

July 25, 2022

**Advice 6663-E**

(Pacific Gas and Electric Company ID U 39 E)

Public Utilities Commission of the State of California

**Subject: Advice Letter Modifying Electric Rule 21 Pursuant to Resolution E-5172**

**Purpose**

Pacific Gas and Electric Company (PG&E) hereby submits this Tier 1 Advice Letter (AL) to modify Electric Rule 21 - *Generating Facility Interconnections* - in compliance with the California Public Utilities Commission (CPUC, Commission) Resolution E-5172,<sup>1</sup> *Approval, with Modifications, of utilities' Advice Letters seeking proposed modifications to Electric Rule 21 Tariff in Compliance with Decision 20-09-035, Ordering Paragraphs 2, 6, 11, 12, and 23 (Resolution E-5172 or Resolution)*. This advice letter makes those modifications identified in Resolution E-5172 to the tariffs submitted in AL 5915-E-B.

**Background****Rulemaking 17-07-007 and Working Groups**

On July 13, 2017, The Commission adopted Order Instituting Rulemaking (R.) 17-07-007 to consider refinements to Electric Tariff Rule 21 of PG&E, San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE) (jointly, Utilities) regarding the interconnection of distributed energy resources.<sup>2</sup>

The October 2, 2017, *Scoping Memo of Assigned Commissioner and Administrative Law Judge* (Scoping Memo) set forth the scope and schedule of the proceeding, including establishment of the working group process, whereby resolution of the

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<sup>1</sup> [CPUC Resolution E-5172](#) - Date of Issuance June 23, 2022 – *Approval, with Modifications, of utilities' Advice Letters seeking proposed modifications to Electric Rule 21 Tariff in Compliance with Decision 20-09-035, Ordering Paragraphs 2, 6, 11, 12, and 23*

<sup>2</sup> The Rule 21 tariff describes the interconnection, operating, and metering requirements for certain generating and storage facilities seeking to connect to the electric distribution system. Rule 21 provides customers access to the electric grid to install generating or storage facilities while protecting the safety and reliability of the distribution and transmission systems at the local and system levels. (See R.17-07-007 at p2.)

technical issues of the proceeding would be proposed by Working Groups One through Six.

#### CPUC Decision (D.) 20-09-035

The CPUC issued CPUC D. 20-09-035<sup>3</sup> (Working Group 2 and 3 Decision or Decision) on September 30, 2020, which modified each Utility's Electric Tariff Rule 21. At a high level, the Decision streamlined the interconnection process by incorporating the Integration Capacity Analysis results from R. 14-08-013, the Distribution Resources Plans proceeding, and also improving efficiency, transparency, certainty, and clarity.

#### AL 6014-E and AL 6014-E-A

On November 30, 2020, PG&E submitted Tier 2 AL 6014-E<sup>4</sup> 60 days after the issuance of D. 20-09-035, as ordered by that decision. That advice letter was protested. Supplemental AL 6014-E-A<sup>5</sup> was submitted June 25, 2021, addressing Ordering Paragraphs (OP) 1, 3, 4, 17 and 18, but OPs 2, 12, and 23 were not addressed there.

#### AL 5915-E

On January 28, 2021, PG&E submitted the original advice letter AL 5915-E 120 days after the issuance of D. 20-09-035, as ordered by that decision. That advice letter was protested.

#### AL 5915-E-A and IREC Protest

On September 3, 2021, PG&E submitted supplemental AL 5915-E-A addressing the unresolved OPs in advice letters AL 6014-E-A (the "60 day" supplemental) for OPs 2, 12, and 23 and AL 5915-E (the "120 days" AL) addressing additional change to OPs 5, 6, 8 and 11. This AL was subsequently protested by IREC on September 10, 2021. The joint IOUs submitted a protest response on September 17, 2021. This advice letter incorporated changes the utilities agreed to make in that protest response, based on guidance from Energy Division.

#### AL 5915-E-B

On November 4, 2021, PG&E submitted supplemental AL 5915-E-B<sup>6</sup>, adopting changes PG&E agreed to make in its protest response to IREC's protest of PG&E Advice Letter 5915-E-A.

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<sup>3</sup> [Decision 20-09-035](#) - Date of Issuance 9/30/2020 - *Decision Adopting Recommendations from Working Groups Two, Three, and Subgroup*

<sup>4</sup> [AL 6014-E](#) *Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3* (due 60 Days from Issuance)

<sup>5</sup> [AL 6014-E-A](#) - *Supplemental: Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3* (due 60 Days from Issuance)

<sup>6</sup> [AL 5915-E-B](#) – *Second Supplemental: Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3* (due 120 Days from Issuance) for Ordering Paragraphs 6 and 11.

### Resolution E-5172

On June 28, 2022, the CPUC issued Resolution E-5172, approving, with modifications, PG&E's AL 5915-E-B. The CPUC further directed PG&E to file a Tier 1 compliance Advice Letter within 30 days to modify Electric Rule 21 Tariff in accordance with Resolution E-5172.

### Overview

The ordering paragraphs in Resolution E-5172 require:

*“2. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall each file a Tier 1 compliance Advice Letter within 30 days to modify Electric Rule 21 Tariff in accordance with Ordering Paragraphs 3 through 6 below.*

*3. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall modify Electric Rule 21: 1) to use the term “active power output” instead of the terms “real power production” and “real power output”, and 2) use the term “ICA-SG 576 Profile” instead of the term “Generating ICA Profile.”*

*4. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall modify Electric Rule 21 Screen M and N tariff language using the exact language in Appendices A and B with no omissions, additions, or modifications of any kind.*

*5. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall modify the Interconnection Technical Framework Overview flowchart in accordance with Appendix E.*

*6. Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric shall modify Electric Rule 21 tariff on design and construction timelines in accordance with Appendix D and use reasonable efforts to comply with the timelines specified in Ordering Paragraph 23 of Decision 20-09-035 and to work with the applicants to reach a reasonable timeline when an emergency occurs.”*

Therefore, based on the above, PG&E modifies the Rule 21 as discussed below.

### Tariff Changes

Consistent with OPs 3 through 6 of Resolution E-5172, the following changes have been made to PG&E's Rule 21.

- Modifications throughout the Electric Rule 21 tariff to change terminology from “real power production” and “real power output” to “active power output”;

- Modifications to change terminology from “Generating ICA Profile” to “ICA-SG 576 Profile”;
- Modifications to Electric Rule 21 regarding Screen M and N to align with language in Resolution E-5172 Appendices A and B;
- Modifications to the Interconnection Technical Framework Overview flowchart (Section G Engineering Review Details flow chart, original Sheet 145), in accordance with Resolution E-5172 Appendix E;
- Modifications on the design and construction timelines in Electric Rule 21 tariff Section F, in accordance with Resolution E-5172 Appendix D.

In addition, PG&E made ministerial changes as needed to correct typographical errors and align language with the model tariff language provided in Resolution E-5172.

For convenience of the reader, PG&E has included “track-change” or “redline” revisions of Rule 21 in Attachment 2. PG&E implemented the use of the “(P)” symbol for Electric Rule 21 to signify material subject to change under a pending advice letter. The redlines in Attachment 2 are color coded to the specific advice letter. See Attachment 2 cover sheet for more details.

### **Protests**

Anyone wishing to protest this submittal may do so by letter sent electronically via E-mail, no later than August 15, 2022, which is 21 days<sup>7</sup> 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

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<sup>7</sup> The 20-day protest period concludes on a weekend; therefore, PG&E is moving this date to the following business day.

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 Resolution E-5172, this advice letter is submitted with a Tier 1 designation. In compliance with OP 7 of Resolution E-5172, this advice letter is requested to become effective August 7, 2022, 45 days after approval of the Resolution.

Separately, PG&E will be submitting a request for an extension of time to comply with Resolution E-5172.

### **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 (Rule 21). 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/

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Sidney Bob Dietz II  
Director, Regulatory Relations

cc: Service List R.17-07-007

### **Attachments:**

**Attachment 1** – Clean version of updated Rule 21 Tariff

**Attachment 2** – Redline Tariff Revisions



# 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 #: (415)973-4587

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) #: 6663-E

Tier Designation: 1

Subject of AL: Advice Letter Modifying Electric Rule 21 Pursuant to Resolution E-5172

Keywords (choose from CPUC listing): Compliance, Rule 21

AL Type:  Monthly  Quarterly  Annual  One-Time  Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #: Resolution E-5172, D.20-09-035

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: 8/7/22

No. of tariff sheets: 20

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 1

Service affected and changes proposed<sup>1</sup>: N/A

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

<sup>1</sup>Discuss 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](mailto: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

Cal P.U.C. Sheet No.	Title of Sheet	Cancelling Cal P.U.C. Sheet No.
53808-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 72	50342-E
53809-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 73	50343-E
53810-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 145	51790-E
53811-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 146	51791-E**
53812-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 161	51806-E
53813-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 162	51807-E
53814-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 163	51808-E
53815-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 164	51809-E
53816-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 165	51810-E
53817-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 166	51811-E
53818-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 202	51847-E
53819-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 204	51849-E
53820-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 205	51850-E
53821-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 207	51852-E

<b>Cal P.U.C. Sheet No.</b>	<b>Title of Sheet</b>	<b>Cancelling Cal P.U.C. Sheet No.</b>
53822-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 208	51853-E
53823-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 209	51854-E
53824-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 213	51858-E
53825-E	ELECTRIC RULE NO. 21 GENERATING FACILITY INTERCONNECTIONS Sheet 223	51868-E
53826-E	ELECTRIC TABLE OF CONTENTS Sheet 1	53705-E
53827-E	ELECTRIC TABLE OF CONTENTS Sheet 20	53803-E



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

Sheet 72

**Ee. MODIFICATION TO INTERCONNECTED GENERATING FACILITIES**

**1. MODIFICATIONS TO EXISTING EQUIPMENT (D.19-03-013 - Type II)**

Certain non-material modifications to existing facilities are permitted as described below in Tables Ee.1, 2 and 3. Modification requests shall incur any incremental fees as noted below. From the date of the proposed modification request is received, the Distribution Provider shall process the request within:

- (a) ten (10) Business Days if no re-study is required
- (b) twenty (20) Business Days if a re-study is required

<b>Table Ee.1 – Replacing existing equipment</b>					
Description of Modification	Notification Required?	Interconnection request is required?	Proceed without PG&E approval?	Fee (See table E.1)	
Replace equipment with exact same equipment type	No	No	Yes	n/a	
Replace with “like-for-like,” <sup>4</sup> where: 1. system output does not exceed what is listed in the original interconnection agreement and 2. operating mode is not adjusted.	Yes	No	Yes	Modification Fee in E.1 <sup>1</sup>	
Replacement increases nameplate capacity of the system, but which employ inverter power controls that limit the active power output to the inverter listed size in the original agreement.	Increases nameplate to <100kw <sup>2</sup>	Yes	No	Modification Fee in E.1 <sup>1</sup>	
	Increases nameplate to >100kw and ≤ 110% of original capacity	Yes	No	Modification Fee in E.1 <sup>1</sup>	(T)
	Increase nameplate to > 100kw and > 110% of original capacity	No	Yes	No	E.1 <sup>3</sup>
Replacing equipment such that the system capacity increases and no inverter power controls are employed to limit the active power output to the inverter listed size in the original agreement	No	Yes	No	E.1 <sup>3</sup>	(T)
All other scenarios	No	Yes	No	E.1	

<sup>1</sup> See Modification Fees in Table E.1.

<sup>2</sup> For projects increasing capacity to less than or equal to 100 kilowatt (kW), pending the creation of certification schemes for inverter power controls (software/firmware) to limit export (per D. 19-03-013, OP6).

<sup>3</sup> “E.1” refers to applicable charges/fees in Rule 21 Table E.1 for a new application.

<sup>4</sup> Like-for-Like is defined in Section C.

(Continued)



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

Sheet 73

Ee. Modification to Interconnected Generating Facilities (CONT'D.)

