

PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco CA 94102-3298



Pacific Gas & Electric Company
ELC (Corp ID 39)
Status of Advice Letter 7010E
As of January 17, 2024

Subject: Modifications to Electric Tariff Rule 21 to Update IEEE 1547.1-2020 Test Procedures for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E-5036

Division Assigned: Energy

Date Filed: 08-25-2023

Date to Calendar: 09-06-2023

Authorizing Documents: E-5000

Authorizing Documents: E-5036

Disposition:	Accepted
Effective Date:	08-29-2023

Resolution Required: No

Resolution Number: None

Commission Meeting Date: None

CPUC Contact Information:

edtariffunit@cpuc.ca.gov

AL Certificate Contact Information:

Kimberly Loo

(279)789-6209

PGETariffs@pge.com

PUBLIC UTILITIES COMMISSION
505 Van Ness Avenue
San Francisco CA 94102-3298



To: Energy Company Filing Advice Letter

From: Energy Division PAL Coordinator

Subject: Your Advice Letter Filing

The Energy Division of the California Public Utilities Commission has processed your recent Advice Letter (AL) filing and is returning an AL status certificate for your records.

The AL status certificate indicates:

- Advice Letter Number
- Name of Filer
- CPUC Corporate ID number of Filer
- Subject of Filing
- Date Filed
- Disposition of Filing (Accepted, Rejected, Withdrawn, etc.)
- Effective Date of Filing
- Other Miscellaneous Information (e.g., Resolution, if applicable, etc.)

The Energy Division has made no changes to your copy of the Advice Letter Filing; please review your Advice Letter Filing with the information contained in the AL status certificate, and update your Advice Letter and tariff records accordingly.

All inquiries to the California Public Utilities Commission on the status of your Advice Letter Filing will be answered by Energy Division staff based on the information contained in the Energy Division's PAL database from which the AL status certificate is generated. If you have any questions on this matter please contact the:

Energy Division's Tariff Unit by e-mail to
edtariffunit@cpuc.ca.gov

August 25, 2023

Advice 7010-E

(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

Subject: Modifications to Electric Tariff Rule 21 to Update IEEE 1547.1-2020 Test Procedures for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E-5036

Purpose

Pacific Gas and Electric Company (PG&E) hereby submits this Tier 1 advice letter to incorporate modifications to PG&E's Electric Rule 21 (Rule 21), replacing the language in Rule 21 Section Hh in its entirety with the recently approved language in Section P and retiring Section P. The modifications contained herein are consistent with the process approved within PG&E's Advice 6635-E/E-A/E-B/E-C, in furtherance of transitioning from UL1741SA to UL1741SB requirements and aligning with IEEE¹ 1547-2018 and IEEE 1547.1-2020 standards for inverter-based Generating Facilities, pursuant to California Public Utilities Commission (CPUC, or Commission) Resolutions E-5000 and E-5036.

The revised tariff sheets are listed on Attachment A and are attached hereto.

Background

PG&E submitted AL 6635-E² on July 1, 2022, in compliance with CPUC Resolutions E-5000³ and E-5036⁴ to incorporate into Rule 21 a transition plan from UL1741SA inverter requirements to new UL1741SB requirements. This established UL 1741 SA in Section Hh, while adding Section P to address UL 1741 SB during the transition period (August 1, 2022 to March 28, 2023). This AL further established that, as of April 1, 2023, following the transition period, applicants would make a full transition to UL1741 and 1741SB standards, and that the language in Rule 21 Section Hh would be replaced in its entirety with the language in Section P.

¹ Institute of Electrical and Electronics Engineers (IEEE)

² PG&E Advice Letter [6635-E](#), *Modifications to Electric Tariff Rule 21 to Incorporate IEEE 1547.1-2020 Test Procedures into Testing Regime for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E5036*, submitted July 1, 2022

³ Resolution [E-5000](#) - *Resolution E-5000. Clarifies smart inverter communications requirements in response to the Petition of the California Solar & Storage Association for Modification of Resolution E-4832 and Resolutions E-4898.*

⁴ Resolution [E-5036](#) - *Resolution E-5036. Clarifies the testing requirements for smart inverter Phase 2 communications and corrects a typographical error in Resolution E-5000.*

PG&E later submitted AL 6635-E-A on July 20, 2022 and AL 6635-E-B on February 24, 2023 to revise Rule 21 to further align with the other Joint Utilities' language and to make minor corrections.

PG&E's AL 6635-E originally proposed a transition schedule from UL1741SA to UL1741SB certification standards for inverters, whereby the date for full transition to UL1741SB would be March 29, 2023. On March 16, 2023, SCE, on behalf of itself, PG&E, and SDG&E, respectfully requested approval of a five-month extension to the requirements in OP 7 of Resolution E-5000 that "[e]ighteen months after the publication of a nationally recognized test procedure containing [Phase 3, Function 1, Monitor Key Data], PG&E, SCE, and SDG&E shall require that the function be tested according to the prescribed procedures." CPUC Executive Director Rachel Peterson granted that request via letter on March 28, 2023, moving the deadline for full transition to UL1741SB from March 29, 2023 to August 29, 2023.

Accordingly, PG&E submitted AL 6635-E-C on May 4, 2023 to, among other things, revise the UL 1741SB full transition start date from April 1, 2023 to August 29, 2023, in accordance with the CPUC Executive Director's letter granting the Joint Utilities' request for an for extension to the requirements in Resolution E-5000 Ordering Paragraph (OP) 7

On July 25, 2023, PG&E received a disposition letter approving PG&E ALs 6635-E, 6635-E-A, 6635-E-B and 6635-E-C with an effective date of August 29, 2023, which is the implementation date for UL 1741 SB inverters.

Although PG&E has already received approval to implement the UL 1741 SB inverter language, in accordance with General Order (GO) 96-B, General Rules, Section 4.7 Form and Content, PG&E is submitting this advice letter to further update Rule 21 to move approved content from one section to another and provide an audit trail of the actions taken.⁵ PG&E's Rule 21 will be updated such that Section P will replace Section Hh in its entirety and Section P will be retired.

⁵ "A utility shall: (2) attach the tariff sheets (new or revised) showing the changes that would be made by the advice letter, and list the numbers and titles of the new tariff sheets (if any) and the numbers of tariff sheets proposed to be canceled (if any). If the advice letter proposes to change tariff sheets currently in effect, the proposed changes shall be shown by providing either (i) a redlined version of the tariff sheets, or (ii) the tariff sheets as currently in effect and as proposed with the changes indicated by appropriate symbols along the right-hand margin, using the symbols set forth in the utility's preliminary statement. If the reviewing Industry Division will assign sheet numbers, so indicate. A tariff sheet number may not be used more than once;" (Emphasis added.)

Proposed Tariff Changes

PG&E proposes to delete UL 1741 SA inverter requirements Rule 21 Section Hh. UL 1741 SB inverter requirements will be relocated from Rule 21 Section P to Section Hh, and Section P will be retired.

PG&E includes these Rule 21 tariff revisions in Attachment A. For convenience of the reader, PG&E has also included redline revisions in Attachment B.

No cost information is required for this advice letter.

This advice letter will not increase any rate or charge, cause the withdrawal of service, or conflict with any other schedule or rule.

Protests

Anyone wishing to protest this submittal may do so by letter sent electronically via E-mail, no later than September 14, 2023, which is 20 days after the date of this submittal. Protests must be submitted to:

CPUC Energy Division
ED Tariff Unit
E-mail: EDTariffUnit@cpuc.ca.gov

The protest shall also be electronically sent to PG&E via E-mail at the address shown below on the same date it is electronically delivered to the Commission:

Sidney Bob Dietz II
Director, Regulatory Relations
c/o Megan Lawson
E-mail: PGETariffs@pge.com

Any person (including individuals, groups, or organizations) may protest or respond to an advice letter (General Order 96-B, Section 7.4). The protest shall contain the following information: specification of the advice letter protested; grounds for the protest; supporting factual information or legal argument; name and e-mail address of the protestant; and statement that the protest was sent to the utility no later than the day on which the protest was submitted to the reviewing Industry Division (General Order 96-B, Section 3.11).

Effective Date

Pursuant to General Order (GO) 96-B, Rule 5.1, this advice letter is submitted with a Tier 1 designation. This advice letter and the implementation of the tariff modifications, are requested to become effective on August 29, 2023.

Notice

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically to parties shown on the attached list and the parties on the service list for R.17-07-007, R. 11-09-011. Address changes to the General Order 96-B service list should be directed to PG&E at email address PGETariffs@pge.com. For changes to any other service list, please contact the Commission's Process Office at (415) 703-2021 or at Process_Office@cpuc.ca.gov. Send all electronic approvals to PGETariffs@pge.com. Advice letter submittals can also be accessed electronically at: <http://www.pge.com/tariffs/>.

/S/

Sidney Bob Dietz II
Director, Regulatory Relations
CPUC Communications

Attachments:

Attachment A: Tariff Sheets
Attachment B: Redline Tariff Revisions

cc: Service List R.17-07-007, R.11-09-011



ADVICE LETTER SUMMARY

ENERGY UTILITY



MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Pacific Gas and Electric Company (ID U39 E)

Utility type:

- ELC GAS WATER
 PLC HEAT

Contact Person: Kimberly Loo

Phone #: (279)789-6209

E-mail: PGETariffs@pge.com

E-mail Disposition Notice to: KELM@pge.com

EXPLANATION OF UTILITY TYPE

ELC = Electric GAS = Gas WATER = Water
 PLC = Pipeline HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 7010-E

Tier Designation: 1

Subject of AL: Modifications to Electric Tariff Rule 21 to Update IEEE 1547.1-2020 Test Procedures for Phase 2 and 3 Requirements in Compliance with Resolutions E-5000 and E-5036

Keywords (choose from CPUC listing): Compliance

AL Type: Monthly Quarterly Annual One-Time Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #: E-5000 and E-5036

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL: No

Summarize differences between the AL and the prior withdrawn or rejected AL:

Confidential treatment requested? Yes No

If yes, specification of confidential information:

Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/ access to confidential information:

Resolution required? Yes No

Requested effective date: 8/29/23

No. of tariff sheets: 111

Estimated system annual revenue effect (%): N/A

Estimated system average rate effect (%): N/A

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: See Attachment A

Service affected and changes proposed¹: N/A

Pending advice letters that revise the same tariff sheets: N/A

¹Discuss in AL if more space is needed.

Protests and correspondence regarding this AL are to be sent via email and are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

California Public Utilities Commission
Energy Division Tariff Unit Email:
EDTariffUnit@cpuc.ca.gov

Contact Name: Sidnev Bob Dietz II. c/o Megan Lawson
Title: Director, Regulatory Relations
Utility/Entity Name: Pacific Gas and Electric Company

Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email: PGETariffs@pge.com

Contact Name:
Title:
Utility/Entity Name:

Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email:

CPUC
Energy Division Tariff Unit
505 Van Ness Avenue
San Francisco, CA 94102

Clear Form

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

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ELECTRIC RULE NO. 21
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GENERATING FACILITY INTERCONNECTIONS

Sheet 181

H. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS
(Cont'd.)

4. SUPPLEMENTAL GENERATING FACILITY REQUIREMENTS

a. Fault Detection

A Generating Facility with an SCCR exceeding 0.1 or one that does not cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line-to-line and line-to-ground, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the initiation of a fault.

b. Transfer Trip

For a Generating Facility that cannot detect Distribution or Transmission System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds, Distribution Provider may require a Transfer Trip system or an equivalent Protective Function.

c. Reclose Blocking

Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, Distribution Provider may require additional Protective Functions, including, but not limited to reclose-blocking on some of the automatic reclosing devices.

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¹ "The Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems".

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 182

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS

(T)

When requirements for “Smart Inverter” are specified in this section, those requirements can also be met by a “DER Interconnection System” as defined in this tariff.

The inverter requirements are intended to be consistent with UL 1741 – Supplement SB using as the source requirement document ANSI/IEEE 1547-2018 and IEEE 1547.1-2020 Standard for Interconnecting Distributed Resources with Electric Power Systems where possible. In the event of conflict between this Rule and UL 1741 – Supplement SB and/or IEEE 1547-2018 or IEEE 1547.1-2020, this Rule shall take precedence.

The Smart Inverter default settings and default activation states may be modified upon mutual agreement between Applicant or Producer and Distribution Provider.

Process for changing default settings for new Interconnection Requests:

Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the reactive power settings, including changes to the reactive power default settings (Example: Deactivate Volt/Var and activate Fixed Power Factor at given power factor).

Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the Ramp Rate settings depending on the Generating Facility technology (such as solar, storage).

Distribution Provider, in the study process for new Generating Facilities, may determine the optimum Smart Inverter Settings for the volt/watt settings, including changes to the default settings (Example: Change the volt/watt set points). The Applicant may select to agree on the new settings or select to perform upgrades to operate using the existing default volt/watt settings.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 183

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

Default settings for voltage ride-through, frequency ride-through requirements, and Frequency/Watt should not be modified on an individual project basis unless the Interconnection Studies have determined that the default settings may not meet grid reliability requirements.

Process for changing default settings for Generating Facilities with an executed Interconnection Agreement:

When grid changes or Generating Facility changes require that the Smart Inverter operating parameters be reevaluated, the Distribution Provider or Producer may request changes to the Smart Inverter operating parameters. The request must include the reason for and timing of the proposed changes. The requested changes must be within the Smart Inverter function adjustability limits, must be within the limits specified in this tariff, and must be mutually agreed upon.

1. General Interconnection and Protective Function Requirements

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

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 184

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

1. General Interconnection and Protective Function Requirements (Cont'd)

a. Protective Functions Required

Smart Inverters operating in parallel with Distribution Provider's Distribution or Transmission System shall be equipped with the following Protective Functions to sense abnormal conditions on Distribution Provider's Distribution or Transmission System and cause the Smart Inverter to be automatically disconnected from Distribution Provider's Distribution or Transmission System or to prevent the Smart Inverter from being connected to Distribution Provider's Distribution or Transmission System inappropriately:

- (i) Over and under voltage trip functions and over and under frequency trip functions;
- (ii) A voltage and frequency sensing and time-delay function to prevent the Smart Inverter from energizing a de-energized Distribution or Transmission System circuit and to prevent the Smart Inverter from reconnecting with Distribution Provider's Distribution or Transmission System unless Distribution Provider's Distribution System service voltage and frequency is within the ANSI C84.1-1995 Table 1 Range B voltage Range of 106 volts to 127 volts (on a 120 volt basis), inclusive, and a frequency range of 59.0 Hz to 60.5 Hz, inclusive, and are stable for at least 15 seconds; and
- (iii) A function to prevent the Smart Inverter from contributing to the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution System within two seconds of the formation of an Unintended Island.

The Smart Inverter shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Smart Inverter shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 185

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.) (T)

1. General Interconnection and Protective Function Requirements (Cont'd)

a. Protective Functions Required (Cont'd)

- (iv) Open-phase condition: Generating Facility shall detect and cease to energize and trip all phases within 2 seconds of any open phase condition in accordance with IEEE 1547-2018, 6.2.2.

The Smart Inverter Facility shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Generating Facility shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).

b. Momentary Paralleling Smart Inverter Generating Facilities

With Distribution Provider's approval, the transfer switch or scheme used to transfer Producer's loads from Distribution Provider's Distribution or Transmission System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.

Smart Inverters which operate using a momentary parallel scheme are not required to comply with the functional requirements as required in the IEEE 1547-2018 standard.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

1. General Interconnection and Protective Function Requirements (Cont'd)

c. Suitable Equipment Required

Circuit breakers or other interrupting equipment located at the Point of Common Coupling (PCC) 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 Smart Inverter 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 Distribution Provider's Distribution and Transmission System. The Smart Inverter paralleling-device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE 1547-2018, 4.11.3). 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 L.3.e (IEEE 1547-2018, 4.11.2).

d. Visible Disconnect Required

When required by Distribution Provider's operating practices, Producer shall furnish and install a ganged, manually-operated isolating switch (or a comparable device mutually agreed upon by Distribution Provider and Producer) near the Point of Interconnection to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System. The device does not have to be rated for load break nor provide over-current protection.

The device must:

- (i) allow visible verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.)
- (ii) Include markings or signage that clearly indicates open and closed positions.
- (iii) be capable of being reached:

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 187

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd) (T)

1. General Interconnection and Protective Function Requirements (Cont'd)

d. Visible Disconnect Required (Cont'd)

(iii) be capable of being reached (Cont'd):

a) for Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction, operation, maintenance, inspection, testing or to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.

b) for Non-Emergency purposes during normal business hours. Distribution Provider, where possible, will provide notice to Customer for gaining access to Customer's premises.

(iv) be capable of being locked in the open position.

(v) be clearly marked on the submitted single line diagram and its type and location approved by Distribution Provider prior to installation. If the device is not adjacent to the PCC, permanent signage must be installed at a Distribution Provider approved location providing a clear description of the location of the device. If the switch is not accessible outside the locked premises, signage with contact information and a Distribution Provider approved locking device for the premises shall be installed.

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

e. Drawings Required

Prior to Parallel Operation or Momentary Parallel Operation of the Smart Inverter, Distribution Provider shall approve Producer's Protective Function and control diagrams. Generating Facilities equipped with Protective Functions and a control scheme previously approved by Distribution Provider for system-wide application or only Certified Equipment may satisfy this requirement by reference to previously approved drawings and diagrams.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 189

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd) (T)

2. Prevention of Interference (Cont'd)

a. Voltage Regulation

If approved by the Distribution Provider, the Smart Inverter may actively regulate the voltage at the PCC while in parallel with Distribution Provider's Distribution System. Smart Inverter shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A. (IEEE 1547-2018, 5.1)

b. Voltage Trip and Ride-Through Setting

The voltage ranges in Table Hh-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 Distribution Provider's Distribution System within the prescribed trip time whenever the voltage at the PCC deviates from the allowable voltage operating range. The Protection Function shall detect and respond to voltage on all phases to which the Generating Facility is connected.

i) Smart Inverters

Smart Inverters shall be capable of operating within the voltage range normally experienced on Distribution Provider's Distribution System from plus to minus 5% of the nominal voltage (e.g. 114 volts to 126 volts, on a 120 volt base), at the service panel or PCC. The trip settings at the generator terminals may be selected in a manner that minimizes nuisance tripping in accordance with Table Hh-1 to compensate for voltage drop between the generator terminals and the PCC. Voltage may be detected at either the PCC or the Point of Interconnection. However, the voltage range at the PCC, with the generator on-line, shall stay within +/-5% of nominal.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 190

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

b. Voltage Trip and Ride-Through Setting (Cont'd)

ii) Voltage Disturbances

Whenever Distribution Provider's Distribution System voltage at the RPA varies from and remains outside the Continuous Operation region for the predetermined parameters set forth in Table Hh-1b, the Smart Inverter's Protective Functions shall cause the Smart Inverter(s) to trip and become isolated from Distribution Provider's Distribution System as required in table Hh-1a:

1. The Smart Inverter shall stay connected to the Distribution Provider's Transmission or Distribution System while the grid remains within the "Voltage Range (p.u.)" and must stay connected in the corresponding "Operating Mode."
2. If the distribution system voltage does not exit the ride-through region and recovers to normal system voltage, the Smart Inverter shall restore continuous operation within 2 sec.
3. If the Distribution Provider's Transmission or Distribution System voltage does not exit the ride-through region and returns from the $V < 0.5$ pu region to the $0.5 \leq V < 0.7$ or $0.7 \leq V < 0.88$ pu region, the Smart Inverter shall restore available current within 2 seconds.
4. Different voltage-time settings could be permitted by the Distribution Provider.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

b. Voltage Trip and Ride-Through Setting (Cont'd)

ii) Voltage Disturbances (Cont'd)

Table Hh-1a: Smart Inverter Voltage Trip Settings

Shall Trip Function	Voltage Trip Default Settings (p.u. of nominal voltage)	Voltage Range of Shall Trip Function (p.u. of nominal voltage)	Default Clearing Time (s)
OV2	1.20	$V \geq 1.20$	0.16
OV1	1.10	$1.10 \leq V < 1.20$	13.0
Continuous Operation	NA	$0.88 < V < 1.10$	NA
UV1	0.88	$0.50 < V \leq 0.88$	21.0
UV2	0.50	$V \leq 0.50$	2.0

Table Hh-1b – Smart Inverter Voltage Ride-through Settings

Voltage Range (p.u.)	Operating mode/response	Minimum ride-through time (s)	Maximum response time (s)
$V > 1.20$	Cease to Energize	NA	0.16
$1.10 < V \leq 1.20$	Momentary Cessation	12	0.083
$0.88 \leq V \leq 1.10$	Continuous Operation	Infinite	NA
$0.70 \leq V < 0.88$	Mandatory Operation	20	NA
$0.50 \leq V < 0.70$	Mandatory Operation	10	NA
$V < 0.50$	Momentary Cessation	1	0.083

iii) Voltage Phase Angle Change Ride-Through

Voltage phase angle change ride-through as specified in IEEE 1547-2018, 6.5.2.6.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

c. Paralleling

The Smart Inverter shall parallel with Distribution Provider's Distribution or Transmission System without causing a voltage fluctuation at the PCC greater than plus/minus 5% of the prevailing voltage level of Distribution Provider's Distribution or Transmission System at the PCC, and meet the flicker requirements of Section H.2.d. Section L, Certification and Testing Criteria, provides technology-specific tests for evaluating the paralleling Function. (IEEE 1547-2018, 4.10.4)

d. Flicker

The Generating Facility shall not create objectionable flicker for other Customers on Distribution Provider's Distribution or Transmission System. To minimize the adverse voltage effects experienced by other Customers, flicker at the P caused by the Generating Facility should not exceed the limits of IEEE 1547-2018, 7.2.3. This requirement is necessary to minimize the adverse voltage affects experienced by other Customers on Distribution Provider's Distribution or Transmission System. Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.

e. Integration with Distribution Provider's Distribution System Grounding

The grounding scheme of the Smart Inverter shall not cause over-voltages that exceed the rating of the equipment connected to Distribution Provider's Distribution System and shall not disrupt the coordination of the ground fault protection on Distribution Provider's Distribution System (IEEE 1547-2018, 4.10.12) (See Section G.1.i, line configuration).

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(T)

2. Prevention of Interference (Cont'd)

f. Frequency

Distribution Provider controls system frequency, and the Smart Inverter shall operate in synchronism with Distribution Provider's Distribution or Transmission System. Whenever Distribution Provider's Distribution or Transmission System frequency at the PCC varies from and remains outside normal (nominally 60 Hz) by the predetermined amounts set forth in Table P 2a, the Smart Inverter's Protective Functions shall cease to energize Distribution Provider's Distribution or Transmission System within the stated maximum trip time.

i) Frequency Ride-Through Requirements

Smart Inverter based systems shall remain connected to the Distribution Provider's Distribution or Transmission System while the grid is within the frequency-time range indicated in Table Hh-2b, and shall disconnect from the electric grid during a high or low frequency event that is outside that frequency-time range as indicated in Table Hh-2a.

Table Hh-2a: Frequency Trip Settings Table

Shall Trip Function	Frequency Trip Default Setting (Hz)	Resulting Range of Shall Trip Function (Hz)	Default Clearing Time (s)
OF2	62.0	$f \geq 62.0$	0.16
OF1	61.2	$61.2 \leq f < 62$	300
Continuous Operation	NA	$58.5 < f < 61.2$	NA
UF1	58.5	$56.5 < f \leq 58.5$	300
UF2	56.5	$f \leq 56.5$	0.16

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

f. Frequency (Cont'd)

i) Frequency Ride-Through Requirements (Cont'd)

Table Hh-2b: Frequency Ride-Through Settings Table

Frequency (Hz)	Operating Mode	Minimum time(s)
$f > 62.0$	No Ride-Through requirements apply to this range	NA
$61.2 < f \leq 61.8$	Mandatory Operation	299
$58.8 \leq f \leq 61.2$	Continuous Operation	Infinite
$57.0 \leq f < 58.8$	Mandatory Operation	299
$F < 57.0$	No Ride-Through requirements apply to this range	NA

ii) Rate of Change of Frequency (ROCOF) Ride-through

Smart Inverter shall not trip for frequency excursion having magnitude rates of change of frequency (ROCOF) that is less than or equal to 3.0Hz per second as specified in IEEE 1547-2018, section 6.5.2.5 category III. For ROCOF greater than 3Hz per second, it is preferred for Smart Inverter to ride-through as long as frequency remains in the continuous operating region, low frequency ride-through region (and corresponding duration times), or high frequency region (and corresponding duration times).

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

Dynamic Volt/Var Operations Default Settings

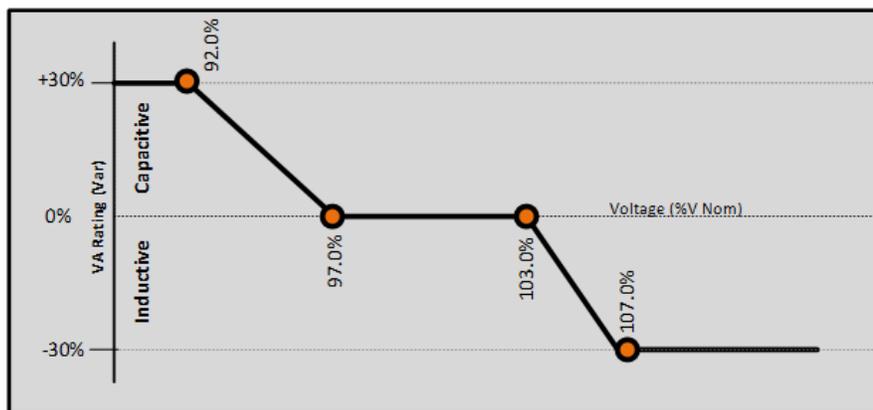
Table Hh-3 and Figure Hh-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

Default Open Loop Response Time for volt/var operation setting should be five (5) seconds.

Table Hh-3: Voltage and Reactive Default Settings

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	97.0%	Q2	0	Unity Power Factor
V3	103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

Figure Hh-1: Voltage and Reactive Default Settings



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**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 197

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

k. Enter Service Ramp Rate Requirements

The Smart Inverter is required to have the following ramp controls.

- Enter Service ramp control requirements as outlined in IEEE 1547-2018 section 4.10.3 with following default settings:
 - Delay enter service shall be 15 seconds per Hh.1.a.ii
 - Default Enter Service Duration shall be 50 seconds

l. Frequency Droop (Frequency Power, Frequency Watt) Requirements

Smart Inverters shall change their real power production as function of system frequency in accordance with IEEE 1547-2018, 6.5.2.7 with the following default settings: Deadband 36 mHz, db_{OF} and db_{UF} . k_{OF} and k_{UF} would be 0.05, open loop response time of 5 seconds.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

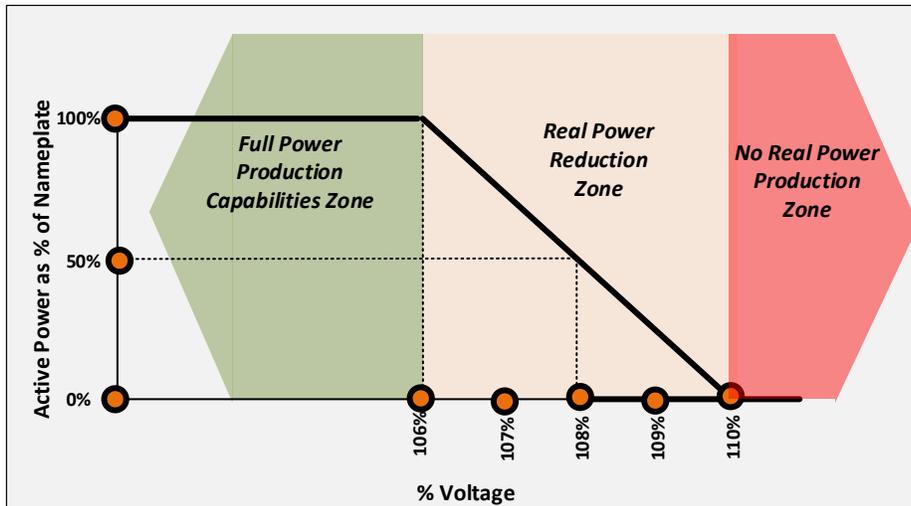
(T)

2. Prevention of Interference (Cont'd)

m. Voltage-Watt Default Settings Requirements

- When the measured voltage is greater than 110% of nominal voltage (Example: 132 volts on a 120 volts nominal), the export of active power to the grid at the PCC or the production of active power by the Smart Inverter shall be reduced to 0 watts.
- Open Loop response time shall be 5 seconds.

