



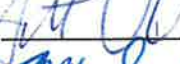


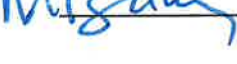
# Roseville Electric

## Rule 21- VERSION 01/2014

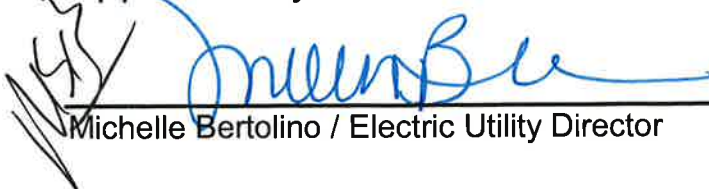
for

### The Interconnection of Distributed Generation in Parallel to the Roseville Electric Distribution System

This Rule 21 has been reviewed and accepted by:

-  - Sonny Person / Assistant Electric Utility Director - Distribution
-  - Mike Bloom / Assistant Electric Utility Director - Planning and Services
-  - Scott Vaughn / Electric Engineering Manager
-  - Rick Corral / Electric Engineering Tech Supervisor
-  - Jason Grace / Electric Operations Manager
-  - Marty Bailey / Electric Retail Services Supervisor

Approved By

  
Michelle Bertolino / Electric Utility Director

12.19.13

Date



## **A. APPLICABILITY**

### **A.1. APPLICABILITY**

This Rule 21 describes the interconnection, operating and metering requirements for all Producers to be interconnected in parallel to Roseville Electric's (RE) Distribution System. Any exceptions to this Rule 21 must be made by separate agreement with RE. Producer's facilities interconnected in parallel with RE Distribution shall interconnect under this Rule 21, regardless of the RE voltage level at the point of interconnection.

As required in the Roseville Municipal Code, Chapter 14.24 ELECTRICAL ENERGY, all Producers, unless explicitly relieved of these requirements in writing by RE, must abide by the requirements as outlined in this Rule 21 to qualify for solar Net Energy Metering, net compensation rates, and/or any other stated solar benefits as stated in Roseville Municipal Code, Chapter 14.24 ELECTRICAL ENERGY.

### **A.2. STANDARDS**

#### **A.2.a Electrical Standards**

This Rule 21 has been harmonized with the requirements of American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) 1547-2008 Standards for Interconnecting Distributed Resources with Electric Power Systems. In some sections, IEEE 1547 language has been adopted directly, in others, IEEE 1547 requirements were interpreted and this Rule's language was changed to maintain the spirit of both documents. The language from IEEE 1547 that has been adopted directly (as opposed to paraphrased language or previous language that was determined to be consistent with IEEE 1547) is followed by a citation that lists the Clause from which the language derived. For example, IEEE 1547-4.1.1 is a reference to Clause 4.1.1. In the event of any conflict between this Rule 21, any of the standards listed herein, or any other applicable standards or codes, the requirements of this Rule 21 shall take precedence.

#### **A.2.b Special Circumstances**

- 1) The Interconnection of any/all non-utility generating facility is at the discretion of the Electric Utility Director, or designee, subject to the requirements of this Rule 21.
- 2) For solar electric PV, per California state law, net metered (NEM) solar electric (PV) may be suspended for new interconnection applications if/when the total system wide capacity of PV (kW) installed in Roseville is greater than or equal to 5% of the utility peak demand (kW).
- 3) Proposed PV systems may be required to mitigate any/all potential distribution irregularities resulting from the incremental addition of a proposed PV system as part of the interconnection process. PV systems, as they are identified, will be required to utilize the Supplemental Application process as outlined in this Rule 21.



As outlined in “RE REVIEW Process / Initial and Supplemental Review Process Flow Chart” in this Rule 21, Applicants may be required to mitigate distribution irregularities in circumstances where:

- 1) An RE distribution feeder where the AC capacity (kW) of the PV installed is already 35% or greater than the total distribution feeder capacity, or
- 2) Where the addition of the incremental proposed PV system would carry the RE distribution feeder capacity of installed PV to 35% or greater of total feeder capacity.

#### **A.2.c City of Roseville Fire Codes**

All Producers must abide by all City of Roseville Fire Codes and standards to gain approval to interconnect in parallel to RE’s distribution grid.

#### **A.3. ADOPTION OF RE SPECIFICATIONS**

**RE Specifications for Residential Construction and RE Specifications for Commercial Construction are adopted as part of this Rule 21.**

By reference, the most recently published versions of the *RE Specifications for Residential Construction* and the *RE Specifications for Commercial Construction* are adopted as part of this Rule 21. In all instances, construction of Distributed Generation for parallel interconnection MUST conform to *RE Specifications for Residential Construction* or *RE Specifications for Commercial Construction*. Where contradictions exist between these two documents, *RE Specifications for Residential Construction* and *RE Specifications for Commercial Construction*, supersede this Rule 21. *RE Specifications for Residential Construction* or *RE Specifications for Commercial Construction* may be found at: <http://www.roseville.ca.us/electric/>, or may be obtained by calling Roseville Electric at 916-79-POWER.

#### **A.4. DEFINITIONS**

Capitalized terms used in this Rule 21, and not defined in RE’s other tariffs, shall have the meaning ascribed to such terms in Section H of this Rule 21. The definitions set forth in Section H of this Rule 21 shall only apply to this Rule 21 and may not apply to RE’s other tariffs.



## **B. GENERAL RULES, RIGHTS AND OBLIGATIONS**

### **B.1. AUTHORIZATION REQUIRED TO OPERATE**

A PRODUCER MUST COMPLY WITH THIS RULE 21, EXECUTE AN INTERCONNECTION AGREEMENT WITH RE WHERE APPLICABLE, AND RECEIVE RE'S EXPRESS WRITTEN PERMISSION BEFORE PARALLEL OPERATION OF ITS GENERATING FACILITY WITH RE'S DISTRIBUTION SYSTEM. Per Section A above, the Electric Utility Director may reject any application for parallel interconnection of the interconnection facility if:

- 1) It is determined that the parallel interconnection will reduce or potentially negatively impact RE system reliability.
- 2) The interconnection will result in an unreasonable financial burden within the customer generator's rate customer class or a financial rate class cross subsidy.
- 3) The interconnection results in an unacceptable impact on RE assets.

### **B.2. SEPARATE AGREEMENTS REQUIRED FOR OTHER SERVICES**

A Producer requiring other electric services from RE including, but not limited to, Distribution Service during periods of curtailment or interruption of the Producer's Generating Facility, must enter into agreements with RE for such services in accordance with RE's approved tariffs. These services and benefits are not guaranteed. Additionally where applicable, it is the responsibility of the Producer to obtain any and all necessary agreements with concerned third party organizations and agencies, including (but not exclusive to) the Western Area Power Administration (WAPA) as part of this interconnection process. Any such agreements will operate on the principle that an interconnection shall provide the Producer no financial advantage to the Distributed Generation interconnected within RE's distribution system vs. not.

### **B.3. TRANSMISSION SERVICE NOT PROVIDED WITH INTERCONNECTION**

Interconnection with RE's Distribution System under this Rule 21 does not provide a Producer any rights to utilize RE's Distribution System for the transmission, distribution, or wheeling of electric power. Any such utilization must be specifically granted by RE as part of a separate negotiation. Such rights are not automatically granted or guaranteed.

### **B.4. COMPLIANCE WITH LAWS, MUNICIPAL CODE, RULES AND TARIFF SCHEDULES**

A Producer shall ascertain and comply with applicable approved City of Roseville Municipal Codes, tariffs of RE; applicable Federal Energy Regulatory Commission (FERC) approved rules, Western Area Power Administration (WAPA) approved rules, all other applicable 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.

### **B.5. DESIGN REVIEWS AND INSPECTIONS**



RE shall have the right to review the design of a Producer's Generating and/or Interconnection Facilities and to inspect a Producer's Generating and/or Interconnection Facilities prior to the commencement of Parallel Operation with RE's Distribution System.

RE may require a Producer to make modifications as necessary to comply with the requirements of this Rule 21. Modifications may include, but are not limited to, documentation, sketches, drawings and constructed facilities. RE's review and authorization for Parallel Operation shall not be construed as confirming or endorsing the Producer's design or as warranting the Generating and/or Interconnection Facilities' safety, durability or reliability. RE shall not, by reason of such review or lack of review, be responsible for the strength, adequacy or capacity of such equipment.

**B.6. RIGHT TO ACCESS DISTRIBUTED GENERATION**

A Producer's Generating Facility and/or Interconnection Facilities shall be reasonably accessible to RE and other authorized City of Roseville personnel as necessary to perform duties and exercise its rights under its Municipal Code, Rule 21, tariffs, and any applicable Interconnection Agreement between RE and the Producer.

**B.7. CONFIDENTIALITY OF INFORMATION**

Any information pertaining to Generating and/or Interconnection Facilities provided to RE by a Producer shall be treated by RE in a confidential manner.

**B.8. PRUDENT OPERATION AND MAINTENANCE REQUIRED**

A Producer shall operate and maintain its Generating Facility and Interconnection Facilities in accordance with Prudent Electrical Practices and shall maintain compliance with Roseville Municipal Codes and this Rule 21.

**B.9. CURTAILMENT AND DISCONNECTION**

RE may limit the operation or disconnect or require the disconnection of a Producer's Generating Facility from RE's Distribution System at any time, with or without notice, in the event of an Emergency, or to correct Unsafe Operating Conditions. RE may also limit the operation or disconnect or require the disconnection of a Producer's Generating Facility from RE's Distribution System upon the provision of reasonable written notice: 1) to allow for routine maintenance, repairs or modifications to RE's Distribution System; 2) upon RE's determination that a Producer's Generating Facility is not in compliance with this Rule 21; or 3) upon termination of any applicable Interconnection Agreement. Upon the Producer's written request, RE shall provide a written explanation of the reason for such curtailment or disconnection.



## **C. APPLICATION AND INTERCONNECTION PROCESS**

### **C.1. APPLICATION PROCESS**

All Producers desiring to interconnect Distributed Generation in parallel to Roseville Electric MUST apply for permission to interconnect via this process. Distributed Generation may not be actively interconnected to Roseville Electric without written approval from Roseville Electric.

