi-directional meter so that power deliveries to and from the Electricity Producer's site can be separately recorded. Alternately, the Producer may, at its sole option and cost, require PWP to install multi-metering equipment to separately record



power deliveries to the Distribution System and retail purchases from PWP. Such Point of Common Coupling Metering shall be designed to prevent reverse registration.

4. **Telemetering.** If the nameplate rating of the Generating Facility is 1 MW or greater, telemetering equipment at the Net Generator Metering location may be required at the Producer's (and Customer's) expense. If the Generating Facility is interconnected to a Distribution System operating at a voltage below 10 kV, then Telemetering equipment may be required on Generating Facilities 250 kW or greater. PWP shall only require Telemetering to the extent that less intrusive and more cost effective options for providing the necessary data in real time are not available.
5. **Location.** Where PWP-owned metering equipment is located on the Producer's premises, Producer shall provide, at no expense to the PWP, a suitable location for all such metering equipment.

H. DISPUTE RESOLUTION PROCESS

Any disputes arising from this Regulation shall be submitted in writing to the General Manager of PWP.

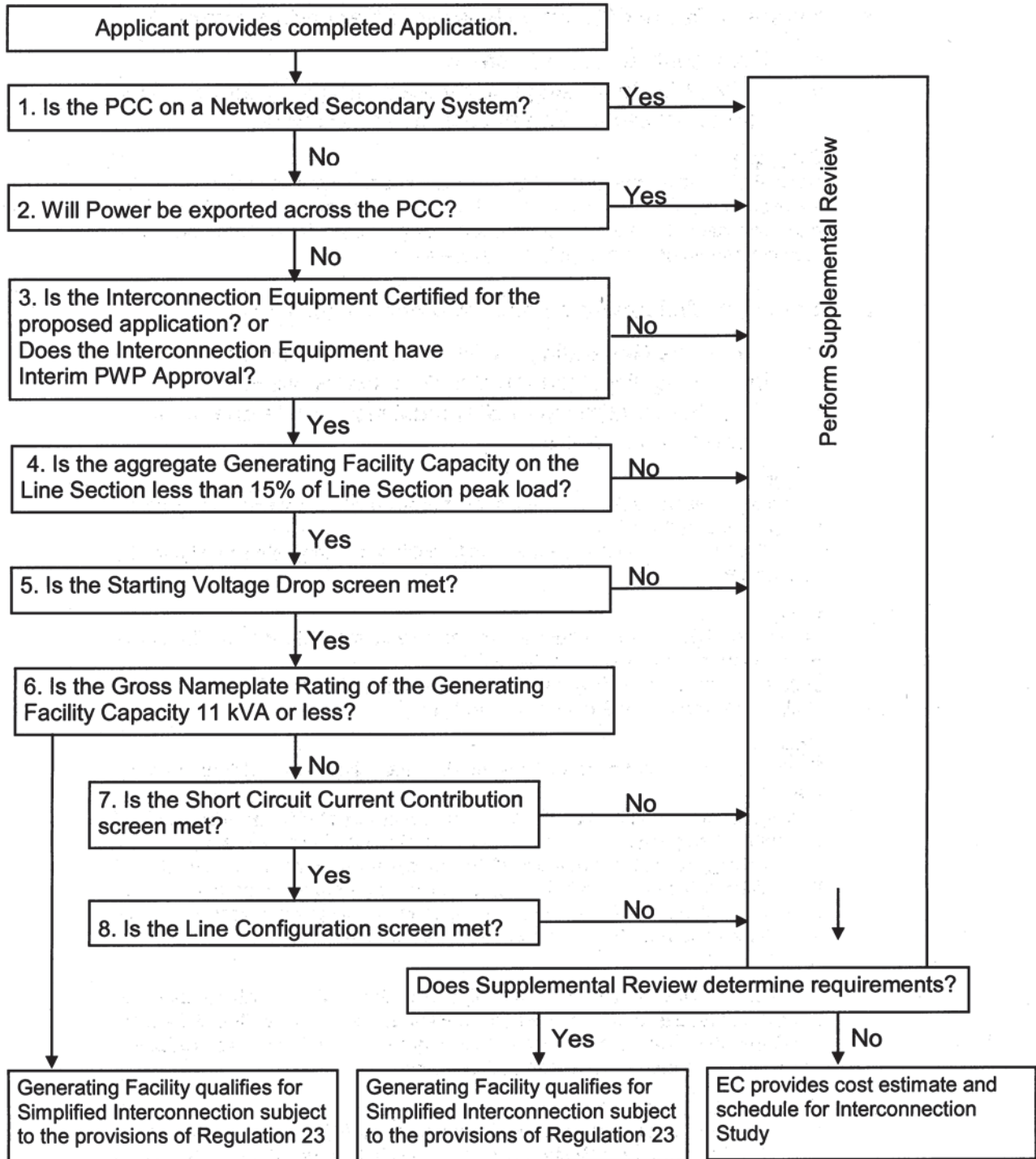
I. INITIAL REVIEW PROCESS FOR APPLICATIONS TO INTERCONNECT A GENERATING FACILITY