1. MODIFICATIONS TO EXISTING EQUIPMENT (D. 19-03-013 - Type II) (CONT'D.)

Table Ee.2 – Upgrading Inverter Firmware /Changing Inverter Characteristics				
Description of Modification:	Notification Required?	Interconnection Request Required	Proceed without PG&E approval?	Fee (See table E.1)
Only performing upgrades to inverter firmware that do not affect grid interactions	No	No	Yes	n/a
Changing inverter operating characteristics.	No	Yes	No	E.1
All Other Scenarios	No	Yes	No	E.1

Table Ee.3 -- Adding Storage or Capacity					
Description of Modification:		Notification Required?	Interconnection Request Required?	Proceed without PG&E approval?	Fee (See table E.1)
Adding storage capacity to an existing storage facility without changing inverter	Generator's maximum output based on its rated capacity <sup>1</sup>	Yes	No	Yes	\$0
	Generator's maximum output based on its operational profiles <sup>2</sup>	Yes	No	Yes	Modification Fees in E.1
Adding storage to an existing generating facility that does not have storage.		No	Yes	No	E.1
Adding such that system capacity increases and no inverter power controls are employed to limit the active power output to the inverter listed size in the original agreement.		No	Yes	No	E.1
All Other Scenarios		No	Yes	No	E.1

<sup>1</sup> If the Commission determines that a generator's maximum output should be based on its rated capacity (per D. 19-03-013, OP6).

<sup>2</sup> If the Commission determines that operational profiles of systems should be used to determine system impacts D.19-03-013, (per OP6).

(T)

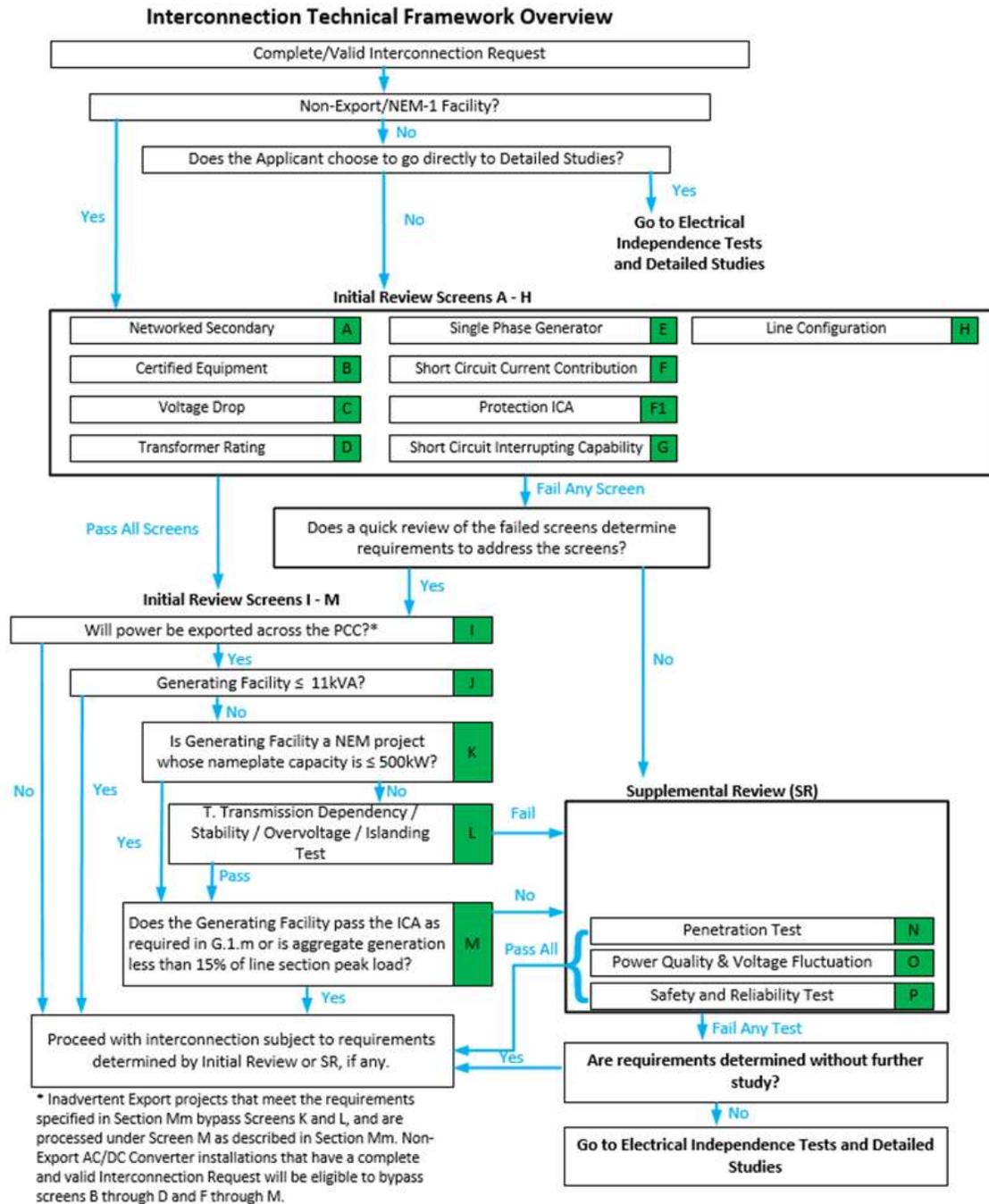
(Continued)





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

**G. ENGINEERING REVIEW DETAILS**



(T)

(Continued)



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

Sheet 161

G. ENGINEERING REVIEW DETAILS (Cont'd.)

(P)

1. INITIAL REVIEW SCREENS (Cont'd.)

m. Screen M: When ICA Values are available at the requested Point of Interconnection, the Distribution Provider shall compare the ICA Values to the Gross Nameplate Rating or typical PV Generation Profile.

For Interconnection Requests based on Gross Nameplate Rating:

a. Is the Generating Facility aggregate Gross Nameplate Rating less than or equal to 90% of the lowest value in the ICA-SG 576 Profile? or

(P)  
(T)/(P)  
(P)

b. Is the Generating Facility aggregate Gross Nameplate Rating less than or equal to 90% of the lowest value in the ICA-OF 576 Profile?

(T)/(P)  
(P)

If the response is "yes" to both a) and b), the Interconnection Request passes Screen M.

(T)  
(T)

If the response is "no" to either a) or b), the Interconnection Request fails Screen M and must be evaluated under the Supplemental Review to determine mitigation requirements.

(T)/(P)  
(P)  
(P)

For Interconnection Requests based on typical PV Generation Profile:

(P)

a. Is the Generating Facility Generation Profile based on PVWatts® or equivalent less than or equal to 90% of the ICA-SG 576 value in any hour? or

(T)/(P)  
(T)/(P)  
(P)

b. Is the Generating Facility Generation Profile based on PVWatts® or equivalent less than or equal to 90% of the ICA-OF 576 value in any hour?

(T)/(P)  
(T)/(P)  
(P)

If the response is "yes" to both a) and b), the Interconnection Request passes Screen M.

(T)  
(T)

If the response is "no" to either a) or b), the Interconnection Request fails Screen M and must be evaluated under the Supplemental Review to determine mitigation requirements.

(T)/(P)  
(P)  
(P)

(Continued)



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

Sheet 162

G. ENGINEERING REVIEW DETAILS (Cont'd.)

1. INITIAL REVIEW SCREENS (Cont'd.)

m. Screen M (Cont'd):

When ICA information is not available at the requested Point of Interconnection, Screen M should be evaluated as follows: (L)  
(L)

Is the aggregate Generating Facility capacity on the Line Section less than 15% of Line Section peak load for all line sections bounded by automatic sectionalizing devices? (P/L)

- If Yes (pass), Initial Review is complete.
- If No (fail), Supplemental Review is required.

Significance:

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

The purpose of this Screen is solely to identify if the Generating Facility needs additional study and is not intended as justification for limiting the penetration of generation on a line section.

2. SUPPLEMENTAL REVIEW SCREENS

The Supplemental Review consists of Screens N through P. If any of the Screens are not passed, a quick review of the failed Screen(s) will determine the requirements to address the failure(s) or that Detailed Studies are required. In certain instances, Distribution Provider may be able to identify the necessary solution and determine that Detailed Studies are unnecessary. Some examples of solutions that may be available to mitigate the impact of a failed Screen are:

1. Replacing a fixed capacitor bank with a switched capacitor bank.
2. Adjustment of line regulation settings.
3. Simple reconfiguration of the distribution circuit. (P/L)

(Continued)



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

Sheet 163

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

If the failure(s) cannot be addressed in Supplemental Review for Screens N through P, and generation is 100% or less of than the applicable ICA value (lowest of the ICA-SG profile or lowest value at each hour) the Distribution Provider must identify a reason and inform the customer why a specific technical constraint is not captured by the ICA and why the project must proceed to Electrical Independence Tests and Detailed Studies. Utilities also must address any concerns in the context of the Screen that triggers the mitigation or detailed study. (N)

a. Screen N: Penetration Test

If Integration Capacity Analysis Values are available at the requested Point of Interconnection, evaluate Screen N as follows: (P)

i) Penetration Level Using ICA-SG 576 Profile: (T)/(P)

For Interconnection Requests based on Gross Nameplate Rating: Is the Generating Facility aggregate Gross Nameplate Rating less than or equal to 100% of the lowest value in the ICA-SG 576 Profile? (P)  
(T)/(P)  
(T)/(P)

For Interconnection Requests based on typical PV Generation Profile: Is the Generating Facility Generation Profile, based on PVWatts® or equivalent, less than or equal to 100% of the ICA-SG 576 Profile in any hour? (P)  
(T)/(P)  
(T)/(P)

ii) Screen F1: Did the Interconnection Request pass Screen F1? (P)

If yes to both of the above (pass), continue to Screen O. (P)

If "no" to either or both of the above(fail), the Distribution Provider must perform a quick review of the failure within Supplemental Review and determine the requirements to address the failure. (T)/(P)  
(T)/(P)

- o If the Distribution Provider requires mitigations or Electrical Independence Tests and Detailed Studies, the Distribution Provider must provide the Customer the reason why. (N)  
(N)

(Continued)



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

Sheet 164

- G. ENGINEERING REVIEW DETAILS (Cont'd.) (P)
- 2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)
- a. Screen N: Penetration Test (Cont'd)
- ii) Screen F1: Did the Interconnection Request pass Screen F1 (Cont'd)?
  - o If the failure(s) cannot be addressed in Supplemental Review, and generation is 100% or less of the applicable ICA value (lowest value of the ICA-SG profile or lowest value at each hour) the Distribution Provider must identify a reason why a specific technical constraint is not captured by the ICA and the why the project must proceed to Electrical Independence Tests and Detailed Studies. (P)
  - o If voltage is a prevailing constraint, then the full range of smart inverter functions including the default volt/var function will be used in power flow analysis for the evaluation of the proposed project. This will reveal if the proposed project causes any voltage impacts of concern. If concerns related to steady state voltage, thermal, or protection exist and the Distribution Provider can identify simple upgrades through power flow analysis (e.g., installation of voltage regulator devices or protection devices to mitigate reduction of reach), then the Distribution Provider will determine the mitigation requirements within Screen N. When larger upgrades or complex protection evaluation is required, Screen N will fail, and the technical evaluation will be conducted under the Electrical Independence Tests or Detailed Study process. (T)/(P)  
(T)/(P)  
(P)
  - o If no reason for further study is identified, or if requirements to address the failure can be identified in screen N, proceed to Screen O. (P)
  - o Note: If Electrical Independence tests and Detailed Studies are required, Applicants will continue to the Electrical Independence Tests and Detailed Studies after review of the remaining Supplemental Review Screens if Applicant elects to proceed.
  - o If Integration Capacity Analysis Values are not available, evaluate Screen N as follows: (P)

(Continued)





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

Sheet 166

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

a. Screen N: Penetration Test (Cont'd.)