#### **C.1.a. Applicant Initiates Contact With RE**

Upon request, RE will provide information and documents (such as sample agreements, Application, technical information, listing of Certified Equipment, Initial and Supplemental Review fee information, applicable tariff schedules and Metering requirements) and notification of any NEM or feeder restrictions to a potential Applicant. Unless otherwise agreed upon, all such information shall normally be sent to an Applicant within ten (10) business days following the initial request from the Applicant. Exceptions to this do exist. Contact RE for more information.

#### **C.1.b. Applicant Completes an Application**

All Applicants shall complete and file an Application and supply any relevant additional information requested by RE. When applicable per Table C.1, an \$800 Initial Review fee shall be included with the Application. Check should be made payable to: Roseville Electric.

#### **C.1.c. Net Metering (NEM) Benefit Qualifications.**

Generating Facilities eligible for Net or Co Energy Metering under Public Utilities Code Section 2827, 2827.8, 2827.9, or 2827.10 are exempt from any costs associated with Interconnection Studies. Generating Facilities eligible for Net Metering and all associated Net Metering benefits must be permanently mounted at the premise. Parallel interconnection shall not be extended to systems not permanently mounted at the premise without written permission from RE.

- 1) Normally, within 20 business days of receiving the Application, RE shall acknowledge its receipt and state whether the Application has been completed adequately. If defects are noted, RE and Applicant shall cooperate in a timely manner to establish a satisfactory Application.
- 2) The Initial Review fee shall be waived for Applications requesting Interconnection pursuant to Sections 2827, 2827.8, 2827.9, or 2827.10 of the Public Utilities Code, and for Solar powered Generating Facilities that do not sell power to the grid.



- 3) Fifty percent of the fees associated with the Initial Review will be returned to the Applicant if the Application is rejected by RE or the Applicant retracts the Application.
- 4) Applications that are over one year old (from the date of RE's acknowledgement) without a signed Interconnection Agreement, or a Generating Facility that has not been approved for parallel operation within one year of completion of all applicable review and/or studies are subject to cancellation by RE.
- 5) RE may negotiate specific costs for reviewing non-standard Applications, such as Applications submitted for multiple Generators, multiple sites, or otherwise as conditions warrant.

**C.1.d. RE Performs an Initial and Supplemental 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, RE 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; or (b) the Generating Facility requires a Supplemental Review.
- 2) Any Producer's Generation Facility desiring to interconnect in parallel with RE not permanently mounted to the building, other associated permanent structures the ground at the premise serviced by the electric revenue meter of record and/or utilizing energy storage MUST apply for interconnection. An application does not guarantee approval for interconnection.
- 3) RE shall endeavor to complete its Initial Review, absent any extraordinary circumstances, within 20 business days after its determination that the Application is complete. If the Initial Review determines the proposed Generating Facility can be interconnected by means of a Simplified Interconnection, RE will provide the Applicant where applicable with an Interconnection Agreement for Applicant's signature<sup>4</sup> If the Generating Facility does not pass the Initial Review for Simplified Interconnection as proposed, RE will notify the applicant and perform a Supplemental Review as described in Section I., Applicant shall pay an additional \$600 for the Supplemental Review, unless the Application is withdrawn. The Supplemental Review will result in RE providing either: (a) Interconnection requirements beyond those for a Simplified Interconnection, and an Interconnection Agreement for Applicant's signature; or (b) a cost estimate and schedule for an Interconnection Study. The Supplemental Review shall be completed, absent any extraordinary circumstances, within 30 business days of receipt of a completed Application and fees.

The Supplemental Review fee shall be waived for Applications requesting



**Rule 21 – Parallel Interconnection Requirements for Distributed Generation**

Interconnection pursuant to Sections 2827, 2827.8, 2827.9, or 2827.10 of the Public Utilities Code.

**C.1.e When Required, Applicant and RE Commits to Additional Interconnection Study Steps.**

When a Supplemental Review reveals that the proposed Generating Facility cannot be Interconnected to RE’s Distribution System by means of a Simplified Interconnection, or that significant RE Interconnection Facilities or Distribution System modifications will be needed to accommodate an Applicant’s Generating Facility, RE and Applicant shall enter into an agreement that provides for RE 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 – if any. The Interconnection Study agreement shall set forth RE’s estimated schedule and charges for completing such work. Initial and

Supplemental Review and Interconnection Study fees for solar generating facilities up to 1 megawatt (MW) that do not sell power to the grid will be waived up to the amount of \$5,000. Generating Facilities eligible for Net or Co Energy Metering under Public Utilities Code Section 2827, 2827.8, 2827.9, or 2827.10 are exempt from any costs associated with Interconnection Studies.

**Table C.1 Summary of Fees and Exemptions**

Generating Facility Type	Initial Review Fee	Supplemental Review Fee	Interconnection Study Fees
<u>Non-Net Energy Metering</u> (Excluding Co Energy Metering per Public Utilities Code Sections 2827)	\$800*	\$600 (additional)	As Specified by RE
<u>Net and Co Energy Metering</u> (per Public Utilities Code Sections 2827, 2827.8, 2827.9, or 2827.10)	\$0	\$0	\$0
<u>Solar 1MW or less that does not sell power to the grid</u> (per D.01-07-027)	\$0	\$0	<b>First \$5,000 of total review and study fees waived</b>

\*Subject to 50% refund pursuant to Section C.1.b.3



## **C.2. INTERCONNECTION PROCESS**

### **C.2.a. Applicant and RE Enter Into an Interconnection Agreement**

- 1) All Producers must enter into an interconnection agreement to interconnect in parallel to RE's Distribution System.
- 2) For qualifying solar, wind or solar/wind hybrid systems, where the system size is less than or equal to 100.0 kW AC watts and all equipment standards are met, the interconnection - shall utilize a program application where the interconnection agreement is integrated in to Application and shall not be required to execute an additional and separate Interconnection Agreement with the City. All interconnected customers shall be required to meet all Rule 21 standards to be granted interconnection status. Where appropriate for all other generation types, sizes and customers - RE shall provide the Applicant with an executable version of the Interconnection Agreement appropriate for the Applicant's Generating Facility and desired mode of operation. Where the Supplemental Review or Interconnection Study performed by RE has determined that modifications or additions to its Distribution System are required RE shall set forth the Applicant's responsibilities, completion schedules, and estimated or fixed price costs for the required work.

**C.2.b. Where Applicable, RE or Producer Installs Required Interconnection Facilities or Modifies RE's Distribution System.** After executing any applicable agreements, RE or Producer will commence construction/installation of RE's Distribution System modifications or Producer will commence construction/installation of Producer's Interconnection Facilities which have been identified in the agreements. The parties will use good faith efforts to meet schedules and fixed costs or estimated costs as appropriate.

**C.2.c. Producer Arranges for and Completes Commissioning Testing of Generating Facility and Producer's Interconnection Facilities.** The Producer is responsible for testing new Generating Facilities and associated Interconnection Facilities according to Section J.5 to ensure compliance with the safety and reliability provisions of this Rule 21 prior to being operated in parallel with RE's Distribution System. For non-Certified Equipment, the Producer shall develop a written testing plan to be submitted to RE for its review and acceptance. RE shall witness the equipment acceptance testing. Alternatively, the Producer and RE may agree to have RE conduct the required testing at the Producer's expense. Where applicable, the test plan shall include the installation test procedures published by the manufacturer of the generation or Interconnection equipment. Facility testing shall be conducted at a mutually agreeable time, and depending on who conducts the test, RE or Producer shall be given the opportunity to witness the tests.



**C.2.d. RE Authorizes Parallel Operation or Momentary Parallel Operation.**

The Producer's Generating Facility shall be authorized for Parallel Operation or Momentary Parallel Operation, as applicable, with RE's Distribution System within 10 working days upon satisfactory compliance with the terms of all applicable agreements and RE's express written permission. 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 agreements formed between the Producer and RE. A Producer shall not commence Parallel Operation of its Generating Facility with RE's system unless it has received RE's express written permission to do so.

For Generating Facilities qualifying for service under Public Utilities Code Sections 2827 and 2827.8, RE approval for interconnection shall normally be provided no later than 30 business days following RE's receipt of 1) Application including all supporting documents and required payments; 2) Metering Interconnection Agreement where applicable; and 3) evidence of the Producer's final inspection clearance from the governmental authority having jurisdiction over the Generating Facility. If the 30-day period cannot be met, the RE shall notify the Applicant.

**D. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS**

This section has been revised to be consistent with the requirements of ANSI/IEEE 1547-2008 *Standard for Interconnecting Distributed Resources with Electric Power Systems* (IEEE 1547). Exceptions are taken to IEEE 1547 Clauses 4.1.4.2 Distribution Secondary Spot Networks and Clauses 4.1.8.1 or 5.1.3.1, which address Protection from Electromagnetic Interference. Also, Rule 21 does not adopt the Generating Facility power limitation of 10 MW incorporated in IEEE 1547. Language from IEEE 1547 that has been adopted directly (as opposed to paraphrased language or previous language that was determined to be consistent with IEEE 1547) is followed by a citation that lists the Clause from which the language derived. For example, IEEE1547-4.1.1 is a reference to Clause 4.1.1.

In the event of any conflict between this rule and any of the standards listed herein, the requirements of this rule shall take precedence.

**D.1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS**

The Protective Functions and requirements of this Rule 21 are designed to protect RE's Distribution System and staff, not the Generating Facility. A Producer shall be solely responsible for providing adequate protection for its Generating Facility and Interconnection Facilities, staff and public. The Producer's Protective Functions shall not impact the operation of other Protective Functions utilized on RE's Distribution System in a manner that would affect RE's capability of providing reliable service to its Customers.

**D.1.a. Protective Functions Required.** Generating Facilities operating in parallel with RE's Distribution System shall, at a minimum, be equipped with the



following Protective Functions to sense abnormal conditions on RE's Distribution System and cause the Generating Facility to be automatically disconnected from RE's Distribution System or to prevent the Generating Facility from being connected to RE's Distribution System inappropriately:

- 1) Over and under voltage trip functions and over and under frequency trip functions;
- 2) A voltage and frequency sensing and time-delay function to prevent the Generating Facility from energizing a de-energized Distribution System circuit and to prevent the Generating Facility from reconnecting with RE's Distribution System unless RE's Distribution System service voltage and frequency is within the ANSI C84.1-1995 Table 1 Range B Voltage Range of 106V to 127V (on a 120V basis), inclusive, and a frequency range of 59.7 Hz to 60.5 Hz, inclusive, and are stable for at least 60 seconds; and
- 3) An automatic function to prevent the Generating Facility from contributing to the formation of an Unintended Island, and cease to energize the RE within two seconds of the formation of an Unintended Island.
- 4) A Visible and Lockable Disconnect required: see Section D.1.d below.