1. **Introduction.** This Initial Review Process was developed to create a path for selection and rapid approval for the Interconnection of those Generating Facilities that do not require an Interconnection Study. The Initial Review process includes a screening to determine if a supplemental review is required.
2. **Purpose.** The Initial Review determines:
 - a. If a Generating Facility qualifies for Simplified Interconnection;
 - b. If a Generating Facility can be made to qualify for Interconnection with Supplemental Review determining any potential additional requirements, or
 - c. If an Interconnection Study is required, the cost estimate and schedule for performing the Interconnection Study.

NOTE: Failure to pass any screen of the Initial Review means only that further review or studies are required before the Generating Facility can be approved for interconnection with the PWP Distribution System. It does not mean that the Generating Facility cannot be interconnected.



Initial Review Process Flow Chart





3. Initial Review Process Details

a. Screen 1: Is the PCC on a Networked Secondary System?

- If No, continue to next screen.
- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform supplemental Review.

Significance:

Special considerations must be given to Generating Facilities proposed to be installed on networked secondary distribution systems because of the design and operational aspects of network protectors. There are no such considerations for radial distribution systems.

b. Screen 2: Will power be exported across the PCC?

- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.
- If No, the Generating Facility must incorporate one of the following four options:

Option 1:

To insure power is never exported, a reverse power Protective Function must be implemented at the PCC.

Default setting shall be 0.1% (export) of transformer rating, with a maximum 2.0 second time delay.

Option 2:

To insure at least a minimum import of power, an under-power Protective Function must implemented at the PCC.

Default setting shall be 5% (import) of the Generating Facility Gross Nameplate Rating, with maximum 2.0 second time delay.

Option 3:

To limit the incidental export of power, all of the following conditions must be met:

The aggregate capacity of the Generating Facility must be no more than 25% of the nominal ampere rating of the Producer's Service Equipment and;

The total aggregate Generating Facility capacity must be no more than 50% of the service transformer rating. (This capacity requirement does not apply to Producers taking primary service without an intervening transformer);

The Generating Facility must be certified as Non-Islanding.

Option 4:

To ensure that the relative size (capacity) of the Generating Facility compared to facility load results in no export of power without the use of additional devices, the Generating Facility capacity must be no greater than 50% of the Producer's verifiable minimum load over the last 12 months.

Significance:

- If it can be assured that the Generating Facility will not export power, PWP's Distribution System does not need to be studied for load-carrying capability or Generating Facility power flow effects on PWP voltage regulators as the Generating Facility will simply be reducing Producer's load on PWP's Distribution System.
- Permits use of reverse-power relaying at the PCC as positive anti-islanding protection.



c. Screen 3: Is the Interconnection Equipment Certified for the Application or does the Interconnection Equipment have Interim PWP Approval?

- If No, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.
- If Yes, continue to next screen.

Significance:

If the Generating Facility has been Certified or previously approved by PWP, PWP does not need to repeat its review and/or test of the Generating Facility's Protective Functions scheme. Site Commissioning Testing may still be required to ensure that the system is connected properly and that the protective functions are working properly.

Certification indicates the following criteria have been tested and verified:

- Basic protective function requirements.
- Harmonic distortion limits.
- Synchronizing requirements.
- Power factor regulation requirements.
- Non-islanding requirements.
- If used, reverse power function requirement.
- If used, under-power function requirement.

d. Is the aggregate Generating Facility capacity on the Line Section less than 15% of Line Section Peak Load?

- If Yes, continue to next screen.
- If No, Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review to determine cumulative impact on Line Section.

Significance:

Low penetration of Generating Facility installations will have a minimal impact on Distribution System and load operation and power restoration.

The operating requirements for a high penetration of Generating Facilities may be different since the impact on PWP's Distribution System operation will no longer be minimal, therefore requiring additional study or controls.

e. Screen 5: Is the Starting Voltage Drop Within Acceptable Limits?