Note 2: When this screen is being applied to a NEM Generating Facility, the net export in kW, if known, that may flow across the Point of Common Coupling into Distribution Provider's Distribution System will be considered as part of the aggregate generation. (T)/(P/L)  
(P/L)  
|  
(P/L)

Note 3: Distribution Provider will not consider as part of the aggregate Generating Facility capacity for purposes of this screen Generating Facility capacity known to be already reflected in the minimum load data. (T)/(P/L)  
(P/L)  
|  
(P/L)

Note 4: NEM Generating Facilities with net export less than or equal to 500 kW that may flow across the Point of Common Coupling into Distribution Provider's Distribution or Transmission System will not be studied in the WDT Transmission Cluster Study Process, but may be studied under the Independent Study Process. (T)/(P/L)  
(P/L)  
|  
(P/L)

Significance: Penetration of Generating Facility capacity that does not result in power flow from the circuit back toward the substation will have a minimal impact on equipment loading, operation, and protection of the Distribution System. (P/L)  
|

b. Screen O: Power Quality and Voltage Tests

In aggregate with existing Generating Facility capacity on the Line Section, distribution circuit, and/or substation.

i) Can it be determined within the Supplemental Review that the voltage regulation on the line section can be maintained in compliance with Commission Rule 2 and/or Conservation Voltage Regulation voltage requirements under all system conditions?

ii) Can it be determined within the Supplemental Review that the voltage fluctuation is within acceptable limits as defined by IEEE 1547-2018, 7.2 or utility practice similar to IEEE 1547-2018, 7.2? (P/L)  
(P)  
(P)

(Continued)





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

Sheet 204

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

2. PREVENTION OF INTERFERENCE (Cont'd.)

g. Harmonics (Cont'd.)

**Table Hh.3**

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

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

(P/L)  
(T)

(Continued)



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

Sheet 205

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

(P/L)

2. PREVENTION OF INTERFERENCE (Cont'd.)

i. Fixed Power Factor (Cont'd.)

(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.

(P/L)  
(T)/(P/L)  
(P/L)

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.

(P/L)  
(T)/(P/L)  
(P/L)

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 ractive 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 Provider.
- Reduction of active power output is allowed to meet the required reactive power ranges.

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(T)/(P/L)  
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(T)/(P/L)  
(P/L)

(Continued)





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

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

(P/L)

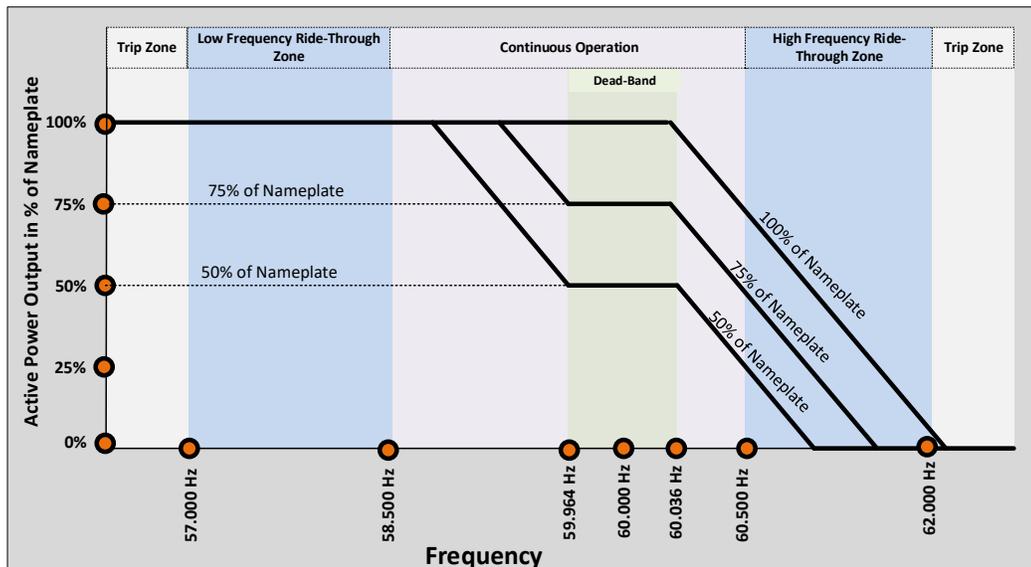
2. PREVENTION OF INTERFERENCE (Cont'd.)

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.

(P/L)  
(T)/(P/L)  
(P/L)

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



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

(P/L)

(Continued)





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

Sheet 213

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

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.

(P/L)  
(T)/(P/L)  
(P/L)

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.

(P/L)

(Continued)



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

Sheet 223

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

8. CONTROL THROUGH COMMUNICATION CAPABILITIES

- 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.

(P/L)  
(T)/(P/L)  
(P/L)

(P/L)

(Continued)



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Sheet 1

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Sheet 20

Table with columns: RULE, TITLE OF SHEET, CAL P.U.C. SHEET NO. Includes entries for Rule 21 (Generating Facility Interconnections), Rule 22 (Direct Access Service), Rule 22.1 (Direct Access Service Switching Exemption Rules), Rule 23 (Standby Service), and Rule 23.2 (Community Choice Aggregation Open Season).

(Continued)

## Attachment 2

### Redline Tariff Revisions

For convenience of the reader, PG&E has included redline revisions in Attachment 2. Where Electric Rule 21 has been revised, the affected sheets are included in Attachment 1.

In this advice letter and accordance to CPUC General Order 96B, Section 9.5.3, PG&E has implemented the use of the “(P)” symbol to signify material subject to change under a pending advice letter. The redlines in Attachment 2 are color coded to the specific advice letter. The color coding is as follows:

Redline Text Color	Advice Letter	Subject	Comments
	5915-E-B	Second Supplemental: Advice Letter Modifying Electric Rule 21 Pursuant to Decision 20-09-035 for Working Group 2 and 3 (due 120 Days from Issuance) for Ordering Paragraphs 6 and 11	Approved with modifications by Resolution E-5172. Pending final disposition.
	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 E 5036	This advice letter is superseded by Advice 6635-E-A. The redline changes remain in red, so the additional supplemental changes can be identified compared to Advice 6635-E revisions.
	6635-E-A	Supplemental: 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 E 5036	In this advice letter, revisions are made pursuant to Resolutions E-5000 and E-5036. Pending Approval.
	6663-E	Advice Letter Modifying Electric Rule 21 Pursuant to Resolution E-5172	In this advice letter, revisions are made pursuant to Resolution E-5172.



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

Sheet 16

B. APPLICABILITY (Cont'd.)

3. APPLICABLE CODES AND STANDARDS

This Rule has been harmonized with the requirements of ~~American National Standards Institute~~/Institute of Electrical and Electronic Engineers (ANSI/IEEE) ~~1547-2003 Standards for Interconnecting Distributed Resources with Electric Power Systems~~2018. In some sections, IEEE 1547-2018 language has been adopted directly or by reference; in others, IEEE 1547-2018 requirements were interpreted and this Rule's language was changed to maintain the spirit of both documents.

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~~UL1741 Supplement SA has been utilized for certification of phase 1 Smart Inverters (Phase 1 Smart Inverter Functions) as outlined in section Hh.~~

(P)  
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(P)

The language from IEEE 1547-2018 that has been adopted directly or by reference (as opposed to paraphrased language or previous language that was determined to be consistent with IEEE 1547-2018) is followed by a citation that lists the clause from which the language derived. For example, IEEE 1547-4.1.1 is a reference to Clause 4.1.1.

(P)  
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(P)

In the event of any conflict between this Rule, any of the standards listed herein, or any other applicable standards or codes, the requirements of this Rule shall take precedence.

4. RETAIL CUSTOMER ENERGY STORAGE DEVICES

For retail customers interconnecting stationary or mobile energy storage devices pursuant to this Rule, the load aspects of the storage devices will be treated pursuant to Rules 2, 3, 15, and 16 just like other load, using the incremental net load for non-residential customers, if any, of the storage devices.

5. APPLICABILITY OF IEEE 1547-2018 REQUIREMENTS

The system's voltage at Point of Interconnection (POI) will determine the required Generating Facility operating requirements. Where voltage at the Point of Interconnection is less than 34.5 kV, for applicable generation technology, IEEE 1547-2018 and related certification requirement are required. Where POI voltage is greater than or equal to 34.5 kV, the Distribution Provider's Interconnection Handbook will outline operating and performance requirements consistent with North American Electric Reliability Corporation (NERC) and CAISO operating requirements.

(P/L)  
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(Continued)

Advice	5187-E-A	Issued by	Date Filed	May 31, 2018
Decision	16-06-052	<b>Robert S. Kenney</b>	Effective	June 30, 2018
		Vice President, Regulatory Affairs	Resolution	



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

Sheet 17

C. DEFINITIONS ~~(Cont'd.)~~

The definitions in this Section C are applicable only to this Rule, the Interconnection Request, Study Agreements and Generator Interconnection Agreements.

(P/L)

Added Facilities: See Special Facilities.

Affected System: An electric system other than Distribution Provider's Distribution or Transmission System that may be affected by the proposed Interconnection.

(P/L)

**Affected System Operator:** The entity that operates an Affected System.

**Affiliate:** With respect to a corporation, partnership or other entity, each such other corporation, partnership or other entity that directly or indirectly, through one or more intermediaries, controls, is controlled by, or is under common control with, such corporation, partnership or other entity.

**Allocated Capacity:** Existing aggregate generation capacity in megawatts (MW) interconnected to a substation/area bus, bank or circuit (i.e., amount of generation online).

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

**Applicant:** The entity submitting an Interconnection Request pursuant to this Rule.

**Application:** See Interconnection Request.

**Available Capacity:** Total Capacity less the sum of Allocated Capacity and Queued Capacity.

**Base Case:** Data including, but not limited to, base power flow, short circuit and dynamic/stability data bases, underlying load, generation, and transmission facility assumptions, contingency lists, including relevant special protection systems, and transmission diagrams used to perform the Interconnection Studies. The Base Case may include Critical Energy Infrastructure Information (as that term is defined by FERC). (Cont'd on next page)

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(Continued)





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

C. DEFINITIONS (Cont'd.)

**Commercial Operation Date:** The date on which a Generator at a Generating Facility commences Commercial Operation, as agreed to by the Parties.

(P/L)

**Commission:** The Public Utilities Commission of the State of California.

(P/L)

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

Verify specific aspects of its performance;

Calibrate its instrumentation;

Establish instrument or Protective Function set-points.

Confidential Information: See Section D.7.

**Conservation Voltage Regulation (CVR):** The CVR program that the Commission directed Distribution Provider to implement as applicable to the operation and design of distribution circuits and related service voltages.

**Construction Activities:** Actions by Distribution Provider that result in irrevocable financial commitments for the purchase of major electrical equipment or land for Distribution Provider's Interconnection Facilities, Distribution Upgrades, or Network Upgrades assigned to the Interconnection Customer that occur after receipt of all appropriate governmental approvals needed for Distribution Provider's Interconnection Facilities, Distribution Upgrades, or Network Upgrades.

**Continuous Operation:** The Smart Inverter operates indefinitely without tripping. Any functions that protect the Smart Inverter from damage may operate as needed.

**Control Area:** As defined in the CAISO Tariff.

**Cost Envelope:** A cost-certainty framework defined as plus or minus twenty-five (25) percent of the estimated cost of certain Interconnection Facilities and/or Distribution Upgrades identified in the Cost Envelope Estimate that is offered to an Applicant based on actual costs within such twenty-five (25) percent envelope. Applicant's cost responsibility for Interconnection Facilities and/or Distribution Upgrades subject to the Cost Envelope is set forth in Section F.7.b.

(Continued)

Advice	5187-E-A	Issued by	Date Filed	May 31, 2018
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**ELECTRIC RULE NO. 21**  
GENERATING FACILITY INTERCONNECTIONS

Sheet 20

C. DEFINITIONS (Cont'd.)

**Cost Envelope Option:** A five-year pilot option described in Section F.7 applicable to Interconnection Requests for Generating Facilities that are processed under the Fast Track Process or Independent Study Process.

**Cost Envelope Estimate:** An estimate prepared by the Distribution Provider and delivered to Applicant pursuant to the Cost Envelope Option that contains (i) the estimated cost of Distribution Provider's required Interconnection Facilities and/or Distribution Upgrades that are offered to Applicant that are subject to the Cost Envelope, and (ii) the estimated costs of related activities and facilities that are excluded from the Cost Envelope and offered on an actual cost basis, both pursuant to Section F.7.

**Customer:** The entity that receives or is entitled to receive Distribution Service through Distribution Provider's Distribution System or is a retail Customer of Distribution Provider connected to the Transmission System.

db<sub>HF</sub>: A single-sided deadband value for high-frequency in Hz used in Section P. (P)

db<sub>LF</sub>: A single-sided deadband value for low-frequency in Hz used in Section P. (P)

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

**Delivery Network Upgrades:** The transmission facilities at or beyond the point where Distribution Provider's Distribution System interconnects to the CAISO Controlled Grid, other than Reliability Network Upgrades, as defined in the CAISO Tariff.