The Generating Facility shall cease to energize RE's Distribution System for faults on RE's Distribution System circuit to which it is connected (IEEE1547-4.2.1). The Generating Facility shall cease to energize RE's Distribution circuit prior to reclosure by RE' Distribution System equipment (IEEE1547-4.2.2).

**D.1.b. Momentary Paralleling Generating Facilities.** With RE's approval, the transfer switch or scheme used to transfer the Producer's loads from RE's Distribution System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.

**D.1.c. Suitable Equipment Required.** *RE Specifications for Residential Construction* and the *RE Specifications for Commercial Construction* provide the basis for this requirement. Circuit breakers or other interrupting equipment 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 single device or component shall not potentially compromise the safety and reliability of RE's Distribution System. The Generating Facility paralleling-device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE1547-4.1.8.3). The Interconnection Facility shall have the capability to withstand voltage and current surges in accordance with the



environments defined in IEEE Std C62.41.2-2002 or IEEE Std C37.90.1-2002 as applicable and as described in J.3.e (IEEE1547-4.1.8.2).

**D.1.d. Visible and Lockable Manual Disconnect Required.**

**IMPORTANT NOTICE: Roseville Electric REQUIRES the installation of a visible manual A/C “blade style” disconnect switch and a visible and lockable manual DC “blade style” disconnect switch unless otherwise relieved of this responsibility in writing. This is in addition to any automatic trip functions provided other system safety mechanisms. See of the *RE Specifications for Residential Construction* and the *RE Specifications for Commercial Construction*.**

In General:

- 1) These requirements are applicable to installations utilizing both “free standing” and module integrated inverters.
- 2) Manually operated visible and lockable A/C “blade style” disconnect must be placed between the inverter and the electric panel within 5 feet, line of sight from the electrical panel, to allow for verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.) Must be capable of being “locked” in the disconnect position.
- 3) Manually operated visible D/C “blade style” disconnect must be placed between the inverter and the PV system (solar array) within 5 feet, line of sight from the electrical inverter, to allow for verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.) Disconnect must be capable of being “locked” in the disconnected/OFF position.
- 4) Manually operated visible and lockable A/C “blade style with visible air gap” disconnect must be placed between the inverter(s) and the electric panel within 5 feet, line of sight from the electrical panel. Visible air gap can be verified by opening disconnect cover. The disconnect device must be capable of being “locked” in the disconnected/OFF position. If applicable, a PBI meter shall be placed within 5 feet of the Disconnect mentioned above and an additional A/C disconnect of same type as above shall be placed within 5 feet of the PBI meter between the PBI meter and the inverter (or combiner box).
- 5) Manually operated visible and lockable D/C “blade style” with visible air gap disconnect must be placed between the inverter and the customer-generator’s electric panel, within 5 feet, line of sight from the electrical panel, to allow for verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.) Must be capable of being “locked” in the disconnect position.



- 6) Disconnect devices shall include markings or signage that clearly indicates open and closed positions.
- 7) Visible and lockable disconnect devices must be quickly accessible 24 hours a day by City of Roseville personnel for emergency operations, construction, operation, maintenance, inspection, testing or reading, without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.
- 8) Be capable of being locked in the open position.
- 9) All disconnect devices shall be clearly marked on the submitted single line diagram and its type and location approved by the RE prior to installation. If the device is not adjacent to the PCC, permanent signage must be installed at an RE-approved location providing a clear description of the location of the device.

Generating Facilities with Non-Islanding inverters totaling one (1) kilovolt-ampere (kVA) or less are exempt from this requirement.

**D.1.e. Drawings Required.** Prior to Parallel Operation or Momentary Parallel Operation of the Generating Facility, RE shall approve the Producer's Protective Function and control diagrams. Generating Facilities equipped with Protective Functions and a control scheme previously approved by RE for system-wide application or only Certified Equipment may satisfy this requirement by reference to previously approved drawings and diagrams.

**D.1.f. Generating Facility Conditions Not Identified.** In the event this Rule 21 does not address the Interconnection conditions for a particular Generating Facility, RE and Producer may agree upon other arrangements.

## **D.2. PREVENTION OF INTERFERENCE**

The Producer shall not operate Generating or Interconnection Facilities that superimpose a voltage or current upon RE's Distribution System that interferes with RE operations, service to RE customers, or 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 RE. If the Producer does not take corrective action in a timely manner, or continues to operate the facilities causing interference without restriction or limit, RE may, without liability, disconnect the Producer's facilities from RE's Distribution System, in accordance with Section B.9 of this Rule 21. To eliminate undesirable interference caused by its operation, each Generating Facility shall meet the following criteria:

**D.2.a. Voltage Regulation.** The GF shall not actively regulate the voltage at the PCC while in parallel with RE's Distribution System. The GF shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A (IEEE1547-4.1.1).

**D.2.b. Operating Voltage Range.** The voltage ranges in Table D.1 define protective trip limits for the Protective Function and are not intended to



define or imply a voltage regulation Function. Generating Facilities shall cease to energize RE's Distribution System within the prescribed trip time whenever the voltage at the Point of Common Coupling deviates from the allowable voltage operating range.. The Protective Function shall detect and respond to voltage on all phases to which the Generating Facility is connected.

- 1) **Generating Facilities (30 kVA or less).** Generating Facilities with a Gross Nameplate Rating of 30 kVA or less shall be capable of operating within the voltage range normally experienced on RE's Distribution System. The operating range shall be selected in a manner that minimizes nuisance tripping between 106 volts and 132 volts on a 120-volt base (90%-110% of nominal voltage). Voltage shall be detected at either the PCC or the Point of Interconnection.
- 2) **Generating Facilities (greater than 30 kVA).** RE may have specific operating voltage ranges for Generating Facilities with Gross Nameplate Ratings greater than 30 kVA, and may require adjustable operating voltage settings. In the absence of such requirements, the Generating Facility shall operate at a range between 90% and 110% of the applicable interconnection voltage. Voltage shall be detected at either the PCC or the Point of Interconnection, with settings compensated to account for the voltage at the PCC, Generating Facilities that are Certified Non-Islanding or that meet one of the options of the Export Screen (Section I.3.b) may detect voltage at the Point of Interconnection without compensation.
- 3) **Voltage Disturbances.** Whenever RE's Distribution System voltage at the Point of Common Coupling varies from and remains outside normal by the predetermined amounts set forth in Table D-1, the Generating Facility's Protective Functions shall cause the Generator(s) to become isolated from RE's Distribution System:



**Table D.1: Voltage Trip Settings**

Voltage at Point of Common Coupling		Maximum Trip Time [1]	
Assuming 120 V Base	% of Nominal Voltage	# of Cycles (Assuming 60Hz Nominal )	Seconds
Less than 60 Volts	Less than 50%	10 Cycles	0.16 Seconds
Greater than or equal to 60 Volts but less than 106 Volts	Greater than or equal to 50% but less than 88%	120 Cycles	2 Seconds
Greater than or equal to 106 Volts but less than or equal to 132 Volts	Greater than or equal to 88% but less than or equal to 110%	Normal Operation	
Greater than 132 Volts but less than or equal to 144 Volts	Greater than 110% but less than or equal to 120%	60 Cycles	1 Second
Greater than 144 Volts	Greater than 120%	10 Cycles	0.16 Seconds

[1] - *"Maximum Trip time" refers to the time between the onset of the abnormal condition and the Generating Facility ceasing to energize RE's Distribution System. Protective Function sensing equipment and circuits may remain connected to RE's Distribution System to allow sensing of electrical conditions for use by the "reconnect" feature. The purpose of the allowed time delay is to allow a Generating Facility to "ride through" short-term disturbances to avoid nuisance tripping. Set points shall not be user adjustable (though they may be field adjustable by qualified personnel). For Generating Facilities with a Gross Nameplate Rating greater than 30 kVA, set points shall be field adjustable and different voltage set points and trip times from those in Table D.1 may be negotiated with RE.*

**D.2.c. Paralleling.** The Generating Facility shall parallel with RE's Distribution System without causing a voltage fluctuation at the PCC greater than  $\pm 5\%$  of the prevailing voltage level of RE's Distribution System at the PCC, and meet the flicker requirements of D.2.d. Section J provides technology-specific tests for evaluating the paralleling Function. (IEEE1547-4.1.3)

**D.2.d. Flicker.** The Generating Facility shall not create objectionable flicker for other customers on RE's Distribution System. To minimize the adverse voltage effects experienced by other customers (IEEE1547-4.3.2), 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 519-1992 (IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, IEEE STD 519-1992, Institute of Electrical and Electronic Engineers, Piscataway, NJ). This requirement is necessary to minimize the adverse voltage affects experienced by other customers on RE's Distribution System. Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.

**D.2.e. Integration with RE's Distribution System Grounding.** The grounding scheme of the Generating Facility interconnection shall not cause over voltages that exceed the rating of the equipment connected to the RE and



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shall not disrupt the coordination of the ground fault protection on the RE's Distribution System (IEEE1547-4.1.2) (See Section I.3.h).

**D.2.f. Frequency.** RE controls system frequency and the Generating Facility shall operate in synchronism with the RE's Distribution System. Whenever RE's Distribution System frequency at the Point of Common Coupling varies from and remains outside normal (nominally 60 Hz) by the predetermined amounts set forth in Table D.2, the Generating Facility's Protective Functions shall cease to energize RE's Distribution System within the stated maximum trip time.

**Table D.2: Frequency Trip Settings**

Generating Facility Rating	Frequency Range (Assuming 60Hz Nominal)	Maximum Trip Time [1] (Assuming 60 Cycles per Second)
Less or equal to 30kW	Less than 59.3 Hz	10 Cycles
	Greater than 60.5 Hz	10 Cycles
Greater than 30kW	Less than 57 Hz	10 Cycles
	Less than an adjustable value between 59.8Hz and 57 Hz but greater than 57 Hz. [2]	Adjustable between 10 and 18,000 Cycles. [2, 3]
	Greater than 60.5 Hz	10 Cycles

[1] - "Maximum Trip time" refers to the time between the onset of the abnormal condition and the Generating Facility ceasing to energize RE's Distribution System. Protective Function sensing equipment and circuits may remain connected to RE's Distribution System to allow sensing of electrical conditions for use by the "reconnect" feature. The purpose of the allowed time delay is to allow a Generating Facility to "ride through" short-term disturbances to avoid nuisance tripping. Set points shall not be user adjustable (though they may be field adjustable by qualified personnel). For Generating Facilities with a Gross Nameplate Rating greater than 30 kVA, set points shall be field adjustable and different voltage set points and trip times from those in Table D.2 may be negotiated with RE.