- If Yes, continue to next screen.
- If No, The Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review to determine cumulative impact on Line Section.

NOTICE: This screen only applies to Generating Facilities that start by motoring the Generator.

PWP has two options in determining whether Starting Voltage Drop could be a problem; which option to use is at PWP's discretion.

Option 1:

PWP may determine that the Generating Facility's starting Inrush Current is equal to or less than the continuous ampere rating of the Producer's service equipment.



Option 2:

PWP may determine the impedances of the service distribution transformer (if present) and secondary conductors to Producer's service equipment and perform a voltage drop calculation. Alternatively, PWP may use tables or nomographs to determine the voltage drop. Voltage drops caused by starting a Generating Unit as a motor must be less than 2.5% for primary interconnection and 5% for secondary interconnection.

Significance:

- This screen addresses potential voltage fluctuation problems for generators that start by motoring.
- When starting, a Generating Facility should have minimal impact on the service voltage to other PWP Customers.
- Passing this screen does not relieve Producer from ensuring that its Generating Facility complies with the flicker requirements of this Regulation, Section D.

f. Screen 6: Is the Gross Nameplate Rating of the Generating Facility 11kVA or less?

- If Yes, the Generating Facility qualifies for Simplified Interconnection. Skip remaining screens.
- If No, continue to next screen.

Significance:

The Generating Facility has minimal impact on fault current levels and any potential line overvoltages from loss of system neutral grounding.

g. Screen 7: Is Short Circuit Current Contribution Within Acceptable Limits?

- If No, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.
- If Yes, continue to next screen.

Short Circuit Current Contribution Screen

The Short Circuit Current Contribution Screen consists of two criteria; both of which must be met when applicable:

- 1) At primary side (high side) of the Dedicated Distribution Transformer, the sum of the Short Circuit Contribution Ratios (SCCR) of all Generating Facilities on the Distribution System circuit may not exceed 0.1.
- 2) At secondary (low side) of a shared distribution transformer, the short circuit contribution of the proposed Generating Facility must be less than or equal to 2.5% of the interrupting rating of Producer's Service Equipment.

Significance:

No significant Generating Impact on:

- (1) Distribution System's short circuit duty
- (2) Distribution System fault detection sensitivity
- (3) Distribution System relay coordination
- (4) Distribution System fuse-saving schemes



If the Generating Facility passes this screen it can be expected that it will have no significant impact on PWP's Distribution System's short circuit duty, fault detection sensitivity, relay coordination or fuse-saving schemes.

h. Screen 8: Is the Line Configuration Acceptable for Simplified Interconnection?

- If No, then the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.
- If Yes, the Generating Facility qualifies for Simplified Interconnection

Line Configuration Screen:

Identify primary distribution line configuration that will serve the proposed Generating Facility. Based on the type of Interconnection to be used for the Generating Facility, determine from the following table if proposed Generating Facility passes the screen.

Primary Distribution Line Type	Type of Interconnection to Primary Distribution Line	Result/Criteria
Three-phase, three wire	Any	Pass screen
Three-phase, four wire	Single-phase, line-to-neutral	Pass screen
Three-phase, four wire (For any line that has such a section OR mixed 3 wire & 4 wire)	All others	To pass, aggregate Generating Facility Capacity must be less than or equal to 10% of Line Section Peak Load.

Significance:

If the primary distribution circuit serving the Generating Facility is of a three-wire type, or if the Generating Facility's Interconnection transformer is single-phase and connected in a line-to-neutral configuration, then there is no concern about overvoltages to PWP's, or other Producer's equipment caused by loss of system neutral grounding during the operating time of anti-islanding protection.

J. TESTING AND CERTIFICATION CRITERIA

- 1. Introduction.** This Section describes the test procedures and requirements for equipment used for the Interconnection of a Generating Facility to PWP's Distribution System. Included are Type Testing, Production Testing, Commissioning Testing, and Periodic Testing. The procedures listed rely heavily on those described in applicable Underwriters Laboratory (UL), Institute of Electrical and Electronic Engineers (IEEE), and International Electrotechnical Commission (IEC) documents—most notably UL 1741 and IEEE 929—as well as the testing described in the New York State Public Service Commission's Interconnection requirements¹. These procedures and requirements were

¹ "New York State Standardized Interconnection Requirements, Application Process, Contract & Application Forms For New Distributed Generators, 300 Kilovolt - Amperes or Less, Connected In Parallel with Radial Distribution Lines", November 9, 2000.



developed prior to the completion of IEEE P1547. *Standard for Distributed Resources Interconnected with Electric Power Systems*, and should be revisited once that standard is published. The tests described here, together with the technical requirements in Section D of this Regulation, are intended to provide assurance that the Generating Facility's equipment will not adversely affect PWP's Distribution System and that a Generating Facility will cease providing power to PWP's Distribution System under abnormal conditions. The tests were developed assuming a low level of Generating Facility penetration. At high levels of Generating Facility penetration, other requirements and corresponding test procedures may need to be defined.