Figure Hh-3: Volt-Watt Requirements



n. Dynamic Reactive Power Support Function

The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 200

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

o. Default Activation States

Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:

Table Hh-4: Default Activation States

Function	State
Anti-islanding	Activated
Low/High Voltage Ride Through	Activated
Low/High Frequency Ride Through	Activated
Dynamic Volt/Var operations	Activated
Enter Service Ramp Control	Activated
Storage Inverter Normal Operation Ramp Control	Deactivated*
Fixed power factor	Deactivated
Reconnect by "soft-start" methods	Activated
Frequency/Watt	Activated
Volt/Watt	Activated
Constant Reactive Power Mode	Deactivated
Set Active Power Function Mode(Optional)	Activated under mutual agreement
Dynamic Reactive Power Support Mode (Optional)	Activated under mutual agreement

These default activation states may be modified by mutual agreement between Distribution Provider and Producer.

(T)

* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E's interconnection handbook(s).

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 201

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

2. Prevention of Interference (Cont'd)

p. Load Shedding or Transfer

The voltage and frequency ride-through requirements of Hh.2.b.ii) and Hh.2.f.i) shall not apply if either: a) The real power across the Point of Common Coupling is continuously maintained at a value less than 10% of the aggregate rating of the Smart Inverters connected to the Generating Facility prior to any voltage disturbance, and the Generation Facility disconnects from the Distribution Provider's Distribution or Transmission System, along with Generating Facility load, such that the net change in real power flow from or to the Distribution Provider's Distribution or Transmission System is less than 10% of the aggregate Smart Inverter capacity; or b) Generating Facility load real power demand equal to 90% to 120% of the predisturbance aggregate Smart Inverter real power is shed within 0.1 seconds of Smart Inverter disconnection.

q. Measurement and Calculation Accuracy

Smart Inverter shall meet minimum steady-state and transient measurement and calculation accuracy as required in IEEE 1547-2018, Section 4.4.

r. Prioritization of Smart Inverter Responses

- a) The response to disable permit to service as specified in section Hh.8.a shall take precedence over any other tripping requirements.
- b) Prioritization of tripping requirements not related to disabling permit to service shall meet IEEE 1547-2018 section 4.7.

(T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

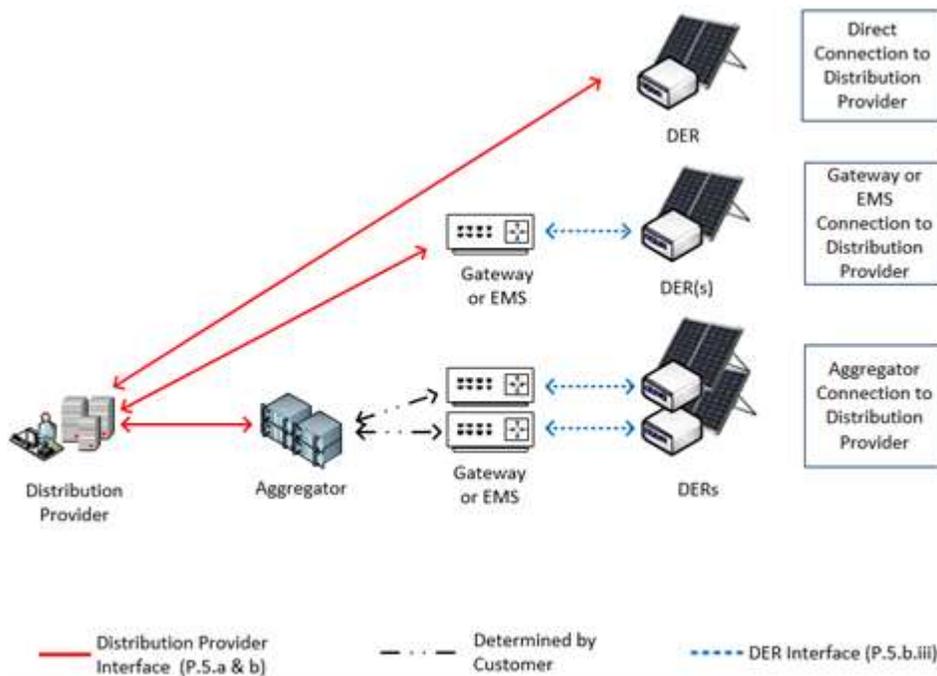
Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

5. Communication Requirements

Should communications to the Distribution Provider be required, Generating Facilities utilizing inverter-based technologies must adhere to the following communication requirements for communications between the Distribution Provider and the Generating Facility. The diagram below shows the interface requirements as applicable for section Hh.5. The Distribution Provider Interface (solid red line) is described in Sections Hh.5.a and Hh.5.b. The local DER interface at the Generating Facility (dotted blue line) is described in Section Hh.5.b.iii. The top row shows a direct connection between the Distribution Provider and the DER. The middle row shows a connection between the Distribution Provider and a gateway (GW) or Energy Management System (EMS). The lower row shows a connection between the Distribution Provider and an aggregator.

Figure Hh-5: Generating Facility Communications



(T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 207

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

5. Communication Requirements (Cont'd)

b. Additional communication protocol requirements shall also apply to Generating Facilities utilizing inverter-based technologies as provided in the following documents:

i. Distribution Provider Generation Interconnection Handbook, which shall include:

A. Details and guidelines for the implementation of communications with Generating Facilities utilizing inverter-based technologies;

B. Cybersecurity and privacy requirements (these may additionally or alternatively be included in the application-level protocol implementation guide (e.g., CSIP); and,

C. Generic device communications registration management requirements, including how to register individual Generating Facilities, Generating Facilities with energy management systems, and aggregators (these additionally or alternatively may be included in the application-level protocol implementation guide); and

D. Conditions under which communication functions are mandatory.

ii. Application-Level Protocol Implementation Guide, which shall provide:

A. Detailed communication requirements and implementation guidelines to ensure consistent interoperability of the Generating Facilities with all California investor-owned utilities under the Commission's jurisdiction.

(T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 209

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

6. Scheduling Capability Requirements

a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:

- i) Modifications to the voltage and reactive set-points of the Dynamic volt/var function.
- ii) Modifications to the reactive power set-points for the fixed power factor function.
- iii) Modifications to the voltage and watt-reduction level set-points for the volt/watt function.

b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options:

- i) Scheduling capability requirements may be implemented at the GW/EMS. The GW/EMS shall communicate the necessary commands to the Smart Inverters within 10 minutes, or by mutual agreement, from when the GW/EMS receives the scheduling information.
- ii) Scheduling capability requirements may be implemented at the DER within the Generating Facility.
- iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverter within 15 minutes of the aggregator receiving the scheduling information.
- iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider.

(T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 211

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.) (T)

7. Monitoring and Telemetry Requirements (Cont'd)

c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:

i) In-Service

An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section Hh.6.

ii) Not In-Service

An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section Hh.6.

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:

i) When the Generating Facility includes only Smart Inverters, the production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.

ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:

a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.

b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility. (T)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 212

- Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.) (T)
- 7. Monitoring and Telemetry Requirements (Cont'd)
- d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows (Cont'd):
 - iii) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available operational energy should be communicated as an aggregate of all the energy storage systems.
 - iv) Nameplate information shall be available through a local Generating Facility Interface as required in IEEE 1547-2018, 10.3 and must include the information as required in IEEE 1547-2018, Table 28.
 - v) Configuration information shall be available through a Local Generating Facility Interface as required in IEEE 1547-2018, 10.4. This information represents the present capacity and ability of the Generating Facility. When a configuration update changes the Generating Facility nameplate information, it may require a study depending on the change.

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 213

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

(T)

8. Control through communication capabilities

The utilization of these functions are permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Smart Inverters shall have the capabilities of accepting operational controls through communications in accordance to the following:

a. Disable permit to service control command

When the Smart Inverter receives a disable permit service command through communication, the Smart Inverter must cease-to energize and trip within 2 seconds or initiate the opening of the switch referenced in the inverter terminal in order to galvanically isolate the Smart Inverter from the Distribution System.

b. Return to service control command

When the Smart Inverter receives a return-to-service control command, the Smart Inverter may return to service operation as required by Generating Facility operator or as required by the scheduling control system as required by section H.6. This shall be accomplished by enabling permit service as required in IEEE 1547-2018, 4.10.3.

c. Limit Active Power command

When the Smart Inverter receives a command to limit its production of real power, the Smart Inverter shall reduce its real power production to the specified percent of real power capacity of the Smart Inverter or to a specified real power value. In no more than 30 seconds or in the time it takes for the primary energy source to reduce its active power output to achieve the requirements of the active power limit set point, whichever is greater.

Where the Smart Inverter operates under a non-export provision, the active power limit set point may be implemented as a maximum active power to serve the host customer load. Under mutual agreement, the Smart Inverter may be required to reduce active power below the level needed to support host customer load.

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(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 214

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

(T)

8. Control through communication capabilities (Cont'd)

d. Set Active Power Level Mode Function

The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.

e. Suspension of Active Power restriction

When the Smart Inverter receives a command to suspend the command for active power reduction, the Smart Inverter may return to normal operation as required by Generating Facility operator or as required by the scheduling control system as required by Section Hh.6.

f. Transition between operating modes

Transition between modes shall commence in no more than 30 seconds after the mode setting change is received at the local Generating Facility communication interface.

Changes of control functional modes shall be executed such that the Smart Inverter output is transitioned smoothly over a time period between 5 s and 300 s.

Ramping of Smart Inverter output is not required for control parameter setting changes.

For all control and protective function parameter settings, the time following the input to the local Generating Facility communication interface and preceding the point in time when the invoked action begins shall be no greater than 30 s.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 215

I. THIRD-PARTY INSTALLATIONS, RESERVATION OF UNUSED FACILITIES, AND REFUND OF SALVAGE VALUE (L)

1. INTERCONNECTION FACILITIES AND DISTRIBUTION UPGRADES

Except as provided for in the Generator Interconnection Agreement of this Rule, Interconnection Facilities connected to Distribution Provider's side of the PCC and Distribution Upgrades shall be provided, installed, owned, and maintained by Distribution Provider at Producer's expense.

2. THIRD-PARTY INSTALLATIONS

Producer may, at its option, employ a qualified contractor that meets the Contractor Qualifications set forth under Electric Rule 15, Section G, to provide and install Interconnection Facilities or Distribution Upgrades, to be owned and operated by Distribution Provider, on Distribution Provider's side of the PCC.* Such Interconnection Facilities and Distribution Upgrades shall be installed in accordance with Distribution Provider's design and specifications. Upon final inspection and acceptance by Distribution Provider, Producer shall transfer ownership of such Producer installed Interconnection Facilities or Distribution Upgrades to Distribution Provider and such facilities shall thereafter be owned and maintained by Distribution Provider at Producer's expense. Producer shall pay Distribution Provider's reasonable cost of design, administration, and monitoring of the installation for such facilities to ensure compliance with Distribution Provider's requirements. Producer shall also be responsible for all costs, including any income tax liability, associated with the transfer of Producer installed Interconnection Facilities and Distribution Upgrades to Distribution Provider.

* Only duly authorized employees of utility are allowed to connect to, disconnect from, or perform any work upon Utility's facilities.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 216

I. THIRD-PARTY INSTALLATIONS, RESERVATION OF UNUSED FACILITIES, AND REFUND OF SALVAGE VALUE (Cont'd.) (L)

3. RESERVATION OF UNUSED FACILITIES

When a Producer wishes to reserve Distribution Provider-owned Interconnection Facilities or Distribution Upgrades installed and operated as Added Facilities for Producer at Producer's expense, but idled by a change in the operation of Producer's Generating Facility or otherwise, Producer may elect to abandon or reserve such facilities consistent with the terms of its agreement with Distribution Provider. If Producer elects to reserve idle Interconnection Facilities or Distribution Upgrades, Distribution Provider shall be entitled to continue to charge Producer for the costs related to the ongoing operation and maintenance of the Added Facilities.

4. REFUND OF SALVAGE VALUE

When a Producer elects to abandon the Special Facilities or Added Facilities for which it has either advanced the installed costs or constructed and transferred to Distribution Provider, Producer shall, at a minimum, receive from Distribution Provider a credit for the net salvage value of the Added Facilities.

J. METERING, MONITORING AND TELEMETERING

1. GENERAL REQUIREMENTS

All Generating Facilities shall be metered in accordance with this Section J and shall meet all applicable standards of Distribution Provider contained in Distribution Provider's applicable tariffs and published Distribution Provider manuals dealing with Metering specifications.

2. METERING BY NON-DISTRIBUTION PROVIDER PARTIES

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

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 217

J. METERING, MONITORING AND TELEMETERING (Cont'd.) (L)

3. NET GENERATION OUTPUT METERING

Generating Facility customers may be required to install Net Generation Output Metering for evaluation, monitoring, and verification purposes and to determine applicable standby and non-bypassable charges as defined in Distribution Provider's tariffs, to satisfy applicable California Independent System Operator (CAISO) reliability requirements, and for Distribution System planning and operations.

However, Generating Facility customers do not need to install Net Generation Output Metering where less intrusive and/or more cost effective options, for Producer/Customer, are available for providing generator data to Distribution Provider. These Generating Facilities may opt to have Distribution Provider estimate load data in accordance with Distribution Provider's applicable tariffs to determine or meet applicable standby and non-bypassable and other applicable charges and tariff requirements. However, if a Generating Facility customer objects to Distribution Provider's estimate of the Generator(s) output, the customer may elect to install the Net Generation Output Metering, or have Distribution Provider install Net Generation Output Metering at the customer's expense.

(a) All metering options available to the customer must conform to the requirements set forth in Distribution Provider's Rule 22. If Distribution Provider does not receive meter data in accordance with Rule 22, Distribution Provider shall have the right to install Distribution Provider-owned Net Generation Output Metering at the customer's expense. The relevant factors in determining the need for Net Generation Output Metering are as listed below:

- i) Data requirements in proportion to need for information;
- ii) Producer's election to install equipment that adequately addresses Distribution Provider's operational requirements;

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 218

J. METERING, MONITORING AND TELEMETERING (Cont'd.) (L)

3. NET GENERATION OUTPUT METERING (Cont'd.)

- iii) Accuracy and type of required Metering consistent with purposes of collecting data;
- iv) Cost of Metering relative to the need for and accuracy of the data;
- v) The Generating Facility's size relative to the cost of the Metering/monitoring;
- vi) Other means of obtaining the data (e.g. Generating Facility logs, proxy data, etc.);
- vii) Requirements under any Generator Interconnection Agreement with Producer.

The requirements in this Section may not apply to Metering of Generating Facilities operating under Distribution Provider's Net Energy Metering tariffs. Nothing in this Section J.3 supersedes Section D.4, Compliance with Laws, Rules and Tariff Schedules.

Distribution Provider will report to the Commission or designated authority, on a quarterly basis, the rationale for requiring Net Generation Output Metering equipment in each instance along with the size and location of the facility.

The standard timeline for installation of Net Generation Output Meters is as follows:

- i) 20 business for design and 20 business days for construction, or
- ii) design and construction timelines as agree with the customer.

The 20-day clock commences upon payment and after the customer had done everything necessary on their end to prepare for construction. By mutual agreement, Applicant and Distribution Provider may agree to a timeline that is different from the timeline described above.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 219

J. METERING, MONITORING AND TELEMETERING (Cont'd.) (L)

4. POINT OF COMMON COUPLING (PCC) METERING

For purposes of assessing Distribution Provider's charges for retail service, Producer's PCC Metering shall be reviewed by Distribution Provider, 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, the Customer's existing meter may be replaced with a bi-directional meter so that power deliveries to and from Producer's site can be separately recorded. Alternately, Producer may, at its sole option and cost, require Distribution Provider to install multi-metering equipment to separately record power deliveries to Distribution Provider's Distribution System and retail purchases from Distribution Provider. Where necessary, such PCC Metering shall be designed to prevent reverse registration.

Generating Facilities participating in Net Energy Metering shall have metering provided pursuant to the terms of the applicable Net Energy Metering tariff schedule.

5. TELEMETERING

If the nameplate rating of the Generating Facility is 1 MW or greater, Telemetering equipment at the Net Generation Output Metering location may be required at Producer's expense. If the Generating Facility is Interconnected to a portion of Distribution Provider's Distribution System operating at a voltage below 10 kV, then Telemetering equipment may be required on Generating Facilities 250 kW or greater. Distribution Provider shall only require Telemetering to the extent that less intrusive and/or more cost effective options for providing the necessary data in real time are not available. Distribution Provider will report to the Commission or designated authority, on a quarterly basis, the rationale for requiring Telemetering equipment in each instance along with the size and location of the facility.

Customer-owned, behind-the-meter, telemetry equipment is allowed where practicable to mitigate the costs associated with Distribution Provider's ownership of the equipment (i.e., the Income Tax Component of Contribution and Cost of Ownership charges), per D.19-03-013 Ordering Paragraph 5. Distribution Provider will allow for a cap of thirty calendar days to repair or replace malfunctioning equipment as notified by the Distribution Provider and if the malfunctioning equipment is not repaired by the thirtieth day, the Distribution Provider can make the necessary repairs and charge the customer for related costs or can disconnect the distributed energy resource.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 220

- J. METERING, MONITORING AND TELEMETERING (Cont'd.) (L)
- 6. LOCATION

Where Distribution Provider-owned Metering is located on Producer's premises, Producer shall provide, at no expense to Distribution Provider, a suitable location for all such Metering Equipment.
- 7. COSTS OF METERING

Producer will bear all costs of the Metering required by this Rule, including the incremental costs of operating and maintaining the Metering Equipment.
- 8. MULTIPLE TARIFF METERING

The requirements of Section J.3 may not apply where a Generating Facility includes multiple generators eligible for service under more than one Net Energy Metering (NEM) tariff schedule (e.g. NEM-1, NEM-2, NEMBIO, NEMFC), or where a Generating Facility consists of one or more NEM-eligible generators in combination with one or more non-NEM eligible generators without Non-Export relays ("Reverse Power Protection"). To ensure proper tariff administration, metering will be required at the PCC and at each of the NEM eligible generator groups eligible for service under the same NEM tariff schedule. For combinations of multiple NEM eligible generators under different tariffs, billing administration and metering requirements will be as specified in the appropriate NEM tariff schedule.

Where a Generating Facility consists of one or more NEM eligible generator groups in combination with one or more non-NEM generators, metering of the non-NEM generators is not required, except as specified in Section J.3.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 221

K. DISPUTE RESOLUTION PROCESS

(L)

In addition to the informal procedures for timeline-related disputes set out in Section F.1.d, the following procedures will apply for disputes arising from this Rule:

1. SCOPE

The Commission shall have initial jurisdiction to interpret, add, delete or modify any provision of this Rule or of any agreements entered into between Distribution Provider and Applicant or Producer to implement this tariff ("Implementing Agreements") and to resolve disputes regarding Distribution Provider's performance of its obligations under Commission-jurisdictional tariffs, the applicable agreements, and requirements related to the interconnection of Applicant's or Producer's Generating Facility or Interconnection Facilities pursuant to this Rule.

2. INFORMAL DISPUTE RESOLUTION PROCEDURES

Any dispute arising between Distribution Provider and Producer (individually referred to in Section K as "Party" and collectively "the Parties") regarding Distribution Provider's or Producer'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 shall be resolved according to the following procedures:

a. Informal Dispute Resolution

To initiate Informal Dispute Resolution, the aggrieved Party may submit a written notice ("notice") to the other party pursuant to either Section K.2.a.(i) (Bilateral Negotiations) or K.2.a.(ii) (Expedited Bilateral Negotiations).

This notice shall:

- specify whether the aggrieved Party is invoking the Informal Dispute Resolution procedures pursuant to either Section K.2.a.(i) (Bilateral Negotiations) or K.2.a.(ii) (Expedited Bilateral Negotiations);
- state the specific dispute and the relief sought; and
- contain all relevant known facts pertaining to the dispute.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 222

K. DISPUTE RESOLUTION PROCESS (Cont'd)

(L)

2. INFORMAL DISPUTE RESOLUTION PROCEDURES (Cont'd)

a. Informal Dispute Resolution (Cont'd)

The notice shall be sent to the Party's email address and physical address set forth in the Generator Interconnection Agreement or Interconnection Request, if there is no Generator Interconnection Agreement. A copy of the notice shall also be sent to the Energy Division, Office of the Director, at the Commission, and Rule21.Disputes@cpuc.ca.gov.

(i) Bilateral Negotiations

- 1) The receiving Party shall acknowledge the notice within five (5) Calendar Days of its receipt.
- 2) Each Party must designate a representative with the authority to make decisions for its respective Party to review the dispute within seven (7) Calendar Days of receiving Party's receipt of the notice.
- 3) The Distribution Provider shall provide the aggrieved Party with all relevant regulatory and/or technical details and analysis regarding any Distribution Provider interconnection requirements under dispute within twenty-one (21) Calendar Days of receiving Party's receipt of the notice.
- 4) Within forty-five (45) Calendar Days of the date of the notice, the Parties' authorized representatives will be required to meet and confer to try to resolve the dispute. Parties are expected to operate in good faith and use best efforts to resolve the dispute.
- 5) Parties may by mutual agreement extend any deadline identified in this section.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 223

K. DISPUTE RESOLUTION PROCESS (Cont'd)

(L)

2. INFORMAL DISPUTE RESOLUTION PROCEDURES (Cont'd)

a. Informal Dispute Resolution (Cont'd)

(ii) Expedited Bilateral Negotiations

- 1) The receiving Party shall acknowledge the notice within five (5) Calendar Days of its receipt.
- 2) Each party must designate a representative with the authority to make decisions for its respective Party to review the dispute within seven (7) Calendar Days of receiving Party's receipt of the notice.
- 3) Distribution Provider shall provide the aggrieved Party with all relevant regulatory and/or technical details and analysis regarding any Distribution Provider interconnection requirements under dispute within ten (10) Business Days of receiving Party's receipt of the notice.
- 4) Within fifteen (15) Business Days of the date of the notice, the Parties' authorized representatives will be required to meet and confer to try to resolve the dispute. Parties are expected to operate in good faith and use best efforts to resolve the dispute.
- 5) Parties may by mutual agreement extend any deadline identified in this section.

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(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 224

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

(L)

2. INFORMAL DISPUTE RESOLUTION PROCEDURES (Cont'd.)

- b. If a resolution of a dispute raised as part of section K.2.a is not reached in forty-five (45) Calendar Days from the date of the notice, either
 - 1) a Party may request to continue negotiations for an additional forty-five (45) Calendar Days; or
 - 2) the Parties may by mutual agreement make a written request for mediation to the ADR Coordinator in the Commission's ALJ Division.

The request may be submitted by electronic mail to adr_program@cpuc.ca.gov. Alternatively, both Parties by mutual agreement may request mediation from an outside third-party mediator with costs to be shared equally between the Parties.

- c. At any time, either Party may file a formal complaint before the Commission.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 225

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

(L)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS

The Expedited Interconnection Dispute Resolution process (“Expedited Process”) may be used to resolve eligible disputes between the Distribution Provider and an Applicant according to the following procedures.

For a complete description of all Expedited Process rules and requirements, please refer to Resolution ALJ-347, Exhibit A “Expedited Interconnection Dispute Resolution Process FINAL”. Information can also be found on the Commission’s website at <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/rule-21-interconnection/expedited-interconnection-dispute-resolution>. In the event of a conflict between the terms of this section and the terms of Resolution ALJ-347, the terms of Resolution ALJ-347 shall govern.

a. Eligibility

i) An Applicant may apply for Expedited Process at any stage of the interconnection process if it can demonstrate that:

- it has, in compliance with Section K.2 requirements, invoked the Section K.2.a Informal Dispute Resolution procedures and has been unable to resolve the dispute in accordance with Section K.2.aⁱⁱ;
- it has, in compliance with Section K.2 requirements, invoked the Section K.2.b Informal Dispute Resolution procedures and has been unable to resolve the dispute in accordance with Section K.2.bⁱⁱ;
- the subject matter of the dispute at issue concerns whether one or both parties’ actions are compliant with established interconnection rules and/or are reasonable, cost efficient and necessarily required under those rules to ensure safe and reliable interconnection.

ⁱⁱ The Commission’s Energy Division has the discretion to grant waivers to this eligibility requirement when the Applicant and Distribution Provider have already engaged in a dispute resolution process equivalent to Section K.2.a or K.2.b, including equivalent duration and with equivalent opportunity for both parties to understand the facts of the dispute and prepare responses. The Applicant or Distribution Provider must make a request to the Energy Division to waive the requirement.

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(Continued)



**ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS**

Sheet 226

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS (Cont'd)

(L)

a. Eligibility (Cont'd)

ii) The Energy Division has the authority to determine that a dispute is not eligible for this process in response to notice submitted in Section K.2.b.

b. Initiation of Expedited Process by Applicant

To request a resolution of a dispute pursuant to the Expedited Process, the Applicant shall download a PDF application form from the CPUC Expedited Interconnection Dispute Resolution Webpage (<https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/rule-21-interconnection/expedited-interconnection-dispute-resolution>), complete the application, and email an electronic PDF application form to Rule21.disputes@cpuc.ca.gov.

i) The Applicant shall include the following in the PDF application form:

- all relevant known facts pertaining to the dispute;
- the specific dispute and the relief sought;
- express notice by the Applicant that it is requesting resolution using the Commission's Expedited Process;
- a description of all efforts to date to resolve the dispute directly with the Distribution Provider, including at minimum a showing that the Applicant meets the eligibility requirements described above; and
- names of all Interconnection Dispute Resolution Panel members who may have a conflict of interest as defined in Public Utilities Code Section 769.5(b)(1).

ii) The Applicant shall also attach to the PDF application form all materials that may aid in review of the dispute, including a copy of the Interconnection Request, any interconnection study performed for that Interconnection Request, and all correspondence between the Applicant and the Distribution Provider relevant to the dispute. For treatment of confidential materials, please refer to Resolution ALJ-347 and the relevant notes on pages 1 and 3 of the PDF application form.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 227

K. DISPUTE RESOLUTION PROCESS (Cont'd.) (236)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS (Cont'd)

(L)

b. Initiation of Expedited Process by Applicant (Cont'd)

iii) The Applicant shall serve this written notice on:

- Energy Division (Rule21.Disputes@cpuc.ca.gov);
- the Distribution Provider's email address set forth in the Generator Interconnection Agreement or Interconnection Request, if there is no Generator Interconnection Agreement;
- the ombudsman designated by Distribution Provider; and
- any other interested persons. "Interested persons" for the purposes of this section are defined as the applicant, utility, a person who has submitted comments on the recommendation of the Review Sub- Panel, or a person who has a demonstrable interest in the outcome of the dispute and has written Energy Division requesting to be added to the distribution list for the dispute.

Please refer to Resolution ALJ-347 for more information and instructions for applying to the Commission for the Expedited Process.

c. Eligibility Verification

- i) The Energy Division will evaluate the submission of an Expedited Process written notice and notify the Applicant and the Distribution Provider of the dispute's eligibility within three (3) Business Days of receiving the request.
- ii) The Energy's Division's notice shall contain specific instructions regarding how the Expedited Process will be resolved. Please refer to Resolution ALJ-347 for more information.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 228

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS (Cont'd.)

(L)

d. Distribution Provider Response

i) Upon receiving notice from the Energy Division of the dispute's eligibility for the Expedited Process, the Distribution Provider shall have five (5) Business Days to serve its response to the Sub-Panel (as defined in Resolution ALJ-347) assigned to the dispute, the Applicant, Energy Division and other interested persons in accordance with the procedures outlined in Resolution ALJ-347.

ii) The Distribution Provider's response shall include:

- the relevant known facts pertaining to the dispute, including the dispute's impact on safe and reliable grid operations;
- its position on the dispute as presented by the Applicant;
- a response to the relief requested by the Applicant; and
- a description of the efforts to date to resolve the dispute directly with the Applicant.

iii) The Distribution Provider shall also include in its response a copy of documentation in its possession that was not previously submitted in the Applicant's written notice that requested the Expedited Process that Distribution Provider believes may aid in review of the dispute, including the Applicant's Interconnection Request, any interconnection study performed for that Interconnection Request, and all correspondence between the Applicant and the Distribution Provider relevant to the dispute. For treatment of confidential materials, please refer to Resolution ALJ-347 and the relevant notes on pages 1 and 3 of the PDF application form.

The Distribution Provider shall serve this written notice on:

- Energy Division (Rule21.Disputes@cpuc.ca.gov);
- the Applicant's email address set forth in Applicant's written notice requesting the Expedited Process; and
- any other interested persons in accordance with the procedures outlined in Resolution ALJ-347.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 229

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS (Cont'd)

(L)

e. Comments on Review Sub-Panel Recommendations

The Review Sub-panel will issue recommendations to the Executive Director of the Commission on how to resolve an Expedited Process's dispute.

Within five (5) Business Days of the issuance of the Review Sub-Panel's recommendations, Applicant, Distribution Provider, and any other interested persons may serve comments on those recommendations via Rule21.Disputes@cpuc.ca.gov.

The Applicant and Distribution Provider may serve a reply to any comments within three (3) Business Days of the last day for service of opening comments via Rule21.Disputes@cpuc.ca.gov.

Please refer to Resolution ALJ-347 and <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/rule-21-interconnection/expedited-interconnection-dispute-resolution> for more information regarding the service requirements.

f. Appealing the Executive Director's Order

Upon receipt of the Review Sub-Panel's recommendations, the Executive Director of the Commission will issue an order resolving the dispute within thirty (30) Calendar Days.