[2] - Unless otherwise required by RE, a trip frequency of 59.3 Hz and a maximum trip time of 10 cycles shall be used.

[3] - When a 10 cycle Maximum trip time is used, a second under frequency trip setting is not required.

**D.2.g. Harmonics.** When the Generating Facility is serving balanced linear loads, harmonic current injection into RE's Distribution System at the PCC shall not exceed the limits stated below in Table D.3. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in RE's Distribution System without the Generating Facility connected (IEEE1547-4.3.3). The harmonic distortion of a Generating Facility located at a Customer's site shall be evaluated using the same criteria as for the Host Loads.



Table D.3: Maximum harmonic current distortion in percent of current (I) [1,2]

Individual harmonic order, h (odd harmonics) [3]	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	Total demand distortion (TDD)
Max Distortion (%)	4.0	2.0	1.5	0.6	0.3	5.0

[1] - IEEE1547-4.3.3

[2] - I = the greater of the maximum Host Load current integrated demand (15 or 30 minutes) without the GF, or the GF rated current capacity (transformed to the PCC when a transformer exists between the GF and the PCC).

[3] - Even harmonics are limited to 25% of the odd harmonic limits above.

**D.2.h. Direct Current Injection.** Generating Facilities should not inject direct current greater than 0.5% of rated output current into RE’s Distribution System.

**D.2.i. Power Factor.** Each non-solar Generator in a Generating Facility shall be capable of operating at some point within a power factor range from 0.9 leading to 0.9 lagging. Operation outside this range is acceptable provided the reactive power of the Generating Facility is used to meet the reactive power needs of the Host Loads or that reactive power is otherwise provided under tariff by RE. The Producer shall notify RE if it is using the Generating Facility for power factor correction. Unless otherwise agreed upon by the Producer and RE, Generating Facilities shall automatically regulate power factor, not voltage, while operating in parallel with RE’s Distribution System.

**D.3. TECHNOLOGY SPECIFIC REQUIREMENTS**

**D.3.a. Three-Phase Synchronous Generators.** For three-phase Generators, the Generating Facility circuit breakers shall be three-phase devices with electronic or electromechanical control. The Producer shall be responsible for properly synchronizing its Generating Facility with RE’s Distribution System by means of either manual or automatic synchronizing equipment. Automatic synchronizing is required for all synchronous Generators that have a Short Circuit Contribution Ratio (SCCR) exceeding 0.05. Loss of synchronism protection is not required except as may be necessary to meet D.2.d (Flicker) (IEEE1547-4.2.5). Unless otherwise agreed upon by the Producer and RE, synchronous Generators shall automatically regulate power factor, not voltage, while operating in parallel with RE’s Distribution System. A power system stabilization Function is specifically not required for Generating Facilities under 10 MW Net Nameplate Rating.

**Induction Generators.** Induction Generators (except self-excited Induction Generators) do not require a synchronizing Function. Starting or rapid load fluctuations on induction generators can adversely impact RE’s 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, RE must review these



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

- D.3.b. Solar Modules.** Unless explicitly allowed in writing by RE, all modules must be current approved list posted at *GoSolarCalifornia*: <http://gosolarcalifornia.org/>.
- D.3.c. Inverters.** Utility-interactive inverters do not require separate synchronizing equipment. Non-utility-interactive or “stand-alone” inverters shall not be used for Parallel Operation with RE’s Distribution System. Systems utilizing a battery backup are explicitly not subject to a Simplified Interconnection process and will default to the Supplemental Interconnection process.
- D.3.d. 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 connected to a center-tapped neutral 240-volt service must be installed such that no more than 6 kVA of imbalanced power is applied to the two “legs” 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.

#### **D.4. SUPPLEMENTAL GENERATING FACILITY REQUIREMENTS**

- D.4.a. Fault Detection.** A Generating Facility with an SCCR exceeding 0.1 or one that does not cease to energize RE’s Distribution System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution System faults, both line-to-line and line-to-ground, and shall cease to energize RE’s Distribution System within two seconds of the initiation of a fault.
- D.4.b. Transfer Trip.** For a Generating Facility that cannot detect Distribution System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize RE’s Distribution System within two seconds, RE may require a Transfer Trip system or an equivalent Protective Function.
- D.4.c. Reclose Blocking.** Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, RE may require additional Protective Functions, including, but not limited to reclose-blocking on some of the automatic reclosing devices.



**E. INTERCONNECTION FACILITIES AND DISTRIBUTION SYSTEM MODIFICATIONS  
OWNERSHIP AND FINANCING**

**E.1. SCOPE AND OWNERSHIP OF INTERCONNECTION FACILITIES AND  
DISTRIBUTION SYSTEM MODIFICATIONS**

**E.1.a. Scope.** Parallel Operation of Generating Facilities may require Interconnection Facilities or modifications to RE's Distribution System ("Distribution System modifications"). The type, extent and costs of Interconnection Facilities and Distribution System modifications shall be consistent with this Rule 21 and determined through the Supplemental Review and/or Interconnection Studies described in Section C.

**E.1.b. Ownership.** Interconnection Facilities installed on Producer's side of the Point of Common Coupling may, per the specifics of this Rule 21, or by separate agreement(s), be owned, operated and maintained by the Producer or RE.

**E.2. RESPONSIBILITY OF COSTS OF INTERCONNECTING A GENERATING FACILITY**

**E.2.a. Study and Review Costs.** A Producer shall be responsible for the reasonably incurred costs of the reviews and studies conducted pursuant to Section C.1 of this Rule 21.

**E.2.b. Facility Costs.** A 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 RE in providing, operating, or maintaining the Interconnection Facilities and Distribution System modifications required solely for the Interconnection of the Producer's Generating Facility with RE's Distribution System. Generating Facilities eligible for Net and Co Energy Metering under California Public Utilities Code 2827, 2827.8, 2827.9, or 2827.10 are exempt from any costs associated with Distribution System modifications.

**E.2.c. Separation of Costs.** Should RE combine the installation of Interconnection Facilities or Distribution System modifications required for the Interconnection of a Generating Facility with modifications to RE's Distribution System to serve other Customers or Producers, RE shall not include the costs of such separate or incremental facilities in the amounts billed to the Producer.

**E.2.d. Reconciliation of Costs and Payments.** If the Producer selected a fixed price billing for the Interconnection Facilities or Distribution System modifications, no reconciliation will be necessary. If the Producer selected actual cost billing, a true up will be required. Within a reasonable time after the Interconnection of a Producer's Generating Facility, RE will reconcile its



actual costs related to the Generating Facility against any advance payments made by the Producer. The Producer will receive either a bill for any balance due or a reimbursement for overpayment as determined by RE's reconciliation. The Producer shall be entitled to a reasonably detailed and understandable accounting for the payments.

### **E.3. INSTALLATION AND FINANCING OF INTERCONNECTION FACILITIES AND DISTRIBUTION SYSTEM MODIFICATIONS**

**E.3.a. Agreement May Be Required.** Where applicable, the costs for Interconnection Facilities and Distribution System modifications shall be paid by the Producer pursuant to the provisions contained in the applicable Interconnection Agreement. Where the type and extent of the Interconnection Facilities or Distribution System modifications warrant additional detail, Producer and RE shall execute separate agreement(s) to more fully describe and allocate the parties' responsibilities for installing, owning, operating and maintaining the Interconnection Facilities and Distribution System modifications.

**E.3.b. Interconnection Facilities and Distribution System Modifications.** Except as provided for in Sections E.2.b. and E.3.c. of this Rule 21, Interconnection Facilities connected to RE's side of the Point of Common Coupling and Distribution System modifications shall be provided, installed, owned and maintained by RE at Producer's expense.

**E.3.c. Third-Party Installations.** Subject to the approval of RE, a Producer may at its option employ a qualified contractor to provide and install Interconnection Facilities or Producer paid Distribution System modifications, to be owned and operated by RE, on RE's side of the Point of Common Coupling. Such Interconnection Facilities and Distribution System modifications shall be installed in accordance with RE's design and specifications. Upon final inspection and acceptance by RE, the Producer shall transfer ownership of such Producer installed Interconnection Facilities or Distribution System modifications to RE and such facilities shall thereafter be owned and maintained by RE at the Producer's expense. The Producer shall pay RE's reasonable cost of design, administration, and monitoring of the installation for such facilities to ensure compliance with RE's requirements. The Producer shall also be responsible for all costs, including any income tax liability, associated with the transfer of Producer installed Interconnection Facilities and Distribution System modifications to RE.

**E.3.d. Reservation of Unused Facilities.** When a Producer wishes to reserve RE-owned Interconnection Facilities or Distribution System modifications, installed and operated as Special Facilities for the Producer at Producer's expense, but idled by a change in the operation of the Producer's Generating Facility or otherwise, Producer may elect to abandon or reserve such facilities consistent with the terms of its agreement with RE. If



Producer elects to reserve idle Interconnection Facilities or Distribution System modifications, RE shall be entitled to continue to charge Producer for the costs related to the ongoing operation and maintenance of the Special Facilities.

## **F. METERING, MONITORING AND TELEMTRY**

### **F.1. GENERAL REQUIREMENTS**

All Generating Facilities shall be metered in accordance with this Section F and shall meet all applicable standards of RE contained in RE's applicable tariffs, laws, ordinances, regulations, and standards (LORS) local LORS dealing with Metering specifications.

As required in the Roseville Municipal Code, Chapter 14.24 ELECTRICAL ENERGY, all Producers, unless explicitly relieved of these requirements in writing by RE, must abide by the requirements as outlined in this Rule 21 to qualify for solar Net Energy Metering, net compensation rates, and/or any other stated solar benefits as stated in Roseville Municipal Code, Chapter 14.24 ELECTRICAL ENERGY.

### **F.2. METERING BY NON-RE PARTIES**

The ownership, installation, operation, reading and testing of revenue Metering Equipment for Generating Facilities shall be by RE, except to the extent that the City authorizes any or all these services be performed by others.