This test specification also provides a means of certifying equipment. Once a Generating Unit or device has been Certified per this Certification Process, it may be considered to be suitable for use as part of a Generating Facility interconnected with PWP's Distribution System. Subject to the exceptions described in this Section, PWP will not require a Producer to repeat the design review or test the Protective Functions of equipment that has been Certified. It should be noted the Certification process is intended to facilitate Generating Facility interconnections. Certification is not a prerequisite to interconnect a Generating Facility. The use of non-certified equipment may be acceptable subject to testing and approval by PWP as discussed below.

- 2. Certification Criteria.** Equipment tested and approved (e.g. listed) by a NRTL as having met both the Type Testing and Production Testing requirements is considered to be Certified Equipment for purposes of Interconnection with PWP's Distribution System. Certification may apply to either a pre-packaged system or an assembly of components that address the necessary functions. Type Testing may be done in the factory/test lab or in the field. At the discretion of the testing laboratory, field-certification may apply only to the particular installation tested. In such cases, some or all of the tests may need to be repeated at other installations.

The use of Certified Equipment is not a requirement for interconnection. However, the use of Certified Equipment will simplify the interconnection approval process by reducing Commissioning and additional test requirements. For non-certified equipment, some or all of the tests described in this document may be required by PWP for each Generating Facility. The manufacturer or a laboratory acceptable to PWP may perform these tests. Test results for non-certified equipment must be submitted to PWP as part of the application process for PWP's review and approval under the Supplemental Review. Approval by PWP for equipment used in a particular application does not guarantee PWP approval for use in other applications or by other California electric utilities.

When equipment is Certified by a NRTL, the NRTL shall provide to the manufacturer, at a minimum, a Certificate with the following information for each device:



- a. Administrative:
 - 1) Effective Date of certification or applicable serial number (range or first in series), other proof that certification is current
 - 2) Equipment model number(s)
 - 3) Software version, if applicable
 - 4) Test procedures specified (including date or revision number)
 - 5) Laboratory accreditation (by whom and to what standard)

- b. Technical (as appropriate):
 - 1) Device Rating (kW, kVA, V, A, etc.)
 - 2) Maximum available fault current, A
 - 3) In-rush current A
 - 4) Trip points, if factory set (trip value and timing)
 - 5) Trip point and timing ranges for adjustable settings
 - 6) Nominal power factor or range if adjustable
 - 7) If the device/system is certified for non-export and the method used (reverse power or under power)
 - 8) If the device/system is certified non-islanding

It is the responsibility of the equipment manufacturer to ensure that certification information is made publicly available by the manufacturer, the testing laboratory, or by a third party. A sample certification information form is provided in Appendix 1.

3. **Type Testing.** Type testing provides a basis for determining that equipment is designed appropriately and meets the specifications for being designated as Certified Equipment under this Regulation. The requirements described in this section cover only issues related to Interconnection and are not intended to address device safety or other issues outside the needs of the relationship between PWP and the Producer operating a Generating Facility.

The following table defines the test requirements by technology. Test References that are preceded by "UL 1741" refer to the section numbers of the document that describe the test requirements² While UL 1741 was written specifically for photovoltaic inverters, the requirements are readily adapted to inverter-based Generating Facilities, synchronous machines, induction machines, as well as single/multi-function controllers and protection relays. Until a standardized test procedure is specified, PWP or NRTL shall adapt the procedures referenced in

² UL 1741, *Inverters, Converters and Charge Controllers for use in Independent Power Systems*, Revised January 2001



the following table as appropriate and necessary for a machine's performance and its control and protection system functions.