Within ten (10) Calendar Days of the issuance of the Executive Director's Order, the Applicant, Distribution Provider, or any interested person may appeal the Order and request Commission review. Such a request must set forth specifically the grounds on which the requester considers the Order to be unlawful or erroneous. Requests for review should be emailed to Rule21.Disputes@cpuc.ca.gov.

(L)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 230

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

(L)

3. EXPEDITED INTERCONNECTION DISPUTE RESOLUTION PROCESS (Cont'd)

g. Withdrawal

At any time following Applicant's submission of a written notice under this Section, the Applicant may withdraw its notice. If the Applicant and Distribution Provider reach a settlement independent of the Commission, it is not necessary for the Commission to approve the settlement.

Notices of withdrawal should be sent to all interested parties and Rule21.Disputes@cpuc.ca.gov. Please refer to Resolution ALJ-347 for more information regarding the service requirements.

4. FORMAL COMPLAINT

At any time, either Party may file a formal complaint before the Commission pursuant to California PUC section 1702 and Article 4 of the Commission's Rules of Practice and Procedure.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 231

K. DISPUTE RESOLUTION PROCESS (Cont'd.)

5. PERFORMANCE DURING DISPUTE

Pending resolution of any dispute under this Section, the Parties shall proceed diligently with the performance of their respective obligations under this Rule and the Implementing Agreements, unless the Implementing Agreements have been terminated. Applicant and Distribution Provider may by mutual agreement suspend performance of their respective obligations under this Rule and any Implementing Agreements while the dispute is active.

Disputes as to the Interconnection Request and implementation of this Section shall be subject to resolution pursuant to the procedures set forth in this Section.

L. CERTIFICATION AND TESTING CRITERIA

1. INTRODUCTION

This Section describes the test procedures and requirements for equipment used for the Interconnection of Generating Facilities to Distribution Provider's Distribution or Transmission 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(including UL 1741-Supplement A or B as appropriate).

(L)

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 232

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

(L)

1. INTRODUCTION (Cont'd.)

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

Section L also provides criteria for "Certifying" Generators, inverters or converters. Once a Generator, inverter or converter has been Certified per this Rule, it may be considered suitable for Interconnection with Distribution Provider's Distribution or Transmission System. Subject to the exceptions described in Section L, Distribution Provider 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 Facilities Interconnections. Certification is not a prerequisite to interconnect a Generating Facility for Section H, except for Non-Export AC/DC Converters seeking an expedited process, but it is a prerequisite for inverters installed after September 8, 2017, pursuant to Section Hh and P of this Rule.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 233

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 2. CERTIFIED AND NON-CERTIFIED INTERCONNECTION EQUIPMENT
 - a. Certified Equipment

Equipment tested and approved (i.e. "Listed") by an accredited 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 Distribution Provider's Distribution or Transmission 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 manufacturer's 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). (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 234

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
2. CERTIFIED AND NON-CERTIFIED INTERCONNECTION EQUIPMENT (Cont'd.)
- a. Certified Equipment (Cont'd.)
- Technical (as appropriate):
- (1) Device ratings (kW, kV, Volts, amps, etc.);
 - (2) Maximum available fault current in amps per IEEE 1547-2018, 11.4;
 - (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 as Non-Exporting and the method used (reverse power or underpower);
 - (8) If the equipment is Certified as Non-Islanding; and
 - (9) If the equipment is Certified as a Non-Export AC/DC Converter.
- 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.
- b. Non-Certified Equipment
- For non-Certified equipment, some or all of the tests described in this Rule may be required by Distribution Provider for each Generating and/or Interconnection Facility. The manufacturer or a laboratory acceptable to Distribution Provider may perform these tests. Test results for non-Certified equipment must be submitted to Distribution Provider for the Supplemental Review. Approval by Distribution Provider for equipment used in a particular Generating and/or Interconnection Facility does not guarantee Distribution Provider's approval for use in other Generating and/or Interconnection Facilities. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 235

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

(L)

3. TYPE TESTING

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 device safety or other issues.

Table L.1 defines the test criteria by Generator or inverter technology. While UL 1741(1) and UL 1741 – Supplement SA** were 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, Distribution Provider or NRTL shall adopt the procedures referenced in Table L.1 as appropriate and necessary for a Generating Facility and/or Interconnection Facilities or associated equipment performance and its control and Protection Functions. These tests shall be performed in the sequence shown in Table L.2.

Non-Export AC/DC Converters must satisfy the requirements in its definition in Section C.

** An exemption exists for DC V2G Electric Vehicle Service Equipment (EVSE) interconnecting for the purpose of participating in the Emergency Load Reduction Program, see footnote * in the opening paragraphs of Section Hh.

(L)

(Continued)



ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

3. TYPE TESTING (Cont'd.)

a. Type Tests and Criteria for Interconnection Equipment Certification (Cont'd.)

Table L.1, Type Test and Requirements for Interconnection Equipment Certification

Table with 7 columns: Type Test, Reference 1, Inverter (6), Smart Inverter (7), Smart Inverter 2022 (Note, 9,10), Synchronous Generators, Induction Generators. Includes various test types like Utility Interaction, DC Isolation, Dielectric Voltage Withstand, etc.

Table Notes:

- (1) References are to section numbers in either UL 1741 and/or UL 1741-Supplement SA (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 Distribution Provider power to motor to speed.
(5) Required for all self-excited induction Generators as well as Inverters that operate as voltage sources when connected to Distribution Provider's Distribution or Transmission System.
(6) Inverters compliant with Section H.
(7) Inverters compliant with Sections H or P.
(8) IEEE 1547.1 refers to 2005 revision.
(9) Smart Inverter which have tested under UL1741SB and IEEE 1547.1-2020
(10) Effective August 1, 2022.

"X" = Required "-" = Not Required

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Advice Decision 7010-E

Issued by Meredith Allen Vice President, Regulatory Affairs

Submitted Effective Resolution August 25, 2023 August 29, 2023 E-5000 and E-5036



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 237

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

(L)

3. TYPE TESTING (Cont'd.)

a. Type Tests and Criteria for Interconnection Equipment Certification (Cont'd.)

Table L.2 Type Tests Sequence for Interconnection Equipment Certification

<u>Test No.</u>	<u>Type Test</u>
1	Distribution Provider Voltage and Frequency Variation
2	Synchronization
3	Surge Withstand Capability
4	Distribution Provider Voltage and Frequency Variation, including ride through
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 test agency.

b. Anti-Islanding Test

Devices that pass the Anti-Islanding test procedure described in UL 1741 Supplemental SB 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.

c. Non-Export Test

Equipment that passes the Non-Export test procedure described in Section L.7.a will be considered Non-Exporting for the purposes of these Interconnection requirements. This test is required only for devices for which a Certified Non-Export designation is desired.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 238

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

3. TYPE TESTING (Cont'd.)

d. In-rush Current Test

Generation equipment that utilizes Distribution Provider power to motor up to speed will be tested using the procedure defined in Section L.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.

e. Surge Withstand Capability Test

The interconnection equipment shall be tested for the surge withstand requirement in Section H.1.c in all normal operating modes in accordance with IEEE Std C62.45-2002 for equipment rates 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 (IEEE 1547-2018, 4.11.2).

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.

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(L)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 239

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)

3. TYPE TESTING (Cont'd.)

f. Synchronization Test

This test is applied to synchronous Generators, self-excited induction generators, and inverters capable of operating as voltage-source while connected to Distribution Provider's Distribution or Transmission System. The test is also applied to the resynchronization Function (transition from stand-alone to parallel operation) on equipment that provides such functionality. This test may not need to be performed on both the synchronization and re-synchronization functions if the manufacturers can verify to the satisfaction of the testing organization that monitoring and controls hardware and software are common to both functions. This test is not necessary for induction generators or current-source inverters. Instead, the In-rush Current test Section L.3.d shall be applied to those generators.

This test shall demonstrate that at the moment of the paralleling-device closure, all three synchronization parameters in Table L.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 (IEEE 1547-2018, 4.10.4). The test will start with only one of the three parameters: (1) voltage difference between Generating Facility and Distribution Provider's Distribution or Transmission System; (2) frequency difference; or (3) phase angle outside of the synchronization specification. Verify that the Generating Facility is brought within specification prior to synchronization. Repeat the test five times for each of the three parameters. For manual synchronization with synch check or manual control with auto synchronization, the test must verify that paralleling does not occur until the parameters are brought within specifications. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 240

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

(L)

3. TYPE TESTING (Cont'd.)

f. Synchronization Test (Cont'd.)

Table L.3
Synchronization Parameter Limits [1]

Aggregate Rating of Generator Units (kVA)	Frequency Difference (Δf, Hz)	Voltage Difference (ΔV, %)	Phase Angle Difference (ΔΦ, °)
0-500	0.3	10	20
> 500-1,500	0.2	5	15
> 1,500-10,000	0.1	3	10

[1] – IEEE 1547-2018, 4.10.4

g. Paralleling Device Withstand Test

The di-electric voltage withstand test specified in Section L.1 shall be performed on the paralleling device to ensure compliance with those requirements specified in Section H.1.c (IEEE 1547-2018, 4.11.2).

h. Backfeed Test

Non-Export AC/DC Converters must satisfy the requirements in its definition in Section C.

4. PRODUCTION TESTING

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

(L)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 241

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 5. COMMISSIONING TESTING
 - a. Commissioning Testing

Commissioning Testing, where required, will be performed on-site to verify protective settings and functionality. Upon initial Parallel Operation of a Generating Facility, or any time interface hardware or software is changed that may affect the functions listed below, a Commissioning Test must be performed. An individual qualified in testing protective equipment (professional engineer, factory-certified technician, or licensed electrician with experience in testing protective equipment) must perform Commissioning Testing in accordance with the manufacturer's recommended test procedure to verify the settings and requirements per this Rule.

Distribution Provider may require written Commissioning test procedure be submitted to Distribution Provider at least 10 working days prior to the performance of the Commissioning Test. Distribution Provider has the right to witness Commissioning Test. Distribution Provider 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:

 - (1) Over and under voltage
 - (2) Over and under frequency
 - (3) Anti-Islanding function (if applicable)
 - (4) Non-Exporting function (if applicable)
 - (5) Inability to energize dead line (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 242

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 5. COMMISSIONING TESTING (Cont'd.)
 - a. Commissioning Testing (Cont'd.)
 - (6) Time delay on restart after Distribution Provider source is stable
 - (7) Distribution Provider system fault detection (if used)
 - (8) Synchronizing controls (if applicable)
 - (9) Other Interconnection Protective Functions that may be required as part of the Generator Interconnection Agreement

Commissioning Test shall include visual inspections of the interconnection equipment and protective settings to confirm compliance with the interconnection requirements.
 - b. Review, Study, and Additional Commissioning Test Verification Costs

A Producer shall be responsible for the reasonably incurred costs of the reviews, studies and additional Commissioning Test verifications conducted pursuant to Section E of this Rule. If the initial Commissioning Test verification is not successful through no fault of Distribution Provider, Distribution Provider may impose upon Producer a cost based charge for subsequent Commissioning Test verifications. All Costs for additional Commissioning Test verifications shall be paid by Producer within thirty days of receipt of Distribution Provider's invoice. The invoice provided by Distribution Provider shall consist of the hourly rate multiplied by the hours incurred by Distribution Provider and will separately specify the amount of time spent on-site from that spent in roundtrip travel to the Commissioning Test site. Additional cost, if any, will be specified on the invoice. If the initial Commissioning Test verification is not successful through the fault of Distribution Provider, that visit will not be considered the initial Commissioning Test verification.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 243

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 5. COMMISSIONING TESTING (Cont'd.)
- c. Other Checks and Tests
 - Other checks and tests that may need to be performed include:
 - (1) Verifying final Protective Function settings
 - (2) Trip test (L.5.g)
 - (3) In-service tests (L.5.h)
- d. Certified Equipment
 - Generating Facilities qualifying for interconnection through the Fast Track process 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 Distribution Provider's Distribution or Transmission 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, at a test connection using a Generator to simulate abnormal Distribution Provider voltage or frequency, or varying the set points to show that the device trips at the measured (actual) Distribution Provider voltage or frequency.
 - (2) The Non-Islanding function shall be checked by operating a load break disconnect switch to verify the Interconnection equipment ceases to energize Distribution Provider's Distribution or Transmission System and does not re-energize it for the required time delay after the switch is closed. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 244

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 5. COMMISSIONING TESTING (Cont'd.)
- d. Certified Equipment (Cont'd.)
 - (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 underpower) are met.
 - The Supplemental Review or an Interconnection Study may impose additional components or additional testing.
- e. Non-Certified Equipment
 - Non-certified Equipment shall be subjected to the appropriate tests described in Type Testing (Section L.3) as well as those described in Certified Equipment Commissioning Tests (Section L.5.d). With Distribution Provider's approval, these tests may be performed in the factory, in the field as part of commissioning, or a combination of both. Distribution Provider, 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.
- f. Verification of Settings
 - At the completion of Commission testing, Producer shall confirm all devices are set to Distribution Provider-approved settings. Verification shall be documented in the Commissioning Test Certification. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 246

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.)

(L)

6. PERIODIC TESTING

Periodic Testing of Interconnection-related Protective Functions shall be performed as specified by the manufacturer, or at least every four years. All Periodic Tests prescribed by the manufacturer shall be performed. Producer shall maintain Periodic Test reports or a log for inspection by Distribution Provider. Periodic Testing conforming to Distribution Provider test intervals for the particular Line Section may be specified by Distribution Provider 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, the battery must be either replaced or a discharge test performed.

7. 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. These Type Tests are not contained in Underwriters Laboratories UL 1741 Standard *Inverters, Converters and Controllers for Use in Independent Power Systems*, or other referenced standards.

a. Non-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 I, Options 1 and 2, of the review process. Tests are provided for discrete relay packages and for controllers and inverters with the intended Functions integrated.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 247

L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)

7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)

a. Non-Exporting Test Procedures (Cont'd.)

i) Discrete Reverse Power Relay Test

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

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 248

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
 - i) Discrete Reverse Power Relay Test (Cont'd.)
 - Step 2: Leading Power Factor Test

Apply rated voltage with a minimum pickup current setting (calculated value for system application) and apply a leading power factor load current in the non-trip direction (current lagging voltage by 135 degrees). Increase the current to relay rated current and verify that the relay does not operate. For relays with adjustable settings, this test should be repeated at the minimum, midpoint, and maximum settings.
 - Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Increase the current level to pickup (about 10 times higher than at 0 degrees) and verify that the relay operates. Repeat for 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.

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 249

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
 - i) Discrete Reverse Power Relay Test (Cont'd.)
 - 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 2 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.

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 250

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
 - i) Discrete Reverse Power Relay Test (Cont'd.)
 - Step 8: Dielectric Test
 - Perform the test described in IEC 414 using 2 kV RMS for 1 minute.
 - Step 9: Surge Withstand Test
 - Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand capability test described in L.3.e.
 - ii) Discrete Underpower Relay Test
 - This version of the Non-Exporting test procedure is intended for discrete underpower relay packages and meets the requirements of Option 2 of Screen I. A trip output will be provided when import power (toward Producer's load) drops below the specified level.
 - Note: For an underpower relay, pickup is defined as the highest power level at which the relay indicates that the power is less than the set level. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 251

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
- ii) Discrete Underpower Relay Test (Cont'd.)
- 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 at 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% 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. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 252

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
 - ii) Discrete Underpower Relay Test (Cont'd.)
 - Step 3: Minimum Power Factor Test

At nominal voltage and with the minimum pickup (or ranges) determined in Step 1, adjust the current phase angle to 84 or 276 degrees. Decrease the current level to pickup (about 10% of the value at 0 degrees) and verify that the relay operates. Repeat for 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% 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 Va at 0 degrees, Vb and Vc at 180 degrees, Ia at 0 degrees, Ib at 180 degrees, and Ic at 0 degrees). Observe that the relay (especially single-phase types) operates properly.

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 253

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
- ii) Discrete Underpower Relay Test (Cont'd.)
- Step 6: Time Delay Settings Test
- Apply Step 1 settings and set time delay to minimum setting. Adjust the current source to the appropriate level to determine operating time, and compare against calculated values. Verify that the timer stops when the relay trips. Repeat at midpoint and maximum delay settings.
- Step 7: Dielectric Test
- Perform the test described in IEC 414 using 2 kV RMS for 1 minute.
- Step 8: Surge Withstand Test
- Perform the surge withstand test described in IEEE C37.90.1.1989 or the surge withstand test described in Section L.3.e. (L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 254

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
 - a. Non-Exporting Test Procedures (Cont'd.)
 - iii) Tests for Inverters and Controllers with Integrated Functions

Inverters and controllers designed to provide reverse or underpower 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 underpower 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 L.7.a.i of this Rule.

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.
 - iv) Tests for Inadvertent Export Inverters

Test requirements for certified inverters with integrated functions for Inadvertent Export shall verify the performance requirements specified in Section Mm of this Rule.

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 255

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- a. Non-Exporting Test Procedures (Cont'd.)
- v) Interim Tests for Non-Export AC/DC Converters (“Converter”)
 - Step 1: Limitation of Back-feed Under Steady State Conditions

Apply the nominal DC operating voltage of the Converter across its DC terminals with a battery source or simulated equivalent of a battery source. Vary the battery source by 100%, 75%, 50%, 25%, and 10% of Converter rated output power. The measured steady-state DC current component at each of the AC terminals of the Converter is required to be less than 0.5% of the Converter’s rated RMS AC current. This test is to be repeated for 80% nominal DC operating voltage and for 125% nominal DC operating voltage. Testing requirements can be modified upon mutual agreement of the Distribution Provider and the Applicant.
 - Step 2: Back-feed Under Fault Conditions – DC Output Shorted

With a battery source or simulated equivalent of a battery source connected to the DC terminals, apply rated conditions of the Converter then short its DC terminals for 200 milliseconds. After 5 cycles of inducing the short circuit, record the measured peak current at each of the AC terminals of the Converter. These peak currents within this time interval are each required to be less than 0.5% of the Converter’s rated RMS AC current. Testing requirements can be modified upon mutual agreement of the Distribution Provider and the Applicant.

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 256

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
 - a. Non-Exporting Test Procedures (Cont'd.)
 - v) Interim Tests for Non-Export AC/DC Converters (“Converter”) (Cont'd.)

Step 3: Back-feed Under Fault Conditions – AC Input Shorted: Phase-Ground, Phase-Phase, and 3-Phase

With a battery source or simulated equivalent of a battery source connected to the DC terminals, apply rated conditions of the Converter, then apply a short between any two phases on the grid side of the Converter for 200 milliseconds. After 5 cycles of inducing the short circuit, record the measured peak current at each of the AC terminals of the Converter. These peak currents within this time interval are each required to be less than 0.5% of the Converter’s rated RMS AC current. This test is to be repeated for phase-ground and 3-phase shorts. Testing requirements can be modified upon mutual agreement of the Distribution Provider and the Applicant.

Step 4: Back-feed Under Fault Conditions – Component Faults

Distribution Provider can elect to test for back-feed under the condition of a short circuit across certain components which are internal to the Converter. Potential tests can include inducing a short circuit across different terminals for electronic switches and/or across different terminals for internal transformers. Ultimately, the components used for testing will be chosen on a case-by-case basis and will depend on the Converter’s circuit topology. Testing requirements can be modified upon mutual agreement of the Distribution Provider and the Applicant.

Step 5: Harmonics Testing

Under normal loading conditions at 10%, 25%, 50%, 75%, and 100% of the Converter’s rated power output, conduct harmonic current distortion measurements on each of the AC terminals. Measurements should be below the maximum harmonic current distortion requirements given in IEEE 1547-4.3.3.

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 257

- L. CERTIFICATION AND TESTING CRITERIA (Cont'd.) (L)
- 7. TYPE TESTING PROCEDURES NOT DEFINED IN OTHER STANDARDS (Cont'd.)
- b. In-rush Current Test Procedures
 - This test will determine the maximum In-rush Current drawn by the Generator.
 - i) Locked-Rotor Method
 - Use the test procedure defined in NEMA MG-1 (manufacturer's data is acceptable if available).
 - ii) 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 Distribution Provider's Distribution or Transmission 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 5%. In-rush Current is defined as the maximum current draw from Distribution Provider during the startup process, using a 10-cycle moving average. During the test, Distribution Provider 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 Distribution Provider. (L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 258

M. INADVERTENT EXPORT

(L)

Under certain operating conditions, an Applicant may choose to completely offset their facility load by installing generation systems which are optimally sized to meet their peak demand with load following functionality on the Generator controls to ensure conditional export of electrical power from the Generating Facility to Distribution Provider's Distribution or Transmission System. In situations where the loading changes rapidly and/or the Generator cannot ramp down quickly enough, the Generating Facility may need to export small amounts of power for limited duration. The event of exporting uncompensated power for a short time is referred to as Inadvertent Export.

The following are the minimum requirements for Inadvertent Export systems. Other factors relevant to the interconnection study process (e.g. 15% screen results, short circuit current ratio, etc.) may necessitate additional technical requirements (e.g. reclose block, transfer trip, ground bank, etc.) that are not explicitly noted here. Inadvertent Export may not be available for interconnections to Networked Secondary Systems.

1. For Inadvertent Export interconnection requests, additional Protective Functions and equipment to detect Distribution or Transmission System faults (per Distribution Provider's standard practices) may be required over and above the basic Protective Functions and equipment associated with the four options in the Export Screen. Protective Functions may include, but are not limited to, directional overcurrent/voltage-restraint overcurrent Protective Functions for line-to-line fault detection and overcurrent/overvoltage Protective Functions for line-to-ground detection. The addition of a ground bank or ground detector may also be necessary.

(L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 259

- M. INADVERTENT EXPORT (Cont'd.) (L)
2. The effect on equipment ratings can be mitigated by limiting the amount of inadvertent export allowed. To a large degree, Voltage Regulation may be similarly handled. The amount of Inadvertent Export is dependent on specific Distribution Provider requirements and should be limited to the lesser of the following values:
 - a. 50% of the Generating Facility Capacity, or
 - b. 10% of the continuous conductor rating in watts at 0.9 power factor for the lowest rated feeder conductor upstream of the GF (i.e. 200kW @ 12kV), or
 - c. 110% of the largest load block in the facility, or
 - d. 500kW or some other maximum level indicated by Distribution Provider
 3. In addition to the limits above, the following are required:
 - a. A reverse power Protective Function will be provided to trip the connected Generator(s) within two seconds if the proposed amount of Inadvertent Export is exceeded.
 - b. The frequency of Inadvertent Export occurrences should be less than two occurrences per 24-hour period.
 - c. A separate reverse power or underpower Protective Function will be required (in addition to the reverse power Protective Function described in 3a. above) to trip the connected Generator(s) if the duration of reverse power or underpower (i.e. ANY export) exceeds 60 seconds. (L)

(Continued)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 260

**Mm. INADVERTENT EXPORT FOR INTERCONNECTION REQUESTS
UTILIZING UL-1741 CERTIFIED OR SA/SB LISTED GRID SUPPORT (NON-
ISLANDING) INVERTERS**

(L)

The following are the minimum requirements for Inadvertent Export systems that meet the criteria specified below. Other factors relevant to the interconnection study process (e.g., 15% screen results, short circuit current ratio, etc.) may necessitate additional technical requirements (e.g., reclose block, transfer trip, ground bank, etc.) that are not explicitly noted here. Inadvertent Export may not be available for interconnections to Networked Secondary Systems.

The certified control functions internal to the inverter control or external control system may be used to replace the discrete reverse/under power relay functions described in Section M provided the requirements outlined below are met.

- 1) All of the following requirements must be met by the Generating Facility to qualify for Inadvertent Export under this Section.
 - a. The Generating Facility must utilize only UL-1741 certified or UL-1741 SB-listed grid support non-islanding inverters; and,
 - b. The Generating Facility must have an aggregate maximum nameplate capacity of 500 kVA or less; and,
 - c. The Generating Facility's total energy export must not exceed its nameplate rating (kVA-gross) multiplied by 0.1 hours per day over a rolling 30-day period (e.g., for a 100 kVA-gross nameplate Generating Facility, the maximum energy allowed to be exported for a 30-day period is 300 kWh) ; and,
 - d. Export from the Generating Facility across the PCC to the Distribution System is less than 100 kVA.

(L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 261

Mm. INADVERTENT EXPORT FOR INTERCONNECTION REQUESTS UTILIZING UL-1741 CERTIFIED OR SA LISTED GRID SUPPORT (NON-ISLANDING) INVERTERS (Cont'd.) (L)

- 2) To govern the level of Inadvertent Export allowable under this Section, the Generating Facility must utilize a NRTL-certified control system or NRTL-certified inverter system that meets all of the following requirements.
 - a. Must result in the Generating Facility disconnecting from the Distribution System, ceasing to energize the Distribution System or halting energy production within two (2) seconds after either:
 - i. The period of continuous export exceeds 30 seconds;
 - or,
 - ii. The level of export exceeds 100 kVA.
 - b. Must monitor that the total energy export is maintained within the allowable energy export outlined above 1.c and provide an indication or notification (e.g., electronic, alarm) if that energy export limit is exceeded.
 - c. Failure of the of the control or inverter system for more than thirty (30) seconds, resulting from loss of control signal, loss of control power or a single component failure or related control sensing of the control circuitry, must result in the Generating Facility entering Non-Export operation where no energy is exported across to the PCC to the Distribution System.

Interim approval of the control or inverter system may be permitted upon mutual agreement of PG&E and the Producer. (L)

(Continued)

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GENERATING FACILITY INTERCONNECTIONS

Sheet 262

Mm. INADVERTENT EXPORT FOR INTERCONNECTION REQUESTS UTILIZING UL-1741 CERTIFIED OR SA LISTED GRID SUPPORT (NON-ISLANDING) INVERTERS (Cont'd.) (L)

3) Applicability of Engineering Review Screens.

Inadvertent Export systems that meet the requirements described herein are processed under Initial Review Screens A through J as described in Section H. If these systems fail Screen J, they then bypass Screens K and L and are processed under Screens M and M1 as described below.

Screen M: Is the aggregate Generating Facility capacity on the Line Section less than 15% of Line Section peak load for all line sections bound by automatic sectionalizing devices?

- If Yes (pass), Initial Review is complete.
- If No (fail), continue to Screen M1.

Screen M1: Is the aggregate of all distributed energy resources (DER) causing reverse power flow (1) at a line section with a voltage regulator device(s) or (2) at a protection device, including the circuit breaker / field recloser?*,**

- If No (pass), existing DER does not cause reverse power flow at (1) or (2) and Initial Review is complete.
- If Yes (fail), existing DER causes reverse power flow at (1) or (2); fail Initial Review and Supplemental Review is required.

* For the purposes of applying Screen M1 herein, Distribution Provider shall utilize a zero coincidence factor when considering the impact of other Inadvertent Export systems that meet the requirements of Section Mm (i.e., projects that qualify for Option 6 under Section G.1.i) such that those Inadvertent Export systems do not impact Screen M1's aggregate analysis determination for the individual Inadvertent Export project being evaluated.

** The presence of existing non-certified DER on the line section may require additional review to ensure safe and reliable grid operation.

(Continued)



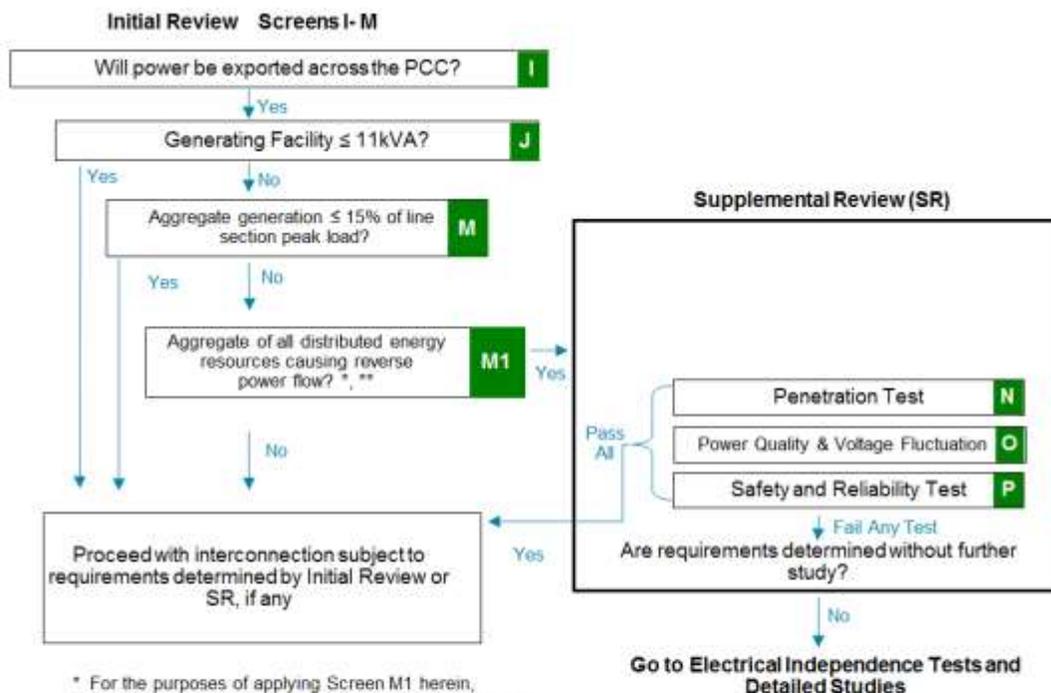
ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 263

Mm. INADVERTENT EXPORT FOR INTERCONNECTION REQUESTS UTILIZING UL-1741 CERTIFIED OR SA LISTED GRID SUPPORT (NON-ISLANDING) INVERTERS (Cont'd.)