### **F.3. NET GENERATION METERING**

For purposes of providing data for account billing for applicable Distributed Generating Facility operations to determine net kWh use and other applicable charges as defined in RE's tariff, RE shall specify the meter type. The meter, installation cost and the cost of any necessary communications (telephone) lines needed to record generation kWh shall be borne by the Producer. If the existing/proposed meter does not meet RE specifications, RE shall provide and install the correct meter at the Producer's expense. RE reserves the right to establish appropriate equipment and installation fees for these services.

For purposes of monitoring Generating Facility operation to determine standby charges, applicable non-by-passable and other applicable charges as defined in RE's tariff, and for Distribution System planning and operations, consistent with Section B.4 of this Rule 21, RE shall have the right to specify the type and require the installation of a second Meter and the necessary data communications (telephone) line. In exercising its discretion to require Net Metering, RE shall consider all relevant factors, including but not limited to:

- 1) Data requirements in proportion to need for information;
- 2) Producer's election to install equipment that adequately addresses RE's operational requirements;
- 3) Accuracy and type of required Metering consistent with purposes of collecting data;



- 4) Cost of Metering relative to the need for and accuracy of the data;
- 5) The Generating Facility's size relative to the cost of the Metering/monitoring;
- 6) Other means of obtaining the data (e.g., Generating Facility logs, proxy data etc.); and
- 7) Requirements under any Interconnection Agreement with the Producer.

The requirements in this Section F.3 do not apply to Metering of Generating Facilities operating under RE's Net or Co Energy Metering tariff pursuant to California Public Utilities Code Section 2827, 2827.8, 2827.9, and 2827.10.

#### **F.4. POINT OF COMMON COUPLING (PCC) METERING**

For purposes of assessing RE charges for retail service, the Producer's PCC Metering shall be reviewed by RE, and if required, replaced to ensure that it will appropriately measure electric power according to the provisions of the Customer's electric service Tariff.

Where required by RE, the Producer will be required by RE to install multi-metering equipment to separately record power deliveries to RE's Distribution System and retail purchases from RE. Where necessary, such PCC Metering shall be designed to prevent reverse registration.

Generating Facilities eligible for Net or Co Energy Metering under Public Utilities Code Section 2827, 2827.8, 2827.9, or 2827.10 shall have metering provided pursuant to the terms of the applicable Net or Co Energy Metering tariff schedule.

#### **F.5. TELE-METERING**

If the nameplate rating of the Generating Facility is 1.0 MW AC or greater, Tele-metering equipment at the Net or Co Generator Metering location may be required at the Producer's expense. If the Generating Facility is Interconnected to a portion of RE's Distribution System operating at a voltage below 10 kV, then Tele-metering equipment may be required. RE shall only require tele-metering to the extent that less intrusive and/or more cost effective options for providing the necessary data in real time are not available.

If the Producer requires tele-metering measure generation kWh as part of a rebate payment, all costs are the responsibility of the Producer.

#### **F.6. LOCATION**

Where RE-owned Metering is located on the Producer's premises, Producer shall provide, at no expense to RE, a suitable location and socket for all such Metering Equipment. RE shall approve location and socket type prior to installation.

#### **F.7. COSTS OF METERING**

The Producer will bear all costs of the Metering required by this Rule 21, including the incremental costs of operating and maintaining the Metering Equipment.



## **G. DISPUTE RESOLUTION PROCESS**

The following procedures will apply for disputes arising from this Rule 21:

- G.1.** RE shall have jurisdiction to interpret, add, delete or modify any provision of this Rule 21 or of any agreements entered into between RE and the Producer to implement this tariff (“The Implementing Agreements”) and to resolve disputes regarding RE’s performance of its obligations under its tariffs, the applicable agreements, and requirements related to the Interconnection of the Producer’s Generating or Interconnection Facilities pursuant to this Rule 21.
- G.2.** Any dispute arising between RE and the Producer (individually “Party” and collectively “the Parties”) regarding RE’s performance of its obligations under its tariffs, the Implementing Agreements, and requirements related to the Interconnection of Producer’s Facilities pursuant to this Rule 21 shall be resolved according to the following procedures:
- 1) The dispute shall be reduced to writing by the aggrieved Party in a letter (“the dispute letter”) to the other Party containing the relevant known facts pertaining to the dispute, the specific dispute and the relief sought, and express notice by the aggrieved Party that it is invoking the procedures under Section G.2. Within 45 calendar days of the date of the dispute letter, the Parties’ authorized representatives will be required to meet and confer to try to resolve the dispute.
- G.3.** Pending resolution of any dispute under this Section, the Parties shall proceed diligently with the performance of their respective obligations under this Rule 21 and the Implementing Agreements, unless the Implementing Agreements have been terminated. Disputes as to the application and implementation of this Section shall be subject to resolution pursuant to the procedures set forth in this Section.

## **H. DEFINITIONS**

The definitions in this Section H are applicable only to this Rule, the Application and Interconnection Agreements.

**Anti-Islanding:** A control scheme installed as part of the Generating Facility or Interconnection Facilities that senses and prevents the formation of an Unintended Island.

**Applicant:** The entity submitting an Application for Interconnection pursuant to this Rule 21.

**Application:** An RE approved standard form submitted to RE for Interconnection of a Generating Facility.

**Certification Test:** A test pursuant to this Rule 21 that verifies conformance of certain equipment with Commission-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 has been approved for use by the California Energy Commission and the California Public Utilities Commission and other relevant certifying agencies.

**Co Energy Metering:** Metering for the receipt and delivery of electricity between the Producer and RE pursuant to Section 2827, 2827.8, 2827.9, or 2827.10 of the Public Utilities Code.

**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; and
- Establish instrument or Protective Function set-points.

**Customer:** The entity that receives or is entitled to receive Distribution Service through the RE'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.

**Device:** A mechanism or piece of equipment designed to serve a purpose or perform a function. The term may be used interchangeably with the terms "equipment" and "function" without intentional difference in meaning. See also Function and Protective Function.

**Distributed Generation:** Producer Generation equipment installed in parallel with RE's distribution grid.

**Distribution Service:** All services required by, or provided to, a Customer/Producer pursuant to the approved tariffs of RE other than services directly related to the Interconnection of a Generating Facility under this Rule 21.

**Distribution System:** All electrical wires, equipment, and other facilities owned or provided by RE, other than Interconnection Facilities, by which RE provides Transmission and/or Distribution Service to its Customers/Producers.

**Emergency:** An actual or imminent condition or situation, which jeopardizes RE's Distribution System Integrity.

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

**Function:** Some combination of hardware and software designed to provide specific features or capabilities. Its use, as in Protective Function, is intended to encompass a range of implementations from a single-purpose device to a section of code and specific pieces of hardware within a larger piece of equipment to a collection of devices and software.

**Generating Facility:** All Generators, electrical wires, equipment, and other facilities owned or provided by Producer for the purpose of producing electric power.



**Generator:** A device converting mechanical, chemical or solar energy into electrical energy, including all of its protective and control Functions and structural appurtenances. One or more Generators comprise a Generating Facility.

**Gross Nameplate Rating; Gross Nameplate Capacity:** The total gross generating capacity of a Generator or Generating Facility as designated by the manufacturer(s) of the Generator(s).

**Host Load:** The electrical power, net the Generator auxiliary load, consumed by the Customer to which the Generating Facility is connected.

**Initial Review:** The review by RE, following receipt of an Application, to determine the following: (a) the Generating Facility qualifies for Simplified Interconnection; or (b) if the Generating Facility can be made to qualify for Interconnection with a Supplemental Review determining any additional requirements.

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

**Interconnection Agreement:** Where applicable, an agreement between RE and the Producer providing for the Interconnection of a Generating Facility that gives certain rights and obligations to effect or end Interconnection.

**Interconnection; Interconnected:** The physical connection of a Generating Facility in accordance with the requirements of this Rule 21 so that Parallel Operation with RE's Distribution System can occur (has occurred).

**Interconnection Facilities:** The electrical wires, switches and related equipment that are required in addition to the facilities required to provide electric Distribution Service to a Customer/Producer to allow Interconnection. Interconnection Facilities may be located on either side of the Point of Common Coupling as appropriate to their purpose and design. Interconnection Facilities may be integral to a Generating Facility or provided separately.

**Interconnection Study:** A study to establish the requirements for Interconnection of a Generating Facility with RE's Distribution System.

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

**Line Section:** That portion of RE's Distribution System connected to a Customer/Producer bounded by automatic sectionalizing devices or the end of the distribution line.

**Load Carrying Capability:** The maximum electrical load that may be carried by a section of RE's Distribution System consistent with reliability and safety under the circumstances being evaluated.

**LORS:** LORS refers to laws, ordinances, regulations, and standards.

**Metering:** The measurement of electrical power in kW and/or energy in kWh, and, if necessary, reactive power in kVAR at a point, and its display to RE, as required by this Rule 21.



**Metering Equipment:** All equipment, hardware, software including meter cabinets, conduit, etc., that are necessary for Metering.

**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 Rule 21.

**Net Energy Metering:** Metering for the receipt and delivery of electricity between the Producer and RE pursuant to Section 2827, 2827.8, 2827.9, or 2827.10 of the Public Utilities Code.

**Net Generation 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 and/or Public Utilities Code Section 218 Load (Section 218 Load), Metering that is located at the Point of Common Coupling. For a Generator with Host Load and/or Section 218 Load, Metering that is located at the Generator but after the point of auxiliary load(s) and prior to serving Host Load and/or Section 218 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).

**Network Service:** More than one electrical feeder providing Distribution Service at a Point of Common Coupling.

**Non-Export; Non-Exporting:** Designed to prevent the transfer of electrical energy from the Generating Facility to RE's Distribution System.

**Non-Islanding:** Designed to detect and disconnect an 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 RE while Interconnected. For the purpose of this Rule 21, Parallel Operation includes only those Generating Facilities that are Interconnected with RE's Distribution System for more than 60 cycles (one second).

**Paralleling Device:** An electrical device, typically a circuit breaker, operating under the control of a synchronization function or by a qualified operator to connect an energized generator to an energized electric power system or two energized power systems to each other.

**Periodic Test:** A test performed on part or all of a Generating Facility/ Interconnection Facilities at pre-determined time or operational intervals to achieve one or more of the following: (1) Verify specific aspects of its performance; (2) Calibrate instrumentation; and (3) Verify and re-establish instrument or Protective Function set-points.