**Detailed Study:** An Independent Study, a Distribution Group Study or a WDT Transmission Cluster Study.

**Detailed Study Agreement:** The agreement entered into by the Interconnection Customer and Distribution Provider which sets forth the Parties' agreement to perform Interconnection Studies under the Independent Study Process or the Distribution Group Study Process.

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

(Continued)

Advice	5187-E-A	Issued by	Date Filed	May 31, 2018
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**ELECTRIC RULE NO. 21**  
**GENERATING FACILITY INTERCONNECTIONS**

Sheet 21

C. DEFINITIONS (Cont'd.)

**DGS Phase I Interconnection Study:** Distribution Group Study (DGS) Phase I Interconnection Study performed by the Distribution Provider under the Distribution Group Study Process per Section G.3.c.i.

**DGS Phase II Interconnection Study:** Distribution Group Study (DGS) Phase II Interconnection Study performed by the Distribution provider under the Distribution Group Study Process per Section G.3.c.ii.

**Dispute Resolution:** See Section K.

**Distributed Energy Resource (DER):** As defined in IEEE 1547-2018.

(P)  
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(P)

**DER Interconnection System:** As defined by "Interconnection System" in IEEE 1547-2018

**Distribution Group Study:** An interconnection engineering study of a group comprised of Interconnection Requests that pass Screen Q as a group and fail Screen R demonstrating they are electrically interdependent in accordance with Section F.3.c.

**Distribution Group Study Process:** The interconnection study process set forth in Section F.3.c.

**Distribution Provider:** Pacific Gas and Electric Company

**Distribution Service:** The service of delivering energy over the Distribution System pursuant to the approved tariffs of Distribution Provider other than services directly related to the Interconnection of a Generating Facility under this Rule.

**Distribution Study Group:** A group comprised of Interconnection Requests that fail Screen R that will be studied pursuant to Section F.3.c because the Screen R results demonstrate they are electrically interdependent.

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

**Distribution Upgrades:** The additions, modifications, and upgrades to Distribution Provider's Distribution System at or beyond the Point of Interconnection to facilitate interconnection of the Generating Facility and render the Distribution Service. Distribution Upgrades do not include Interconnection Facilities.

(Continued)

Advice	5187-E-A	Issued by	Date Filed	May 31, 2018
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**ELECTRIC RULE NO. 21**  
GENERATING FACILITY INTERCONNECTIONS

Sheet 23

C. DEFINITIONS (Cont'd.)

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

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

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

**Generating Facility Capacity:** The net capacity of the Generating Facility and the aggregate net capacity of the Generating Facility where it includes multiple Generators.

**Generation Profile:** The active power output of a Generating Facility over a period of time. The Generation Profile may be less than the Gross Nameplate Capacity at certain times, for example when using a typical PV Generation Profile or a Limited Generation Profile.

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

**Generator Interconnection Agreement:** An agreement between Distribution Provider and Producer providing for the Interconnection of a Generating Facility that gives certain rights and obligations to effect or end Interconnection. For the purpose of this Rule, Net Energy Metering or power purchase agreements authorized by the Commission are also defined as Generator Interconnection Agreements.

(Continued)

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

Sheet 24

C. DEFINITIONS (Cont'd.)

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

**Governmental Authority:** Any federal, state, local or other governmental regulatory or administrative agency, court, commission, department, board, or other governmental subdivision, legislature, rulemaking board, tribunal, or other governmental authority having jurisdiction over the Parties, their respective facilities, or the respective services they provide, and exercising or entitled to exercise any administrative, executive, police, or taxing authority or power; provided, however, that such term does not include Interconnection Customer, Distribution Provider, or any Affiliate thereof.

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

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

**Inadvertent Export:** The unscheduled and uncompensated export of real power\* from a Generating Facility (GF) for a limited duration as specified in Sections M, Mm and Mm3. (P)

**Independent Study Process:** The interconnection study process set forth in Section F.3.d.

**Initial Review:** See Section F.2.a.

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

In-Service Date: The estimated date upon which Applicant reasonably expects it will be ready to begin use of Distribution Provider's Interconnection Facilities. (P)

\* For the purposes of Rule 21, real power is the same as active power. (P)

(Continued)



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

C. DEFINITIONS (Cont'd.)

**Integration Capacity Analysis (ICA) Values:** Values which represent the maximum capacity that can be interconnected at a given Point of Interconnection without exceeding Distribution Provider equipment thermal limits or any of the Distribution System voltage, power quality, protection, and operational flexibility (safety) limits, each of which is independently calculated.

**Integration Capacity Analysis – Operational Flexibility 576 (ICA-OF 576) Profile:** Annual Profile composed of 576 hours where each hour is represented by its ICA-OF Value.

**Integration Capacity Analysis – Operational Flexibility (ICA-OF) Values:** The minimum ICA value at a given Point of Interconnection from the set of the thermal, voltage, power quality, protection, and operational flexibility ICA Values.

**Integration Capacity Analysis – Static Grid 576 (ICA-SG 576) Profile:** Annual Profile composed of 576 hours where each hour is represented by its ICA-SG Value.

**Integration Capacity Analysis – Static Grid (ICA-SG) Values:** The minimum ICA value at a given Point of Interconnection from the set of the thermal, voltage, power quality, and protection ICA Values.

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

**Interconnection Agreement:** See Generator Interconnection Agreement.

**Interconnection Customer:** See Applicant.

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

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(P)

(Continued)



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

C. DEFINITIONS (Cont'd.)

**Interconnection Facilities Study:** A study conducted by Distribution Provider for an Interconnection Customer under the Independent Study Process to determine a list of facilities (including Distribution Provider's Interconnection Facilities, Distribution Upgrades, and Network Upgrades as identified in the Interconnection System Impact Study), the cost of those facilities, and the time required to interconnect the Generating Facility with Distribution Provider's Distribution or Transmission System. The scope of the study is defined in Section G.3.c.

(P/L)

**Interconnection Financial Security:** Any of the financial instruments listed in Section F.4.a.

(P/L)

**Interconnection Request:** An Applicant's request to interconnect a new Generating Facility, or to increase the capacity of, or make a Material Modification to the operating characteristics of, an existing Generating Facility that is interconnected with Distribution Provider's Distribution or Transmission System.

**Interconnection Study:** A study to establish the requirements for Interconnection of a Generating Facility with Distribution Provider's Distribution System or Transmission System, pursuant to this Rule.

**Interconnection System Impact Study:** An engineering study conducted by Distribution Provider for an Interconnection Customer under the Independent Study Process that evaluates the impact of the proposed interconnection on the safety and reliability of Distribution Provider's Distribution and/or Transmission System and, if applicable, an Affected System. The scope of the study is defined in Section G.3.c.i.

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

**k<sub>of</sub>:** The per-unit frequency change corresponding to 1 per-unit power output change (frequency droop), unitless used in Section P.

(P)

**k<sub>uf</sub>:** The per-unit frequency change corresponding to 1 per-unit power output change (frequency droop), unitless used in Section P.

(P)

**Large Generating Facility:** A Generating Facility having a Generating Facility Capacity of more than 20 MW.

(P/L)

(Continued)



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

Sheet 27

C. DEFINITIONS (Cont'd.)

Like for like: For inverters, like-for-like means certified, same nameplate or smaller, same fault current or smaller. For solar panels, like-for-like means certified, same CEC-AC rating of the system or smaller. For batteries, like-for-like means same or less kWh & kW rating and same operating profile. For transformers, like-for-like means same connection type, same or smaller impedance and capacity.

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(P/L)

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

(P/L)  
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(P/L)

Local DER Generating Facility Communication Interface: Interface at the Generating Facility capable of communicating to support the information exchange requirements specified in this rule and as required in IEEE 1547-2018 for all applicable functions that are in Section P.

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(P)

Local Furnishing Bond: Tax-exempt bonds utilized to finance facilities for the local furnishing of electric energy, as described in Internal Revenue Code, 26 U.S.C. § 142(f).

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Local Furnishing Distribution Provider: Any Distribution Provider that owns facilities financed by Local Furnishing Bonds.

(P/L)

**Mandatory Operation:** The Smart Inverter operates at maximum available current without tripping during Distribution Provider's Transmission or Distribution System excursions outside the region of continuous operation. Any functions that protect the Smart Inverter from damage may operate as needed.

**Material Modification:** Those modifications that have a material impact on cost or timing of any Interconnection Request with a later queue priority date or a change in Point of Interconnection. A Material Modification does not include a change in ownership of a Generating Facility, (ii) a modification described in Table F.1, nor (iii) a modification described in Tables Ee.1, 2 or 3 that does not require a new interconnection request.

**Metering:** The measurement of electrical power in kilowatts (kW) and/or energy in kilowatt-hours (kWh), and if necessary, reactive power in kVAR at a point, and its display to Distribution Provider, as required by this Rule.

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

(P/L)  
(P/L)

(Continued)

Advice	5187-E-A	Issued by	Date Filed	May 31, 2018
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		Vice President, Regulatory Affairs	Resolution	





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

Sheet 29

C. DEFINITIONS (Cont'd.)

**Non-Export; Non-Exporting:** When the Generating Facility is sized and designed such that the Generator output is used for Host Load only and is designed to prevent the transfer of electrical energy from the Generating Facility to Distribution Provider's Distribution or Transmission System.

(P/L)  
↓  
(P/L)

**Non-Export AC/DC Converter:** A one-way only device that takes alternating current (AC) power from the Distribution System and converts it into direct current (DC) power for DC loads in the Customer's facility. A Non-Export AC/DC Converter must be certified by a Nationally Recognized Test Lab as non-export, meaning it must be certified to not export power back into the grid (i.e. exports less than 0.5% of its rated current towards the grid under steady-state conditions or after 5 cycles of an induced fault condition) and it must meet IEEE 1547-4.3.3 harmonic requirements. Until a national certification standard is approved and the Non-Export AC/DC Converter can be certified by a NRTL, the requirement can be satisfied through Distribution Provider's interim approval process. An interim approval will apply to devices that complete the Distribution Provider's testing procedure described in Section L.7.a.v. The interim approval will be effective upon the Distribution Provider acknowledging that the test results for a particular model of Non-Export AC/DC Converter confirm satisfactory completion of the testing procedures. Twelve months after the UL 1741 Non-Export Certification Requirement Document (CRD) standard is available, new interconnections requests for non-export using an AC/DC converter must use an NRTL certified non-export converter.

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

**Open Loop Response Time:** The duration from a step change in control signal input (reference value) until the output changes to 90 percent of its final change, before any overshoot.

**Parallel Operation:** The simultaneous operation of a Generator with power delivered or received by Distribution Provider while Interconnected. For the purpose of this Rule, Parallel Operation includes only those Generating Facilities that are Interconnected with Distribution Provider's Distribution or Transmission System for more than 60 cycles (one second).

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

(Continued)

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

Sheet 30

C. DEFINITIONS (Cont'd.)

**Party, Parties:** Applicant or Distribution Provider.

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

**Permissive Operation:** The Smart Inverter is allowed, but not required, to operate at any current level.

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

**Point of Interconnection (POI):** The point where the Interconnection Facilities connect with Distribution Provider's Distribution or Transmission System. This may or may not be coincident with the Point of Common Coupling.

(P)

**Point of Generating Resource Connection (POC):** The point where a DER unit is electrically connected in a Generating Facility and meets the requirements of this rule.

(P)

|

(P)

**Pre-Construction Activities:** The actions by Distribution Provider, other than those required by an Engineering and Procurement Agreement under Section F.3.f, undertaken prior to Construction Activities in order to prepare for the construction of Distribution Provider's Interconnection Facilities, Distribution Upgrades, or Network Upgrades assigned to the Interconnection Customer, including, but not limited to, preliminary engineering, permitting activities, environmental analysis, or other activities specifically needed to obtain governmental approvals for Distribution Provider's Interconnection Facilities, Distribution Upgrades, or Network Upgrades.

(Continued)

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

Sheet 31

C. DEFINITIONS (Cont'd.)

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

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

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

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

**Queue Position:** See Section E.5.C.

**Queued Capacity:** Aggregate queued generation capacity (in MW) for a substation/area bus, bank or circuit (i.e., amount of generation in the queue).