(L)

3) Applicability of Engineering Review Screens. (Cont'd.)



* For the purposes of applying Screen M1 herein, Distribution Provider shall utilize a zero coincidence factor when considering the impact of other Inadvertent Export systems that meet with the requirements of Section Mm (i.e., projects that qualify for Option 6 under Section G 1.1) such that those Inadvertent Export systems do not impact Screen M1's aggregate analysis determination for the individual analysis determination for the individual Inadvertent Export project being evaluated.

** The presence of existing non-certified DER on the line section may require additional review to ensure safe and reliable grid operation.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 264

Mm1. OPTION 8: Non-Export Utilizing Certified Power Control Systems

(L)

The following are the minimum requirements for Non-Export systems that use certified power control systems (PCS) with an open loop response time (OLRT) no more than two seconds. It should be noted that other factors relevant to the Interconnection Study process may necessitate additional technical requirements that are not explicitly noted here.

1. Use a PCS that passes the requirements of the 2019 Underwriters Laboratories (UL) Power Control Systems Certification Requirements Decision (CRD) test protocol. Non-Export systems may use a PCS that passes later published revisions to the CRD test protocol or may use a PCS that is certified to the UL 1741 certification standard, if UL incorporates the test protocol for PCS into UL 1741 in the future. The NRTL evaluation must have determined that the PCS conforms to the non-exporting functionality in accordance with the relevant CRD or UL published standard.
2. Use a PCS that is certified with an OLRT of two seconds or less, as provided in the PCS's specification data sheets.
3. The PCS must reduce export to zero or less within two seconds of commencing export. A PCS that is certified with an open-loop response time of two seconds or less, and a time to reach steady state of 10 seconds or less, meets this requirement.
4. Set the PCS to not export (zero-export).
5. Use only UL 1741 listed grid-support non-islanding inverters as approved by this tariff.
6. Maintain voltage fluctuations at the limits specified in Electric Rule 2.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 265

Mm1. OPTION 8: Non-Export Utilizing Certified Power Control Systems (Cont'd)

(L)

The evaluation of a Non-Export system requesting interconnection under this section:

1. Shall omit evaluation for screen D;
2. Shall utilize the Generating Facility's Gross Nameplate Rating for screens F, F1, and G;
3. If the Non-export system has an aggregate PCS controlled nameplate greater than 600 kVA and the maximum reported steady state value of the PCS is greater than 1% of the PCS controlled nameplate (as provided in the NRTL testing reports), the evaluation may utilize the following calculation when determining the impacts to the grid under screens I, J, K, M, N, and O: The sum of the nameplate values of the exporting DER resource (if any) plus the maximum percentage steady state value of the PCS (as provided in the NRTL testing reports) times PCS controlled nameplate capacity.
4. Screen P may be applied using the Generating Facility's Gross Nameplate Rating for evaluations that use fault current calculations. For other evaluations under screen P, the value identified in 3 above may be used.

(L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 266

Mm2. OPTION 9: Limited Export Utilizing Certified Power Control Systems

(L)

The following are minimum requirements for limited export systems that use certified power control systems (PCS) with an open loop response time (OLRT) no more than two seconds to maintain a level of export that is lower than the nameplate rating. It should be noted that other factors relevant to the Interconnection Study process may necessitate additional technical requirements that are not explicitly noted here.

1. Use a PCS that passes the requirements of the 2019 Underwriters Laboratories (UL) Power Control Systems Certification Requirements Decision (CRD) test protocol. Limited export systems may use a PCS that passes later published revisions to the CRD test protocol, or may use a PCS that is certified to the UL 1741 certification standard, if UL incorporates the test protocol for PCS into UL 1741 in the future. The NRTL evaluation must have determined that the PCS conforms to the export limiting functionality in accordance with the relevant CRD or UL published Standard.
2. Use a PCS that is certified with an OLRT of two seconds or less as provided in the PCS's specification data sheets.
3. The PCS must reduce export to the approved export limit, or less, within two seconds of exceeding the approved export limit. A PCS that is certified with an open-loop response time of two seconds or less, and a time to reach steady state of ten seconds or less, meets this requirement.
4. Set the PCS to not exceed the proposed level of export.
5. Use only UL 1741 listed grid-support non-islanding inverters as approved by this tariff.
6. Maintain voltage fluctuations at the limits specified in Electric Rule 2.

(L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 267

Mm2. OPTION 9: Limited Export Utilizing Certified Power Control Systems (Cont'd)

(L)

The evaluation of a limited export system requesting interconnection under this section:

1. Shall utilize the Generating Facility's Gross Nameplate Rating for screens F, F1, and G.
2. If the maximum steady state value is greater than 1% of the PCS controlled nameplate (as provided in the NRTL testing reports) utilize the requested limited export value plus the maximum steady state value of the PCS times the PCS controlled nameplate, to evaluate the impacts to the grid under screens D, I, J, K, M, N, and O. If the maximum steady state value is less than 1% of the PCS controlled nameplate (as provided in the NRTL testing reports), utilize only the requested limited export value under screens D, I, J, K, M, N and O.
3. Screen P shall be applied using the Generating Facility's Gross Nameplate Rating for evaluations that use fault current calculations. For other evaluations under screen P, the value identified in 2 above may be used.

(L)

(Continued)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 268

Mm3. OPTION 10: Non-Export with Inadvertent Export Utilizing Certified Power Control Systems (L)

The following are the minimum requirements for Non-Export systems that use certified power control systems (PCS) with an open loop response time (OLRT) between two and ten seconds. It should be noted that other factors relevant to the Interconnection Study process may necessitate additional technical requirements that are not explicitly noted here.

1. Have a nameplate capacity equal to or less than 1,000 kVA.
2. Use a PCS that passes the requirements of the 2019 Underwriters Laboratories (UL) Power Control Systems Certification Requirements Decision (CRD) test protocol. Non-Export may use a PCS that pass later published revisions to the CRD test protocol, or may use a PCS that is certified to the UL 1741 certification standard, if UL incorporates the test protocol for PCS into UL 1741 in the future. The NRTL evaluation must have determined that the PCS conforms to the non-exporting functionality in accordance with the relevant CRD or UL published standard.
3. Use a PCS that is certified with an OLRT of no more than ten seconds, as provided in the PCS's specification data sheets.
4. Set the PCS to not export (zero-export).
5. Use only UL 1741 listed grid-support non-islanding inverters as approved by this tariff.
6. Maintain voltage fluctuations at the limits specified in Electric Rule 2. (L)

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 269

Mm3. OPTION 10: Non-Export with Inadvertent Export Utilizing Certified Power Control Systems (Cont'd) (L)

The Distribution Provider evaluating Generating Facilities requesting interconnection under this section shall:

1. Apply screens A through M using the aggregate nameplate inverter rating.
2. Notify the applicant if supplemental review is required, and if so, require the applicant to identify, within 15 business days of being notified, the frequency of inadvertent export, the real power level in watts of inadvertent export, and the time duration of inadvertent export.
3. If distribution upgrades are identified, use screen P to recognize power control parameters, taking into account local feeder conditions; the customer's operating profile; and the magnitude, duration, and frequency of anticipated export;
4. Complete supplemental review within 15 days of receiving the required information specified under 2 above.
5. If the applicant does not provide the operating profile information within the specified 15 business days, perform supplemental review based on information included in the interconnection request within 30 business days of the request for customer operating profile information.
6. Use only the largest facility in the line section for aggregate evaluation for subsequent interconnection requests.

(L)

(Continued)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 270

Mm4. OPTION 11: Limited Export with Inadvertent Export Utilizing Certified Power Control Systems (L)

The following are the minimum requirements for limited export controlled systems that use certified power control systems (PCS) with an open loop response time (OLRT) between two and ten seconds to maintain a level of export that is lower than the nameplate rating. It should be noted that other factors relevant to the Interconnection Study process may necessitate additional technical requirements that are not explicitly noted here.

1. Have a nameplate capacity equal to or less than 1,000 kVA.
2. Use a PCS that passes the requirements of the 2019 Underwriters Laboratories (UL) Power Control Systems Certification Requirements Decision (CRD) test protocol. Limited export systems may use a PCS that pass later published revisions to the CRD test protocol, or may use a PCS that is certified to the UL 1741 certification standard, if UL incorporates the test protocol for PCS into UL 1741 in the future. The NRTL evaluation must have determined that the PCS conforms to the export limiting functionality in accordance with the relevant CRD or UL published standard.
3. Use a PCS that is certified with an OLRT of no more than ten seconds, as provided in the PCS's specification data sheets.
4. Set the PCS to not to exceed the proposed level of export.
5. Use only UL 1741 listed grid-support non-islanding inverters as approved by this tariff.
6. Maintain voltage fluctuations at the limits specified in Electric Rule 2. (L)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

Sheet 271

Mm4. OPTION 11: Limited Export with Inadvertent Export Utilizing Certified Power Control Systems (Cont'd) (L)

The Distribution Provider evaluating Generating Facilities requesting interconnection under this section shall:

1. Apply screens A through M using the aggregate nameplate inverter rating.
2. Notify the applicant if supplemental review is required, and if so, require the applicant to identify, within 15 business days of being notified, the frequency of inadvertent export, the real power level in watts of inadvertent export, and the time duration of inadvertent export.
3. If distribution upgrades are identified, use screen P to recognize power control parameters, taking into account local feeder conditions; the customer's operating profile; and the magnitude, duration, and frequency of anticipated export.
4. Complete supplemental review within 15 days of receiving the required information specified under 2 above.
5. If the applicant does not provide the operating profile information within the specified 15 business days, perform supplemental review based on information included in the interconnection request within 30 business days of the request for customer operating profile information. (L)

(Continued)

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 272

N. EXPEDITED INTERCONNECTION PROCESS FOR NON-EXPORT ENERGY STORAGE GENERATING FACILITIES (L)

Applicants with Interconnection Requests for Non-Export Energy Storage Generating Facilities who meet the requirements outlined below are eligible for expedited interconnection in accordance with the Fast Track Process technical review requirements of Section F.2. Applicants with Non-Export AC/DC Converters that meet the requirements outlined in O. below are also eligible.

1. ELIGIBILITY REQUIREMENTS

Applicants seeking to interconnect a Generating Facility under the provisions of this Section N must meet the following eligibility requirements.

- a. Applicant must electronically submit a completed Interconnection Request, including completing all application fields and submitting all supporting documentation necessary to facilitate the expedited review as required by Distribution Provider. Such documentation may include, but is not limited to, single line diagrams with specific details, manufacturer data sheets for proposed equipment, description of control systems, validation of the right to do business in the state, etc. Distribution Provider shall clearly communicate these requirements as part of the application process. Applicant shall select this process option in the Interconnection Request.
- b. Applicant's Generating Facility must meet the requirements outlined in Section N.2 below.
- c. Applicant's Interconnection Request must be eligible for and select the Fast Track Process.
- d. Applicant's Interconnection Request must pass Fast Track Initial Review and not require any Interconnection Facilities, Distribution Upgrades or Network Upgrades to remain eligible under this Section. As such, Interconnection Requests that select the Cost Envelope Option are not eligible.
- e. Applicants selecting this section shall use the corresponding interconnection agreement type provided for eligible Generating Facilities.

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ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 273

N. EXPEDITED INTERCONNECTION PROCESS FOR NON-EXPORT ENERGY STORAGE GENERATING FACILITIES (Cont'd.) (L)

2. GENERATING FACILITY ELIGIBILITY CRITERIA

An Applicant's Generating Facility must meet and adhere to the following criteria.

- a. The Generating Facility must be comprised solely of the following specific categories of generation technology: Non-Exporting battery storage.
- b. The Generating Facility must have an aggregate maximum inverter nameplate rating of no greater than 500 kW. There is no limitation on an energy storage device's kWh capacity rating.
- c. The Generating Facility must be located behind an existing single retail meter and Point of Common Coupling with a single, clearly marked and accessible disconnect. No other Generators, other than isolated back-up Generators, may be at the same Point of Interconnection or Point of Common Coupling.
- d. The Generating Facility must utilize Option 3 or Option 4 to meet the non-export protection requirements of Screen I in Section G.1.i.
- e. The Generating Facility must have a single or coordinated control system for all charging functions if utilizing multiple inverters. The control system must also ensure that there is no increase in the Interconnection Customer's existing peak load demand.
- f. The Generating Facility must utilize only inverter-based, UL 1741 and UL 1741 SA-listed equipment. Additionally, all installed equipment must meet Distribution Provider's current electric service requirements with no violations or variances.

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Sheet 274

O. Non-Export AC/DC CONVERTER ELIGIBILITY CRITERIA

Applicants with Non-Export AC/DC Converters who meet the eligibility criteria below qualify for the expedited interconnection process outlined in Section N of this Rule.

1. The Non-Export AC/DC Converter must have an aggregate maximum inverter nameplate rating of no greater than 500 kW. There is no limitation on an energy storage device’s kWh capacity rating.
2. Applicant’s Interconnection Request must be eligible for and select the Fast Track Process.
3. Applicant’s Interconnection Request must pass Fast Track Initial Review and not require any Interconnection Facilities, Distribution Upgrades or Network Upgrades to remain eligible under this Section.
4. Applicants selecting this section shall use the corresponding interconnection agreement type provided for Non-Export AC/DC Converters eligible under this Section. As such, Interconnection Requests that select the Cost Envelope Option are not eligible.
5. Applicant’s Non-Export AC/DC converter must meet the Certification requirements in the Section C Definition of “Non-Export AC/DC Converters”.

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GENERATING FACILITY INTERCONNECTIONS

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Appendix A Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
AUTHORIZATION TO RECEIVE CUSTOMER INFORMATION			
79-1095	Authorization to Receive Customer Information or Act Upon a Customer's Behalf	Rule 21	Authorization for Third Party
PRE-APPLICATION REQUEST			
79-1181	Rule 21 Pre-Application Report Request	Rule 21	For Generator Developer to request basic info about local distribution circuit
COST ENVELOPE			
79-1182	Cost Envelope Option Non-NEM Request	Rule 21	Non-NEM Customer Only
79-1183	Cost Envelope Option Non-NEM Agreement Appendix	Rule 21	Non-NEM Customer Only
79-1184	Cost Envelope Option NEM Request	Rule 21	NEM Customer Only
79-1185	Cost Envelope Option NEM Agreement Appendix	Rule 21	NEM Customer Only
GENERATOR INTERCONNECTION APPLICATION (most Rule 21 programs)			
79-1174-02	Rule 21 Generator Interconnection Application	<ul style="list-style-type: none"> • NEM/NEM2 • NEMEXP • NEMMT • NEMA • NEMFC • NEMV/NEMV2, • NEMVMASH/ NEM2VMSH • NEM2VSOM • RES-BCT • Rule 21 • Export Non-export 	Rule 21 customer interconnection application form for expanded net-energy metered (all NEM > 30 kw and all non-Solar/Wind NEM), NEMFC, NEMV, NEMVMASH, RES-BCT, and non-export and limited export Rule 21 generation. (Standard NEM for solar and/or wind ≤ 30 kw will continue to use the 79-1151B application.)
79-1174-02A	Rule 21 Generator Interconnection Application – Attachment A Customer and Project Information	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment A to Form 79-1174-02
79-1174-02B	Rule 21 Generator Interconnection Application – Attachment B Non-Export	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment B to Form 79-1174-02

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GENERATING FACILITY INTERCONNECTIONS

Sheet 276

Appendix A (Cont'd.) Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
GENERATOR INTERCONNECTION APPLICATION (most Rule 21 programs) (Cont'd)			
79-1174-02C	Rule 21 Generator Interconnection Application – Attachment C Export	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment C to Form 79-1174-02
79-1174-02D	Rule 21 Generator Interconnection Application – Attachment D Solar (PV) Technology	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment D to Form 79-1174-02
79-1174-02E	Rule 21 Generator Interconnection Application – Attachment E Wind Turbine Technology	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment E to Form 79-1174-02
79-1174-02F	Rule 21 Generator Interconnection Application – Attachment F Machine-Based Technology	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment F to Form 79-1174-02 Rule 21 Generator Interconnection Application – Attachment F Machine-Based Technology
79-1174-02G	Rule 21 Generator Interconnection Application – Attachment F Machine-Based Technology	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment G to Form 79-1174-02
79-1174-02H	Rule 21 Generator Interconnection Application – Attachment H Energy Storage Technology	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment H to Form 79-1174-02
79-1174-02I	Rule 21 Generator Interconnection Application – Attachment I RES-BCT	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment I to Form 79-1174-02

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GENERATING FACILITY INTERCONNECTIONS

Sheet 277

Appendix A (Cont'd.)			
Forms Associated with Rule 21			
Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
GENERATOR INTERCONNECTION APPLICATION (most Rule 21 programs) (Cont'd)			
79-1174-02J	Rule 21 Generator Interconnection Application – Attachment I RES-BCT	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment J to Form 79-1174-02
79-1174-02K	Rule 21 Generator Interconnection Application – Attachment K NEMFC Load Aggregation	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment K to Form 79-1174-02
79-1174-02L	Rule 21 Generator Interconnection Application – Attachment K NEMFC Load Aggregation	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment L to Form 79-1174-02
79-1174-02M	Rule 21 Generator Interconnection Application – Attachment M NEMVMASH Single Service Delivery Point	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment M to Form 79-1174-02
79-1174-02N	Rule 21 Generator Interconnection Application – Attachment N NEMVMASH Development	NEM (NEMEXP, NEMMT and NEMA), NEMFC, NEMV, NEMVMASH, RES-BCT, Rule 21	Attachment N to Form 79-1174-02 Rule 21 Generator Interconnection Application – Attachment N NEMVMASH Development
NEM and NEM2			
STANDARD NEM			
79-1151A	Agreement be used with 79-1151B Application Agreement And Customer Authorization Net Energy Metering For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less	Standard NEM	NEM Customer Only Interconnection
79-1151A-02	Agreement And Customer Authorization - Net Energy Metering (NEM2) Interconnection For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less	Standard NEM2	NEM2 Application to be used with 79-1151B-02 Interconnection Agreement

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GENERATING FACILITY INTERCONNECTIONS

Appendix A (Cont'd.) Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
STANDARD NEM (Cont'd)			
79-1151B	Application - Net Energy Metering Interconnection For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less	Standard NEM	NEM Customer Only Application to be used with 79-1151A Interconnection Agreement
79-1151B-02	Application - Net Energy Metering (NEM2) Interconnection For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less	Standard NEM2	NEM2 Application to be used with 79-1151A-02 Interconnection Agreement
79-1217	Agreement And Customer Authorization Net Energy Metering (NEM2) Interconnection For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less With Energy Storage Of 10 Kilowatts Or Less	Standard NEM2 + ≤ 10kw storage	Customer Authorization for Third Party Information
79-1193	Agreement and Customer Authorization Net Energy Metering (NEM) Interconnection for Solar and/or Wind Electric Generating Facilities of 30 Kilowatts or Less: with Energy Storage of 10 Kilowatts or Less	Standard NEM + ≤ 10 storage	NEM Customer Only For NEM pair storage scenarios using Power Control Systems to ensure NEM integrity
79-1193-02	Agreement and Customer Authorization Net Energy Metering (NEM2) Interconnection for Solar and/or Wind Electric Generating Facilities of 30 Kilowatts or Less: with Energy Storage of 10 Kilowatts or Less	Standard NEM2 + ≤ 10 storage	For NEM2 pair storage scenarios using Power Control Systems to ensure NEM integrity
79-1218	Agreement And Customer Authorization Net Energy Metering (NEM2) Interconnection For Solar And/Or Wind Electric Generating Facilities Of 30 Kilowatts Or Less For New Residential Construction	Standard NEM2 for New Construction	Customer Authorization for Third Party Information for New Residential Construction

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GENERATING FACILITY INTERCONNECTIONS

Appendix A (Cont'd.) Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
EXPANDED NEM			
79-1220	Interconnection Agreement for Net Energy Metering (NEM) of a Renewable Electric Generating Facility of 1,000 kW or Less, Except Solar or Wind Facilities of 30 kW or Less, and Virtual Net Energy Metering (NEMV) of a Renewable Electric Generating Facility of 1,000 kW or Less.	Expanded NEM	NEM Customer Only Interconnection Agreement
79-1220-02	Interconnection Agreement for Net Energy Metering (NEM) of a Renewable Electric Generating Facility of 1,000 kW or Less, Except Solar or Wind Facilities of 30 kW or Less, and Virtual Net Energy Metering (NEMV) of a Renewable Electric Generating Facility of 1,000 kW or Less.	Expanded NEM	NEM2 Interconnection Agreement
LARGE NEM ≥ 1MW			
79-1198-02	Interconnection Agreement For Net Energy Metering (NEM2) And Renewable Electrical Generating Facility Sized Greater Than 1,000 Kw	>1MW NEM2	FT and Detailed Study Interconnection Agreement for >1MW NEM2 Generating Facilities
NEMA			
79-1153	NEM Load Aggregation Appendix	NEM – NEMA	NEM Customer Only - Use as an Appendix with Form 79-1151A, 79-1220, or 79-1069
79-1153-02	NEM2A Load Aggregation Appendix	NEM2 – NEM2A	Use as an Appendix with Form 79-1151A-02, 79-1220-02 or 79-1069-02
79-1202 ****	Load Aggregation Appendix	NEM, NEM2, Rule 21	Use as an Appendix with Form 79-1151A, 79-1151A-02, 79-978, 79-978-02, 79-1137, 79-1137-02, 79-1069 or 79-1069-02
NEMMT (Multiple Tariff)			
79-1069	Generating facility Interconnection Agreement (Multiple Tariff)	NEM, Rule 21	NEM Customer Only NEMMT Interconnection Agreement used with Form 79-1174-02
79-1069-02	Generating Facility Interconnection Agreement (Multiple Tariff NEM2MT)	NEM2, Rule 21	NEM2MT Interconnection Agreement used with Form 79-1174-02
MISCELLANEOUS NEM FORMS			
79-1130	Request to Opt-out of / Opt-in to Compensation for Surplus Electricity	NEM	AB 920- Opt not to receive compensation for net annual excess energy
79-1114	NEM 2010 Early True-up Request Form	NEM	NEM Customer Only

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Sheet 280

Appendix A (Cont'd.) Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
MISCELLANEOUS NEM FORMS (Cont'd)			
79-1155	Schedules NEM, NEMV, NEMVMASH, Net Surplus Electricity (NSE) Renewable Energy Credits Compensation	NEM, Rule 21	NEM Customer Only
79-1155-02	Schedules NEM2, NEM2V, NEM2VMASH, Net Surplus Electricity (NSE) Renewable Energy Credits Compensation	NEM2 NEM2V NEM2VMASH, Rule 21	NEM2 Customer Only
NEMFC (Fuel Cell)			
79-1010	Interconnection Agreement for Net Energy Metering of Fuel Cell Generating Facilities	NEM, Rule 21	NEMFC Interconnection Agreement used with Form 79-1174-02
NEMV/NEM2V			
See 79-1220 and 79-1220-02		See the Expanded NEM Section Above	
NEMVMASH/NEM2VMASH			
79-1189	Eligible Low Income Development Virtual Net Energy Metering (NEM2VMASH) Interconnection Agreement for Multifamily Affordable Housing with Solar Generation Totaling 1 MW or Less	NEM2VMASH s	NEM2VMASH Interconnection Agreement
79-1125	NEM / NEMV / NEMVMASH Inspection Report	NEM	NEM Customer Only
79-1195	Eligible Low Income Development Virtual Net Energy Metering (NEMVMASH) Interconnection Agreement for Multifamily Affordable Housing with Solar Generation Totaling 1 MW or Less	NEMVMASH, Rule 21	NEM Customer Only NEMVMASH Interconnection Agreement
NEM2VSOM			
79-1206-02	Eligible Low-Income Development Virtual Net Energy Metering (NEM2VSOM) Interconnection Agreement For The Solar On Multifamily Affordable Housing (SOMAH) Program With Solar Generation Totaling 1 Mw Or Less	NEM2VSOM	NEM2VSOM Interconnection agreement for solar 1 MW or less.
RES-BCT			
79-1191	Interconnection Agreement for Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) Generating Facility	Rule 21	RES-BCT Interconnection Agreement
79-1197	Local Government Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) Re-Allocation Request	RES-BCT	Use to establish RES-BCT benefiting account re-allocations

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Appendix A (Cont'd.) Forms Associated with Generator Interconnection Tariffs Subject to Rule 21			
Form Number	Title	Associated Tariffs	Use Guidance
RULE 21 NON-EXPORT			
79-973	Generating Facility Interconnection Agreement For Non-Export Generating Facilities (Rule 21 Interconnection Agreement)	Rule 21 Non-Export RES-BCT	Interconnection Agreement used for RESBCT and non-NEM generation with Application 79-1197
79-992	Customer Generation Agreement (Third party Generator on Premises, Non-Exporting)	3-Party Rule 21	Third Party Non-Exporting Interconnection Agreement
79-1070	Export Addendum to Generating Facility Interconnection Agreement for Non-Export Generating Facilities (Form 79-973) Sized 2 Megawatts or Less	Rule 21	Export addendum used with Form 79-973
79-988	Generating Facility Interconnection Agreement (Third Party Non-Exporting)	3-Party Rule 21	Third Party Non-Exporting Interconnection Agreement
79-1212	Rule 21 Non-Export Generator Interconnection Notification	Rule 21	Notification Form for New Non-Export Interconnection
79-1213	Agreement and Customer Authorization Non-Export Generating Facility Sized 30 Kilowatts or Less	Rule 21	Interconnect and Operate a Non-Export Generating Facility
79-1214	Notification-Only Pilot Program Developer Eligibility Application	Rule 21	Eligibility to Participate in the Notification-only Pilot Program
STORAGE			
79-1192	Interconnection Agreement for Non-Export Storage Generating Facilities 500KW or Less	Rule 21	Used for expedited interconnection of non-export energy storage, pursuant to Rule 21 Section N, PG&E AL 4941-E & E-A and D.16-06-052, & Attachment C, Section II.1
79-1199	Agreement And Customer Authorization Non-Export Stand-Alone Energy Storage Of 30 Kilowatts Or Less	Rule 21	Interconnection Agreement For non-export storage ≤ 30 kW
RULE 21 EXPORT FOR SALE INTERCONNECTION FORMS			
79-1145	Rule 21 Exporting Generator Interconnection Request	Rule 21	For Exporting Generator
79-1200	Rule 21 Generator Interconnection Agreement For Exporting Generating Facilities	Rule 21	FT and Detailed Study Interconnection Agreement for Exporting Generating Facilities

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GENERATING FACILITY INTERCONNECTIONS

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Appendix A (Cont'd.)			
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Generator Interconnection Tariffs Subject to Rule 21			
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RULE 21 OTHER AGREEMENTS			
INDEPENDENT STUDY & DISTRIBUTION GROUP STUDY PROCESS STUDY AGMT			
79-1162	Rule 21 Detailed Study Agreement	Rule 21	Independent Study and Distribution Group Study Process Study Agreement
79-1136	PG&E Interconnection Agreement For an Existing Small Generating Facility Interconnecting to the Distribution System under Rule 21	Rule 21	Used for existing QFs with Form 79-1174-02
MATERIAL MODIFICATIONS			
79-1211	Generating Facility Material Modification Notification Worksheet	Rule 21	Used to make Material Modifications to the Generating Facility
SPECIAL FACILITIES AGREEMENT			
79-280	Agreement for Installation of Allocation of Special Facilities for Parallel Operation of Non-Utility-Owned Generation and/or Electrical Standby Service (Electric Rules 2 and 21)	Rule 21	Special Facilities Agreement to be used with Form 79-702- this form is required every time facilities above and beyond what is required to serve a standard customer – load and a meter.
79-255	Agreement for Installation or Allocation of Special Facilities	Rule 21	Installation or Allocation of Special Facility
79-702	Appendix A: Detail of Special Facilities Charges to be used in concert with form 79-280	Rule 21	Used with Form 79-280- this appendix specifies the detail employed in determining the total charges assessed for the special facilities in the SFA
79-1100	Electric Rule 21 - Agreement to Install Applicant Requested NGOM Special Facilities for Solar Performance Metering	Rule 21	Installation of Solar Generation Performance Metering Equipment
STANDBY			
79-285	Special Agreement for Electrical Standby Service	Rule 21	Standby Service - Use this form for all generators connected in parallel not eligible for any of the NEM tariffs. Back-up generators (BUGs) do not pay standby and consequently this form is not applicable to them

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Attachment B

Redline Tariff Revisions



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

Sheet 182

H. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS
(Cont'd.)