**Point of Common Coupling (PCC):** The transfer point for electricity between the electrical conductors of RE and the electrical conductors of the Producer.



**Point of Common Coupling Metering:** Metering located at the Point of Common Coupling.

**Point of Interconnection:** The electrical transfer point between a Generating Facility and RE's Distribution System. This may or may not be coincident with the Point of Common Coupling.

**Producer:** The entity that executes an Interconnection Agreement with RE. 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 and/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.

**Residential Customer:** A customer accepting service at a residential electric tariff rate.

**Scheduled Operation Date:** The date specified in the Interconnection Agreement when the Generating Facility is, by the Producer's estimate, expected to begin operation pursuant to this Rule 21.

**Secondary Network:** A network supplied by several primary feeders suitably interlaced through the area in order to achieve acceptable loading of the transformers under emergency conditions and to provide a system of extremely high service reliability. Secondary networks usually operate at 600 V or lower.

**Section 218 Load:** Electrical power that is supplied in compliance with California Public Utilities Code Section 218. Public Utilities Code Section 218 defines an "Electric Corporation" and provides conditions under which a transaction involving a Generating Facility would not classify a Producer as an Electric Corporation. These conditions relate to "over-the-fence" sale of electricity from a Generating Facility without using RE's Distribution System.

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

**Simplified Interconnection:** Interconnection conforming to the Initial Review requirements under this Rule 21 as determined by Section I.

**Single Line Diagram; Single Line Drawing:** A schematic drawing, showing the major electric switchgear, Protective Function 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.



**Small Commercial Customer:** Defined by California law as a non-residential customer with a maximum annual historical peak demand (kW) of 10kW or less.

**Special Facilities:** As defined in RE's Rules governing Special Facilities.

**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 volts on a particular base voltage, (e.g., 6 volts on a 120-volt base, yielding a 5% drop).

**Supplemental Review:** A process wherein RE 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) approval of Interconnection; (b) approval of Interconnection with additional requirements; or (c) cost and schedule for an Interconnection Study.

**System Integrity:** The condition under which RE's Distribution System is deemed safe and can reliably perform its intended functions in accordance with the safety and reliability rules of RE.

**Telemetry:** The electrical or electronic transmittal of Metering data in real-time to RE.

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

**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 RE's Distribution System, without the approval of RE.

**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.

## **I. REVIEW PROCESS FOR APPLICATIONS TO INTERCONNECT GENERATING FACILITIES**

### **I.1. INTRODUCTION**

This Review Process allows for rapid approval for the interconnection of those Generating Facilities that are Simplified and do not require an Interconnection Study. The review process includes a screening to determine if a Supplemental Review is required.

Note: Failure to pass any screen of the review process means only that further review and/or studies are required before the Generating Facility can be approved for Interconnection with RE's Distribution System. It does not mean that the Generating Facility cannot be Interconnected. Though not explicitly covered in the Initial Review Process the Generating Facility shall be designed to meet all of the applicable requirements in Section D.



## **I.2. PURPOSE**

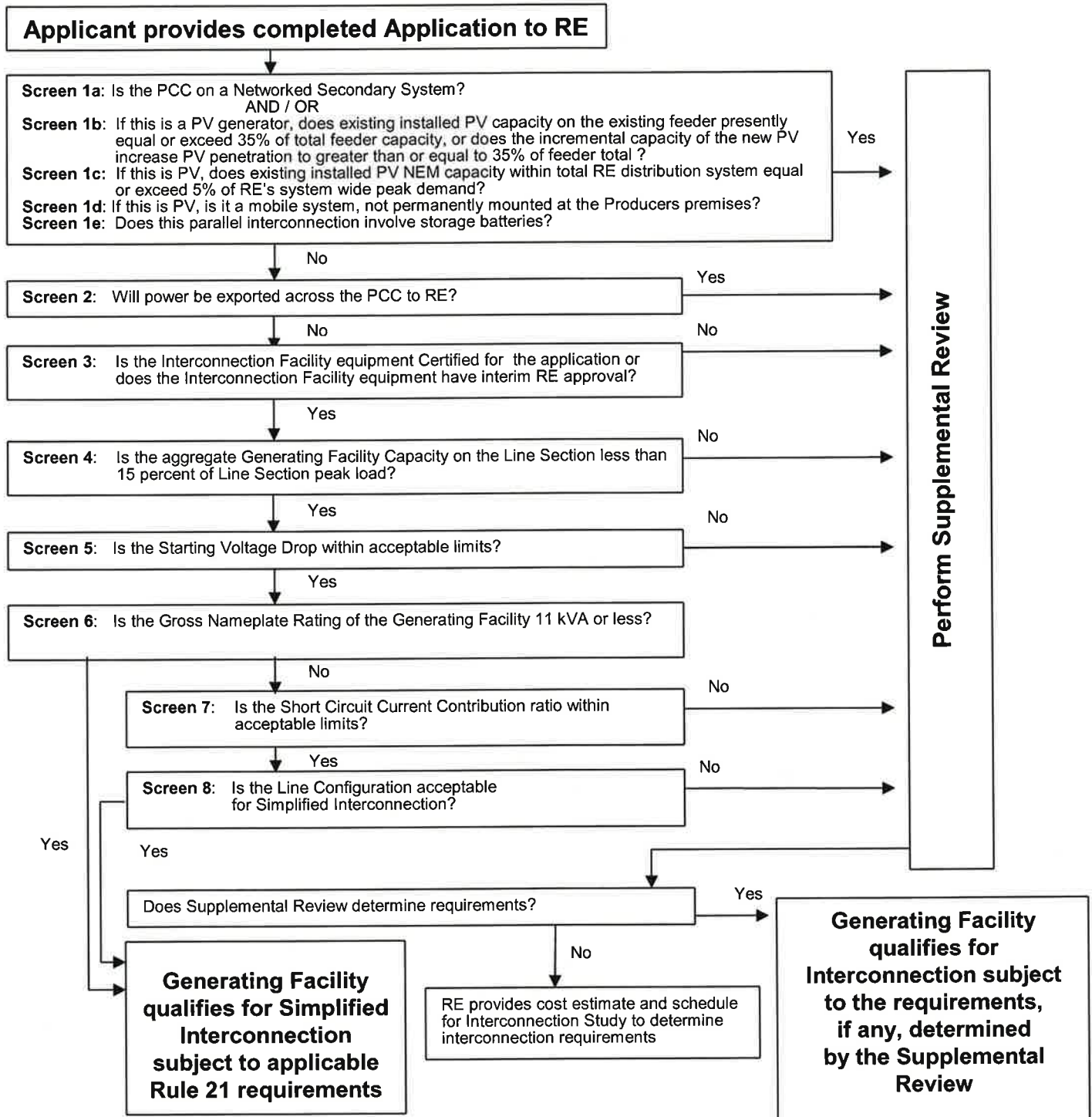
The review determines the following:

- a. If a Generating Facility qualifies for Simplified Interconnection;
- b. If a Generating Facility can be made to qualify for Interconnection with a Supplemental Review determining any additional requirements; or
- c. If an Interconnection Study is required, the cost estimate and schedule for performing the Interconnection Study.



**I.3. RE REVIEW PROCESS DETAILS**

**Initial and Supplemental Review Process Flow Chart**





**I.3.a. Screens 1a, 1b 1c, 1d and 1e: ATTENTION: If the response is “YES” to any one of Screens 1a, 1b or 1c – A Supplemental Review MUST be performed.**

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

- 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.

**Screen 1b: If this is a PV generator, does existing installed PV capacity on the existing electric distribution feeder presently equal or exceed 35% of total electrical distribution feeder load, or does the incremental capacity of the new PV increase PV penetration to greater than or equal to 35% of electrical distribution feeder total load.?**

- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.

Significance: Studies have indicated that when PV penetration on an electric distribution feeder is 35% or greater than total feeder load, there exists the potential for the PV to be responsible for voltage and/or frequency disruption under certain circumstances. RE must review the interconnection plan to determine if the Applicant must mitigate these potential issues.

**Screen 1c: If this is PV, does existing installed PV NEM capacity within total RE distribution system equal or exceed 5% of RE’s system wide peak demand?**

- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.

Significance: California state law allows RE to limit NEM if the total installed aggregated PV capacity (kW) is 5% or greater than the total RE system wide peak demand (kW).

**Screen 1d: If this is PV, is it a mobile system, not permanently mounted at the Producers premises?**

- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.

Significance: Mobile generation may restricted by NEC.

**Screen 1e: Does this parallel interconnection involve energy storage batteries?**



- If Yes, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review.

Significance: Generation systems interconnected in parallel with RE's Distribution system which proposed to utilize battery storage systems may require special interconnection mitigations.

**I.3.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 ("Reverse Power Protection"): To ensure that power is not exported across the PCC, a reverse power Protective Function may be provided.. The default setting for this Protective Function, when used, shall be 0.1% (export) of the service transformer's rating, with a maximum 2.0 second time delay.

Option 2 ("Minimum Power Protection"): To ensure that at least a minimum amount of power is imported across the PCC at all times (and therefore, that power is not exported), an under-power Protective Function may be provided.. The default setting for this Protective Function, when used, shall be 5% (import) of the Generating Facility's total Gross Nameplate Rating, with a maximum 2.0 second time delay.

Option 3 ("Certified Non-Islanding Protection"): To ensure that the incidental export of power across the PCC is limited to acceptable levels, this option, when used, requires that all of the following conditions be met: (a) the total Gross Nameplate Capacity of the Generating Facility must be no more than 25% of the nominal ampere rating of the Producer's service equipment; (b) the total Gross Nameplate Capacity of the Generating Facility must be no more than 50% of the Producer's service transformer capacity rating (this capacity requirement does not apply to customers taking primary service without an intervening transformer); and (c) the Generating Facility must be certified as Non-Islanding.

The ampere rating of the Customer's Service Equipment to be used in this evaluation will be that rating for which the customer's utility service was originally sized or for which an upgrade has been approved. It is not the intent of this provision to allow increased export simply by increasing the size of the customer's service panel, without separate approval for the resize.

Option 4 ("Relative Generating Facility Rating"): This option, when used, requires Net Nameplate Rating of the Generating Facility to be so small in comparison to its host facility's minimum load, that the use of additional Protective Functions is not required to insure that power will not be exported to RE's Distribution System. This option requires the Generating Facility capacity to be no greater than 50% of the Producer's verifiable minimum Host Load over the past 12 months.