**Reasonable Efforts:** With respect to an action required to be attempted or taken by a Party under this Rule, efforts that are timely and consistent with Good Utility Practice and are otherwise substantially equivalent to those a Party would use to protect its own interests.

**Reference Point of Applicability (RPA):** The location where the Generating Facility interconnection and interoperability performance requirements shall be met.

(P)  
|  
(P)

**Reliability Network Upgrades:** The transmission facilities at or beyond the point where Distribution Provider's Distribution System interconnects to the CAISO Controlled Grid, necessary to interconnect one or more Generating Facility(ies) safely and reliably to the CAISO Controlled Grid, as defined in the CAISO Tariff.

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

(Continued)



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

Sheet 71

**Ee. MODIFICATION TO INTERCONNECTED GENERATING FACILITIES**

1. MODIFICATIONS TO EXISTING EQUIPMENT (D. 19-03-013 - Type II)  
Certain non-material modifications to existing facilities are permitted as described below in Tables Ee.1, 2 and 3. Modification requests shall incur any incremental fees as noted below. From the date of the proposed modification request is received, the Distribution Provider shall process the request within:
  - (a) ten (10) Business Days if no re-study is required
  - (b) twenty (20) Business Days if a re-study is required

**Table Ee.1 – Replacing existing equipment**

Description of Modification	Notification Required?	Interconnection request is required?	Proceed without PG&E approval?	Fee (See table E.1)
Replace equipment with exact same equipment type	No	No	Yes	n/a
Replace with "like-for-like," <sup>4</sup> where: 1. system output does not exceed what is listed in the original interconnection agreement and 2. operating mode is not adjusted.	Yes	No	Yes	Modification Fee in E.1 <sup>1</sup>
Replacement increases nameplate capacity of the system, but which employ inverter power controls that limit the <b>real-active</b> power output to the inverter listed size in the original agreement.	Increases nameplate to <100kw <sup>2</sup>	Yes	No	Modification Fee in E.1 <sup>1</sup>
	Increases nameplate to >100kw and < 110% of original capacity	Yes	No	Modification Fee in E.1 <sup>1</sup>
	Increase nameplate to > 100kw and > 110% of original capacity	No	Yes	E.1 <sup>3</sup>
Replacing equipment such that the system capacity increases and no inverter power controls are employed to limit the <b>real-active</b> power output to the inverter listed size in the original agreement	No	Yes	No	E.1 <sup>3</sup>
All other scenarios	No	Yes	No	E.1

(T)

(T)

<sup>1</sup> See Modification Fees in Table E.1.  
<sup>2</sup> For projects increasing capacity to less than or equal to 100 kilowatt (kW), pending the creation of certification schemes for inverter power controls (software/firmware) to limit export (per D. 19-03-013, OP6)  
<sup>3</sup> "E.1" refers to applicable charges/fees in Rule 21 Table E.1 for a new application.  
<sup>4</sup> Like-for-Like is defined in Section C.

(Continued)



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

Sheet 71

Ee. Modification to Interconnected Generating Facilities (CONT'D.)

1. MODIFICATIONS TO EXISTING EQUIPMENT (D. 19-03-013 - Type II) (CONT'D.)

Table Ee.2 – Upgrading Inverter Firmware /Changing Inverter Characteristics				
Description of Modification:	Notification Required?	Interconnection Request Required	Proceed without PG&E approval?	Fee (See table E.1)
Only performing upgrades to inverter firmware that do not affect grid interactions	No	No	Yes	n/a
Changing inverter operating characteristics.	No	Yes	No	E.1
All Other Scenarios	No	Yes	No	E.1

Table Ee.3 -- Adding Storage or Capacity					
Description of Modification:		Notification Required?	Interconnection Request Required?	Proceed without PG&E approval?	Fee (See table E.1)
Adding storage capacity to an existing storage facility without changing inverter	generator's maximum output based on its rated capacity <sup>1</sup>	Yes	No	Yes	\$0
	Generator's maximum output based on its operational profiles <sup>2</sup>	Yes	No	Yes	Modification Fees in E.1
Adding storage to an existing generating facility that does not have storage.		No	Yes	No	E.1
Adding such that system capacity increases and no inverter power controls are employed to limit the <b>real-active</b> power output to the inverter listed size in the original agreement.		No	Yes	No	E.1
All Other Scenarios		No	Yes	No	E.1

<sup>1</sup> If the Commission determines that a generator's maximum output should be based on its rated capacity (per D. 19-03-013, OP6).

<sup>2</sup> If the Commission determines that operational profiles of systems should be used to determine system impacts D. 19-03-013, (per OP6).

(T)

(Continued)



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

Sheet 75

F. REVIEW PROCESS FOR INTERCONNECTION REQUESTS (Cont'd.)

2. FAST TRACK INTERCONNECTION REVIEW PROCESS

a. Initial Review

Upon receipt of a complete and valid Interconnection Request, Distribution Provider shall perform Initial Review using the process in Section G.1. The Initial Review determines if (i) the Generating Facility qualifies for Fast Track Interconnection through Initial Review, or (ii) the Generating Facility requires a Supplemental Review. Absent extraordinary circumstances, Distribution Provider shall notify Applicant in writing of the results of Initial Review within fifteen (15) Business Days following validation of an Interconnection Request.

As part of the evaluation of Screen M, when Integration Capacity Analysis Values are available at the requested Point of Interconnection, Distribution Provider will determine if Integration Capacity Analysis Values at the proposed Point of Interconnection need to be updated. If Distribution Provider determines that the Integration Capacity Analysis Values at the proposed Point of Interconnection need to be updated, the Distribution Provider will update the values for the proposed Point of Interconnection using the Integration Capacity Analysis tool on the specific electrical node or by running the Integration Capacity Analysis on all the electrical nodes in the circuit. Distribution Provider shall not perform additional Integration Capacity Analysis as part of the interconnection process of projects with less than 30 kilovolt amperes nameplate capacity. Distribution Provider shall share the results of any Integration Capacity Analysis updates with the Applicant and provide an explanation of changes to grid conditions or the interconnection queue which led to the need to obtain updated Integration Capacity Analysis Values. Distribution Provider shall comply with confidentiality provisions and data redaction policies.

(P)

(P)

(P/L)

(P/L)

(Continued)



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

Sheet 75

F. REVIEW PROCESS FOR INTERCONNECTION REQUESTS (Cont'd.)

(P/L)

2. FAST TRACK INTERCONNECTION REVIEW PROCESS

a. Initial Review (Cont'd)

For all Interconnection Requests that pass Initial Review and do not require Interconnection Facilities or Distribution Upgrades, Distribution Provider shall provide Applicant with a Generator Interconnection Agreement within fifteen (15) Business Days of providing notice of Initial Review results. For Interconnection Requests that pass Initial Review but do require Interconnection Facilities or Distribution Upgrades, within fifteen (15) Business Days of providing notice of Initial Review results, Distribution Provider shall provide Applicant with a non-binding cost estimate of the Interconnection Facilities or Distribution Upgrades. For those Interconnection Requests where Applicant has selected the Cost Envelope Option, within ten (10) Business Days of providing Applicant the non-binding cost estimate for the required Interconnection Facilities and/or Distribution Upgrades, Applicant shall provide the Distribution Provider the Cost Envelope Option deposit, in accordance with Section F.7.a.i.3. If Applicant fails to provide the Cost Envelope Option deposit in accordance with Section F.7.a.i.3, Applicant's request for the Cost Envelope Option shall be deemed withdrawn and the Interconnection Request shall not be eligible for the Cost Envelope Option.

For all Interconnection Requests that pass Initial Review, refer to Section F.2.e for cost responsibility and time frames for completing the Generator Interconnection Agreement.

(P/L)

(Continued)

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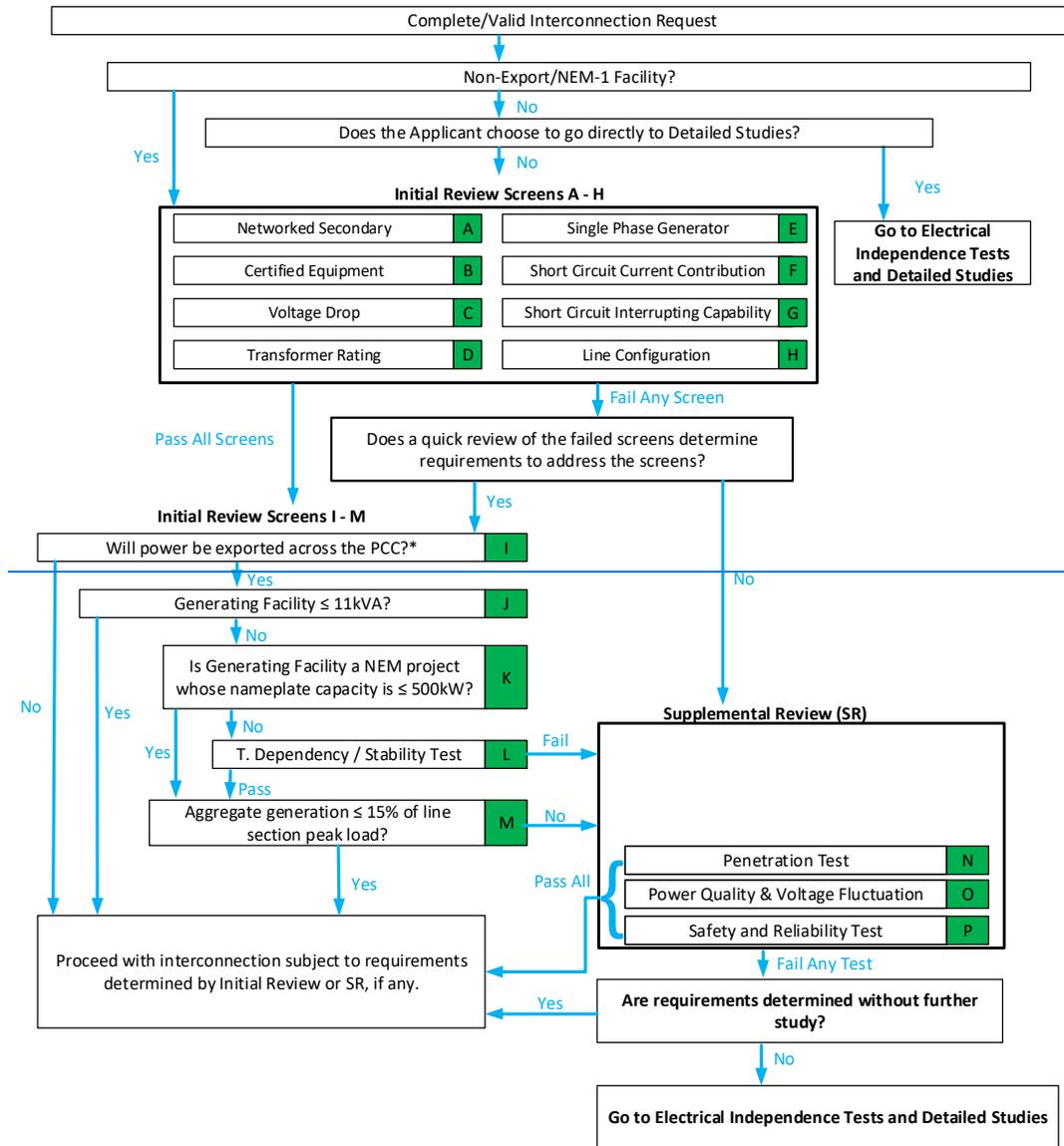
**ELECTRIC RULE NO. 21**  
**GENERATING FACILITY INTERCONNECTIONS**

**G. ENGINEERING REVIEW DETAILS**

Delete table below:

Delete pending table below:

**Interconnection Technical Framework Overview**



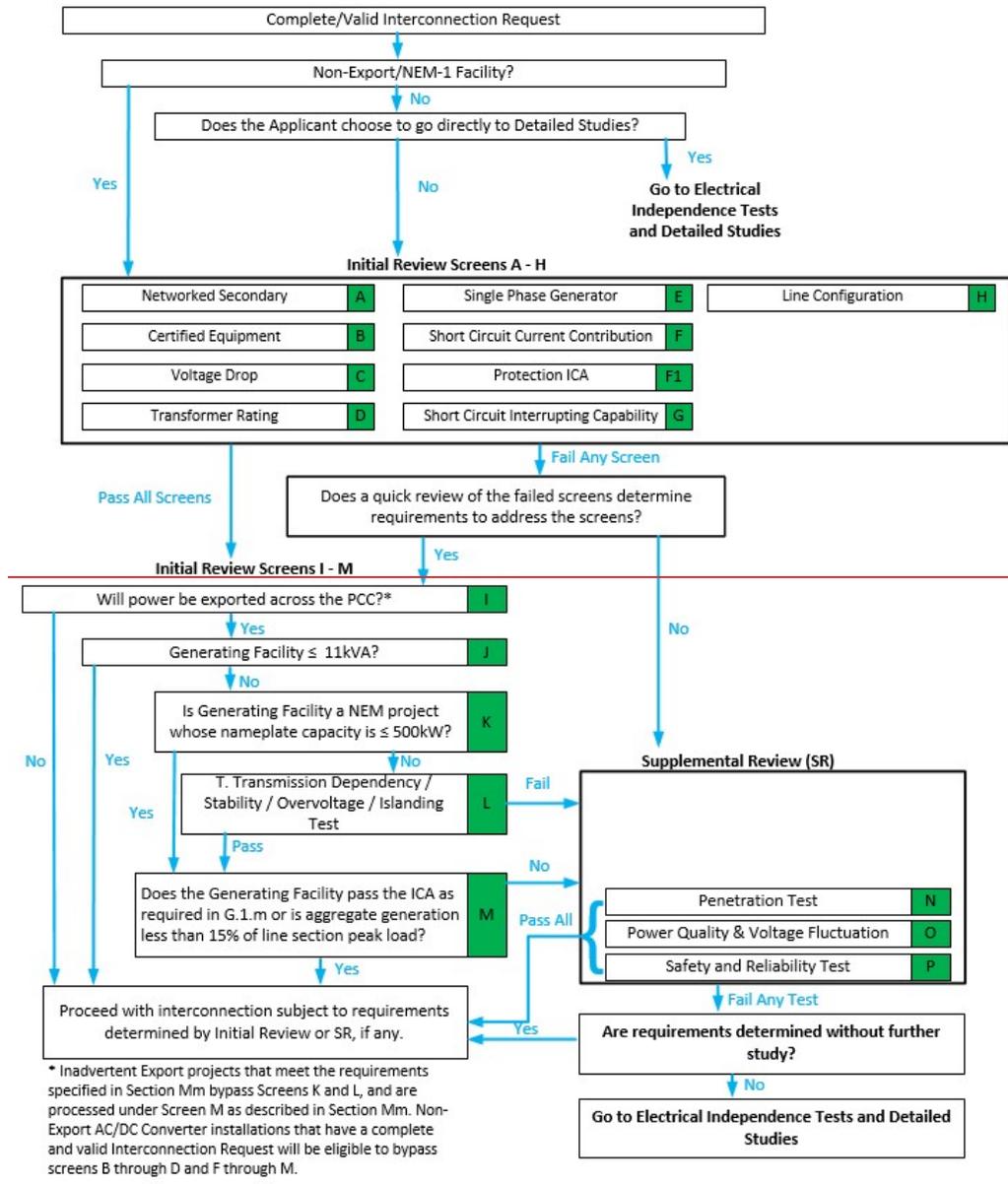
(Continued)



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

Add new table below:

**Interconnection Technical Framework Overview**



\* If Generating Facility meets the conditions in Screen I below (Section G.1.i), skip Screens K, L, and M.

(Continued)





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

Sheet 149

G. ENGINEERING REVIEW DETAILS (Cont'd.)

1. INITIAL REVIEW SCREENS (Cont'd.)

g. Screen G: Is the Short Circuit Interrupting Capability Exceeded? (Cont'd)

Note: This Screen does not apply to Generating Facilities with a Gross Rating of ~~3011~~ kVA or less.

(P)

Significance: If the Generating Facility passes this screen, it can be expected that it will not cause any of Distribution Provider's equipment to be overstressed.h. Screen H: Is the line configuration compatible with the Interconnection type?

- If Yes (pass), continue to Screen I.
- If No (fail), continue to Screen I pursuant to Section G.1.

Note: This Screen does not apply to Generating Facilities with a Gross Rating of ~~3011~~ kVA or less

(P)

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

**Table G-1**  
**Type of Interconnection**

Primary Distribution Line Type Configuration	Type of Interconnection to be made to Primary Distribution Line	Result/Criteria
Three-phase, three-wire	Any type	Pass Screen
Three-phase, four-wire	Single-phase, line-to-neutral	Pass Screen
Three-phase, four-wire (For any line that has such a section OR mixed three-wire & four-wire)	All others	To pass, aggregate Generating Facility nameplate rating must be less than or equal to 10% of Line Section peak load

(Continued)

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 153

G. ENGINEERING REVIEW DETAILS (Cont'd.)

1. INITIAL REVIEW SCREENS (Cont'd.)

j. Screen J: Is the Gross Rating of the Generating Facility 3011 kVA or less? (P)

- If Yes (pass), skip Screens K, L and M; Initial Review is complete.
- If No (fail), continue to Screen K.<sup>i</sup>

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

k. Screen K: Is the Generating Facility a Net Energy Metering (NEM) Generating Facility with nameplate capacity less than or equal to 500 kW?

- If Yes (pass), skip screen L and continue to screen M.
- If No (fail), continue to screen L.

Significance: The purpose of this Screen is solely to facilitate interconnection of NEM facilities below this size threshold by allowing such facilities to bypass Screen M. The use of nameplate capacity expedites the Initial Review analysis. In Supplemental Review, the net export will be analyzed.

<sup>i</sup> Inadvertent Export systems that meet the requirements specified in Section Mm bypass Screens K and L, and are processed under Screen M as described in Section Mm.

(Continued)

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

G. ENGINEERING REVIEW DETAILS (Cont'd.)

(P)

1. INITIAL REVIEW SCREENS (Cont'd.)

m. Screen M: When ICA Values are available at the requested Point of Interconnection, the Distribution Provider shall compare the ICA Values to the Gross Nameplate Rating or typical PV Generation Profile.

For Interconnection Requests based on Gross Nameplate Rating:

a. Is the Generating Facility aggregate Gross Nameplate Rating ~~less than or equal to~~ 90% of the lowest value in the ICA-SG 576 Profile? or

(P)  
(T)/(P)  
(P)

b. Is the Generating Facility aggregate Gross Nameplate Rating ~~greater than~~ less than or equal to 90% of the lowest value in the ICA-OF 576 Profile?

(P)  
(T)  
(P)

If the response is "yes" to both a) and b), the Interconnection Request passes Screen M.

(T)/(P)  
(T)

If the response is "no" to either a) or b), the Interconnection Request fails Screen M and must be evaluated under the Supplemental Review to determine mitigation requirements.

(T)/(P)  
(P)

For Interconnection Requests based on typical PV Generation Profile:

(P)

a. Is the Generating Facility Generation Profile based on PVWatts® or equivalent ~~greater than~~ less than or equal to 90% of the ICA-SG 576 value in any hour? or

(T)/(P)  
(T)/(P)  
(P)

b. Is the Generating Facility Generation Profile based on PVWatts® or equivalent ~~greater than~~ less than or equal to 90% of the ICA-OF 576 value in any hour?

(T)/(P)  
(T)/(P)  
(P)

If the response is "yes" to both a) and b), the Interconnection Request passes Screen M.

(T)/(P)  
(T)

If the response is "no" to either a) or b), the Interconnection Request fails Screen M and must be evaluated under the Supplemental Review to determine mitigation requirements.

(T)/(P)  
(P)  
(P)

(Continued)



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

Sheet 155

G. ENGINEERING REVIEW DETAILS (Cont'd.)

1. INITIAL REVIEW SCREENS (Cont'd.)

m. Screen M (Cont'd):

When ICA information is not available at the requested Point of Interconnection, Screen M should be evaluated as follows: (L)  
(L)

Is the aggregate Generating Facility capacity on the Line Section less than 15% of Line Section peak load for all line sections bounded by automatic sectionalizing devices? ~~ii~~ (Cont'd.)

- If Yes (pass), Initial Review is complete.
- If No (fail), Supplemental Review is required.

(P/L)  
↓  
(P/L)

~~When ICA information is not available at the requested Point of Interconnection, Screen M should be evaluated as follows:~~

Significance:

1. Low penetration of Generating Facility capacity will have a minimal impact on the operation and load restoration efforts of Distribution Provider's Distribution System.

(P/L)  
↓  
(P/L)

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

The purpose of this Screen is solely to identify if the Generating Facility needs additional study and is not intended as justification for limiting the penetration of generation on a line section.

2. SUPPLEMENTAL REVIEW SCREENS

The Supplemental Review consists of Screens N through P. If any of the Screens are not passed, a quick review of the failed Screen(s) will determine the requirements to address the failure(s) or that Detailed Studies are required. In certain instances, Distribution Provider may be able to identify the necessary solution and determine that Detailed Studies are unnecessary. Some examples of solutions that may be available to mitigate the impact of a failed Screen are:

1. Replacing a fixed capacitor bank with a switched capacitor bank.

(Continued)

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

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

If the failure(s) cannot be addressed in Supplemental Review for Screens N through P, and generation is 100% or less of than the applicable ICA value (lowest of the ICA-SG profile or lowest value at each hour) the Distribution Provider must identify a reason and inform the customer why a specific technical constraint is not captured by the ICA and why the project must proceed to Electrical Independence Tests and Detailed Studies. Utilities also must address any concerns in the context of the Screen that triggers the mitigation or detailed study. (N)  
↓  
↓  
↓  
↓  
(N)

a. Screen N: Penetration Test

If Integration Capacity Analysis Values are available at the requested Point of Interconnection, evaluate Screen N as follows: (P)  
(P)

i) Penetration Level Using ~~Generating ICA Profile~~ ICA-SG 576 Profile: (T)/(P)

For Interconnection Requests based on Gross Nameplate Rating: Is the Generating Facility aggregate Gross Nameplate Rating equal to or below 90% less than or equal to 100% of the lowest value in the ICA-SG 576 Profile? (P)  
(T)/(P)  
(T)/(P)  
(P)

For Interconnection Requests based on typical PV Generation Profile: Is the Generating Facility Generation Profile, based on PVWatts® or equivalent, equal to or below 90% less than or equal to 100% of the ICA-SG value at each hour in the ICA-SG-576 Profile in any hour? (P)  
(T)/(P)  
↓  
(T)/(P)

ii) Screen F1: Did the Interconnection Request pass Screen F1? (P)

If yes to both of the above (pass), continue to Screen O. (P)  
↓  
(P)

If "no" to either or both of the above (fail), the Distribution Provider must perform a quick review of the failure within Supplemental Review and may determine the requirements to address the failure; otherwise Electrical Independence Tests or Detailed Studies are required. (T)/(P)  
↓  
(T)/(P)  
(T)

o If the Distribution Provider requires mitigations or Electrical Independence Tests and Detailed Studies, the Distribution Provider must provide the Customer the reason why. If the failure(s) that cannot be addressed in Supplemental Review, the Distribution Provider will conduct a review to identify the reasons why further studies are required. (N)  
↓  
(N)  
(D)  
↓  
(D)

(Continued)



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

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

a. Screen N: Penetration Test (Cont'd)

ii) Screen F1: Did the Interconnection Request pass Screen F1 (Cont'd)?

o If the failure(s) cannot be addressed in Supplemental Review, and generation is 100% or less of the applicable ICA value (lowest value of the ICA-SG profile or lowest value at each hour) the Distribution Provider must identify a reason why a specific technical constraint is not captured by the ICA and the why the project must proceed to Electrical Independence Tests and Detailed Studies.

o If voltage is a prevailing constraint, then the full range of smart inverter functions including the default volt/var function will be used in power flow analysis for the evaluation of the proposed project. This will reveal if the proposed project causes any voltage impacts of concern. If concerns related to steady state voltage, thermal, or protection exist and the Distribution Provider can identify simple upgrades through power flow analysis (e.g., installation of voltage regulator devices or protection devices to mitigate reduction of reach), then the Distribution Provider will determine the mitigation requirements within Screen N. When larger upgrades or complex protection evaluation is required, Screen N will fail, and the technical evaluation will be conducted under the Electrical Independence Tests or Detailed Study process.

o If no reason for further study is identified, or if requirements to address the failure can be identified in screen N, proceed to Screen O.

o Note: If Electrical Independence tests and Detailed Studies are required, Applicants will continue to the Electrical Independence Tests and Detailed Studies after review of the remaining Supplemental Review Screens if Applicant elects to proceed.

o If Integration Capacity Analysis Values are not available, evaluate Screen N as follows:

(P)

(P)

(T)/(P)

(T)/(P)

(P)

(T)/(P)

(T)/(P)

(P)

(P)

(Continued)



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

Sheet 157

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

a. Screen N: Penetration Test (Cont'd)

Where 12 months of line section minimum load data is available, can be calculated, can be estimated from existing data, or determined from a power flow model, is the aggregate Generating Facility capacity on the Line Section less than 100% of the minimum load for all line sections bounded by automatic sectionalizing devices upstream of the Generating Facility?