Type Tests and Requirements for Interconnection Equipment Certification

Type Test	Reference ¹	Inverter	Synchronous Machine	Induction Machine
Utility Interaction	UL 1741 – 39	X	X	X
DC Isolation	UL 1741 - 40.1	X	---	---
Simulated PV Array (Input) Requirements	UL 1741 - 41.2	X	---	---
Dielectric Voltage Withstand	UL 1741 – 44	X	X	X
Power Factor	UL 1741 - 45.2.2	X	X	X
Harmonic Distortion	UL 1741 - 45.4	X	X	X
DC Injection	UL 1741 - 45.5	X	---	---
Utility Voltage and Frequency Variation	UL 1741 - 46.2	X	X	X
Reset Delay	UL 1741 - 46.2.3	X	X	X
Loss of Control Circuit	UL 1741 - 46.4	X	X	X
Short Circuit	UL 1741 - 47.3	X	X	X
Load Transfer	UL 1741 - 47.7	X	X	X
Surge Withstand	J.3.a	X	X	X
Anti Islanding	J.3.b	(2)	(2)	(2)
Non-Export	J.3.c	(3)	(3)	(3)
In-Rush Current	J.3.d	(4)	(4)	(4)
Synchronization	J.3.e	(5)	X	---

Notes: X = Required; -- = Not required;

Table Notes:

- (1) Reference refers to section number in either UL 1741 or this Regulation. References within UL 1741 to "photovoltaics" or "inverter" may have to be interpreted by the testing laboratory to appropriately apply the tests to other technologies.
- (2) Required only if Non-Islanding designation is desired
- (3) Required only if Non-Export designation is desired.
- (4) Required for devices that use PWP power to motor to speed
- (5) Required for all synchronous machines as well as inverters that operate as voltage sources when connected to PWP.

- a. **Anti-Islanding Test.** Devices that are tested to and pass the Anti-Islanding test procedure described in UL 1741 Section 46.3 will be considered Non-Islanding for the purposes of these interconnection requirements. This test is required only for devices for which a certified Non-Islanding designation is desired.
- b. **Non-Export Test.** Devices that pass the Non-Export test procedure described in Section J.7.a. will be considered Non-Exporting for the purposes of these interconnection requirements. This test is required only for devices for which a certified Non-Export designation is desired.
- c. **In-rush Current Test** will be tested using the procedure defined in Section J.7.b. to determine the maximum current drawn during this startup process. The resulting in-rush current is used to estimate the starting voltage drop.



- d. **Surge Withstand Capability Test.** Interconnection equipment shall be tested for surge withstand capability (SWC), both oscillatory and fast transient, in accordance with the test procedure defined in IEEE/ANSI C62.45 using the peak values defined in IEEE/ANSI C62.41 Tables 1 and 2 for location category B3. An acceptable result occurs even if the device is damaged by the surge, but is unable to operate or energize PWP's Distribution System. If the device remains operable after being subject to the surge conditions, previous type tests related to PWP protection and power quality will need to be repeated to ensure the unit will still pass those tests following the surge test.
- e. **Synchronization Test.** This test verifies that the unit synchronizes within the specified voltage/frequency/phase angle requirements. It is applied to synchronous generators and inverters capable of operating as voltage-sources while connected to PWP. This test is not necessary for induction generators or current-source inverters.

The test will start with only one of the three parameters--voltage difference between Generating Facility and PWP Distribution System, frequency difference, or phase angle--outside of the synchronization specification. Initiate the synchronization routine and verify that the Generating Facility is brought within specification prior to synchronization. Repeat the test five times for each of the three parameters.

For manual synchronization with synch check or manual control with auto synchronization, the test must verify that paralleling does not occur until the parameters are brought within specifications.

4. **Production Testing.** As a minimum, the Utility Voltage and Frequency Variation Test procedure described in UL1741 under Manufacturing and Production Tests, Section 68 shall be performed as part of routine production (100 percent) on all equipment used to interconnect Generating Facilities to PWP's Distribution System. This testing may be performed in the factory or as part of a Commissioning Test (Section J.5).
5. **Commissioning Testing.** Commissioning Testing, where required, will be performed on-site to verify protective settings and functionality. Upon initial Parallel Operation of a Generating Facility, or any time interface hardware or software is changed that may affect the functions listed below, a Commissioning Test must be performed. An individual qualified in testing protective equipment (professional engineer, factory-certified technician, or licensed electrician with experience in testing protective equipment) must perform commissioning testing in accordance with the manufacturer's recommended test procedure to prove the settings and requirements of this Regulation.



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PWP has the right to witness Commissioning Tests as described below, or to require written certification by the installer describing which tests were performed and their results.