Significance:



- 1) If it can be ensured that the Generating Facility will not export power, RE's Distribution System does not need to be studied for Load-Carrying Capability or Generating Facility power flow effects on RE voltage regulators.
- 2) This Screen permits the use of reverse-power or minimum-power relaying as a Non-Islanding Protective Function (Options 1, 2 and 3).
- 3) This Screen allows, under certain defined conditions, for Generating Facilities that incorporate Certified Non-Islanding protection to qualify for Simplified Interconnection without implementing reverse power or minimum power Protective Functions (Option 3).

**I.3.c. Screen 3: Is the Interconnection Facilities equipment Certified for the application or does the Interconnection Facilities equipment have interim RE approval?**

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

Interim approval allows the RE to treat equipment that has not completed the Rule 21 certification requirements as having met the intent of this screen. Interim approval is granted, at RE's discretion, on a case by case basis, and approval for one Generating Facility does not guarantee approval for any other Generating Facility

Significance: If the Generating Facility and/or Interconnection Facilities has been Certified or previously approved by RE, RE does not need to repeat its full review and/or test of the Generating and/or Interconnection Facilities' Protective Functions. Site Commissioning Testing may still be required to insure that the Protective Functions are working properly.

Certification indicates the following criteria have been tested and verified:

- Basic Protective Function requirements met.
- Harmonic distortion limits met.
- Synchronizing requirements met.
- Power factor regulation requirements met.
- Non-Islanding requirements met.
- If used, reverse power Function requirement met.
- If used, under-power Function requirement met.

**I.3.d. Screen 4: 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, the Generating Facility does not qualify for Simplified Interconnection. Perform Supplemental Review to determine cumulative impact on Line Section.

Significance:

- 1) Low penetration of Generating Facility installations will have a minimal impact on the operation and load restoration efforts of RE's Distribution System.
- 2) The operating requirements for a high penetration of Generating Facilities may be different since the impact on RE's Distribution System will no longer be minimal, therefore requiring additional study or controls.

**I.3.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.

Note: This Screen only applies to Generating Facilities that start by motoring the Generator(s).

RE has two options in determining whether Starting Voltage Drop is acceptable. The option to be used is at RE's discretion:

Option 1: RE may determine that the Generating Facility's starting In-rush Current is equal to or less than the continuous ampere rating of the customer's service equipment.

Option 2: RE may determine the impedances of the service distribution transformer (if present) and the secondary conductors to Customer's service equipment and perform a voltage drop calculation. Alternatively, RE may use tables or nomographs to determine the voltage drop. Voltage drops caused by starting a Generator as a motor must be less than 2.5% for primary interconnections and 5% for secondary interconnections.

Significance:

- 1) This Screen addresses potential voltage fluctuation problems that may be caused by Generators that start by motoring.
- 2) When starting, Generating Facilities should have minimal impact on the service voltage to other RE Customers.
- 3) Passing this screen does not relieve the Producer from ensuring that its Generating Facility complies with the flicker requirements of this Rule, Section D.2.d.

**I.3.f. Screen 6: Is the Gross Nameplate Rating of the Generating Facility 11 kVA or less?**

- If Yes, the Generating Facility qualifies for Simplified Interconnection. Skip remaining screens.



- If No, continue to next screen.

Significance: The Generating Facility will have a minimal impact on fault current levels and any potential line over voltages from loss of RE's Distribution System neutral grounding.

**I.3.g. Screen 7: Is the Short Circuit Current Contribution Ratio within acceptable limits?**

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

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

- 1) When measured at primary side (high side) of a Dedicated Distribution Transformer serving a Generating Facility, the sum of the Short Circuit Contribution Ratios of all generating facilities connected to RE's Distribution System circuit that serves the Generating Facility must be less than or equal to 0.1, and
- 2) When measured at the secondary side (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 the Producer's Service Equipment.

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

**I.3.h. Screen 8: Is the Line Configuration acceptable for Simplified Interconnection?**

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

Line Configuration Screen: Identify primary distribution line configuration that will serve the Generating Facility. Based on the type of Interconnection to be used for the Generating Facility, determine from the Table I.1 if the proposed Generating Facility passes the screen.



**Rule 21 – Parallel Interconnection  
Requirements for Distributed Generation**

Primary Distribution Line Type Configuration	Table I.1 Type of Interconnection to be Made to Primary Distribution Line	Results/Criteria
Three-phase, three wire	Any type	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 three wire and four wire)	All others	To pass, aggregate GF Nameplate Rating must be less than or equal to 10% of Line Section peak load

**Significance:** If the primary distribution line serving the Generating Facility is of a “three-wire” configuration, or if the Generating Facility’s distribution transformer is single-phase and connected in a line-to-neutral configuration, then there is no concern about over voltages to RE’s, or other Customer’s equipment caused by loss of system neutral grounding during the operating time of the Non-Islanding Protective Function.

**J. CERTIFICATION AND TESTING CRITERIA**

**J.1. INTRODUCTION**

This Section describes the test procedures and requirements for equipment used for the Interconnection of Generating Facilities to RE’s Distribution System. Included are Type Testing, Production Testing, Commissioning Testing and Periodic Testing. The procedures listed rely heavily on those described in appropriate 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 *May 1999 New York State Public Services Commission Standardized Interconnection Requirements*. As noted in Section A, this rule has been revised to be consistent with *ANSI/IEEE 1547-2003 Standard for Interconnecting Distributed Resources with Electric Power Systems*. Language from IEEE 1547 that has been adopted directly (as opposed to paraphrased language or previous language that was determined to be consistent with IEEE 1547) is followed by a citation that lists the Clause from which the language derived. For example, IEEE1547-4.1.1 is a reference to Clause 4.1.1

The tests described here, together with the technical requirements in Section D of this Rule 21, are intended to provide assurance that the Generating Facility’s equipment will not adversely affect RE’s Distribution System and that a Generating Facility will cease providing power to RE’s Distribution System under abnormal conditions. The tests were developed assuming a low level of Generating Facility penetration or number of connections to RE’s Distribution System. At high levels of Generating Facility penetration, additional requirements and corresponding test procedures may need to be defined.



Section J also provides criteria for “Certifying” Generators or inverters. Once a Generator or inverter has been Certified per this Rule, it may be considered suitable for Interconnection with RE’s Distribution System. Subject to the exceptions described in Section J, RE will not repeat the design review or require retesting of such Certified Equipment. It should be noted that the Certification process is intended to facilitate Generating Facility Interconnections. Certification is not a prerequisite to interconnect a Generating Facility.

The revisions made to this document relative to IEEE 1547-2003 have resulted in changes in set points, test criteria, test procedures, and other requirements that will impact previously certified or listed equipment as well as equipment currently under evaluation. These changes were made to provide consistency with IEEE 1547.

#### **J.1.a. Certified Equipment**

Equipment tested and approved (e.g., “Listed”) by an accredited by the *GoSolarCalifornia* web site sponsored by the California Energy Commission (CEC) and/or Nationally Recognized Testing Laboratory (“NRTL”) as having met both the Type Testing and Production Testing requirements described in this document is considered to be Certified Equipment for purposes of Interconnection with RE’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 manufactures’ factory or test laboratory, 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.

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:

##### **Administrative:**

- 1) The effective date of Certification or applicable serial number (range or first in series), and/or other proof that Certification is current;
- 2) Equipment model number(s) of the Certified Equipment;
- 3) The software version utilized in the equipment, if applicable;
- 4) Test procedures specified (including date or revision number); and
- 5) Laboratory accreditation (by whom and to what standard).

##### **Technical (as appropriate):**

- 1) Device ratings (kW, kVA, Volts, Amps, etc.);
- 2) Maximum available fault current in Amps;
- 3) In-rush Current in Amps;



- 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 equipment is Certified for Non-Exporting and the method used (reverse power or under power); and
- 8) If the equipment 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.

#### **J.1.b. Non-Certified Equipment**

For non-Certified Equipment, some or all of the tests described in this Rule may be required by RE for each Generating Facility and/or Interconnection Facilities. The manufacturer or a laboratory acceptable to RE may perform these tests. Test results for Non-Certified Equipment must be submitted to RE for the Supplemental Review. Approval by RE for equipment used in a particular Generating Facility and/or Interconnection Facilities does not guarantee RE's approval for use in other Generating Facility and/or Interconnection Facilities.

## **J.2. TYPE TESTING**

### **J.2.a. Type Tests and Criteria for Interconnection Equipment Certification.**

Type Testing provides a basis for determining that equipment meets the specifications for being designated as Certified Equipment under this Rule. The requirements described in this Section cover only issues related to Interconnection and are not intended to address equipment safety or other issues.

Table J.1. defines the test criteria by Generator or inverter technology. While UL 1741<sup>1</sup> was written specifically for inverters, the requirements are readily adaptable to synchronous Generators, induction Generators, as well as single/multi-function controllers and protection relays. Until a universal test standard is developed, RE or NRTL shall adapt the procedures referenced in Table J.1 as appropriate and necessary for a Generating Facility and/or Interconnection Facilities or associated equipment performance and its control and Protective Functions. The tests shall be performed in the sequence shown in Table J.2 below.



**Table J.1 Type Tests and Requirements for Interconnection Equipment Certification**

Type Test	Reference (1)	Inverter	Synchronous Generator	Induction Generator
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 Capability	J.3.e (?)	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)
Synchronization	J.3.f (?)	(5)	X	(5)

Table Notes: (1) References are to section numbers in either UL 1741 (Inverters, Converters and Charge Controllers for use in Independent Power Systems) or this Rule. References in UL 1741 to “photovoltaics” or “inverter” may have to be adapted to the other technologies by the testing laboratory to appropriately apply in the tests to other technologies.

(2) Required only if Non-Islanding designation.

(3) Required only if Non-Export designation is desired.

(4) Required for Generators that use RE power to motor to speed.

(5) Required for all self-excited induction generators and Inverters that operate as voltage sources when connected to RE.

X = Required  
 — = Not Required

**Table J.2 Type Tests Sequence for Interconnection Equipment Certification**

Test No.	Type Test
1	Utility Voltage and Frequency Variation
2	Synchronization
3	Surge Withstand Capability
4	Utility Voltage and Frequency Variation
5	Synchronization
6	Other Required and Optional Tests

Tests 1, 2, and 3 must be done first and in the order shown. Tests 4 and on follow in order convenient to the testing agency.