(P/L)

• If yes (pass), continue to Screen O.

• If no (fail), a quick review of the failure may determine the requirements to address the failure: If voltage is a prevailing constraint, then the full range of smart inverter functions including the volt/var function will be used in power flow analysis for the evaluation of the proposed project. This will reveal if the proposed project causes any voltage impacts of concern. If concerns related to steady state voltage, thermal, or protection exist and the Distribution Provider can identify simple upgrades through power flow analysis (e.g., installation of voltage regulator devices or protection devices to mitigate reduction of reach), then the Distribution Provider will determine the mitigation requirements within Screen N. When larger upgrades or complex protection evaluation is required, Screen N will fail, and the technical evaluation will be conducted under otherwise Electrical Independence Tests and Detailed Studies are required. Continue to Screen O. (Note: If Electrical Independence tests and Detailed Studies are required, Applicants will continue to the Electrical Independence Tests and Detailed Studies after review of the remaining Supplemental Review Screens, if Applicant elects to proceed.)

(P/L)

(N)

(N)

(T)(P/L)

(P/L)

(P/L)

Note 1: If none of the above options are available, this screen defaults to Screen M.

(D)

(D)

Note 12: The type of Generating Facility technology will be taken into account when calculating, estimating, or determining circuit or Line Section minimum load relevant for the application of this screen. For solar Generating Facilities with no battery storage, daytime minimum load will be used (i.e., 10 am to 4 pm for fixed panel solar Generating Facilities and 8 am to 6 pm for solar Generating Facilities utilizing tracking systems), while absolute minimum load will be used for all

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[other Generating Facility technologies.](#)

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[\(P/L\)](#)

(Continued)

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*Decision* D.20-09-035

*Issued by*  
**Robert S. Kenney**  
*Vice President, Regulatory Affairs*

*Submitted* May 19, 2021  
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*Resolution* \_\_\_\_\_



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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 157

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

a. Screen N: Penetration Test (Cont'd.)

Note 23: When this screen is being applied to a NEM Generating Facility, the net export in kW, if known, that may flow across the Point of Common Coupling into Distribution Provider's Distribution System will be considered as part of the aggregate generation.

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Note 43: Distribution Provider will not consider as part of the aggregate Generating Facility capacity for purposes of this screen Generating Facility capacity known to be already reflected in the minimum load data.

(T)

Note 54: NEM Generating Facilities with net export less than or equal to 500 kW that may flow across the Point of Common Coupling into Distribution Provider's Distribution or Transmission System will not be studied in the WDT Transmission Cluster Study Process, but may be studied under the Independent Study Process.

(T)

Significance: Penetration of Generating Facility capacity that does not result in power flow from the circuit back toward the substation will have a minimal impact on equipment loading, operation, and protection of the Distribution System.

b. Screen O: Power Quality and Voltage Tests

In aggregate with existing Generating Facility capacity on the Line Section, distribution circuit, and/or substation.

i) Can it be determined within the Supplemental Review that the voltage regulation on the line section can be maintained in compliance with Commission Rule 2 and/or Conservation Voltage Regulation voltage requirements under all system conditions?

ii) Can it be determined within the Supplemental Review that the voltage fluctuation is within acceptable limits as defined by IEEE ~~1453-1547-2018, 7.2~~ or utility practice similar to ~~IEEE1453~~IEEE 1547-2018, 7.2?

(P)  
(P)

(Continued)



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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 158

G. ENGINEERING REVIEW DETAILS (Cont'd.)

2. SUPPLEMENTAL REVIEW SCREENS (Cont'd.)

b. Screen O: Power Quality and Voltage Tests (Cont'd.)

In aggregate with existing Generating Facility capacity on the Line Section, distribution circuit, and/or substation. (Cont'd.)

iii) Can it be determined within the Supplemental Review that the harmonic levels meet IEEE 519-1547-2018, 7.3 limits at the Point of Common Coupling (PCC)? (P)

iv) Can it be determined within the Supplemental Review that the Generating Facility will not cause any voltage impacts considering the settings of the Volt-Var function and the characteristics of the circuit segment?

- If yes to all of the above (pass), continue to Screen P.
- If no to any of the above (fail), a quick review of the failure may determine the requirements to address the failure; otherwise Electrical Independence Tests and Detailed Studies are required. Continue to Screen P. (Note: If Electrical Independence tests and Detailed Studies are required, Applicants will continue to the Electrical Independence Tests and Detailed Studies after review of the remaining Supplemental Review Screens.)

Significance: Adverse voltages and undesirable interference may be experienced by other Customers on Distribution Provider's Distribution System caused by operation of the Generating Facility(ies).

c. Screen P: Safety and Reliability Tests

Does the location of the proposed Generating Facility or the aggregate generation capacity on the Line Section create impacts to safety or reliability that cannot be adequately addressed without Detailed Study?

- If yes (fail), review of the failure may determine the requirements to address the failure; otherwise Electrical Independence Tests and Detailed Studies are required. Continue to Section G.3.
- If no (pass), Supplemental Review is complete.

(Continued)

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G. ENGINEERING REVIEW DETAILS (Cont'd.)

3. DETAILED STUDY SCREENS (Cont'd.)

c. Independent Study Process and Distribution Group Study Process Interconnection Studies (Cont'd.)

ii) Interconnection Facilities Study and DGS Phase II Interconnection Study. (Cont'd.)

(1) Scope and Purpose of the Interconnection Facilities and DGS Phase II Interconnection Study. (Cont'd.)

Good Utility Practice to physically and electrically connect the Generating Facility to the Distribution or Transmission System. The Interconnection Facilities Study or DGS Phase II Interconnection Study shall also identify (i) the electrical switching configuration of the connection equipment, including, without limitation: the transformer, switchgear, meters, and other station equipment; the nature and estimated cost of any Distribution Provider's Interconnection Facilities, Distribution Upgrades, and Network Upgrades necessary to accomplish the interconnection; and an estimate of the time required to complete the construction and installation of such facilities. The analyses in the Interconnection System Impact Study (or DGS Phase I Interconnection Study in the case of the Distribution Group Study Process) will be updated as necessary in the Interconnection Facilities Study (or DGS Phase II Interconnection Study), to account for withdrawal of interconnection requests in the interconnection queue.

H. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS

Section H shall be used for interconnection of non-inverter based technologies.

~~Section H shall also 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.~~

(P)  
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(P)

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 168

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

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

**a. Protective Functions Required (Cont'd.)**

ii) 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 59.3 Hz to 60.5 Hz, inclusive, and are stable for at least 60 seconds; and

iii) A function to prevent the Generating Facility 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.

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. (P)  
(P)

The Generating 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 1547-4.2.12018, 6.2.1). (P)  
The Generating Facility shall cease to energize Distribution Provider's Distribution circuit prior to re-closure by Distribution Provider's Distribution System equipment (IEEE 1547-4.2.22018, 6.3). (P)

**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.

Generating facilities which operate using a momentary parallel scheme are not required to comply with the functional requirements as required in the IEEE 1547-2018 standard. (P)  
(P)

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(P/L)

(Continued)



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

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

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

c. Suitable Equipment Required ~~(Cont'd.)~~

(P)

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 Generating Facility and Interconnection Facilities shall be designed so that the failure of any single device or component shall not potentially compromise the safety and reliability of Distribution Provider's Distribution and Transmission System. The Generating Facility paralleling-device shall be capable of withstanding 220% of the Interconnection Facility rated voltage (IEEE 1547-4.1.8-32018, 4.11). 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 1547-4.1.8-22018, 4.11).

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(P)

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 Generating Facility 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:
  - a) for Emergency purposes quickly and conveniently 24 hours a day by Distribution Provider personnel for construction,

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 171

**H. GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS**  
(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 Generating Facility, Distribution Provider and Producer may agree upon other arrangements

**2. PREVENTION OF INTERFERENCE**

Producer shall not operate Generating or Interconnection Facilities 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 Generating Facility shall meet the following criteria:

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

(P)

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 POC.

(P)

**a. Voltage Regulation**

The Generating Facility shall not actively regulate the voltage at the PCC while in parallel with Distribution Provider's Distribution System. The Generating Facility 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)~~.

(P)

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 175

**H. 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 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~~2018~~, 4.10)

(P)

**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 PCC caused by the Generating Facility should not exceed the limits of (IEEE 1547-4.3.2~~2018~~, 7.2.3), ~~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.

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 176

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

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

**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~~2018, 4.10) (See Section G.1.i, line configuration).

(P)

**f. Frequency**

Distribution Provider controls system frequency, and the Generating Facility 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 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.

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

Sheet 178

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

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

**g. Harmonics**

When the Generating Facility 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 H.3~~ **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 Generating Facility connected ~~(IEEE 1547-4.3.3.)~~. The harmonic distortion of a Generating Facility shall be evaluated using the same criteria as for the Host Loads.

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***Table H.3***

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

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

[1] — IEEE 1547-4.3.3

[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.

(P)

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

Sheet 180

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

**3. TECHNOLOGY SPECIFIC REQUIREMENTS**

**a. Technology Specific Requirements**

Three-Phase Synchronous Generators: For three phase Generators, the Generating Facility circuit breakers shall be three-phase devices with electronic or electromechanical control. Producer shall be responsible for properly synchronizing its Generating Facility with Distribution Provider's Distribution or Transmission System by means of either manual or automatic synchronous equipment. Automatic synchronizing is required for all synchronous Generators that have a Short Circuit Contribution Ratio (SCCR) exceeding 0.05. Loss of synchronism protection is not required except as may be necessary to meet Section H.2.d (Flicker) (IEEE 1547-4.2.52018, 7.3). Unless otherwise agreed upon by Producer and Distribution Provider, synchronous Generators shall automatically regulate power factor, not voltage, while operating in parallel with Distribution Provider's Distribution System. A power system stabilization Function is specifically not required for Generating Facilities under 10 MW Net Rating.

(P)

**b. Induction Generators**

Induction Generators (except self-excited Induction Generators) do not require a synchronizing Function. Starting or rapid load fluctuations on induction Generators can adversely impact Distribution Provider's Distribution or Transmission System voltage. Corrective step-switched capacitors or other techniques may be necessary and may cause undesirable ferro-resonance. When these counter measures (e.g. additional capacitors) are installed on Producer's side of the PCC, Distribution Provider must review these measures. Additional equipment may be required as determined in a Supplemental Review or an Interconnection Study.

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**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 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.

(P)

**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.

\* Any 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.

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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 192

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 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 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 real-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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Sheet 194

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]**

Individual harmonic order, h (odd harmonics) [3]	h<11	11≤ h<17	17≤ h<23	23≤ h<35	35≤ h	Total demand distortion
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 Real Power Production active power output.

(T)

(Continued)



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**GENERATING FACILITY INTERCONNECTIONS**

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

2. PREVENTION OF INTERFERENCE (Cont'd.)

i. Fixed Power Factor (Cont'd.)