Functions to be tested during commissioning, particularly with respect to non-certified equipment, may consist of the following:

- Over-and under-voltage
- Over and under-frequency
- Anti-Islanding (if applicable)
- Non-Export (if applicable)
- Inability to energize dead line
- Time delay restart after utility source is stable
- Utility system detection (if used)
- Synchronizing controls (if applicable)
- Other interconnection protective functions that may be required as part of the Interconnection Agreement

Other checks and tests that may need to be performed include:

- Verifying final protective settings
- Trip test
- In-Service Test

a. **Certified Equipment.** Generating Facilities qualifying for Simplified Interconnection incorporate Certified Equipment that have, at a minimum, passed the Type Tests and Production Tests described in this document, are judged to have little or no potential impact on PWP's Distribution System. For such Generating Facilities, it is necessary to perform only the Facilities qualifying for Simplified Interconnection incorporate Certified Equipment that have, at a minimum, passed the Type Tests and Production Tests described in this document, are judged to have little or no potential impact on PWP's Distribution System. For such Generating Facilities, it is necessary to perform only the following tests following tests:

- 1) Protection settings that have been changed after factory testing will require field verification. Tests will be performed using injected secondary voltages and currents, applied waveforms, a test connection using a generator to simulate abnormal utility voltage or frequency, or varying the set points to show that the device trips at the measured (actual) utility voltage or frequency.
- 2) Non-Islanding function, if included, will be checked by opening a load break disconnect switch to verify the interconnection equipment ceases to energize the line and does not re-energize for the required time delay after the switch is closed.



- 3) Non-Export function, if included, will be checked using secondary injection techniques. This function may also be tested by adjusting the Generating Facility output and local loads to verify that the applicable non-export criteria (i.e., reverse power or under power) are met.

The supplemental Review or an Interconnection Study may impose additional components or additional testing.

- b. **Non-Certified Equipment.** Non-certified equipment shall be subjected to the appropriate tests described in Type Testing (Section J.3.) as well as those described in Certified Equipment (Section J.5.a.). With PWP approval, these tests may be performed in the factory, in the field as part of commissioning, or a combination of both. PWP, at its discretion, may also approve a reduced set of tests for a particular application or, for example, if it determines it has sufficient experience with the equipment.
- c. **Verification of Settings.** If the testing is part of the commissioning process, then, at the completion of such testing, Producer shall confirm all devices are set to PWP-approved settings. This step shall be documented in the Commissioning Test Certification.
- d. **Trip Test.** Interconnection protective devices (e.g. reverse power relay) that have not previously been tested as part of the interconnection system with their associated interrupting devices (e.g. contactor or circuit breaker) shall be trip tested during commissioning. The trip test shall be adequate to prove that the associated interrupting devices open when the protective devices operate.

Interlocking circuits between protective devices or between interrupting devices shall be similarly tested unless they are part of a system that has been tested and approved during manufacture.

- e. **In-Service Test.** Interconnection protective devices that have not previously been tested as part of the interconnection system with their associated instrument transformers or that are wired in the field shall be given an in-service test during commissioning. This test will verify proper wiring, polarity, CT/PT ratios, and proper operation of the measuring circuits. The in-service test shall be made with the power system energized and carrying a known level of current. A measurement shall be made of the magnitude and phase angle of each ac voltage and current connected to the protective device and the results compared to expected values.

For protective devices with built-in metering functions that indicate current and voltage magnitudes and phase angles, or magnitudes of current, voltage, and real and reactive power, the metered values may be used for in-service testing. Otherwise, portable ammeters, voltmeters, and phase-angle meters shall be used.



6. **Periodic Testing.** Periodic Testing of Interconnection-related Protective Functions shall be performed as specified by the manufacturer, or at least every four years. All periodic tests prescribed by the manufacturer shall be performed. Producer shall maintain periodic test reports or a log for inspection by PWP. Periodic Testing conforming to PWP test intervals for the particular line section may be specified by PWP under special circumstances, such as high fire hazard areas.

A system that depends upon a battery for trip power shall be checked and logged once per month for proper voltage. Once every four years, the battery must be either replaced or a discharge test performed.

7. **Detailed Type Test Procedures and Requirements.** This section describes the additional Type Test procedures necessary to qualify a device as Certified, for use on the PWP Distribution System. These Type Tests are not contained in Underwriters Laboratories UL 1741 Standard *Inverters, Converters and Controllers for Use in Independent Power Systems*, or other referenced standards.