**J.2.b. Anti-Islanding Test**

Devices that 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. The test is required only for devices for which a Certified Non-Islanding designation is desired.



### **J.2.c. Non-Export Test**

Equipment that passes 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 equipment for which a Certified Non-Export designation is desired. (Replace this section with Section j.7.a??)

### **J.2.d. In-Rush Current Test**

Generation equipment that utilizes RE power to motor up to speed 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.

### **J.2.e. Surge Withstand Capability Test**

The interconnection equipment shall be tested for the surge withstand requirement in D.1.c in all normal operating modes in accordance with IEEE Std C62.45-2002 for equipment rated less than 1000 V to confirm that the surge withstand capability is met by using the selected test level(s) from IEEE Std C62.41.2-2002. Interconnection equipment rated greater than 1000 V shall be tested in accordance with manufacturer or system integrator designated applicable standards. For interconnection equipment signal and control circuits, use IEEE Std C37.90.1-2002. These tests shall confirm the equipment did not fail, did not misoperate, and did not provide misinformation (IEEE1547-5.1.3.2).

The location/exposure category for which the equipment has been tested shall be clearly marked on the equipment label or in the equipment documentation. External surge protection may be used to protect the equipment in harsher location/exposure categories.

### **J.2.f. Synchronization Test**

This test is applied to synchronous Generators, self-excited induction machines, and inverters capable of operating as voltage-source while connected to RE's Distribution System. The test is also applied to the resynchronization Function (transition from stand-alone to parallel operation) on equipment that provides such functionality<sup>1</sup>. This test is not necessary for induction generators or current-source inverters. Instead, the in-rush current test J.3.d shall be applied to those units.

This test shall demonstrate that at the moment of the paralleling-device closure, all three synchronization parameters in Table J.3 are within the stated limits. This test shall also demonstrate that if any of the parameters are outside of the limits stated in the table, the paralleling-device shall not close (IEEE1547-5.1.2A). The test will start with only one of the three parameters: (1) voltage difference between Generating Facility and RE's Distribution System; (2) frequency difference; or (3) phase angle outside of the synchronization specification. Verify that the Generating Facility is brought within

<sup>1</sup> The test may not need to be performed on both the synchronization and re-synchronization functions if the manufacturer can verify to the satisfaction of the testing organization that monitoring and controls hardware and software are common to both functions



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.

Table J.3. Synchronization Parameter Limits<sup>[1]</sup>

Aggregate Rating of Generator Units (kVA)	Frequency Difference ( $\Delta f$ , Hz)	Voltage Difference ( $\Delta V$ , %)	Phase Angle Difference ( $\Delta \Phi$ , °)
0 – 500	0.3	10	20
> 500 – 1,500	0.2	5	15
> 1,500 – 10,000	0.1	3	10

[1] - IEEE1547-5.1.1B

**J.2.g. Paralleling Device Withstand Test**

The di-electric voltage withstand test specified in J.1 shall be performed on the paralleling device to ensure compliance with those requirements specified in D.1.c (IEEE1547-5.1.3.3).

**J.3. PRODUCTION TESTING**

As a minimum, each interconnection system shall be subjected to the Utility Voltage and Frequency Variation Test procedure described in UL1741 under Manufacturing and Production Tests, Section 68 and the Synchronization test specified in J.3.f. Interconnection systems with adjustable set points shall be tested at a single set of set points as specified by the manufacturer. This testing may be performed in the factory or as part of a Commissioning Test (Section J.5.).

**J.4. COMMISSIONING TESTING**

**J.4.a. 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 verify the settings and requirements per this Rule 21.

RE may require a written commissioning test procedure be submitted to the RE at least 10 working days prior to the performance of the commissioning test. RE has the right to witness Commissioning Tests. RE may also require written Certification by the installer describing which tests were performed and their results. Protective 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 Function (if applicable)
- Non-Export Function (if applicable)
- Inability to energize dead line
- Time delay on restart after utility source is stable
- Utility system fault detection (if used)
- Synchronizing controls (if applicable)
- Other Interconnection Protective Functions that may be required as part of the Interconnection Agreement

Commissioning test shall include visual inspections of the interconnection equipment and protective settings to confirm compliance with the interconnection requirements.

**J.4.b.** Other checks and tests that may need to be performed include:

- Verifying final Protective Function settings
- Trip test (J.5.f)
- In-service test (J.5.g)

**J.4.c. 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 Rule and are judged to have little or no potential impact on RE's Distribution System. For such Generating Facilities, it is necessary to perform only the following tests:

- 1) Protective Function settings that have been changed after Production Testing will require field verification. Tests shall be performed using injected secondary frequencies, 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) The Non-Islanding Function will be checked by operating a load break disconnect switch to verify the Interconnection equipment ceases to energize RE's Distribution System and does not re-energize it for the required time delay after the switch is closed.
- 3) The Non-Exporting Function shall 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-Exporting criteria (i.e., reverse power or under power) are met.

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



#### **J.4.d. 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 Commissioning Tests (Section J.5.c.). With RE's approval, these tests may be performed in the factory, in the field as part of commissioning, or a combination of both. RE, at its discretion, may also approve a reduced set of tests for a particular Generating Facility or, for example, if it determines it has sufficient experience with the equipment.

#### **J.4.e. Verification of Settings**

At the completion of Commissioning testing, the Producer shall confirm all devices are set to RE-approved settings. Verification shall be documented in the Commissioning Test Certification.

#### **J.4.f. Trip Tests**

Interconnection Protective Functions and devices (e.g., reverse power relays) that have not previously been tested as part of the Interconnection Facilities 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 Function devices or between interrupting devices shall be similarly tested unless they are part of a system that has been tested and approved during manufacturing.

#### **J.4.g. In-Service Tests**

Interconnection Protective Functions and devices that have not previously been tested as part of the Interconnection Facilities 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 Alternating Current (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 report current and voltage magnitudes and phase angles, or magnitudes of current, voltage, and real and reactive power, the metered values may be used for in-service testing. Otherwise, portable ammeters, voltmeters, and phase-angle meters shall be used.

### **J.5. 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. The Producer shall maintain periodic test reports or a log for inspection by RE. Periodic Testing conforming to RE test intervals for the particular Line Section may be specified by RE under special circumstances, such as high fire hazard areas. Batteries used to activate any Protective Function shall be checked and logged once per



month for proper voltage. Once every four years, these batteries must be replaced or a discharge test must be performed.

## **J.6. TYPE-TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS**

This section describes the additional Type Tests necessary to qualify a device as Certified under this Rule 21. 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, but are considered necessary for Certification by RE.

### **J.6.a. Non-Exporting Test Procedures**

The Non-Exporting test is intended to verify the operation of relays, controllers and inverters designed to limit the export of power and certify the equipment as meeting the requirements of Screen 2, Options 1 and 2, of the review process. Tests are provided for discrete relay packages and for controllers and inverters that include the intended Function.

#### **1) Discrete Reverse Power Relay Test**

This version of the Non-Exporting test procedure is intended for discrete reverse power and under power relay packages provided to meet the requirements of Options 1 and 2 of Screen 2. It should be understood that in the reverse power application, the relay will provide a trip output with power flowing in the export (toward RE's Distribution System) direction.

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

Determine the corresponding secondary pickup current for the desired export power flow of 0.5 secondary watts (the minimum pickup setting, assumes 5 Amps and 120V CT/PT secondary). Apply nominal voltage with minimum current setting at zero (0) degrees phase angle 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% 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 relay's 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 phase angles of 90, 180 and 270 degrees and verify that the relay does not operate.

*Step 4: Negative Sequence Voltage Test*

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

*Step 6: Unbalanced Fault Test*

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

*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 one 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.e.

**2) Discrete Under-Power Relay Test**

This version of the Non-Exporting test procedure is intended for discrete under-power relay packages and meets the requirements of Option 2 of Screen 2. A trip



output will be provided when import power (toward the Producer's Load) drops below the specified level.

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

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

Determine the corresponding secondary pickup current for the desired power flow pickup level of 5% of peak load minimum pickup setting). Apply rated voltage and current 0 (zero) degrees phase angle 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% of the expected power. For relays with adjustable settings, repeat the test at the midpoint and maximum settings. Repeat at phase angles of 90, 180 and 270 degrees and verify that the relay operates (measured watts will be zero or negative).

*Step 2: Leading Power Factor Test*

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

*Step 3: Minimum Power Factor Test*

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

*Step 4: Negative Sequence Voltage Test*

Using the pickup settings determined in Step 1, apply rated relay voltage and 25 percent of rated current in the normal load direction, to simulate light load conditions. Remove Phase 1 voltage and observe that the relay does not operate. Repeat for Phases 2 and 3.

*Step 5: Unbalanced Fault Test*

Using the pickup settings determined in Step 1, apply rated voltage and two times rated current, to simulate an unbalanced fault in the normal load direction (use  $V_a$  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 types, operates properly.

*Step 6: Time Delay Settings Test*

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

*Step 7: Dielectric Test*

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

*Step 8: Surge Withstand*

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

**3) Tests for Inverters and Controllers with Integrated Functions**

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 acceptable:

Method 1: If the inverter or controller utilizes external current/voltage measurement to determine the reverse or under-power condition, then the inverter or controller shall be functionally tested by application of appropriate secondary currents and potentials as described in the Discrete Reverse Power Relay Test, Section J.7.a.(1) of this Rule 21.

Method 2: If external secondary current or voltage 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 may be factory tests, if the measurement and control points are integral to the unit, or they may be performed in the field.

**J.6.b. In-Rush Current Tests Procedures**

This test will determine the maximum In-rush Current drawn by the Generator.

**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 RE's Distribution System. Startup shall follow the normal, manufacturer-specified procedure. Sufficient time and current resolution and accuracy shall be used to capture the maximum current draw within five percent. In-rush Current is defined as the maximum current draw from RE 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 +/- 5% 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 RE.

## **IMPORTANT NOTICE:**

**ALL PV INTERCONNECTION  
DIAGRAMS AND REQUIRED  
SIGNAGE CAN BE FOUND IN RE'S  
RESIDENTIAL AND COMMERCIAL  
CONSTRUCTION STANDARDS.**

<http://www.roseville.ca.us/electric/default.asp>

**THESE TWO DOCUMENTS ARE  
ADDED TO RULE 21 BY  
REFERENCE.**