4. SUPPLEMENTAL GENERATING FACILITY REQUIREMENTS

a. Fault Detection

A Generating Facility with an SCCR exceeding 0.1 or one that does not cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line-to-line and line-to-ground, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the initiation of a fault.

b. Transfer Trip

For a Generating Facility that cannot detect Distribution or Transmission System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds, Distribution Provider may require a Transfer Trip system or an equivalent Protective Function.

c. Reclose Blocking

Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, Distribution Provider may require additional Protective Functions, including, but not limited to reclose-blocking on some of the automatic reclosing devices.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS~~

~~Section H shall continue to be used for interconnection of inverter based technologies until September 8, 2017. Following such date, Section Hh shall apply for interconnection of inverter based technologies. Until such date, Section Hh may be used in all or in part, for inverter based technologies by mutual agreement of the Distribution Provider and the Applicant.~~

¹ "The Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems".

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS

When requirements for “Smart Inverter” are specified in this section, those requirements can also be met by a “DER Interconnection System” as defined in this tariff.

The inverter requirements are intended to be consistent with UL 1741 – Supplement SB using as the source requirement document ANSI/IEEE 1547-2018 and IEEE 1547.1-2020 Standard for Interconnecting Distributed Resources with Electric Power Systems where possible. In the event of conflict between this Rule and UL 1741 – Supplement SB and/or IEEE 1547-2018 or IEEE 1547.1-2020, this Rule shall take precedence.

The Smart Inverter default settings and default activation states may be modified upon mutual agreement between Applicant or Producer and Distribution Provider.

Process for changing default settings for new Interconnection Requests:

Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the reactive power settings, including changes to the reactive power default settings (Example: Deactivate Volt/Var and activate Fixed Power Factor at given power factor).

Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the Ramp Rate settings depending on the Generating Facility technology (such as solar, storage).

Distribution Provider, in the study process for new Generating Facilities, may determine the optimum Smart Inverter Settings for the volt/watt settings, including changes to the default settings (Example: Change the volt/watt set points). The Applicant may select to agree on the new settings or select to perform upgrades to operate using the existing default volt/watt settings.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~The inverter requirements are intended to be consistent with UL 1741 – Supplement SA^{**} using Section Hh of Rule 21 as the source requirement document and ANSI/IEEE 1547-2003 and 1547a Standard for Interconnecting Distributed Resources with Electric Power Systems (IEEE 1547 including amendment 1547a), where possible. In the event of conflict between this Rule, and UL 1741 – Supplement SA, and/or IEEE 1547-2003 or IEEE 1547a, this Rule shall take precedence. Exceptions are taken to IEEE 1547 Clauses 4.1.4.2~~ (Continued)



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~~Distribution Secondary Spot Networks and Clauses 4.1.8.1 or 5.1.3.1, which address Protection from Electromagnetic Interference. Rule 21 does not adopt the Generating Facility power limitation of 10 MW incorporated in IEEE 1547.~~

~~The Smart Inverter default settings and default activation states may be modified upon mutual agreement between Applicant or Producer and Distribution Provider.~~

~~Process for changing default settings for new Interconnection Requests:~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the reactive power settings, including changes to the reactive power default settings (Example: Deactivate Volt/Var and activate Fixed Power Factor at given power factor).~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the Ramp Rate settings depending on the Generating Facility technology (such as solar, storage).~~

~~²Any DC V2G Electric Vehicle Service Equipment (EVSE) that has UL 1741 certification but not UL 1741 SA certification, any subsequent UL 1741 supplement certification required in Rule 21, or Smart Inverter Working Group recommended smart inverter functions may interconnect initially for the purpose of participating in the Emergency Load Reduction Program (ELRP), subject to all other Rule 21 interconnection requirements.~~

~~PG&E may request the termination of this interconnection pathway after the 2024 ELRP season if the market has developed to provide multiple V2G capable EVSEs that meet the full smart inverter certification standards required in Rule 21. Termination of this pathway would not affect previously interconnected EVSE, and they may continue to operate parallel to the grid as per their Interconnection Agreement.~~

~~** V2G-DC EVSE manufactured in an earlier year will be deemed to meet certification requirements and allowed to interconnect as long as the EVSE: (1) met all applicable certification requirements in the year of manufacture (the "model year"); (2) the model year is no more than five years old; and (3) the EVSE does not impose any safety risks due to not complying with applicable requirements at the time of interconnection.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

Default settings for voltage ride-through, frequency ride-through requirements, and Frequency/Watt should not be modified on an individual project basis unless the Interconnection Studies have determined that the default settings may not meet grid reliability requirements.

Process for changing default settings for Generating Facilities with an executed Interconnection Agreement:

When grid changes or Generating Facility changes require that the Smart Inverter operating parameters be reevaluated, the Distribution Provider or Producer may request changes to the Smart Inverter operating parameters. The request must include the reason for and timing of the proposed changes. The requested changes must be within the Smart Inverter function adjustability limits, must be within the limits specified in this tariff, and must be mutually agreed upon.

1. General Interconnection and Protective Function Requirements

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

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~Process for changing default settings for new Interconnection Requests (Cont'd):~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine the optimum Smart Inverter Settings for the volt/watt settings including changes to the default settings (Example: Change the volt/watt set points). The Applicant may select to agree on the new settings or select to perform upgrades to operate using the existing default volt/watt settings.~~

~~Default settings for voltage ride-through, frequency ride-through requirements, and Frequency/Watt should not be modified on an individual project basis unless the Interconnection Studies have determined that the default settings may not meet grid reliability requirements.~~

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~~Process for changing default settings for Generating Facilities with an executed Interconnection Agreement:~~

~~When grid changes or Generating Facility changes require that the Smart Inverter operating parameters be reevaluated, the Distribution Provider or Producer may request changes to the Smart Inverter operating parameters. The request must include the reason for and timing of the proposed changes. The requested changes must be within the Smart Inverter function adjustability limits, must be within the limits specified in this tariff, and must be mutually agreed upon.~~

~~1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS~~

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

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

1. General Interconnection and Protective Function Requirements (Cont'd)

a. Protective Functions Required

Smart Inverters operating in parallel with Distribution Provider's Distribution or Transmission System shall be equipped with the following Protective Functions to sense abnormal conditions on Distribution Provider's Distribution or Transmission System and cause the Smart Inverter to be automatically disconnected from Distribution Provider's Distribution or Transmission System or to prevent the Smart Inverter from being connected to Distribution Provider's Distribution or Transmission System inappropriately:

- (i) Over and under voltage trip functions and over and under frequency trip functions;
- (ii) A voltage and frequency sensing and time-delay function to prevent the Smart Inverter from energizing a de-energized Distribution or Transmission System circuit and to prevent the Smart Inverter from reconnecting with Distribution Provider's Distribution or Transmission System unless Distribution Provider's Distribution System service voltage and frequency is within the ANSI C84.1-1995 Table 1 Range B voltage Range of 106 volts to 127 volts (on a 120 volt basis), inclusive, and a frequency range of 59.0 Hz to 60.5 Hz, inclusive, and are stable for at least 15 seconds; and
- (iii) A function to prevent the Smart Inverter from contributing to the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution System within two seconds of the formation of an Unintended Island.

The Smart Inverter shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Smart Inverter shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

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~~1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS (Cont'd.)~~

~~a. Protective Functions Required~~

~~Smart Inverters operating in parallel with Distribution Provider's Distribution or Transmission System shall be equipped with the following Protective Functions to sense abnormal conditions on Distribution Provider's Distribution or Transmission System and cause the Smart Inverter to be automatically disconnected from Distribution Provider's Distribution or Transmission System or to prevent the Smart Inverter from being connected to Distribution Provider's Distribution or Transmission System inappropriately:~~

- ~~(i) Over and under voltage trip functions and over and under frequency trip functions;~~
- ~~(ii) A voltage and frequency sensing and time-delay function to prevent the Smart Inverter from energizing a de-energized Distribution or Transmission System circuit and to prevent the Smart Inverter from reconnecting with Distribution Provider's Distribution or Transmission System unless Distribution Provider's Distribution System service voltage and frequency is within the ANSI C84.1-1995 Table 1 Range B voltage Range of 106 volts to 127 volts (on a 120 volt basis), inclusive, and a frequency range of 58.5 Hz to 60.5 Hz, inclusive, and are stable for at least 15 seconds; and~~
- ~~(iii) A function to prevent the Smart Inverter from contributing to the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution System within two seconds of the formation of an Unintended Island.~~

~~The Smart Inverter shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-4.2.1). The Smart Inverter shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-4.2.2).~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

1. General Interconnection and Protective Function Requirements (Cont'd)

a. Protective Functions Required (Cont'd)

(iv) Open-phase condition: Generating Facility shall detect and cease to energize and trip all phases within 2 seconds of any open phase condition in accordance with IEEE 1547-2018, 6.2.2.

The Smart Inverter Facility shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Generating Facility shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).

b. Momentary Paralleling Smart Inverter Generating Facilities

With Distribution Provider's approval, the transfer switch or scheme used to transfer Producer's loads from Distribution Provider's Distribution or Transmission System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.

Smart Inverters which operate using a momentary parallel scheme are not required to comply with the functional requirements as required in the IEEE 1547-2018 standard.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS (Cont'd.)~~

~~b. Momentary Paralleling Generating Facilities~~

~~With Distribution Provider's approval, the transfer switch or scheme used to transfer Producer's loads from Distribution Provider's Distribution or Transmission System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.~~

~~c. Suitable Equipment Required~~

(Continued)



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~~Circuit breakers or other interrupting equipment located at the Point of Common Coupling (PCC) 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 Smart Inverter 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 Distribution Provider's Distribution and Transmission System. The Smart Inverter paralleling device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE 1547 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 L.3.e (IEEE 1547 4.1.8.2).~~

~~d. Visible Disconnect Required~~

~~When required by Distribution Provider's operating practices, Producer shall furnish and install a ganged, manually operated isolating switch (or a comparable device mutually agreed upon by Distribution Provider and Producer) near the Point of Interconnection to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System. The device does not have to be rated for load break nor provide over-current protection.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

1. General Interconnection and Protective Function Requirements (Cont'd)

c. Suitable Equipment Required

Circuit breakers or other interrupting equipment located at the Point of Common Coupling (PCC) 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 Smart Inverter 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 Distribution Provider's Distribution and Transmission System. The Smart Inverter paralleling-device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE 1547-2018, 4.11.3). 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 L.3.e (IEEE 1547-2018, 4.11.2).

d. Visible Disconnect Required

When required by Distribution Provider's operating practices, Producer shall furnish and install a ganged, manually-operated isolating switch (or a comparable device mutually agreed upon by Distribution Provider and Producer) near the Point of Interconnection to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System. The device does not have to be rated for load break nor provide over-current protection.

The device must:

- (i) allow visible verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.)
- (ii) Include markings or signage that clearly indicates open and closed positions.

(iii) be capable of being reached:Hh.— SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

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~~1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS (Cont'd.)~~

~~d. Visible Disconnect Required (Cont'd.)~~

~~The device must:~~

~~(i) allow visible verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.)~~

~~(ii) include markings or signage that clearly indicates open and closed positions.~~

~~(iii) be capable of being reached:~~

~~a) for Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction, operation, maintenance, inspection, testing or to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.~~

~~b) for Non-Emergency purposes during normal business hours. Distribution Provider, where possible, will provide notice to Customer for gaining access to Customer's premises.~~

~~(iv) be capable of being locked in the open position.~~

~~(v) be clearly marked on the submitted single line diagram and its type and location approved by Distribution Provider prior to installation. If the device is not adjacent to the PGC, permanent signage must be installed at a Distribution Provider approved location providing a clear description of the location of the device. If the switch is not accessible outside the locked premises, signage with contact information and a Distribution Provider approved locking device for the premises shall be installed.~~

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

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

1. General Interconnection and Protective Function Requirements (Cont'd)

d. Visible Disconnect Required (Cont'd)

(iii) be capable of being reached (Cont'd):

- a) for Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction, operation, maintenance, inspection, testing or to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.
- b) for Non-Emergency purposes during normal business hours. Distribution Provider, where possible, will provide notice to Customer for gaining access to Customer's premises.

(iv) be capable of being locked in the open position.

(v) be clearly marked on the submitted single line diagram and its type and location approved by Distribution Provider prior to installation. If the device is not adjacent to the PCC, permanent signage must be installed at a Distribution Provider approved location providing a clear description of the location of the device. If the switch is not accessible outside the locked premises, signage with contact information and a Distribution Provider approved locking device for the premises shall be installed.

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

e. Drawings Required

Prior to Parallel Operation or Momentary Parallel Operation of the Smart Inverter, Distribution Provider shall approve Producer's Protective Function and control diagrams. Generating Facilities equipped with Protective Functions and a control scheme previously approved by Distribution Provider for system-wide application or only Certified Equipment may satisfy this requirement by reference to previously approved drawings and diagrams.

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

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~~1. GENERAL INTERCONNECTION AND PROTECTIVE FUNCTION REQUIREMENTS (Cont'd.)~~

~~e. Drawings Required~~

~~Prior to Parallel Operation or Momentary Parallel Operation of the Smart Inverter, Distribution Provider shall approve Producer's Protective Function and control diagrams. Generating Facilities equipped with Protective Functions and a control scheme previously approved by Distribution Provider for system wide application or only Certified Equipment may satisfy this requirement by reference to previously approved drawings and diagrams.~~

~~f. Generating Facility Conditions Not Identified~~

~~In the event this Rule does not address the Interconnection conditions for a particular Smart Inverter, Distribution Provider and Producer may agree upon other arrangements.~~

~~2. PREVENTION OF INTERFERENCE~~

~~Producer shall not operate Smart Inverters that superimpose a voltage or current upon Distribution Provider's Distribution or Transmission System that interferes with Distribution Provider operations, service to Distribution Provider Customers, or communication facilities. If such interference occurs, Producer must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by Distribution Provider. If Producer does not take corrective action in a timely manner, or continues to operate the facilities causing interference without restriction or limit, Distribution Provider may, without liability, disconnect Producer's facilities from Distribution Provider's Distribution or Transmission System, in accordance with Section D.9 of this Rule. To eliminate undesirable interference caused by its operation, each Smart Inverter shall meet the following criteria:~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

2. PREVENTION OF INTERFERENCE (Cont'd.)

1. General Interconnection and Protective Function Requirements (Cont'd)

f. Generating Facility Conditions Not Identified

In the event this Rule does not address the Interconnection conditions for a particular Smart Inverter, Distribution Provider and Producer may agree upon other arrangements.

g. Generating Facilities that use certified Power Control Systems (PCS) must use PCS listed in a Distribution Provider pre-approved list.

2. Prevention of Interference

Producer shall not operate Smart Inverters that superimpose a voltage or current upon Distribution Provider's Distribution or Transmission System that interferes with Distribution Provider operations, service to Distribution Provider Customers, or communication facilities. If such interference occurs, Producer must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by Distribution Provider. If Producer does not take corrective action in a timely manner, or continues to operate the facilities causing interference without restriction or limit, Distribution Provider may, without liability, disconnect Producer's facilities from Distribution Provider's Distribution or Transmission System, in accordance with Section D.9 of this Rule. To eliminate undesirable interference caused by its operation, each Smart Inverter shall meet the following criteria:

Except as otherwise stated, the RPA for all performance requirements shall be met at the PCC.

When the Generating Facility is less than 500KVA or when the Generating Facility operates under one of the non-exporting options or inadvertent export of no longer than 30 seconds, the RPA may be the Point of Generating Resource Connection (POC).

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

(Continued)



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~~a.—Voltage Regulation~~

~~If approved by the Distribution Provider, the Smart Inverter may actively regulate the voltage at the PCC while in parallel with Distribution Provider’s Distribution System. The Smart Inverter shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A (IEEE 1547-4.1.1).~~

~~b.—Voltage Trip and Ride-Through Settings~~

~~The voltage ranges in Table Hh-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 Distribution Provider’s Distribution System within the prescribed trip time whenever the voltage at the PCC deviates from the allowable voltage operating range. The Protection Function shall detect and respond to voltage on all phases to which the Generating Facility is connected.~~

~~(i)—Smart Inverters~~

~~Smart Inverters shall be capable of operating within the voltage range normally experienced on Distribution Provider’s Distribution System from plus to minus 5% of the nominal voltage (e.g. 114 volts to 126 volts, on a 120-volt base), at the service panel or PCC. The trip settings at the generator terminals may be selected in a manner that minimizes nuisance tripping in accordance with Table Hh-1 to compensate for voltage drop between the generator terminals and the PCC. Voltage may be detected at either the PCC or the Point of Interconnection. However, the voltage range at the PCC, with the generator on-line, shall stay within +/- 5% of nominal.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

2. Prevention of Interference (Cont'd)

a. Voltage Regulation

If approved by the Distribution Provider, the Smart Inverter may actively regulate the voltage at the PCC while in parallel with Distribution Provider's Distribution System. Smart Inverter shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A. (IEEE 1547-2018, 5.1)

b. Voltage Trip and Ride-Through Setting

The voltage ranges in Table Hh-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 Distribution Provider's Distribution System within the prescribed trip time whenever the voltage at the PCC deviates from the allowable voltage operating range. The Protection Function shall detect and respond to voltage on all phases to which the Generating Facility is connected.

i) Smart Inverters

Smart Inverters shall be capable of operating within the voltage range normally experienced on Distribution Provider's Distribution System from plus to minus 5% of the nominal voltage (e.g. 114 volts to 126 volts, on a 120 volt base), at the service panel or PCC. The trip settings at the generator terminals may be selected in a manner that minimizes nuisance tripping in accordance with Table Hh-1 to compensate for voltage drop between the generator terminals and the PCC. Voltage may be detected at either the PCC or the Point of Interconnection. However, the voltage range at the PCC, with the generator on-line, shall stay within +/-5% of nominal.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~b. Voltage Trip and Ride-Through Settings (Cont'd.)~~

~~(ii) Voltage Disturbances~~

~~Whenever Distribution Provider's Distribution System voltage at the PCC varies from and remains outside near Nominal voltage~~ (Continued)



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~~for the predetermined parameters set forth in Table Hh-1, the Smart Inverter's Protective Functions shall cause the Smart Inverter(s) to become isolated from Distribution Provider's Distribution System:~~

- ~~1. The Smart Inverter shall stay connected to the Distribution Provider's Transmission or Distribution System while the grid remains within the "Ride-Through Until" voltage time range and must stay connected in the corresponding "Operating Mode.~~
- ~~2. For voltage excursions beyond the near Nominal (NN) magnitude range and within the range of the HV1 or LV3 regions, the Smart Inverter shall momentarily cease to energize within 0.16 seconds.~~
- ~~3. In the HV1 region, the Smart Inverter is permitted to reduce power output as a function of voltage under mutual agreement between the Producer and the Distribution Provider.~~
- ~~4. If the distribution system voltage does not exit the ride through region and recovers to normal system voltage, the Smart Inverter shall restore continuous operation within 2 seconds.~~
- ~~5. If the Distribution Provider's Transmission or Distribution System voltage does not exit the ride through region and returns from the LV3 region to the LV2 or LV1 region, the Smart Inverter shall restore available current within 2 seconds.~~
- ~~6. Different voltage time settings could be permitted by the Distribution Provider.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

b. Voltage Trip and Ride-Through Setting (Cont'd)

ii) Voltage Disturbances

Whenever Distribution Provider's Distribution System voltage at the RPA varies from and remains outside the Continuous Operation region for the predetermined parameters set forth in Table Hh-1b, the Smart Inverter's Protective Functions shall cause the Smart Inverter(s) to trip and become isolated from Distribution Provider's Distribution System as required in table Hh-1a:

1. The Smart Inverter shall stay connected to the Distribution Provider's Transmission or Distribution System while the grid remains within the "Voltage Range (p.u.)" and must stay connected in the corresponding "Operating Mode."
2. If the distribution system voltage does not exit the ride-through region and recovers to normal system voltage, the Smart Inverter shall restore continuous operation within 2 sec.
3. If the Distribution Provider's Transmission or Distribution System voltage does not exit the ride-through region and returns from the $V < 0.5$ pu region to the $0.5 \leq V < 0.7$ or $0.7 \leq V < 0.88$ pu region, the Smart Inverter shall restore available current within 2 seconds.
4. Different voltage-time settings could be permitted by the Distribution Provider.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~b. Voltage Trip and Ride Through Settings (Cont'd.)~~

~~(ii) Voltage Disturbances (Cont'd.)~~

~~Table Hh.1: Voltage Ride-Through Table~~

(Continued)



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Region	Voltage at Point of Common Coupling (% Nominal Voltage)	Ride-Through Until	Operating Mode	Maximum Trip Time
High Voltage 2 (HV2)	$V \geq 120$			0-16 seconds
High Voltage 1 (HV1)	$110 < V < 120$	12 seconds	Momentary Cessation	13 seconds
Near Nominal (NN)	$88 \leq V \leq 110$	Indefinite	Continuous Operation	Not Applicable
Low Voltage 1 (LV1)	$70 \leq V < 88$	20 seconds	Mandatory Operation	21 seconds
Low Voltage 2 (LV2)	$50 \leq V < 70$	10 seconds	Mandatory Operation	11 seconds
Low Voltage 3 (LV3)	$V < 50$	1 seconds	Momentary Cessation	1.5 seconds

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

b. Voltage Trip and Ride-Through Setting (Cont'd)

ii) Voltage Disturbances (Cont'd)

Table Hh-1a: Smart Inverter Voltage Trip Settings

Shall Trip Function	Voltage Trip Default Settings (p.u. of nominal voltage)	Voltage Range of Shall Trip Function (p.u. of nominal voltage)	Default Clearing Time (s)
OV2	1.20	$V \geq 1.20$	0.16
OV1	1.10	$1.10 \leq V < 1.20$	13.0
Continuous Operation	NA	$0.88 < V < 1.10$	NA
UV1	0.88	$0.50 < V \leq 0.88$	21.0
UV2	0.50	$V \leq 0.50$	2.0

Table Hh-1b – Smart Inverter Voltage Ride-through Settings

Voltage Range (p.u.)	Operating mode/response	Minimum ride-through time (s)	Maximum response time (s)
$V > 1.20$	Cease to Energize	NA	0.16
$1.10 < V \leq 1.20$	Momentary Cessation	12	0.083
$0.88 \leq V \leq 1.10$	Continuous Operation	Infinite	NA
$0.70 \leq V < 0.88$	Mandatory Operation	20	NA
$0.50 \leq V < 0.70$	Mandatory Operation	10	NA
$V < 0.50$	Momentary Cessation	1	0.083

iii) Voltage Phase Angle Change Ride-Through

Voltage phase angle change ride-through as specified in IEEE 1547-2018, 6.5.2.6.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~c. Paralleling~~

~~The Generating Facility shall parallel with Distribution Provider's Distribution or Transmission System without causing a voltage~~

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

~~fluctuation at the PCC greater than plus/minus 5% of the prevailing voltage level of Distribution Provider's Distribution or Transmission System at the PCC, and meet the flicker requirements of Section H.2.d. Section L, Certification and Testing Criteria, provides technology specific tests for evaluating the paralleling Function. (IEEE 1547-4.1.3)~~

~~d. Flicker~~

~~The Generating Facility shall not create objectionable flicker for other customers on Distribution Provider's Distribution or Transmission System. To minimize the adverse voltage effects experienced by other customers (IEEE 1547-4.3.2), flicker at the PCC 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). This requirement is necessary to minimize the adverse voltage affects experienced by other Customers on Distribution Provider's Distribution or Transmission System. Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.~~

~~e. Integration with Distribution Provider's Distribution System Grounding~~

~~The grounding scheme of the Generating Facility shall not cause over-voltages that exceed the rating of the equipment connected to Distribution Provider's Distribution System and shall not disrupt the coordination of the ground fault protection on Distribution Provider's Distribution System (IEEE 1547-4.1.2) (See Section G.1.i, line configuration).~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

c. Paralleling

The Smart Inverter shall parallel with Distribution Provider's Distribution or Transmission System without causing a voltage fluctuation at the PCC greater than plus/minus 5% of the prevailing voltage level of Distribution Provider's Distribution or Transmission System at the PCC, and meet the flicker requirements of Section H.2.d. Section L, Certification and Testing Criteria, provides technology-specific tests for evaluating the paralleling Function. (IEEE 1547-2018, 4.10.4)

d. Flicker

The Generating Facility shall not create objectionable flicker for other Customers on Distribution Provider's Distribution or Transmission System. To minimize the adverse voltage effects experienced by other Customers, flicker at the P caused by the Generating Facility should not exceed the limits of IEEE 1547-2018, 7.2.3. This requirement is necessary to minimize the adverse voltage affects experienced by other Customers on Distribution Provider's Distribution or Transmission System. Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.

e. Integration with Distribution Provider's Distribution System Grounding

The grounding scheme of the Smart Inverter shall not cause over-voltages that exceed the rating of the equipment connected to Distribution Provider's Distribution System and shall not disrupt the coordination of the ground fault protection on Distribution Provider's Distribution System (IEEE 1547-2018, 4.10.12) (See Section G.1.i, line configuration).

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~f. Frequency~~

~~Distribution Provider controls system frequency, and the Generating Facility shall operate in synchronism with Distribution Provider's~~

(Continued)



ELECTRIC RULE NO. 21
GENERATING FACILITY INTERCONNECTIONS

~~Distribution or Transmission System. Whenever Distribution Provider's Distribution or Transmission System frequency at the PGC varies from and remains outside normal (nominally 60 Hz) by the predetermined amounts set forth in Table H.2, the Generating Facility's Protective Functions shall cease to energize Distribution Provider's Distribution or Transmission System within the stated maximum trip time.~~

~~(i) Frequency Ride-Through Requirements~~

~~Smart Inverter based systems shall remain connected to the Distribution Provider's Distribution or Transmission System while the grid is within the frequency time range indicated in Table Hh-2, and shall disconnect from the electric grid during a high or low frequency event that is outside that frequency time range.~~

~~The frequency values are shown in Table Hh.2. These values provide default interconnection system response to abnormal frequencies. The inverter shall disconnect by the default clearing times. In the high frequency range between 60.2 Hz and 61.5 Hz, or some other mutually agreed range, the Smart Inverter is permitted to reduce active power output until it ceases to export power by 61.5 Hz, or other frequency value mutually agreed between the generating facility operator and the Distribution Provider. Islands and microgrids may need different default frequency settings.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

2. Prevention of Interference (Cont'd)

f. Frequency

Distribution Provider controls system frequency, and the Smart Inverter shall operate in synchronism with Distribution Provider's Distribution or Transmission System. Whenever Distribution Provider's Distribution or Transmission System frequency at the PCC varies from and remains outside normal (nominally 60 Hz) by the predetermined amounts set forth in Table P 2a, the Smart Inverter's Protective Functions shall cease to energize Distribution Provider's Distribution or Transmission System within the stated maximum trip time.

i) Frequency Ride-Through Requirements

Smart Inverter based systems shall remain connected to the Distribution Provider's Distribution or Transmission System while the grid is within the frequency-time range indicated in Table Hh-2b, and shall disconnect from the electric grid during a high or low frequency event that is outside that frequency-time range as indicated in Table Hh-2a.

Table Hh-2a: Frequency Trip Settings Table

<u>Shall Trip Function</u>	<u>Frequency Trip Default Setting (Hz)</u>	<u>Resulting Range of Shall Trip Function (Hz)</u>	<u>Default Clearing Time (s)</u>
<u>OF2</u>	<u>62.0</u>	<u>$f \geq 62.0$</u>	<u>0.16</u>
<u>OF1</u>	<u>61.2</u>	<u>$61.2 \leq f < 62$</u>	<u>300</u>
<u>Continuous Operation</u>	<u>NA</u>	<u>$58.5 < f < 61.2$</u>	<u>NA</u>
<u>UF1</u>	<u>58.5</u>	<u>$56.5 < f \leq 58.5$</u>	<u>300</u>
<u>UF2</u>	<u>56.5</u>	<u>$f \leq 56.5$</u>	<u>0.16</u>

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

2. PREVENTION OF INTERFERENCE (Cont'd.)

f. Frequency (Cont'd.)

(i) Frequency Ride-Through Requirements (Cont'd.)