- a. **Non-Export Test Procedure.** The non-export test is intended to verify the operation of relays, controllers and inverters designed to limit the export of power and certify the equipment as meeting the requirements of Screen 2, Options 1 and 2, of the Initial Review Process. Tests are provided for discrete relay packages and for controllers and inverters that include the intended function.

- 1) **Reverse Power Relay Test.** This version of the Non-Export test procedure is intended for stand-alone reverse power and under power relay packages provided to meet the requirements of Options 1 and 2 of the Non-Export Screen. It should be understood that in the reverse power application, the relay will provide a trip output with power in the export (toward PWP system) direction.

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

Determine the appropriate secondary pickup current for the desired export power flow of 0.5 secondary watts (the agreed-upon minimum pickup setting assumes 5 Amp and 120V CT/PT secondary). Apply nominal voltage with minimum current setting at 0 degrees in the trip direction. Increase the current to pickup level. Observe the relay's (LCD or computer display) indication of power values. Note the indicated power level at which the relay trips. The power indication should be within 2 percent of the expected power. For relays with adjustable settings, repeat this test at the midpoint, and maximum settings.

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

Step 2: Leading Power Factor Test



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

Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Increase the current level to pickup (about 10 times higher than at 0 degrees) and verify that the relay operates. Repeat for angles 90, 180 and 270 degrees and verify that the relay does NOT operate.

Step 4: Negative Sequence Voltage Test

Using the pickup settings determined in Step 1, apply rated relay voltage and current at 180 degrees from tripping direction, to simulate normal load conditions (for 3-phase relays, use I_a at 180, I_b at 60 and I_c and 300 degrees). Remove Phase-1 voltage and observe that the relay does not operate. Repeat for phase-2 and 3.

Step 5: Load Current Test

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

Step 6: Unbalanced Fault Test

Using the pickup settings determined in Step 1, apply rated voltage and 2 times rated current, to simulate an unbalanced fault in the non-trip direction (use V_a at 0 degrees, V_b and V_c at 180 degrees, I_a at 180 degrees, I_b at 0 degrees, and I_c at 180 degrees). Observe that the relay, especially single phase, does not misoperate.

Step 7: Time Delay Settings Test

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

Step 8: Dielectric Test

Perform the test described in IEC 414 using 2 kV RMS for 1 minute.

Step 9: Surge Withstand

Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand test described in Section J.3.g.



- 2) **Under Power Relay Test.** In the underpower application, the relay will provide a trip output when import power (toward the Producer) drops below the specified power level.

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

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

Determine the appropriate secondary pickup current for the desired power flow pickup level of 5% of peak load (the agreed-upon minimum pickup setting). Apply rated voltage and current setting at 0 degrees in the direction of normal load current. Decrease the current to pickup level. Observe the relay's (LCD or computer display) indication of power values. Note the indicated power level at which the relay trips. The power indication should be within 2 percent of the expected power. For relays with adjustable settings, repeat the test at the midpoint, and maximum settings.

Repeat at phase angles of 90, 180 and 270 degrees and verify that the relay operates (measured watts will be zero or negative).

Step 2: Leading Power Factor Test

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

Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Decrease the current level to pickup (about 10% of the value at 0 degrees) and verify that the relay operates. Repeat for angles 90, 180 and 270 degrees and verify that the relay operates for any current less than rated current.

Step 4: Negative Sequence Voltage Test

Using the pickup settings determined in Step 1, apply rated relay voltage and 25% of rated current in the normal load direction, to simulate light load conditions. Remove Phase-A voltage and observe that the relay does not operate, repeat for phase-B and C.



Step 5: Unbalanced Fault Test

Using the pickup settings determined in Step 1, apply rated voltage and 2 times rated current, to simulate an unbalanced fault in the normal load direction (use V_a at 0 degrees, V_b and V_c at 180 degrees, I_a at 0 degrees, I_b at 180 degrees, and I_c at 0 degrees). Observe that the relay, especially single phase, operates properly.

Step 6: Time Delay Settings Test

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

Step 7: Dielectric Test

Perform the test described in IEC 414 using 2 kV RMS for 1 minute.

Step 8: Surge withstand

Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand test described in Section J.3.g.

- 3) **Functional Test for Inverters and Controllers.** Inverters and controllers designed to provide reverse or under power functions shall be tested to certify the intended operation of this function. Two methods are provided.

Method 1: If the controller utilizes external current/voltage measurement to determine the reverse or underpower condition, then the controller shall be functionally tested by application of appropriate secondary currents and potentials as described in the Reverse Power Relay Test, Section J.7.a.(1) of this Regulation.