(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 ~~Real Power Production~~ active power output. (T)

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 ~~Real Power Production~~ active power output. This dynamic Volt/VAR capability shall be able to be activated or deactivated in accordance with Distribution Provider requirements. (T)  
(T)

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 ~~real power production~~ active power output, but the maximum reactive power provided to the system shall be as directed by the Distribution Provide (T)
- Reduction of ~~real power production~~ active power output is allowed to meet the required reactive power ranges. (T)

(Continued)



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**GENERATING FACILITY INTERCONNECTIONS**

Sheet 197

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

l. 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 ~~real power production~~ active power output as a function of system frequency, in accordance with the following:

(T)  
(T)

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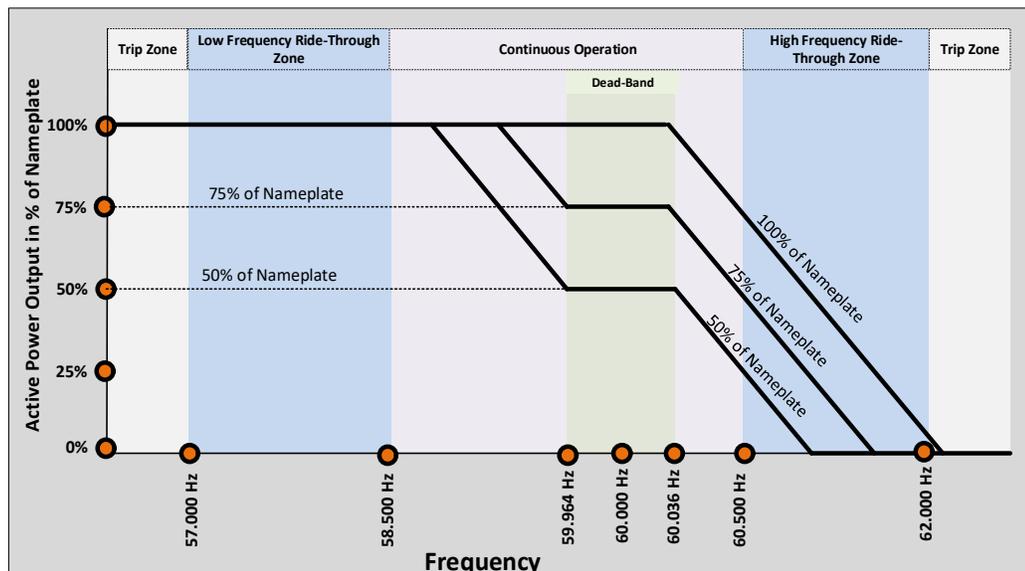
Hh. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS (Cont'd.)

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 ~~real power production~~ active power output. (T)
- 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



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

(Continued)



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

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 ~~real power production~~ 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:

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- 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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**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), and IEEE 929 as well as the testing described in May 1999 New York State Public Service Commission's Interconnection Requirements. As noted in Section B, this Rule has been revised to be consistent with ANSI/IEEE 1547-2003 Standard for Interconnecting Distribution Resources with Electric Power Systems.

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Sheet 223

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

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.

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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.

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**GENERATING FACILITY INTERCONNECTIONS**

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

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.

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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.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 Section 46.3~~ will be considered Non-Islanding for the purposes of these Interconnection requirements. The test is required only for devices for which a Certified Non-Islanding designation is desired.

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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.

(Continued)



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Sheet 229

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-~~5.1.3.22018~~, 4.11.2).

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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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Sheet 231

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

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 1547-5.1.1B2018, 4.10

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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 1547-5.1.3.32018, 4.11.3).

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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).

(Continued)



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

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 SA-SB-listed grid support non-islanding inverters; and, (P)
  - 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.

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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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Sheet 257

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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**ELECTRIC RULE NO. 21  
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Sheet 257

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 58.8 Hz to 61.2 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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Sheet 257

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, 4.11.4).

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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Sheet 257

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.

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(Continued)



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Sheet 257

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 (POC)

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**ELECTRIC RULE NO. 21  
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Sheet 257

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

(P)

2. Prevention of Interference (Cont'd)

a. Voltage Regulation

The Generating Facility shall not actively regulate the voltage at the PCC while in parallel with Distribution Provider's Distribution System. The Generating Facility shall not cause the service voltage at other customers to go outside the requirements of ANSI C84.1-1995, Range A.

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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**ELECTRIC RULE NO. 21  
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Sheet 257

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. 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 (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.

(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)

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, 4.10.4) (See Section G.1.i, line configuration).

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Sheet 257

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

(P)

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

<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><math>f \geq 62.0</math></u>	<u>0.16</u>
<u>OF1</u>	<u>61.2</u>	<u><math>61.2 \leq f &lt; 62</math></u>	<u>300</u>
<u>Continuous Operation</u>	<u>NA</u>	<u><math>58.5 &lt; f &lt; 61.2</math></u>	<u>NA</u>
<u>UF1</u>	<u>58.5</u>	<u><math>56.5 &lt; f \leq 58.5</math></u>	<u>300</u>
<u>UF2</u>	<u>56.5</u>	<u><math>f \leq 56.5</math></u>	<u>0.16</u>

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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

<u>Frequency (Hz)</u>	<u>Operating Mode</u>	<u>Minimum time(s)</u>
<u>f&gt;62.0</u>	<u>No Ride-Through requirements apply to this range</u>	<u>NA</u>
<u>61.2&lt;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&lt;58.8</u>	<u>Mandatory Operation</u>	<u>299</u>
<u>F&lt;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).

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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-4.

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(P)

2. Prevention of Interference (Cont'd)

Dynamic Volt/Var Operations Default Settings

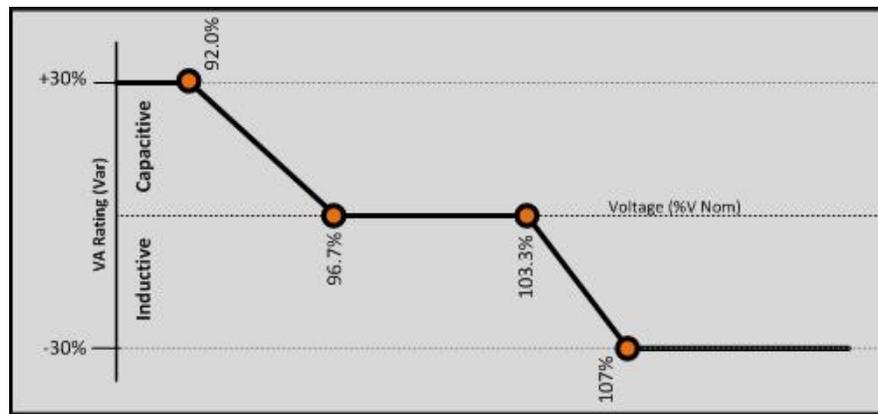
Table P-4 and Figure P-1 depict the default setting, which should be applied for all inverter size. Specific volt/var settings may be required for larger generating facilities (such as 100 kW or greater) or for specific areas with the Distribution System as determined by the Distribution Provider.

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

Table P-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%	Q2	0	Unity Power Factor
V3	103.3%	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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P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)

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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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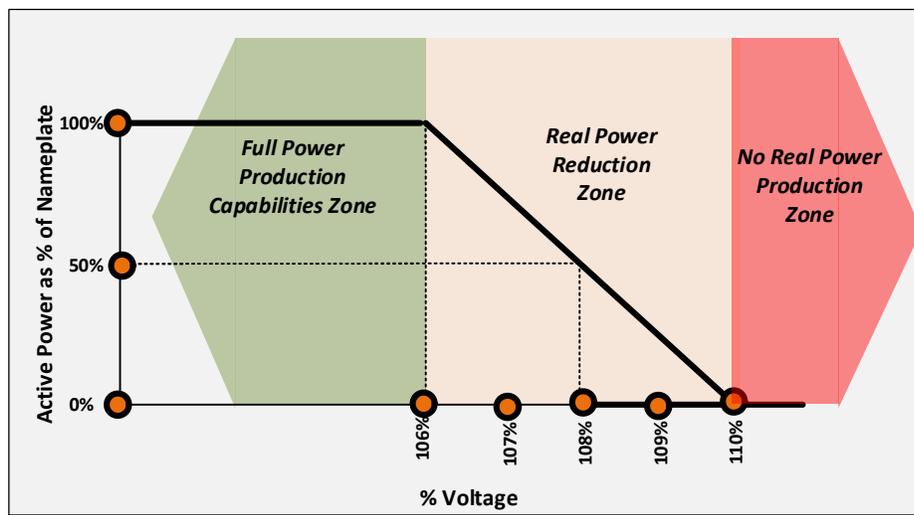
(P)

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)

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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 P-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>Activated</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.

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

(P)

2. Prevention of Interference (Cont'd)

s. Storage Inverter Normal Operation Ramp Control Requirements

Smart Inverters used for energy storage applications shall 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 Conservative 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, 6.4.2.5.

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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(P)

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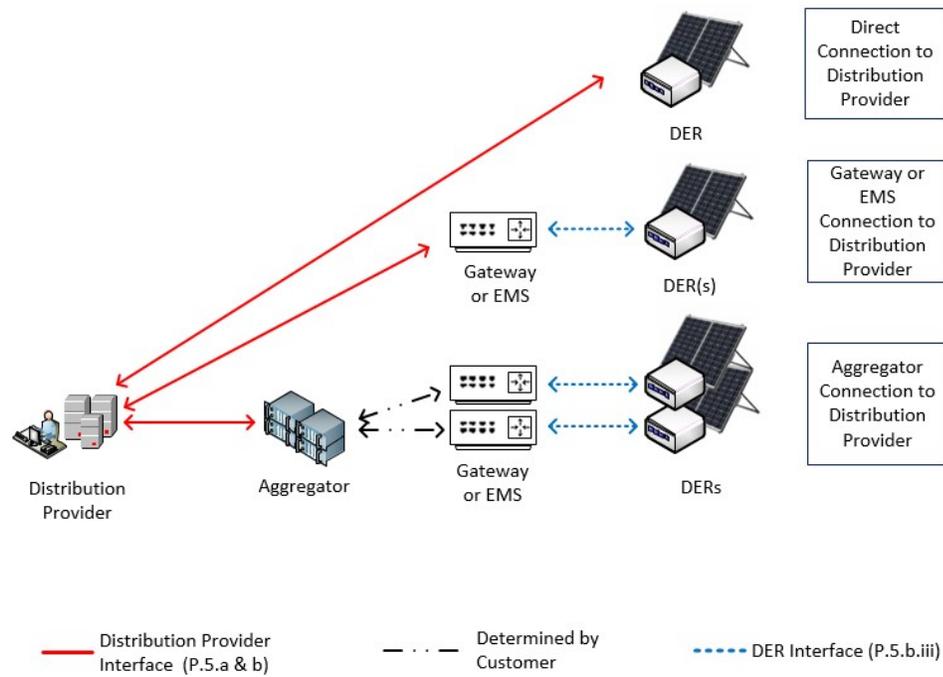
**P. SMART INVERTER GENERATING FACILITY DESIGN AND OPERATING REQUIREMENTS FOR UL1741SB INVERTERS (Cont'd)**

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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)

(P)

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.

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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.

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6. Scheduling Capability Requirements

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:

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

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

- 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.
- Scheduling capability requirements may be implemented at the DER within the Generating Facility.
- 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.
- Other options may be utilized by mutual agreement between the Applicant and Distribution Provider

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6. Scheduling Capability Requirements (Cont'd)

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.

7. Monitoring and Telemetry Requirements

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:

- a. Smart Inverter production or consumption of active power (watts).
- b. Smart Inverter consumption or production of reactive power (vars)
- c. Phase measured at the AC terminals of the Smart Inverter (volts)
- d. Frequency measured at the AC terminals of the Smart Inverter (Hz)
- e. Connection Status
- f. Alarm Status

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.

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7. Monitoring and Telemetry Requirements (Cont'd)

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:

• 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

• 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

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

- 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.
- When a Generating Facility includes Smart Inverters and other technologies such as synchronous or induction generation systems, the Generating Facility shall communicate the following:
  - The production or consumption of active and reactive power shall be communicated in aggregate of all Smart Inverters within the Generating Facility.
  - 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)

7. Monitoring and Telemetry Requirements (Cont'd)

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

- 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.
- 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.
- 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.

(P)

(Continued)



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

Sheet 257

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

(P)

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.

(P)

(Continued)



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

Sheet 257

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

(P)

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)

**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 Blasing Smith Wynne, P.C.  
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

East Bay Community Energy Ellison  
Schneider & Harris LLP  
Engineers and Scientists of California

GenOn Energy, Inc.  
Goodin, MacBride, Squeri, Schlotz &  
Ritchie  
Green Power Institute  
Hanna & Morton  
ICF  
International Power Technology

Intertie

Intestate Gas Services, Inc.  
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  
NLine Energy, Inc.  
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.  
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