(Continued)



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GENERATING FACILITY INTERCONNECTIONS

~~Table Hh.2: Frequency Ride-Through and Trip Settings Table~~

System Frequency Default Settings (Hz)	Minimum Range of Adjustability (Hz)	Ride-Through Until	Ride-Through Operational Mode	Maximum Trip Time
$f > 62$	62–64	No Ride Through	Not Applicable	0.16 seconds
$60.5 < f \leq 62$	60.1–62	299 seconds	Mandatory Operation	300 seconds
$58.5 \leq f \leq 60.5$	Not Applicable	Indefinite	Continuous Operation	Not Applicable
$57.0 \leq f < 58.5$	57–59.9	299 seconds	Mandatory Operation	300 seconds
$f < 57.0$	53–57	No Ride Through	Not Applicable	0.16 seconds

~~g. Harmonics~~

~~When the Smart Inverter is serving balanced linear loads, harmonic current injection into Distribution Provider’s Distribution or Transmission System at the PCC shall not exceed the limits stated in Table Hh.43. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in Distribution Provider’s Distribution or Transmission System without the Smart Inverter connected (IEEE 1547-4.3.3.). The harmonic distortion of a Smart Inverter shall be evaluated using the same criteria as for the Host Loads.~~

(Continued)



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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

f. Frequency (Cont'd)

i) Frequency Ride-Through Requirements (Cont'd)

Table Hh-2b: Frequency Ride-Through Settings Table

<u>Frequency (Hz)</u>	<u>Operating Mode</u>	<u>Minimum time(s)</u>
<u>f>62.0</u>	<u>No Ride-Through requirements apply to this range</u>	<u>NA</u>
<u>61.2<f≤61.8</u>	<u>Mandatory Operation</u>	<u>299</u>
<u>58.8≤f≤61.2</u>	<u>Continuous Operation</u>	<u>Infinite</u>
<u>57.0≤f<58.8</u>	<u>Mandatory Operation</u>	<u>299</u>
<u>F<57.0</u>	<u>No Ride-Through requirements apply to this range</u>	<u>NA</u>

ii) Rate of Change of Frequency (ROCOF) Ride-through

Smart Inverter shall not trip for frequency excursion having magnitude rates of change of frequency (ROCOF) that is less than or equal to 3.0Hz per second as specified in IEEE 1547-2018, section 6.5.2.5 category III. For ROCOF greater than 3Hz per second, it is preferred for Smart Inverter to ride-through as long as frequency remains in the continuous operating region, low frequency ride-through region (and corresponding duration times), or high frequency region (and corresponding duration times).

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~g. Harmonics (Cont'd.)~~

Table Hh.3

Maximum harmonic current distortion in percent of current (I) [1,2]

(Continued)



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Individual harmonic order, h (odd harmonics) [3]	Total demand distortion					
	h < 11	11 ≤ h < 17	17 ≤ h < 23	23 ≤ h < 35	35 ≤ h	
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 average demand over 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.

h.—Direct Current Injection

Smart Inverter should not inject direct current greater than 0.5% of rated output current into Distribution Provider’s Distribution or Transmission System.

i.—Fixed Power Factor

Producer shall provide adequate reactive power compensation on site to maintain the Smart Inverter power factor near unity at rated output or a Distribution Provider specified power factor in accordance with the following requirements:

- (i) Default Power Factor setting: Absorbing reactive power at 0.95 lagging power factor.
- (ii) Aggregate generating facility is greater than 15 kW: 1.0 +/- 0.15 (0.85 Lagging to 0.85 Leading) down to 20% rated power irrespective of active power output.

(Continued)



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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

g. Harmonics

When the Smart Inverter is serving balanced linear loads, harmonic current injection into Distribution Provider's Distribution or Transmission System at the PCC shall not exceed the limits stated in IEEE 1547-2018, 7.3. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in Distribution Provider's Distribution or Transmission System without the Smart Inverter connected. The harmonic distortion of a Smart Inverter shall be evaluated using the same criteria as for the Host Loads.

h. Direct Current Injection

Smart Inverter should not inject direct current greater than 0.5% of rated output current into Distribution Provider's Distribution or Transmission System.

i. Smart Inverter Reactive Power Requirements

Smart Inverter Reactive Power capabilities shall comply with IEEE 1547-2018, Section 5.2 Category B requirement.

j. Dynamic Volt/Var Operations

The Smart Inverter shall be capable of supporting dynamic reactive power compensation (dynamic Volt/Var operation) within the following constraints:

- The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage as indicated in Table Hh-3.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~i. Fixed Power Factor (Cont'd.)~~

(Continued)



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~~(iii) Aggregate generating facility is less than or equal to 15 kW: 1.0 +/- 0.10 (0.90 Lagging to 0.90 Leading) down to 20% rated power irrespective of active power output.~~

~~j. Dynamic Volt/VAR Operations~~

~~The Smart Inverter shall be capable of operating dynamically within a power factor range of +/- 0.85 PF for larger (>15 kW) systems, down to 20% of rated active power, and +/- 0.9 PF for smaller systems (≤15 kW), down to 20% of rated active power, irrespective of active power output. This dynamic Volt/VAR capability shall be able to be activated or deactivated in accordance with Distribution Provider requirements.~~

~~The Distribution Provider may permit or require the Smart Inverter systems to operate in larger power factor ranges, including in 4-quadrant operations for storage systems with the implementation of additional anti-islanding protection as determined by the Distribution Provider.~~

~~The Smart Inverter shall be capable of providing dynamic reactive power compensation (dynamic Volt/VAR operation) within the following constraints:~~

- ~~• The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage.~~
- ~~• The reactive power provided shall be per the range irrespective of active power output, but the maximum reactive power provided to the system shall be as directed by the Distribution Provide~~
- ~~• Reduction of active power output is allowed to meet the required reactive power ranges.~~

(Continued)



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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

Dynamic Volt/Var Operations Default Settings

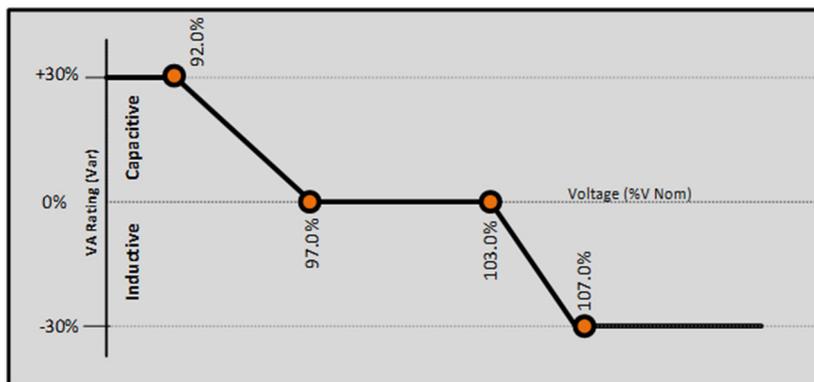
Table Hh-3 and Figure Hh-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

Default Open Loop Response Time for volt/var operation setting should be five (5) seconds.

Table Hh-3: Voltage and Reactive Default Settings

<u>Voltage Setpoint</u>	<u>Voltage Value</u>	<u>Reactive Setpoint</u>	<u>Reactive Value</u>	<u>Operation</u>
<u>V1</u>	<u>92.0%</u>	<u>Q1</u>	<u>30%</u>	<u>Reactive Power Injection</u>
<u>V2</u>	<u>97.0%</u>	<u>Q2</u>	<u>0</u>	<u>Unity Power Factor</u>
<u>V3</u>	<u>103.0%</u>	<u>Q3</u>	<u>0</u>	<u>Unity Power Factor</u>
<u>V4</u>	<u>107.0%</u>	<u>Q4</u>	<u>30%</u>	<u>Reactive Power Absorption</u>

Figure Hh-1: Voltage and Reactive Default Settings



(Continued)



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~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~j. Dynamic Volt/VAR Operations (Cont'd.)~~

~~Dynamic Volt/Var Operations Default Settings~~

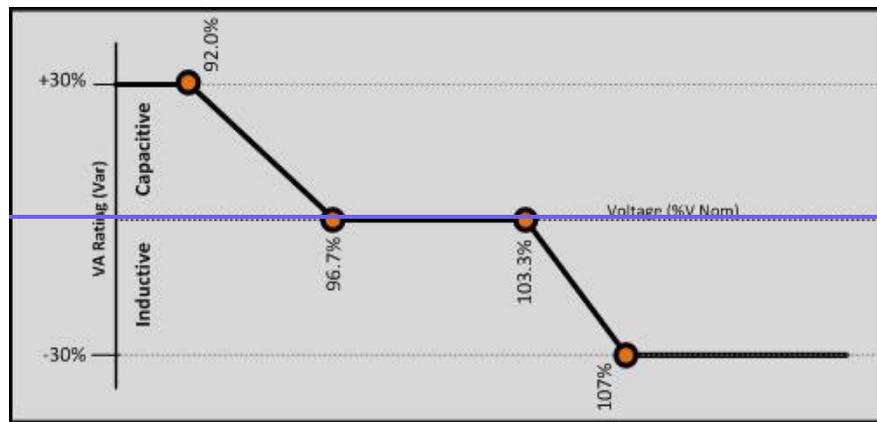
~~Table Hh-4 and Figure Hh-1 depict the default settings, which should be applied for all inverter sizes. Specific volt/var settings may be required for larger Generating Facilities (such as 100 kw or greater), or for specific areas with the Distribution Systems as determined by the Distribution Provider.~~

~~Default Open Loop Response Time for volt/var operation should be five (5) seconds.~~

~~Table Hh-4: Voltage and Reactive Default Settings~~

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	96.7% 97.0%	Q2	0	Unity Power Factor
V3	103.3% 103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

~~Figure Hh-1: Voltage and Reactive Default Settings~~



(Continued)



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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

k. Enter Service Ramp Rate Requirements

The Smart Inverter is required to have the following ramp controls.

- Enter Service ramp control requirements as outlined in IEEE 1547-2018 section 4.10.3 with following default settings:
 - Delay enter service shall be 15 seconds per Hh.1.a.ii
 - Default Enter Service Duration shall be 50 seconds

l. Frequency Droop (Frequency Power, Frequency Watt) Requirements

Smart Inverters shall change their real power production as function of system frequency in accordance with IEEE 1547-2018, 6.5.2.7 with the following default settings: Deadband 36 mHz, db_{OF} and db_{UF} . k_{OF} and k_{UF} would be 0.05, open loop response time of 5 seconds.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~k. Ramp Rate Requirements~~

~~The Smart Inverter is required to have the following ramp controls for at least the following four conditions. These functions can be established by multiple control functions or by one general ramp rate control function. Ramp rates are contingent upon sufficient energy available from the Smart Inverter.~~

- ~~• Normal ramp-up rate: For transitions between energy output levels over the normal course of operation. The default value is 100% of maximum current output per second with a range of adjustment between 1% to 100%, with specific settings as mutually agreed by the Distributor Provider and the Producer.~~
- ~~• Connect/Reconnect Ramp-up rate: Upon starting to inject power into the grid, following a period of inactivity or a disconnection, the inverter shall be able to control its rate of increase of power from 1 to 100% maximum current per second. The default value is 2% of~~

(Continued)



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~~maximum current output per second, with specific settings as mutually agreed upon by the Distribution Provider and the Producer.~~

~~I.—Frequency Watt Requirements~~

~~This requirement will become mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted on or after February 22, 2019, nine (9) months following the approval of the SunSpec Alliance Communication Protocol Certification Test Standard.~~

~~The utilization of this function is permissible under mutual agreement between the utility and the generating facility before the effective date.~~

~~Smart Inverters shall reduce their active power output as a function of system frequency, in accordance with the following:~~

- ~~• When system frequency exceeds 60.036 Hz, the active power output produced by the Smart Inverter shall be reduced by 50% of real power nameplate rating per hertz (5% of real power nameplate rating reduction per 0.1 hertz)~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

m. Voltage-Watt Default Settings Requirements

Smart Inverters shall reduce their real power production as a function measured voltage at the inverter terminal or at the Generating Facility Point of Common Coupling (PCC) in accordance with the following:

When the measured voltage is greater than 106% of nominal voltage (Example: 127.2 volts on a 120 volts nominal), the export of active power at the PCC or the production of active power by the Smart Inverter shall be reduced at a rate of 25% of active power nameplate rating per one percent of nominal voltage. Figure Hh-3 Volt-Watt Requirements illustrate the required rate of reduction. When export of active power is controlled, a certified inverter and control system shall be used.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~I. Frequency Watt Requirements (Cont'd.)~~

- ~~• When system frequency moves under 59.964 Hz, the active power output produced by the Smart Inverter shall be increased by 50% of real power nameplate rating per hertz (5% of real power nameplate rating increase per 0.1 hertz) when inverter is capable of increasing active power output.~~
- ~~• The default dead band should be +/- 0.036 Hz from 60 Hertz (59.964 Hz to 60.036 Hz). When the system frequency is in range of 59.964 Hz and 60.036 Hz, the Smart Inverter is not required to decrease power as a function of system frequency.~~
- ~~• Open loop response time for Frequency Watt shall be 5 seconds.~~
- ~~• Figure Hh-2 illustrated this requirement for three levels of output power. Figure Hh-2 is for illustration purposes only.~~

~~Figure Hh-2: Active Power as a Function of System Frequency~~

(Continued)

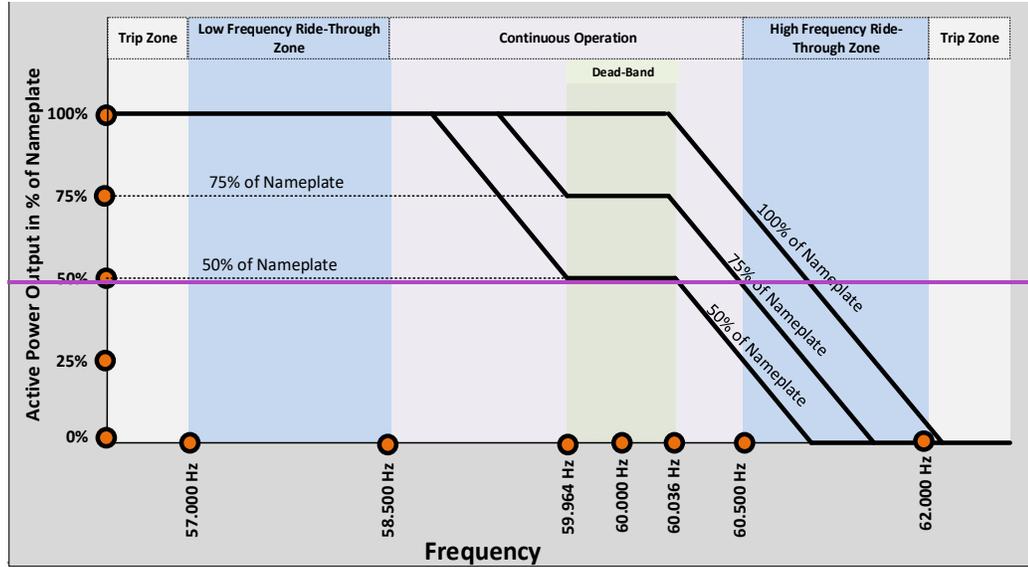
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Note: the frequency markers on the horizontal axis are not drawn to scale.

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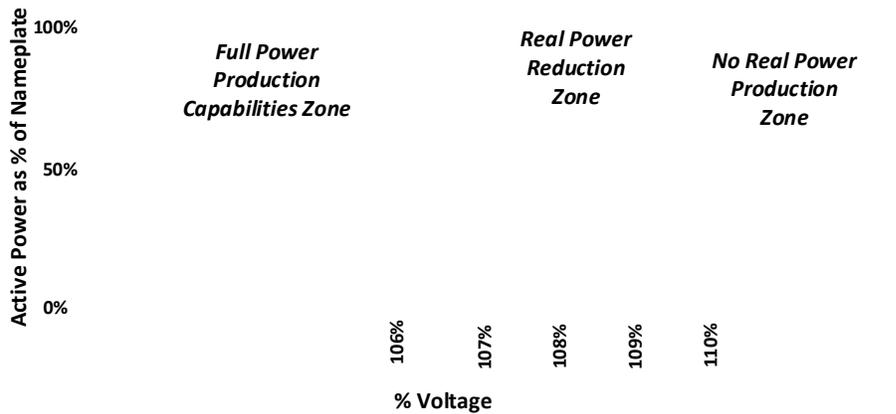
Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

m. Voltage-Watt Default Settings Requirements

- When the measured voltage is greater than 110% of nominal voltage (Example: 132 volts on a 120 volts nominal), the export of active power to the grid at the PCC or the production of active power by the Smart Inverter shall be reduced to 0 watts.
- Open Loop response time shall be 5 seconds.

Figure Hh-3: Volt-Watt Requirements



n. Dynamic Reactive Power Support Function

The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

(Continued)



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~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~m. Voltage-Watt Default Settings Requirements~~

~~— This requirement will become mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted on or after February 22, 2019, nine (9) months following the approval of the SunSpec Alliance Communication Protocol Certification Test Standard.~~

~~The utilization of this function is permissible under mutual agreement between the utility and the generating facility before the effective date.~~

~~Smart Inverters shall reduce their active power output as a function of measured voltage at the inverter terminals or at the Generating Facility Point of Common Coupling (PCC) in accordance with the following:~~

- ~~• When the measured voltage is greater than 106% of nominal voltage (for example: 127.2 volts on a 120 volts nominal), the export of active power at the PCC or the production of active power by the Smart Inverter shall be reduced at a rate of 25% of active power nameplate rating per one percent of nominal voltage. Figure Hh-3— Volt Watt Requirements— illustrates the required rate of reduction. When export of active power is controlled, a certified inverter and control system shall be used.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

o. Default Activation States

Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:

Table Hh-4: Default Activation States

<u>Function</u>	<u>State</u>
<u>Anti-islanding</u>	<u>Activated</u>
<u>Low/High Voltage Ride Through</u>	<u>Activated</u>
<u>Low/High Frequency Ride Through</u>	<u>Activated</u>
<u>Dynamic Volt/Var operations</u>	<u>Activated</u>
<u>Enter Service Ramp Control</u>	<u>Activated</u>
<u>Storage Inverter Normal Operation Ramp Control</u>	<u>Deactivated*</u>
<u>Fixed power factor</u>	<u>Deactivated</u>
<u>Reconnect by "soft-start" methods</u>	<u>Activated</u>
<u>Frequency/Watt</u>	<u>Activated</u>
<u>Volt/Watt</u>	<u>Activated</u>
<u>Constant Reactive Power Mode</u>	<u>Deactivated</u>
<u>Set Active Power Function Mode(Optional)</u>	<u>Activated under mutual agreement</u>
<u>Dynamic Reactive Power Support Mode (Optional)</u>	<u>Activated under mutual agreement</u>

These default activation states may be modified by mutual agreement between Distribution Provider and Producer.

* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E's interconnection handbook(s).

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

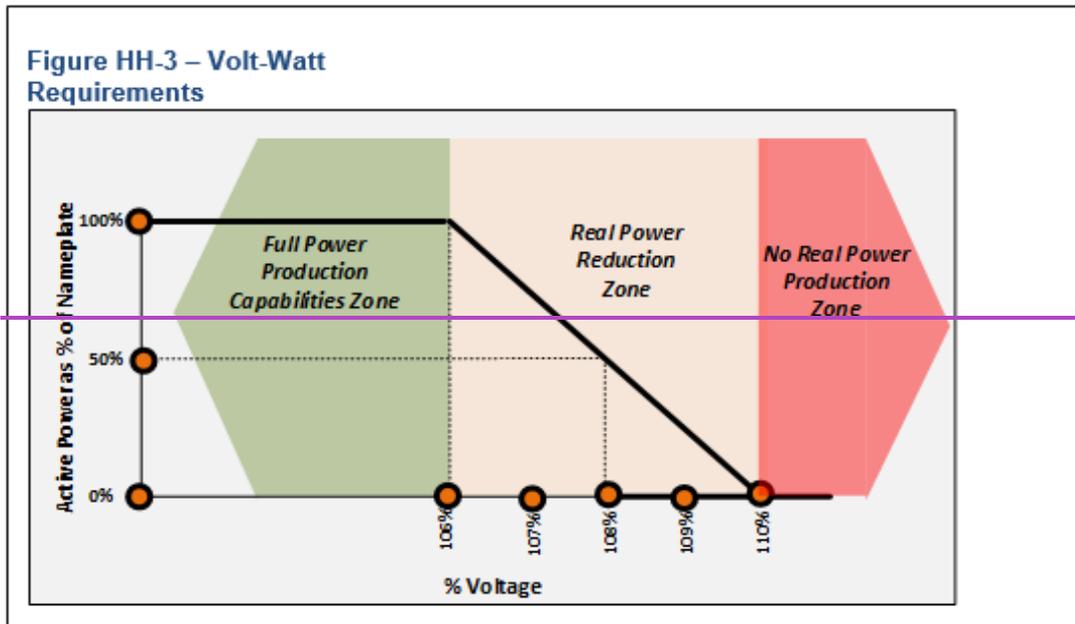
~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

(Continued)

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m. (Cont'd.)

- When the measured voltage is greater than 110% of nominal voltage (Example: 132 volts on a 120 volts nominal), the export of active power output to the grid at the PGC or the production of active power by the Smart Inverter shall be reduced to 0 watts



Percent (%) of nominal voltage

(Continued)



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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

p. Load Shedding or Transfer

The voltage and frequency ride-through requirements of Hh.2.b.ii) and Hh.2.f.i) shall not apply if either: a) The real power across the Point of Common Coupling is continuously maintained at a value less than 10% of the aggregate rating of the Smart Inverters connected to the Generating Facility prior to any voltage disturbance, and the Generation Facility disconnects from the Distribution Provider's Distribution or Transmission System, along with Generating Facility load, such that the net change in real power flow from or to the Distribution Provider's Distribution or Transmission System is less than 10% of the aggregate Smart Inverter capacity; or b) Generating Facility load real power demand equal to 90% to 120% of the predisturbance aggregate Smart Inverter real power is shed within 0.1 seconds of Smart Inverter disconnection.

q. Measurement and Calculation Accuracy

Smart Inverter shall meet minimum steady-state and transient measurement and calculation accuracy as required in IEEE 1547-2018, Section 4.4.

r. Prioritization of Smart Inverter Responses

a) The response to disable permit to service as specified in section Hh.8.a shall take precedence over any other tripping requirements.

b) Prioritization of tripping requirements not related to disabling permit to service shall meet IEEE 1547-2018 section 4.7.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~n. Dynamic Reactive Power Support Function~~

~~The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function.~~

(Continued)



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The utilization of this function is allowed and optional upon the mutual agreement of the Distribution Provider and the Applicant, before the effective date.

~~e. Default Activation States~~

Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:

	<u>Function</u>	<u>State</u>
1	Anti-islanding	activated
2	Low/High Voltage Ride-Through	activated
3	Low/High Frequency Ride-Through	activated
4	Dynamic Volt/VAR operations	activated
5	Ramp rates	activated
6	Fixed power factor	deactivated
7	Reconnect by "soft-start" methods	activated
8	Frequency-Watt [±]	activated
9	Volt/Watt [±]	activated
10	Set Active Power Function Mode (Optional)	activated under mutual agreement
11	Dynamic Reactive Power Support Mode (Optional)	activated under mutual agreement

These default activation states may be modified by mutual agreement between Distribution Provider and Producer.

[±]—These functions must be activated for Interconnection Requests submitted on or after February 22, 2019.

(Continued)



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Sheet 202

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

s. Storage Inverter Normal Operation Ramp Control Requirements

Smart Inverters used for energy storage applications may optionally include ramp-up rate control. The default value shall be 100% of maximum current output per second or slower if required by Applicant. Other ramp-up control settings can be used, when required, as mutually agreed by the Distribution Provider and the Applicant.

t. Ride-through of Consecutive Voltage Disturbances

Ride-through of consecutive voltage disturbances shall be in accordance with IEEE 1547-2018, 6.4.2.5.

u. Restore output without dynamic voltage support

Restore output without dynamic voltage support shall be in accordance with IEEE 1547-2018, 6.4.2.7.1.

v. Transition between performance operating regions:

Transition between performance operating regions should be in accordance with IEEE 1547-2018, 6.4.2.7.3.

w. Constant Reactive Power Mode

When in this mode, the Smart Inverter shall maintain a constant reactive power. The target reactive power level and mode (injection or absorption) shall be specified by the Distribution Provider and shall be within the same range specified in IEEE 1547-2018 section 5.3.5. The reactive power settings are allowed to be adjusted locally and/or remotely as specified by the Distribution Provider. The maximum Smart Inverter response time to maintain constant reactive power shall be 10 seconds or less.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~p. Phase 3 Functions~~

(Continued)



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Table of Phase 3 Effective Dates Pursuant to Resolution E-4898 and Resolution E-5000 and CPUC Letter of March 20, 2020 responding to a request to extend the date for Functions 1, 2, 3 and 8:

<u>Phase 3 Function #</u>		
	<u>Description</u>	<u>Effective Date (note)</u>
1	Monitor Key DER Data	June 22, 2020
2	DER Disconnect and Reconnect Command (Cease to Energize and Return to Service)	June 22, 2020
3	Limit Maximum Active Power Mode	June 22, 2020
4	Set Active Power Mode	12 months after approval of a nationally recognized standard that includes the function.
5	Frequency Watt Mode	February 22, 2019 , which is 9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
6	Volt Watt Mode	February 22, 2019 , which is 9 months following SunSpec Alliance Communication Protocol Certification Test Standard.
7	Dynamic Reactive Support	12 months after approval of a nationally recognized standard that includes the function.
8	Scheduling Power Values and Modes	June 22, 2020

Note: The utilization of any of these functions is permissible under mutual agreement between the utility and the generating facility before the effective date.

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

2. Prevention of Interference (Cont'd)

x. Generating Facility Rapid Voltage Changes (RVC)

Generating step or ramp changes shall meet the requirements as specified in IEEE 1547-2018 section 7.2.2.

y. Limitations of Overvoltage Over One Fundamental Frequency Period

Generating Facility shall not contribute to instantaneous or fundamental frequency overvoltage conditions per IEEE 1547-2018, 7.4.1.

z. Limitation of Cumulative Instantaneous Overvoltage

Generating Facility shall not cause the instantaneous voltage on any portion of the Distribution or Transmission System to exceed the magnitudes per IEEE 1547-2018, 7.4.2.

3. Technology Specific Requirements

Grid-interactive inverters do not require separate synchronizing equipment. Non grid-interactive or "stand-alone" inverters shall not be used for Parallel Operation with Distribution Provider's Distribution or Transmission System.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~2. PREVENTION OF INTERFERENCE (Cont'd.)~~

~~q. Load Shedding or Transfer~~

~~The voltage and frequency ride-through requirements of Hh.2.b.(ii) and Hh.2.f.(i) shall not apply if either: a) The real power across the Point of Common Coupling is continuously maintained at a value less than 10% of the aggregate rating of the Smart Inverters connected to the Generation Facility prior to any voltage disturbance, and the Generation Facility disconnects from the Distribution Provider's T&D system, along with Generation Facility load, such that the net change in real power flow from or to the Distribution Provider is less than 10% of the aggregate Smart Inverter capacity; or b) Generation Facility load real power demand equal to 90% to 120% of the pre-disturbance aggregate Smart Inverter active power output is shed within 0.1 seconds of Smart Inverter disconnection.~~

(Continued)



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~~3. TECHNOLOGY SPECIFIC REQUIREMENTS~~

~~Grid interactive inverters do not require separate synchronizing equipment. Non-grid interactive or “stand-alone” inverters shall not be used for Parallel Operation with Distribution Provider’s Distribution or Transmission System.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

4. Supplemental Smart Inverter Requirements

a. Fault Detection

A Smart Inverter with an SCCR exceeding 0.1 or one that does not cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line-to-line and line-to-ground, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the initiation of a fault.

b. Transfer Trip

For a Generating Facility that cannot detect Distribution or Transmission System faults (both line-to-line and line-to-ground) or the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds, Distribution Provider may require a Transfer Trip system or an equivalent Protective Function.

c. Reclose Blocking

Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, Distribution Provider may require additional Protective Functions, including, but not limited to reclose-blocking on some of the automatic reclosing devices.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~4. SUPPLEMENTAL SMART INVERTER REQUIREMENTS~~

~~a. Fault Detection~~

~~A Smart Inverter with an SCCR exceeding 0.1 or one that does not cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line-to-line and line-to-ground, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the initiation of a fault.~~

(Continued)



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~~b.—Transfer Trip~~

~~For a Generating Facility that cannot detect Distribution or Transmission System faults (both line to line and line to ground) or the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds, Distribution Provider may require a Transfer Trip system or an equivalent Protective Function.~~

~~c.—Reclose Blocking~~

~~Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, Distribution Provider may require additional Protective Functions, including, but not limited to reclose blocking on some of the automatic reclosing devices.~~

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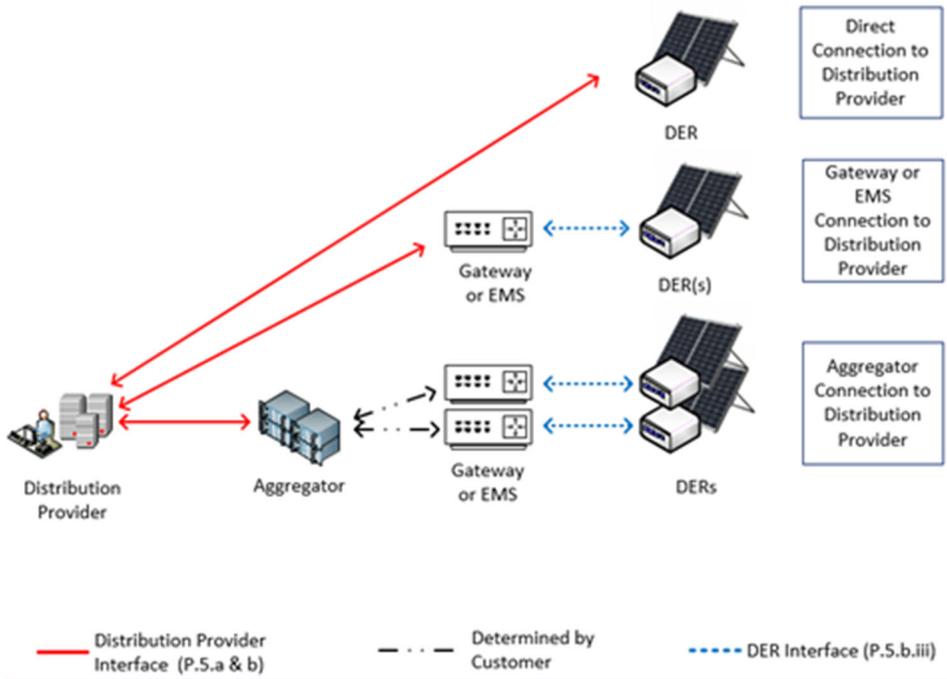
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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

5. Communication Requirements

Should communications to the Distribution Provider be required, Generating Facilities utilizing inverter-based technologies must adhere to the following communication requirements for communications between the Distribution Provider and the Generating Facility. The diagram below shows the interface requirements as applicable for section Hh.5. The Distribution Provider Interface (solid red line) is described in Sections Hh.5.a and Hh.5.b. The local DER interface at the Generating Facility (dotted blue line) is described in Section Hh.5.b.iii. The top row shows a direct connection between the Distribution Provider and the DER. The middle row shows a connection between the Distribution Provider and a gateway (GW) or Energy Management System (EMS). The lower row shows a connection between the Distribution Provider and an aggregator.