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

- b. **In-Rush Current Test.** This test will determine the maximum in-rush current drawn by the unit.

- 1) **Locked-Rotor Method.** Use the test procedure defined in NEMA MG-1 (manufacturer's data is acceptable if available).
- 2) **Start-up Method.** Install and setup the Generating Facility equipment as specified by the manufacturer. Using a calibrated oscilloscope or data acquisition equipment with appropriate speed and accuracy, measure the current draw at the Point of Interconnection as the Generating Facility starts up and parallels with PWP's Distribution System. Startup shall follow the normal, manufacturer-specified procedure.



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Sufficient time and current resolution and accuracy shall be used to capture the maximum current draw within five percent. In-rush current is defined as the maximum current draw from PWP's Distribution System during the startup process, using a 10-cycle moving average. During the test, the utility source, real or simulated, must be capable of maintaining voltage within +/- five percent of rated at the connection to the unit under test. Repeat this test five times. Report the highest 10-cycle current as the in-rush current.

A graphical representation of the time-current characteristic along with the certified in-rush current must be included in the test report and made available to PWP.



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Appendix 1

Utility Interconnection Equipment Certification Form



Utility Interconnection Equipment Certification

The information on this form is provided to indicate the compliance of the generation equipment listed below with the utility interconnection certification requirements defined in this Regulation.

Certifying Laboratory *The information on this form is provided by the following Nationally Recognized Test Laboratory:*

Laboratory: _____
Contact Name: _____ Phone: _____ E-mail: _____
Address: _____
City: _____ State: _____ Zip: _____
Accredited by: _____ Date: _____
Accredited to (test standards)¹: _____

Equipment Specification *The information on this form applies to the following equipment:*

Equipment Manufacturer: _____
Address: _____
City: _____ State: _____ Zip: _____
Model Number(s): _____
Software Version(s): _____
Effective²: _____
Device Description³: _____



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Test Results ⁴

Mark the box next to each requirement that has been met and each test that has been performed and successfully passed. Provide an explanation of any exceptions or omissions on a separate sheet. List additional test documents used on a separate sheet.

UL 1741: (Section number listed)

- 39 - 40.1 - 41.2 - 44 - 45.2.2 - 45.4 - 45.5
 - 46.2 - 46.2.3 - 46.4 - 47.3 - 47.7 *Optional:* - 46.3
 - IEEE/ANSI C62.45/C62.41 (location Category B3)

California Regulation 21: - J.3.e Non-export - J.3.f In-Rush Current - J.3.h Synchronization

Device Rating:⁵ _____

Maximum available fault current, A _____

In-rush current⁶, A _____

Trip settings⁷:

		Setting 1	Setting 2	Setting 3	Setting 4	Setting 5	Factory Settings ⁸
Fast Over Voltage	Setting	/	/	/	/	/	/
	Measured	/	/	/	/	/	/
Fast Over Voltage	Setting	/	/	/	/	/	/
	Measured	/	/	/	/	/	/
Fast Over Voltage	Setting	/	/	/	/	/	/
	Measured	/	/	/	/	/	/
Fast Over Voltage	Setting	/	/	/	/	/	/
	Measured	/	/	/	/	/	/
Fast Over Voltage	Setting	/	/	/	/	/	/
	Measured	/	/	/	/	/	/

Nominal Power Factor (Range, if adjustable) _____

Non Islanding: Yes ___ No ___ Maximum trip time: _____

Non Export: Yes ___ No ___ Method: _____

Other⁸: _____



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NOTES

- 1 Accreditation must apply to test standards listed herein
- 2 Note here the date of certification, applicable serial number (range or first in series), or other information that indicates which units the certification applies to.
- 3 List appropriate functions, capabilities, applications, limitations, etc. Use additional sheets as necessary.
- 4 List all test documents (i.e. UL 1741, IEEE C62.45) and specific procedures (i.e. UL 1741 Sec 39.1 – 39.5, etc.) used to evaluate device's suitability for utility interconnection
- 5 kW, kVA, V, A, etc as appropriate
- 6 For devices that use grid power to motor to speed
- 7 Trip value (Voltage in volts or frequency in Hz) and timing (in cycles). Devices with adjustable settings shall provide test results over the range of settings. For each test setting provide the setting values in the upper box and measured results in the lower box. List device ranges, if adjustable.
- 8 Provide any additional information that may be useful in evaluating these results such as test configurations, device settings used to meet requirements, etc. Use additional sheets if necessary.