Figure Hh-5: Generating Facility Communications



(Continued)



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~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~5. COMMUNICATION REQUIREMENTS~~

~~a. The communication protocol requirements included in this section Hh.5 shall become mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted June 22, 2020. Until such date, this subsection may be used in all or in part by inverter based technologies by mutual agreement of the Distribution Provider and the Applicant. The communications requirements herein shall be between:~~

- ~~(i) the Distribution Provider and the individual Generating Facility's inverter control or energy management system;~~
- ~~(ii) the Distribution Provider and communication to the Generating Facility through an aggregator not co-located or part of the Generating Facility; or~~
- ~~(iii) other communication options as are mutually agreed to are by Applicant and the Distribution Provider.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

5. Communication Requirements (Cont'd)

The communications requirements herein shall be between

- (i) the Distribution Provider and the individual DER, GW, or EMS;
- (ii) the Distribution Provider and communication to the Generating Facility through an aggregator not co-located or part of the Generating Facility; or
- (iii) other communication options as mutually agreed to by Applicant and Distribution Provider.

a. The communications requirements in this Section pertain to communications between the Distribution Provider and communications option selected, or required, from section Hh.5. This Rule does not specify the communication between the selected communication option and Smart Inverter but performance will be enforced by compliance with this Rule:

- i. Shall be capable of communications;
- ii. Software shall be updateable via communications remotely;
- iii. The transport level protocol shall be TCP/IP; and,
- iv. The default application-level protocol shall be IEEE 2030.5 as defined in the latest final version of the Common Smart Inverter Profile (CSIP), the Interconnection Handbook, Cyber Security Requirements or Programs and Contracts. Other application-level protocols may be used by mutual agreement of the parties including IEEE 1815/DNP3 for SCADA real-time monitoring and control and IEC 61850.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~5. COMMUNICATION REQUIREMENTS (Cont'd.)~~

~~b. Generating Facilities utilizing inverter based technologies must adhere to all of the following communication protocol requirements for communications between Distribution Provider and communication option selected in section Hh. 5. This Rule does not specify the communication between the selected communication option and~~

(Continued)



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~~Smart Inverter but performance will be enforced by in compliance with this Rule:~~

- ~~(i) Shall be capable of communications;~~
- ~~(ii) Software shall be updateable via communications remotely;~~
- ~~(iii) The transport level protocol shall be TCP/IP; and,~~
- ~~(iv) The default application level protocol shall be IEEE 2030.5 (i.e., Smart Energy Profile 2.0 (SEP 2)) as defined in the California IEEE 2030.5 Implementation Guide, but other application level protocols may be used by mutual agreement of the parties including IEEE 1815/DNP3 for SCADA real-time monitoring and control and IEC 61850.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

5. Communication Requirements (Cont'd)

b. Additional communication protocol requirements shall also apply to Generating Facilities utilizing inverter-based technologies as provided in the following documents:

i. Distribution Provider Generation Interconnection Handbook, which shall include:

A. Details and guidelines for the implementation of communications with Generating Facilities utilizing inverter-based technologies;

B. Cybersecurity and privacy requirements (these may additionally or alternatively be included in the application-level protocol implementation guide (e.g., CSIP); and,

C. Generic device communications registration management requirements, including how to register individual Generating Facilities, Generating Facilities with energy management systems, and aggregators (these additionally or alternatively may be included in the application-level protocol implementation guide); and

D. Conditions under which communication functions are mandatory.

ii. Application-Level Protocol Implementation Guide, which shall provide:

A. Detailed communication requirements and implementation guidelines to ensure consistent interoperability of the Generating Facilities with all California investor-owned utilities under the Commission's jurisdiction.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~5. COMMUNICATION REQUIREMENTS (Cont'd.)~~

~~c. Additional communication protocol requirements shall also apply to Generating Facilities utilizing inverter-based technologies as provided in the following documents:~~

(Continued)



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- ~~(i) Distribution Provider Generation Interconnection Handbook, which shall include:

 - ~~a) Details and guidelines for the implementation of communications with Generating Facilities utilizing inverter-based technologies;~~
 - ~~b) Cybersecurity and privacy requirements (these may additionally or alternatively be included in the application-level protocol implementation guide); and,~~
 - ~~c) Generic device communications registration management requirements, including how to register individual Generating Facilities, Generating Facilities with energy management systems, and aggregators (these requirements additionally or alternatively may be included in the application-level protocol implementation guide).~~~~
- ~~(ii) Application Level Protocol Implementation Guide, which shall provide:

 - ~~a) Communication requirements and implementation guidelines to ensure consistent interoperability of the Generating Facilities with all California investor-owned utilities under the Commission's jurisdiction.~~~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

5. Communication Requirements (Cont'd)

b. Additional communication protocol requirements shall also apply to Generating Facilities utilizing inverter-based technologies as provided in the following documents (Cont'd):

iii. Communication Protocol and Performance Requirements

A. Communication performance requirements for the interface to the Generating Facility shall comply with IEEE 1547-2018, 10.8.

B. The protocol requirements at the Generating Facility shall be per IEEE 1547-2018, 10.7.

a. If choosing IEEE 2030.5 as the protocol, then CSIP certification is required.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~6. SCHEDULING CAPABILITY REQUIREMENTS~~

~~a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with a minimum scheduling memory capability of at least 24 events. The capability for this requirement will be mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted on or after June 22, 2020.~~

~~The utilization of this function is permissible under mutual agreement between the utility and the generating facility before the effective date.~~

~~Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function.~~

~~(i) Modifications to the voltage and reactive set points of the Dynamic volt/var function.~~

~~(ii) Modifications to the reactive power set points for the fixed power factor function.~~

(Continued)



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~~(iii) Modifications to the voltage and watt reduction level set points for the volt/watt function.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

6. Scheduling Capability Requirements

a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:

- i) Modifications to the voltage and reactive set-points of the Dynamic volt/var function.
- ii) Modifications to the reactive power set-points for the fixed power factor function.
- iii) Modifications to the voltage and watt-reduction level set-points for the volt/watt function.

b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options:

- i) Scheduling capability requirements may be implemented at the GW/EMS. The GW/EMS shall communicate the necessary commands to the Smart Inverters within 10 minutes, or by mutual agreement, from when the GW/EMS receives the scheduling information.
- ii) Scheduling capability requirements may be implemented at the DER within the Generating Facility.
- iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverter within 15 minutes of the aggregator receiving the scheduling information.
- iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider.

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

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~~6. SCHEDULING CAPABILITY REQUIREMENTS (Cont'd.)~~

~~b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options.~~

~~(i) Scheduling capability requirements may be stored at the Generating Facility Energy Management System (GFEMS). The GFEMS shall communicate the necessary commands to the Smart Inverters within 10 minutes from when GFEMS received the scheduling information:~~

~~(ii) Scheduling capability requirements may be stored at the Smart Inverter Control Unit (SMCU) within the Generating Facility. The SMCU shall communicate necessary commands to the Smart Inverters within 10 minutes from when SMCU received the scheduling information.~~

~~(iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverters within 15 minutes of the aggregator receiving the scheduling information.~~

~~(iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider.~~

~~c. The selected scheduling control system shall store the schedules and shall send operational commands to the Smart Inverters as required by the schedule received from the Distribution Provider. The Smart Inverter shall respond by changing its mode of operation as commanded at the schedule start time with no unreasonable delay.~~

~~Each scheduled mode of operation shall include and start time and duration. The Smart Inverter should return to its default settings at the end of the duration time or shall enter a new operational mode as directed by the scheduling control system.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

6. Scheduling Capability Requirements (Cont'd)

- c. The selected scheduling control system shall store the schedules and shall send operational commands to the Smart Inverters as required by the schedule received from the Distribution Provider. The Smart Inverter shall respond by changing its mode of operation as commanded at the schedule start time with no unreasonable delay.
- d. Each scheduled mode of operation shall include and start-time and duration The Smart Inverter should return to its default settings at the end of the duration time or shall enter a new operational mode as directed by the scheduling control system.

7. Monitoring and Telemetry Requirements

- a. The Smart Inverter shall have the capability to communicate its performance information per IEEE 1547-2018, 10.5 Table 29, unless otherwise provided by PG&E, pursuant to its Distribution Generation Interconnection Handbook:
 - i) Smart Inverter production or consumption of active power (watts).
 - ii) Smart Inverter consumption or production of reactive power (vars)
 - iii) Phase measured at the AC terminals of the Smart Inverter (volts)
 - iv) Frequency measured at the AC terminals of the Smart Inverter (Hz)
 - v) Connection Status
 - vi) Alarm Status
- b. When the Generating Facility includes energy-storage with Smart Inverters, the following monitoring and telemetry capability is required:

The Smart Inverter shall be capable of communicating the operational state of charge as a percent of energy storage capacity.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

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~~7. MONITORING AND TELEMETRY REQUIREMENTS~~

~~a. The capability for this requirement will be mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted on or after June 22, 2020.~~

~~The utilization of this function is permissible under mutual agreement between the utility and the generating facility before the effective date.~~

~~Smart Inverter shall have the capability to communicate its performance information including:~~

~~(i) Smart Inverter production or consumption of active power (Watts).~~

~~(ii) Smart Inverter consumption or production of reactive power (VARs)~~

~~(iii) Phase measured at the AC terminals of the Smart Inverter (Volts)~~

~~(iv) Frequency measured at the AC terminals of the Smart Inverter (Hz)~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

7. Monitoring and Telemetry Requirements (Cont'd)

c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:

i) In-Service

An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section Hh.6.

ii) Not In-Service

An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section Hh.6.

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:

i) When the Generating Facility includes only Smart Inverters, the production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.

ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:

a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.

b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility.

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~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~7. MONITORING AND TELEMETRY REQUIREMENTS (Cont'd.)~~

~~b. When the Generating Facility includes energy storage with Smart Inverters, the following monitoring and telemetry capability are required:~~

~~(i) The Smart Inverter shall be capable of communicating the operational state of charge as a percentage of energy storage capacity.~~

~~c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:~~

~~(i) In-Service state: An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section Hh.6~~

~~(ii) Not In-Service state: An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section Hh.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

7. Monitoring and Telemetry Requirements (Cont'd)

d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows (Cont'd):

iii) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available operational energy should be communicated as an aggregate of all the energy storage systems.

iv) Nameplate information shall be available through a local Generating Facility Interface as required in IEEE 1547-2018, 10.3 and must include the information as required in IEEE 1547-2018, Table 28.

v) Configuration information shall be available through a Local Generating Facility Interface as required in IEEE 1547-2018, 10.4. This information represents the present capacity and ability of the Generating Facility. When a configuration update changes the Generating Facility nameplate information, it may require a study depending on the change.

~~Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)~~

~~7. MONITORING AND TELEMETRY REQUIREMENTS (Cont'd.)~~

~~d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:~~

~~(i) When the Generating Facility includes only Smart Inverters: The production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.~~

~~(ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility should communicate the following:~~

~~a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility~~

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- ~~b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility~~
- ~~(iii) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems: The available operational energy should be communicated as an aggregate of all the energy storage systems.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd.)

8. Control through communication capabilities

The utilization of these functions are permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Smart Inverters shall have the capabilities of accepting operational controls through communications in accordance to the following:

a. Disable permit to service control command

When the Smart Inverter receives a disable permit service command through communication, the Smart Inverter must cease-to energize and trip within 2 seconds or initiate the opening of the switch referenced in the inverter terminal in order to galvanically isolate the Smart Inverter from the Distribution System.

b. Return to service control command

When the Smart Inverter receives a return-to-service control command, the Smart Inverter may return to service operation as required by Generating Facility operator or as required by the scheduling control system as required by section H.6. This shall be accomplished by enabling permit service as required in IEEE 1547-2018, 4.10.3.

c. Limit Active Power command

When the Smart Inverter receives a command to limit its production of real power, the Smart Inverter shall reduce its real power production to the specified percent of real power capacity of the Smart Inverter or to a specified real power value. In no more than 30 seconds or in the time it takes for the primary energy source to reduce its active power output to achieve the requirements of the active power limit set point, whichever is greater.

Where the Smart Inverter operates under a non-export provision, the active power limit set point may be implemented as a maximum active power to serve the host customer load. Under mutual agreement, the Smart Inverter may be required to reduce active power below the level needed to support host customer load.

Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

8. CONTROL THROUGH COMMUNICATION CAPABILITIES

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~~a. The capability for these requirements will be mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted on or after the earlier of the dates shown in the "Table of Phase 3 Effective Dates Pursuant to Resolution E-4898" in Section Hh.2.p.~~

~~The utilization of these functions is permissible under mutual agreement between the utility and the generating facility before the effective date.~~

~~Smart Inverters shall have the capabilities of accepting an operational controls through communications in accordance to the following:~~

- ~~(i) Cease to energize control command. When the Smart Inverter receives a cease to energize command through communication it must enter into a cease to energize state of operation or shall initiate the opening of the DER switch referenced in the ECP in order to galvanically isolate the DER system from the Distribution System~~
- ~~(ii) Return to service control command. When the Smart Inverter receives a return to service control command, the Smart Inverter may return to service operation as required by Generating Facility operator or as required by the scheduling control system as required by section H.6~~
- ~~(iii) Limit Active Power command. When the Smart Inverter receives a command to limit its production of real power, the Smart Inverter shall reduce its active power output to the specified percent of real power capacity of the Smart Inverter or to a specified real power value.~~
- ~~(iv) Set Active Power Level Mode Function. The capability for this requirement will become mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function.~~
- ~~(v) Suspension of Active Power restriction. When the Smart Inverter receives a command to suspend the command for active power reduction, the Smart Inverter may return to normal operation as required by Generating Facility operator or as required by the scheduling control system as required by section H.6.~~

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Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

8. Control through communication capabilities (Cont'd)

d. Set Active Power Level Mode Function

The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.

e. Suspension of Active Power restriction

When the Smart Inverter receives a command to suspend the command for active power reduction, the Smart Inverter may return to normal operation as required by Generating Facility operator or as required by the scheduling control system as required by Section Hh.6.

f. Transition between operating modes

Transition between modes shall commence in no more than 30 seconds after the mode setting change is received at the local Generating Facility communication interface.

Changes of control functional modes shall be executed such that the Smart Inverter output is transitioned smoothly over a time period between 5 s and 300 s.

Ramping of Smart Inverter output is not required for control parameter setting changes.

For all control and protective function parameter settings, the time following the input to the local Generating Facility communication interface and preceding the point in time when the invoked action begins shall be no greater than 30 s.

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS~~

~~(P)~~

~~When requirements for “Smart Inverter” are specified in this section, those requirements can also be met by a “DER Interconnection System” as defined in this tariff~~

~~The inverter requirements are intended to be consistent with UL 1741 Supplement SB using as the source requirement document ANSI/IEEE 1547-2018 and IEEE 1547.1-2020 Standard for Interconnecting Distributed Resources with Electric Power Systems where possible. In the event of conflict between this Rule and UL 1741 Supplement SB and/or IEEE 1547-2018 or IEEE 1547.1-2020, this Rule shall take precedence.~~

~~The Smart Inverter default settings and default activation states may be modified upon mutual agreement between Applicant or Producer and Distribution Provider.~~

~~Process for changing default settings for new Interconnection Requests:~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the reactive power settings, including changes to the reactive power default settings (Example: Deactivate Volt/Var and activate Fixed Power Factor at given power factor).~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine and provide the optimum Smart Inverter Settings for the Ramp Rate settings depending on the Generating Facility technology (such as solar, storage).~~

~~Distribution Provider, in the study process for new Generating Facilities, may determine the optimum Smart Inverter Settings for the volt/watt settings, including changes to the default settings (Example: Change the volt/watt set points). The Applicant may select to agree on the new settings or select to perform upgrades to operate using the existing default volt/watt settings.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~Default settings for voltage ride-through, frequency ride-through requirements, and Frequency/Watt should not be modified on an individual project basis unless the Interconnection Studies have determined that the default settings may not meet grid reliability requirements.~~

~~Process for changing default settings for Generating Facilities with an executed Interconnection Agreement:~~

~~When grid changes or Generating Facility changes require that the Smart Inverter operating parameters be reevaluated, the Distribution Provider or Producer may request changes to the Smart Inverter operating parameters. The request must include the reason for and timing of the proposed changes. The requested changes must be within the Smart Inverter function adjustability limits, must be within the limits specified in this tariff, and must be mutually agreed upon.~~

~~1. General Interconnection and Protective Function Requirements~~

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

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~1. General Interconnection and Protective Function Requirements (Cont'd)~~

~~a. Protective Functions Required~~

~~Smart Inverters operating in parallel with Distribution Provider's Distribution or Transmission System shall be equipped with the following Protective Functions to sense abnormal conditions on Distribution Provider's Distribution or Transmission System and cause the Smart Inverter to be automatically disconnected from Distribution Provider's Distribution or Transmission System or to prevent the Smart Inverter from being connected to Distribution Provider's Distribution or Transmission System inappropriately:~~

~~(i) Over and under voltage trip functions and over and under frequency trip functions;~~

~~(ii) A voltage and frequency sensing and time-delay function to prevent the Smart Inverter from energizing a de-energized Distribution or Transmission System circuit and to prevent the Smart Inverter from reconnecting with Distribution Provider's Distribution or Transmission System unless Distribution Provider's Distribution System service voltage and frequency is within the ANSI C84.1-1995 Table 1 Range B voltage Range of 106 volts to 127 volts (on a 120 volt basis), inclusive, and a frequency range of 59.0 Hz to 60.5 Hz, inclusive, and are stable for at least 15 seconds; and~~

~~(iii) A function to prevent the Smart Inverter from contributing to the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution System within two seconds of the formation of an Unintended Island.~~

~~The Smart Inverter shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Smart Inverter shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~1. General Interconnection and Protective Function Requirements (Cont'd)~~

~~a. Protective Functions Required (Cont'd)~~

~~(iv) Open phase condition: Generating Facility shall detect and cease to energize and trip all phases within 2 seconds of any open phase condition in accordance with IEEE 1547-2018, 6.2.2.~~

~~The Smart Inverter Facility shall cease to energize Distribution Provider's Distribution System for faults on Distribution Provider's Distribution System circuit to which it is connected (IEEE 1547-2018, 6.2.1). The Generating Facility shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-2018, 6.3).~~

~~b. Momentary Paralleling Smart Inverter Generating Facilities~~

~~With Distribution Provider's approval, the transfer switch or scheme used to transfer Producer's loads from Distribution Provider's Distribution or Transmission System to Producer's Generating Facility may be used in lieu of the Protective Functions required for Parallel Operation.~~

~~Smart Inverters which operate using a momentary parallel scheme are not required to comply with the functional requirements as required in the IEEE 1547-2018 standard.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~1. General Interconnection and Protective Function Requirements (Cont'd)~~

~~c. Suitable Equipment Required~~

~~Circuit breakers or other interrupting equipment located at the Point of Common Coupling (PCC) 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 Smart Inverter 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 Distribution Provider's Distribution and Transmission System. The Smart Inverter paralleling device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE 1547-2018, 4.11.3). 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 L.3.e (IEEE 1547-2018, 4.11.2).~~

~~d. Visible Disconnect Required~~

~~When required by Distribution Provider's operating practices, Producer shall furnish and install a ganged, manually operated isolating switch (or a comparable device mutually agreed upon by Distribution Provider and Producer) near the Point of Interconnection to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System. The device does not have to be rated for load break nor provide over-current protection.~~

~~The device must:~~

- ~~(i) allow visible verification that separation has been accomplished. (This requirement may be met by opening the enclosure to observe contact separation.)~~
- ~~(ii) Include markings or signage that clearly indicates open and closed positions.~~
- ~~(iii) be capable of being reached:—~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

~~(P)~~

~~1. General Interconnection and Protective Function Requirements (Cont'd)~~

~~d. Visible Disconnect Required (Cont'd)~~

~~(iii) be capable of being reached (Cont'd):~~

- ~~a) for Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction, operation, maintenance, inspection, testing or to isolate the Smart Inverter from Distribution Provider's Distribution or Transmission System without obstacles or requiring those seeking access to obtain keys, special permission, or security clearances.~~
- ~~b) for Non-Emergency purposes during normal business hours. Distribution Provider, where possible, will provide notice to Customer for gaining access to Customer's premises.~~

~~(iv) be capable of being locked in the open position.~~

~~(v) be clearly marked on the submitted single line diagram and its type and location approved by Distribution Provider prior to installation. If the device is not adjacent to the PCC, permanent signage must be installed at a Distribution Provider approved location providing a clear description of the location of the device. If the switch is not accessible outside the locked premises, signage with contact information and a Distribution Provider approved locking device for the premises shall be installed.~~

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

~~e. Drawings Required~~

~~Prior to Parallel Operation or Momentary Parallel Operation of the Smart Inverter, Distribution Provider shall approve Producer's Protective Function and control diagrams. Generating Facilities equipped with Protective Functions and a control scheme previously approved by Distribution Provider for system wide application or only Certified Equipment may satisfy this requirement by reference to previously approved drawings and diagrams.~~

~~(P)~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~1. General Interconnection and Protective Function Requirements (Cont'd)~~

~~f. Generating Facility Conditions Not Identified~~

~~In the event this Rule does not address the Interconnection conditions for a particular Smart Inverter, Distribution Provider and Producer may agree upon other arrangements.~~

~~g. Generating Facilities that use certified Power Control Systems (PCS) must use PCS listed in a Distribution Provider pre-approved list.~~

~~2. Prevention of Interference~~

~~Producer shall not operate Smart Inverters that superimpose a voltage or current upon Distribution Provider's Distribution or Transmission System that interferes with Distribution Provider operations, service to Distribution Provider Customers, or communication facilities. If such interference occurs, Producer must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by Distribution Provider. If Producer does not take corrective action in a timely manner, or continues to operate the facilities causing interference without restriction or limit, Distribution Provider may, without liability, disconnect Producer's facilities from Distribution Provider's Distribution or Transmission System, in accordance with Section D.9 of this Rule. To eliminate undesirable interference caused by its operation, each Smart Inverter shall meet the following criteria:~~

~~Except as otherwise stated, the RPA for all performance requirements shall be met at the PCC.~~

~~When the Generating Facility is less than 500KVA or when the Generating Facility operates under one of the non-exporting options or inadvertent export of no longer than 30 seconds, the RPA may be the Point of Generating Resource Connection (POG)~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~a. Voltage Regulation~~

~~If approved by the Distribution Provider, the Smart Inverter may actively regulate the voltage at the PCC while in parallel with Distribution Provider's Distribution System. Smart Inverter shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A. (IEEE 1547-2018, 5.1)~~

~~b. Voltage Trip and Ride-Through Setting~~

~~The voltage ranges in Table P-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 Distribution Provider's Distribution System within the prescribed trip time whenever the voltage at the PCC deviates from the allowable voltage operating range. The Protection Function shall detect and respond to voltage on all phases to which the Generating Facility is connected.~~

~~i) Smart Inverters~~

~~Smart Inverters shall be capable of operating within the voltage range normally experienced on Distribution Provider's Distribution System from plus to minus 5% of the nominal voltage (e.g. 114 volts to 126 volts, on a 120-volt base), at the service panel or PCC. The trip settings at the generator terminals may be selected in a manner that minimizes nuisance tripping in accordance with Table P-1 to compensate for voltage drop between the generator terminals and the PCC. Voltage may be detected at either the PCC or the Point of Interconnection. However, the voltage range at the PCC, with the generator on-line, shall stay within +/- 5% of nominal.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~b. Voltage Trip and Ride-Through Setting (Cont'd)~~

~~ii) Voltage Disturbances~~

~~Whenever Distribution Provider's Distribution System voltage at the RPA varies from and remains outside the Continuous Operation region for the predetermined parameters set forth in Table P-1b, the Smart Inverter's Protective Functions shall cause the Smart Inverter(s) to trip and become isolated from Distribution Provider's Distribution System as required in table P-1a:~~

- ~~1. The Smart Inverter shall stay connected to the Distribution Provider's Transmission or Distribution System while the grid remains within the "Voltage Range (p.u.)" and must stay connected in the corresponding "Operating Mode."~~
- ~~2. If the distribution system voltage does not exit the ride-through region and recovers to normal system voltage, the Smart Inverter shall restore continuous operation within 2 sec.~~
- ~~3. If the Distribution Provider's Transmission or Distribution System voltage does not exit the ride-through region and returns from the $V < 0.5$ pu region to the $0.5 \leq V < 0.7$ or $0.7 \leq V < 0.88$ pu region, the Smart Inverter shall restore available current within 2 seconds.~~
- ~~4. Different voltage time settings could be permitted by the Distribution Provider.~~

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(P)

~~2. Prevention of Interference (Cont'd)~~

~~b. Voltage Trip and Ride-Through Setting (Cont'd)~~

~~ii) Voltage Disturbances (Cont'd)~~

~~Table P-1a: Smart Inverter Voltage Trip Settings~~

Shall Trip Function	Voltage Trip Default Settings (p.u. of nominal voltage)	Voltage Range of Shall Trip Function (p.u. of nominal voltage)	Default Clearing Time (s)
OV2	1.20	$V \geq 1.20$	0.16
OV1	1.10	$1.10 \leq V < 1.20$	13.0
Continuous Operation	NA	$0.88 < V < 1.10$	NA
UV1	0.88	$0.50 < V \leq 0.88$	21.0
UV2	0.50	$V \leq 0.50$	2.0

~~Table P-1b Smart Inverter Voltage Ride through Settings~~

Voltage Range (p.u.)	Operating mode/response	Minimum ride-through time (s)	Maximum response time (s)
$V > 1.20$	Cease to Energize	NA	0.16
$1.10 < V \leq 1.20$	Momentary Cessation	12	0.083
$0.88 \leq V \leq 1.10$	Continuous Operation	Infinite	NA
$0.70 \leq V < 0.88$	Mandatory Operation	20	NA
$0.50 \leq V < 0.70$	Mandatory Operation	10	NA
$V < 0.50$	Momentary Cessation	1	0.083

~~iii) Voltage Phase Angle Change Ride Through~~

(P)

~~Voltage phase angle change ride-through as specified in IEEE 1547-2018, 6.5.2.6.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~e. Paralleling~~

~~The Smart Inverter shall parallel with Distribution Provider's Distribution or Transmission System without causing a voltage fluctuation at the PCC greater than plus/minus 5% of the prevailing voltage level of Distribution Provider's Distribution or Transmission System at the PCC, and meet the flicker requirements of Section H.2.d. Section L, Certification and Testing Criteria, provides technology specific tests for evaluating the paralleling Function. (IEEE 1547-2018, 4.10.4)~~

~~d. Flicker~~

~~The Generating Facility shall not create objectionable flicker for other Customers on Distribution Provider's Distribution or Transmission System. To minimize the adverse voltage effects experienced by other Customers, flicker at the P caused by the Generating Facility should not exceed the limits of IEEE 1547-2018, 7.2.3. This requirement is necessary to minimize the adverse voltage affects experienced by other Customers on Distribution Provider's Distribution or Transmission System. Generators may be connected and brought up to synchronous speed (as an induction motor) provided these flicker limits are not exceeded.~~

~~e. Integration with Distribution Provider's Distribution System Grounding~~

~~The grounding scheme of the Smart Inverter shall not cause over-voltages that exceed the rating of the equipment connected to Distribution Provider's Distribution System and shall not disrupt the coordination of the ground fault protection on Distribution Provider's Distribution System (IEEE 1547-2018, 4.12) (See Section G.1.i, line configuration).~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

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~~2. Prevention of Interference (Cont'd)~~

~~f. Frequency~~

~~Distribution Provider controls system frequency, and the Smart Inverter shall operate in synchronism with Distribution Provider's Distribution or Transmission System. Whenever Distribution Provider's Distribution or Transmission System frequency at the PCC varies from and remains outside normal (nominally 60 Hz) by the predetermined amounts set forth in Table P-2a, the Smart Inverter's Protective Functions shall cease to energize Distribution Provider's Distribution or Transmission System within the stated maximum trip time.~~

~~i) Frequency Ride-Through Requirements~~

~~Smart Inverter based systems shall remain connected to the Distribution Provider's Distribution or Transmission System while the grid is within the frequency-time range indicated in Table P-2b, and shall disconnect from the electric grid during a high or low frequency event that is outside that frequency-time range as indicated in Table P-2a.~~

~~Table P-2a: Frequency Trip Settings Table~~

Shall Trip Function	Frequency Trip Default Setting (Hz)	Resulting Range of Shall Trip Function (Hz)	Default Clearing Time (s)
OF2	62.0	$f \geq 62.0$	0.16
OF1	61.2	$61.2 \leq f < 62$	300
Continuous Operation	NA	$58.5 < f < 61.2$	NA
UF1	58.5	$56.5 < f \leq 58.5$	300
UF2	56.5	$f \leq 56.5$	0.16

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~f. Frequency (Cont'd)~~

~~i) Frequency Ride Through Requirements (Cont'd)~~

~~Table P-2b: Frequency Ride Through Settings Table~~

Frequency (Hz)	Operating Mode	Minimum time(s)
$f > 62.0$	No Ride-Through requirements apply to this range	NA
$61.2 < f \leq 61.8$	Mandatory Operation	299
$58.8 \leq f \leq 61.2$	Continuous Operation	Infinite
$57.0 \leq f < 58.8$	Mandatory Operation	299
$F < 57.0$	No Ride-Through requirements apply to this range	NA

~~ii) Rate of Change of Frequency (ROCOF) Ride-through~~

~~Smart Inverter shall not trip for frequency excursion having magnitude rates of change of frequency (ROCOF) that is less than or equal to 3.0Hz per second as specified in IEEE 1547-2018, section 6.5.2.5 category III. For ROCOF greater than 3Hz per second, it is preferred for Smart Inverter to ride-through as long as frequency remains in the continuous operating region, low frequency ride-through region (and corresponding duration times), or high frequency region (and corresponding duration times).~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~g. Harmonics~~

~~When the Smart Inverter is serving balanced linear loads, harmonic current injection into Distribution Provider's Distribution or Transmission System at the PCC shall not exceed the limits stated in IEEE 1547-2018, 7.3. The harmonic current injections shall be exclusive of any harmonic currents due to harmonic voltage distortion present in Distribution Provider's Distribution or Transmission System without the Smart Inverter connected. The harmonic distortion of a Smart Inverter shall be evaluated using the same criteria as for the Host Loads.~~

~~h. Direct Current Injection~~

~~Smart Inverter should not inject direct current greater than 0.5% of rated output current into Distribution Provider's Distribution or Transmission System.~~

~~i. Smart Inverter Reactive Power Requirements~~

~~Smart Inverter Reactive Power capabilities shall comply with IEEE 1547-2018, Section 5.2 Category B requirement.~~

~~j. Dynamic Volt/Var Operations~~

~~The Smart Inverter shall be capable of supporting dynamic reactive power compensation (dynamic Volt/Var operation) within the following constraints:~~

- ~~• The Smart Inverter shall be able to consume reactive power in response to an increase in line voltage, and produce reactive power in response to a decrease in line voltage as indicated in Table P-3.~~

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(Continued)



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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~— Dynamic Volt/Var Operations Default Settings~~

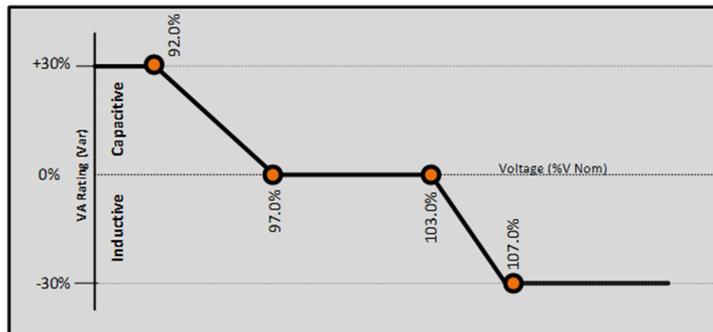
~~Table P-3 and Figure P-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.~~

~~Default Open Loop Response Time for volt/var operation setting should be five (5) seconds.~~

~~Table P-3: Voltage and Reactive Default Settings~~

Voltage Setpoint	Voltage Value	Reactive Setpoint	Reactive Value	Operation
V1	92.0%	Q1	30%	Reactive Power Injection
V2	97.0%	Q2	0	Unity Power Factor
V3	103.0%	Q3	0	Unity Power Factor
V4	107.0%	Q4	30%	Reactive Power Absorption

~~Figure P-1: Voltage and Reactive Default Settings~~



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(N)

(N)

(Continued)



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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~k. Enter Service Ramp Rate Requirements~~

~~The Smart Inverter is required to have the following ramp controls.~~

- ~~• Enter Service ramp control requirements as outlined in IEEE 1547-2018 section 4.10.3 with following default settings:

 - ~~○ Delay enter service shall be 15 seconds per P.1.a.ii~~
 - ~~○ Default Enter Service Duration shall be 50 seconds~~~~

~~l. Frequency Droop (Frequency Power, Frequency Watt) Requirements~~

~~Smart Inverters shall change their real power production as function of system frequency in accordance with IEEE 1547-2018, 6.5.2.7 with the following default settings: Deadband 36 mHz, db_{OF} and db_{UF} , k_{OF} and k_{UF} would be 0.05, open loop response time of 5 seconds.~~

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~~2. Prevention of Interference (Cont'd)~~

~~m. Voltage-Watt Default Settings Requirements~~

~~Smart Inverters shall reduce their real power production as a function measured voltage at the inverter terminal or at the Generating Facility Point of Common Coupling (PCC) in accordance with the following:~~

~~When the measured voltage is greater than 106% of nominal voltage (Example: 127.2 volts on a 120 volts nominal), the export of active power at the PCC or the production of active power by the Smart Inverter shall be reduced at a rate of 25% of active power nameplate rating per one percent of nominal voltage. Figure Hh-3 Volt-Watt Requirements illustrate the required rate of reduction. When export of active power is controlled, a certified inverter and control system shall be used.~~

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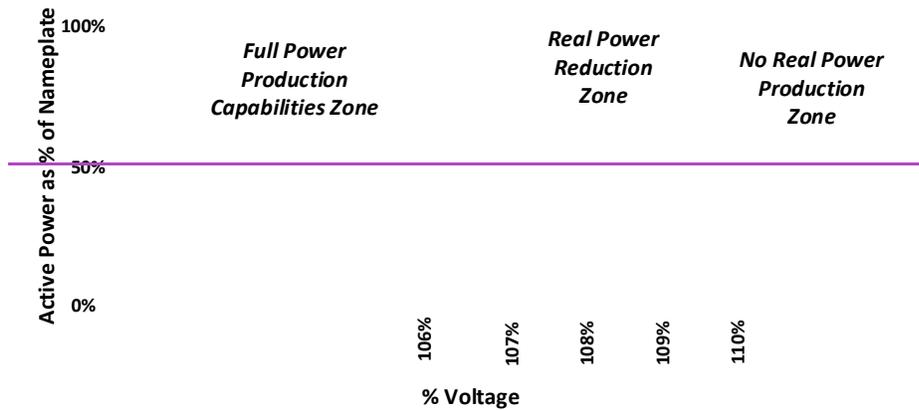
(P)

~~2. Prevention of Interference (Cont'd)~~

~~m. Voltage-Watt Default Settings Requirements~~

- ~~• When the measured voltage is greater than 110% of nominal voltage (Example: 132 volts on a 120 volts nominal), the export of active power to the grid at the PCC or the production of active power by the Smart Inverter shall be reduced to 0 watts.~~
- ~~• Open Loop response time shall be 5 seconds.~~

Figure P-3: Volt-Watt Requirements



~~n. Dynamic Reactive Power Support Function~~

~~The capability for this requirement will become mandatory for Generating Facilities utilizing inverter-based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~e. Default Activation States~~

~~Unless otherwise provided by Distribution Provider, pursuant to Distribution Provider's Distribution Generation Interconnection Handbook, the default settings will be as follows:~~

~~Table P-4: Default Activation States~~

Function	State
Anti-islanding	Activated
Low/High Voltage Ride Through	Activated
Low/High Frequency Ride Through	Activated
Dynamic Volt/Var operations	Activated
Enter Service Ramp Control	Activated
Storage Inverter Normal Operation Ramp Control	-Deactivated*
Fixed power factor	Deactivated
Reconnect by "soft-start" methods	Activated
Frequency/Watt	Activated
Volt/Watt	Activated
Constant Reactive Power Mode	Deactivated
Set Active Power Function Mode(Optional)	Activated under mutual agreement
Dynamic Reactive Power Support Mode (Optional)	Activated under mutual agreement

~~These default activation states may be modified by mutual agreement between Distribution Provider and Producer.~~

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~~* May be activated under mutual agreement. For projects where the SB storage inverter Ramp Control is activated by mutual agreement, the inverter will be tested per SA 11 normal ramp rate tests. The testing must be done by a NRTL or, if available, in accordance with PG&E's interconnection handbook(s).~~

(N)

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~2. Prevention of Interference (Cont'd)~~

~~p. Load Shedding or Transfer~~

~~The voltage and frequency ride through requirements of P.2.b.ii) and P.2.f.i) shall not apply if either: a) The real power across the Point of Common Coupling is continuously maintained at a value less than 10% of the aggregate rating of the Smart Inverters connected to the Generating Facility prior to any voltage disturbance, and the Generation Facility disconnects from the Distribution Provider's Distribution or Transmission System, along with Generating Facility load, such that the net change in real power flow from or to the Distribution Provider's Distribution or Transmission System is less than 10% of the aggregate Smart Inverter capacity; or b) Generating Facility load real power demand equal to 90% to 120% of the predisturbance aggregate Smart Inverter real power is shed within 0.1 seconds of Smart Inverter disconnection.~~

~~q. Measurement and Calculation Accuracy~~

~~Smart Inverter shall meet minimum steady state and transient measurement and calculation accuracy as required in IEEE 1547-2018, Section 4.4.~~

~~r. Prioritization of Smart Inverter Responses~~

- ~~a) The response to disable permit to service as specified in section P.8.a shall take precedence over any other tripping requirements.~~
- ~~b) Prioritization of tripping requirements not related to disabling permit to service shall meet IEEE 1547-2018 section 4.7.~~

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~~(P)~~

~~2. Prevention of Interference (Cont'd)~~

~~s. Storage Inverter Normal Operation Ramp Control Requirements~~

~~Smart Inverters used for energy storage applications may optionally include ramp-up rate control. The default value shall be 100% of maximum current output per second or slower if required by Applicant. Other ramp-up control settings can be used, when required, as mutually agreed by the Distribution Provider and the Applicant.~~

~~t. Ride-through of Consecutive Voltage Disturbances~~

~~Ride-through of consecutive voltage disturbances shall be in accordance with IEEE 1547-2018, 6.4.2.5.~~

~~u. Restore output without dynamic voltage support~~

~~Restore output without dynamic voltage support shall be in accordance with IEEE 1547-2018, 6.4.2.7.1.~~

~~v. Transition between performance operating regions:~~

~~Transition between performance operating regions should be in accordance with IEEE 1547-2018, 6.4.2.7.3.~~

~~w. Constant Reactive Power Mode~~

~~When in this mode, the Smart Inverter shall maintain a constant reactive power. The target reactive power level and mode (injection or absorption) shall be specified by the Distribution Provider and shall be within the same range specified in IEEE 1547-2018 section 5.3.5. The reactive power settings are allowed to be adjusted locally and/or remotely as specified by the Distribution Provider. The maximum Smart Inverter response time to maintain constant reactive power shall be 10 seconds or less.~~

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~~2. Prevention of Interference (Cont'd)~~

~~x. Generating Facility Rapid Voltage Changes (RVC)~~

~~Generating step or ramp changes shall meet the requirements as specified in IEEE 1547-2018 section 7.2.2.~~

~~y. Limitations of Overvoltage Over One Fundamental Frequency Period~~

~~Generating Facility shall not contribute to instantaneous or fundamental frequency overvoltage conditions per IEEE 1547-2018, 7.4.1.~~

~~z. Limitation of Cumulative Instantaneous Overvoltage~~

~~Generating Facility shall not cause the instantaneous voltage on any portion of the Distribution or Transmission System to exceed the magnitudes per IEEE 1547-2018, 7.4.2.~~

~~3. Technology Specific Requirements~~

~~Grid interactive inverters do not require separate synchronizing equipment. Non-grid interactive or "stand-alone" inverters shall not be used for Parallel Operation with Distribution Provider's Distribution or Transmission System.~~

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~~4. Supplemental Smart Inverter Requirements~~

~~a. Fault Detection~~

~~A Smart Inverter with an SCCR exceeding 0.1 or one that does not cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the formation of an Unintended Island shall be equipped with Protective Functions designed to detect Distribution or Transmission System faults, both line to line and line to ground, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds of the initiation of a fault.~~

~~b. Transfer Trip~~

~~For a Generating Facility that cannot detect Distribution or Transmission System faults (both line to line and line to ground) or the formation of an Unintended Island, and cease to energize Distribution Provider's Distribution or Transmission System within two seconds, Distribution Provider may require a Transfer Trip system or an equivalent Protective Function.~~

~~c. Reclose Blocking~~

~~Where the aggregate Generating Facility capacity exceeds 15% of the peak load on any automatic reclosing device, Distribution Provider may require additional Protective Functions, including, but not limited to reclose blocking on some of the automatic reclosing devices.~~

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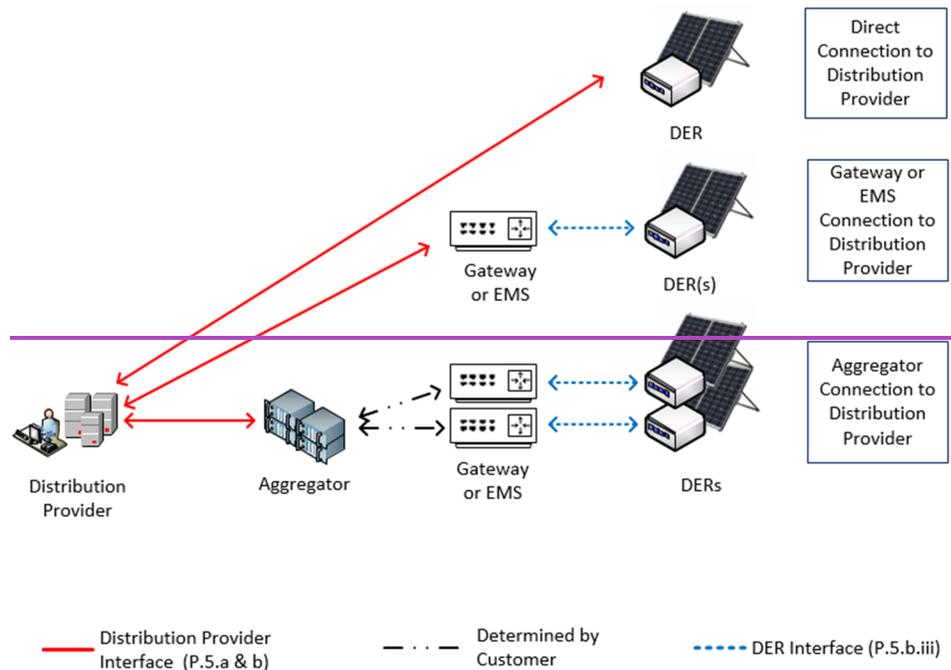
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~~5. Communication Requirements~~

~~Should communications to the Distribution Provider be required, Generating Facilities utilizing inverter-based technologies must adhere to the following communication requirements for communications between the Distribution Provider and the Generating Facility. The diagram below shows the interface requirements as applicable for section P.5. The Distribution Provider Interface (solid red line) is described in Sections P.5.a and P.5.b. The local DER interface at the Generating Facility (dotted blue line) is described in Section P.5.b.iii. The top row shows a direct connection between the Distribution Provider and the DER. The middle row shows a connection between the Distribution Provider and a gateway (GW) or Energy Management System (EMS). The lower row shows a connection between the Distribution Provider and an aggregator.~~

~~Figure P-5: Generating Facility Communications~~



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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

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~~5. Communication Requirements (Cont'd)~~

~~The communications requirements herein shall be between~~

- ~~(i) the Distribution Provider and the individual DER, GW, or EMS;~~
- ~~(ii) the Distribution Provider and communication to the Generating Facility through an aggregator not co-located or part of the Generating Facility; or~~
- ~~(iii) other communication options as mutually agreed to by Applicant and Distribution Provider.~~

~~a. The communications requirements in this Section pertain to communications between the Distribution Provider and communications option selected, or required, from section P.5. This Rule does not specify the communication between the selected communication option and Smart Inverter but performance will be enforced by compliance with this Rule:~~

- ~~i. Shall be capable of communications;~~
- ~~ii. Software shall be updateable via communications remotely;~~
- ~~iii. The transport level protocol shall be TCP/IP; and,~~
- ~~iv. The default application-level protocol shall be IEEE 2030.5 as defined in the latest final version of the Common Smart Inverter Profile (CSIP), the Interconnection Handbook, Cyber Security Requirements or Programs and Contracts. Other application-level protocols may be used by mutual agreement of the parties including IEEE 1815/DNP3 for SCADA real-time monitoring and control and IEC 61850.~~

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~~(P)~~

~~5. Communication Requirements (Cont'd)~~

~~b. Additional communication protocol requirements shall also apply to Generating Facilities utilizing inverter based technologies as provided in the following documents:~~

~~i. Distribution Provider Generation Interconnection Handbook, which shall include:~~

~~A. Details and guidelines for the implementation of communications with Generating Facilities utilizing inverter-based technologies;~~

~~B. Cybersecurity and privacy requirements (these may additionally or alternatively be included in the application-level protocol implementation guide (e.g., CSIP); and,~~

~~C. Generic device communications registration management requirements, including how to register individual Generating Facilities, Generating Facilities with energy management systems, and aggregators (these additionally or alternatively may be included in the application-level protocol implementation guide); and~~

~~D. Conditions under which communication functions are mandatory.~~

~~ii. Application Level Protocol Implementation Guide, which shall provide:~~

~~A. Detailed communication requirements and implementation guidelines to ensure consistent interoperability of the Generating Facilities with all California investor-owned utilities under the Commission's jurisdiction.~~

~~(P)~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

~~(P)~~

~~6. Scheduling Capability Requirements~~

~~a. Generating Facilities which incorporate Smart Inverters shall incorporate scheduling capabilities with minimum scheduling memory capability of at least 24 events. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Each event is composed of modifications to each, selected group of, or all of the following Smart Inverter function:~~

- ~~i) Modifications to the voltage and reactive set points of the Dynamic volt/var function.~~
- ~~ii) Modifications to the reactive power set points for the fixed power factor function.~~
- ~~iii) Modifications to the voltage and watt reduction level set points for the volt/watt function.~~

~~b. The Generating Facility's scheduling capability requirement herein shall be met by one or more of the following options:~~

- ~~i) Scheduling capability requirements may be implemented at the GW/EMS. The GW/EMS shall communicate the necessary commands to the Smart Inverters within 10 minutes, or by mutual agreement, from when the GW/EMS receives the scheduling information.~~
- ~~ii) Scheduling capability requirements may be implemented at the DER within the Generating Facility.~~
- ~~iii) Scheduling capability requirements may be stored at an aggregator not co-located within the Generating Facility. The aggregator shall communicate the necessary commands to the Smart Inverter within 15 minutes of the aggregator receiving the scheduling information.~~

~~iv) Other options may be utilized by mutual agreement between the Applicant and Distribution Provider~~

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~~(P)~~

~~6. Scheduling Capability Requirements (Cont'd)~~

- ~~c. The selected scheduling control system shall store the schedules and shall send operational commands to the Smart Inverters as required by the schedule received from the Distribution Provider. The Smart Inverter shall respond by changing its mode of operation as commanded at the schedule start time with no unreasonable delay.~~
- ~~d. Each scheduled mode of operation shall include and start time and duration. The Smart Inverter should return to its default settings at the end of the duration time or shall enter a new operational mode as directed by the scheduling control system.~~

~~7. Monitoring and Telemetry Requirements~~

~~a. The Smart Inverter shall have the capability to communicate its performance information per IEEE 1547-2018, 10.5 Table 29, unless otherwise provided by PG&E, pursuant to its Distribution Generation Interconnection Handbook:~~

- ~~i) Smart Inverter production or consumption of active power (watts).~~
- ~~ii) Smart Inverter consumption or production of reactive power (vars)~~
- ~~iii) Phase measured at the AC terminals of the Smart Inverter (volts)~~
- ~~iv) Frequency measured at the AC terminals of the Smart Inverter (Hz)~~
- ~~v) Connection Status~~
- ~~vi) Alarm Status~~

~~b. When the Generating Facility includes energy storage with Smart Inverters, the following monitoring and telemetry capability is required:~~

~~The Smart Inverter shall be capable of communicating the operational state of charge as a percent of energy storage capacity.~~

~~(P)~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

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~~7. Monitoring and Telemetry Requirements (Cont'd)~~

~~c. Operational State as In-Service or not In-service communication capability requirements. The Smart Inverter shall be capable of communicating when the Smart Inverter is capable of providing electric services as follows:~~

~~i) In-Service~~

~~An operational state which indicates that the Smart Inverter is connected to the electric system and operating as determined locally by the Generating Facility operator or by a scheduling control system as outlined in section P.6~~

~~ii) Not In-Service~~

~~An operating state which indicates that the Smart Inverter is not capable of connecting to the electric system and not capable of providing any type of electrical support as required locally or as commanded by a scheduling control system as outlined in section P.6~~

~~d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows:~~

~~i) When the Generating Facility includes only Smart Inverters, the production or consumption of active and reactive power shall be communicated as an aggregate of all Smart Inverters within the Generating Facility.~~

~~ii) When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:~~

~~a) The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.~~

~~b) The production or consumption of active and reactive power shall be communicated in aggregate of all the other technologies within the Generating Facility.~~

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~~P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)~~

(P)

~~7. Monitoring and Telemetry Requirements (Cont'd)~~

~~d. Monitoring and performance information should be communicated in aggregate at the Generating Facility as follows (Cont'd):~~

~~iii) When the Generating Facility with Smart Inverters includes one or multiple energy storage systems. The available operational energy should be communicated as an aggregate of all the energy storage systems.~~

~~iv) Nameplate information shall be available through a local Generating Facility Interface as required in IEEE 1547-2018, 10.3 and must include the information as required in IEEE 1547-2018, Table 28.~~

~~v) Configuration information shall be available through a Local Generating Facility Interface as required in IEEE 1547-2018, 10.4. This information represents the present capacity and ability of the Generating Facility. When a configuration update changes the Generating Facility nameplate information, it may require a study depending on the change.~~

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~~8. Control through communication capabilities~~

~~The utilization of these functions are permissible under mutual agreement between Distribution Provider and the generating facility before the effective date. Smart Inverters shall have the capabilities of accepting operational controls through communications in accordance to the following:~~

~~a. Disable permit to service control command~~

~~When the Smart Inverter receives a disable permit service command through communication, the Smart Inverter must cease to energize and trip within 2 seconds or initiate the opening of the switch referenced in the inverter terminal in order to galvanically isolate the Smart Inverter from the Distribution System.~~

~~b. Return to service control command~~

~~When the Smart Inverter receives a return-to-service control command, the Smart Inverter may return to service operation as required by Generating Facility operator or as required by the scheduling control system as required by section H.6. This shall be accomplished by enabling permit service as required in IEEE 1547-2018, 4.10.3.~~

~~c. Limit Active Power command~~

~~When the Smart Inverter receives a command to limit its production of real power, the Smart Inverter shall reduce its real power production to the specified percent of real power capacity of the Smart Inverter or to a specified real power value. In no more than 30 seconds or in the time it takes for the primary energy source to reduce its active power output to achieve the requirements of the active power limit set point, whichever is greater.~~

~~Where the Smart Inverter operates under a non-export provision, the active power limit set point may be implemented as a maximum active power to serve the host customer load. Under mutual agreement, the Smart Inverter may be required to reduce active power below the level needed to support host customer load.~~

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~~8. Control through communication capabilities (Cont'd)~~

~~d. Set Active Power Level Mode Function~~

~~The capability for this requirement will become mandatory for Generating Facilities utilizing inverter based technologies for which an Interconnection Request is submitted twelve (12) months after approval of a nationally recognized standard that includes the function. The utilization of this function is permissible under mutual agreement between Distribution Provider and the generating facility before the effective date.~~

~~e. Suspension of Active Power restriction~~

~~When the Smart Inverter receives a command to suspend the command for active power reduction, the Smart Inverter may return to normal operation as required by Generating Facility operator or as required by the scheduling control system as required by Section P.6.~~

~~f. Transition between operating modes~~

~~Transition between modes shall commence in no more than 30 seconds after the mode setting change is received at the local Generating Facility communication interface.~~

~~Changes of control functional modes shall be executed such that the Smart Inverter output is transitioned smoothly over a time period between 5 s and 300 s.~~

~~Ramping of Smart Inverter output is not required for control parameter setting changes.~~

~~For all control and protective function parameter settings, the time following the input to the local Generating Facility communication interface and preceding the point in time when the invoked action begins shall be no greater than 30 s.~~

(P)

(Continued)

Advice 5988-E-A
Decision D.20-09-035

Issued by
Robert S. Kenney
Vice President, Regulatory Affairs

Submitted May 19, 2021
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Resolution

**PG&E Gas and Electric
Advice Submittal List
General Order 96-B, Section IV**

AT&T
Albion Power Company

Alta Power Group, LLC
Anderson & Poole

Atlas ReFuel
BART

Barkovich & Yap, Inc.
Braun Blaising Smith Wynne, P.C.
California Community Choice Association
California Cotton Ginners & Growers Assn
California Energy Commission

California Hub for Energy Efficiency
Financing

California Alternative Energy and
Advanced Transportation Financing
Authority
California Public Utilities Commission
Calpine

Cameron-Daniel, P.C.
Casner, Steve
Center for Biological Diversity

Chevron Pipeline and Power
City of Palo Alto

City of San Jose
Clean Power Research
Coast Economic Consulting
Commercial Energy
Crossborder Energy
Crown Road Energy, LLC
Davis Wright Tremaine LLP
Day Carter Murphy

Dept of General Services
Don Pickett & Associates, Inc.
Douglass & Liddell
Downey Brand LLP
Dish Wireless L.L.C.

East Bay Community Energy Ellison
Schneider & Harris LLP

Electrical Power Systems, Inc.
Fresno
Engineers and Scientists of California

GenOn Energy, Inc.
Green Power Institute
Hanna & Morton
ICF

iCommLaw
International Power Technology
Intertie

Intestate Gas Services, Inc.

Johnston, Kevin
Kelly Group
Ken Bohn Consulting
Keyes & Fox LLP
Leviton Manufacturing Co., Inc.

Los Angeles County Integrated
Waste Management Task Force
MRW & Associates
Manatt Phelps Phillips
Marin Energy Authority
McClintock IP
McKenzie & Associates

Modesto Irrigation District
NRG Solar

OnGrid Solar
Pacific Gas and Electric Company
Peninsula Clean Energy

Pioneer Community Energy

Public Advocates Office

Redwood Coast Energy Authority
Regulatory & Cogeneration Service, Inc.

Resource Innovations

SCD Energy Solutions
San Diego Gas & Electric Company

SPURR
San Francisco Water Power and Sewer
Sempra Utilities

Sierra Telephone Company, Inc.
Southern California Edison Company
Southern California Gas Company
Spark Energy
Sun Light & Power
Sunshine Design
Stoel Rives LLP

Tecogen, Inc.
TerraVerde Renewable Partners
Tiger Natural Gas, Inc.

TransCanada
Utility Cost Management
Utility Power Solutions
Water and Energy Consulting Wellhead
Electric Company
Western Manufactured Housing
Communities Association (WMA)
Yep Energy