

## Distributed Generation Protection Requirements

### SUMMARY

The protection requirements for connecting new Distributed Generation (DG) have been modified to reduce the need for Direct Transfer Trip (DTT) schemes which are costly to employ and difficult to manage.

Level of Use: Informational Use

### AFFECTED DOCUMENT

Distribution Interconnection Handbook (DIH)

TD-2306B-001, Interconnecting Large 2-20MW Generation Systems

### TARGET AUDIENCE

Employees involved with generation interconnection on electric distribution circuits.

### DEFINITIONS

**Certified Inverter** – For the purposes of this document it is an inverter that has been “Certified” per UL 1741 or UL 1741A to trip in 2 seconds or less after the formation of an unintended island.

**DG; Distributed Generation** – Electric power producing devices or equipment, not directly connected to the bulk electric system, includes both generators and electric storage devices.

**Line Section** – Defines the zone of protection for the DG in which it is expected to detect and trip for faults and is bounded by a 3 phase fault interrupting device. A given line section or sections could include multiple zones of protection.

**Minimum load** – The absolute minimum load that is based on a years’ worth of load data. For solar generating facilities with no battery storage daytime load will be used (10 am to 4 pm for fixed panel installations and 8 am to 6 pm for solar generating facilities with tracking systems).

### WHAT YOU NEED TO KNOW

#### Distribution Evaluation

The requirements below are subject to the following:

- (1) PG&E at its discretion may still require DTT on any DG system, especially for those that may not trip for end of line faults and has significant fault current contributions.
- (2) Phase and ground protection are required to detect end-of-line faults. This may be waived for smaller certified units that have aggregated fault current contribution less than 10% and expected to trip due to anti-islanding protection after the feeder breaker tripped.

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- (3) These exemptions do not apply to certified and non-certified Inverters with Stand-Alone capabilities.
- (4) Transmission DTT requirements are independent and still apply.
- (5) For a line section with all certified inverters, reclose blocking will not be required if the first reclose can be delayed to 10 seconds.
- (6) If an existing uncertified DG already has DTT then this uncertified DG would not count towards the 10% limit for the “other machine or uncertified DG is > 10% of project” screen. Other uncertified DG with previously approved protection may still need to be re-studied on a case by case basis.

### 1 Certified Inverter:

#### 1.1 < 40 kW, then

- DTT and ground fault protection are not required

#### 1.2 $\geq$ 40 kW and < 1000 kW, and

##### 1. Line section aggregated DG $\leq$ 50% of minimum load then

- DTT and ground fault protection are not required

##### 2. Line section aggregated DG > 50% of minimum load, and

###### a. Aggregate machine $\leq$ 40% or uncertified DG is < 10% of the aggregate DG (all types) on line section, then

- DTT and ground fault protection are not required

###### b. Aggregate machine > 40% or uncertified DG is > 10% of the aggregate DG (all types) on line section requires:

- Ground Fault Protection and Reclose Blocking
- PG&E SCADA equipped recloser or interrupter

#### 1.3 $\geq$ 1000 kW, and

##### Line section aggregated DG $\leq$ 50% of minimum load, then

- Requires PG&E SCADA equipped recloser or interrupter

##### 1. Line section aggregated DG > 50% of minimum load, and

###### a. Aggregate machine $\leq$ 40% or uncertified DG is < 10% of the aggregate DG (all types) on line section, and

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- (1) Short circuit contribution ratio  $\leq 10\%$ , then
    - PG&E SCADA equipped recloser or interrupter
  - (2) Short circuit contribution ratio  $> 10\%$ , then requires:
    - Ground Fault Protection and Reclose Blocking
    - PG&E SCADA equipped recloser or interrupter
- b. Aggregate machine  $> 40\%$  or uncertified DG is  $> 10\%$  of the aggregate DG (all types) on line section requires:
- Ground Fault Protection and Reclose Blocking
  - PG&E SCADA equipped recloser or interrupter

### 2 Uncertified Inverter:

Requires:

- Ground Fault Protection and Reclose Blocking
- PG&E SCADA equipped recloser or interrupter
- Customer side interrupter or recloser
- Redundant sets of PG&E approved protective relays

### 3 Machine – Induction or Synchronous:

3.1  $< 40$  kW, then DTT and ground fault protection are not required

3.2  $\geq 40$  kW and  $< 400$  kW, and

1. Line section aggregated DG  $\leq 50\%$  of minimum load, and
  - a. Short circuit contribution ratio  $\leq 10\%$ , then requires:
    - Redundant sets of PG&E approved protective relays
  - b. Short circuit contribution ratio  $> 10\%$ , then requires:
    - Ground Fault Protection and Reclose Blocking
    - Redundant sets of PG&E approved protective relays
2. Line section aggregated DG  $> 50\%$  of minimum load, then requires:

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- Ground Fault Protection and Reclose Blocking
- PG&E SCADA equipped recloser or interrupter
- Redundant sets of PG&E approved protective relays

3.3  $\geq 400$  kW, and

1. Line section aggregated DG  $\leq 50\%$  of minimum load, then requires:
  - Ground Fault Protection and Reclose Blocking
  - Redundant sets of PG&E approved protective relays
2. Line section aggregated DG  $> 50\%$  of minimum load, then requires:
  - Ground Fault Protection and Reclose Blocking
  - PG&E SCADA equipped recloser or interrupter
  - Redundant sets of PG&E approved protective relays

Note: When distribution upgrades such as reclose blocking are required additional time is needed before the DG facility is allowed to parallel with the PG&E system.

Flow chart – 1 is appended in reference to the requirements in sections 1-3 above.

### **Transmission and Substation Evaluation**

For distributed generation, (i.e. generation connected to non-dedicated distribution circuits), the protection requirements for substation and transmission installations are as follows:

The requirements below are subject to the following:

- (1) PG&E at its discretion may still require DTT on any DG system, especially for those that may not trip for end of line faults and has significant fault current contribution.
- (2) If an existing uncertified DG already has DTT this uncertified DG would not count towards the 40% limit for machines or the 10% limit of "Other uncertified DG". This includes existing hardwire CB tripping. Other uncertified DG with previously approved protection may still need to be restudied on a case per case basis.
- (3) The machine generation shall be fixed P/Q type (fixed power factor).
- (4) Excess generation on an ungrounded system could lead to temporary phase to ground overvoltages during transmission SLG faults, an evaluation will be needed to determine if overvoltage mitigation is required.

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- (5) These exemptions do not apply to certified and non-certified Inverters with Stand-Alone capabilities.

### 4 Certified Inverter Substation and Transmission Line Section Review:

#### 4.1 Substation Transformer

1. Transformer aggregated DG  $\leq$  50% of minimum load then
  - DTT and transformer tripping is not required. End of review.
2. Transformer section aggregated DG  $>$  50% of minimum load

If the substation transformer is ungrounded then

- a. Evaluation will be required which may include grounding the transformer or installation of an overvoltage tripping scheme to prevent overvoltage of Transmission equipment on the affected line section.

If the substation transformer is grounded

- b. Aggregate machine  $\leq$  40% or uncertified DG to total generation ratio is  $<$  10% of the transformer aggregate DG (all types), then
  - DTT and transformer tripping are not required continue to substation review.
- c. Aggregate machine  $>$  40% or uncertified DG to total generation ratio is  $>$  10% of the transformer aggregate DG (all types), the following is required:
  - Transformer protection tripping of feeder breakers is required. Tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme would also be required for a single transformer station. Continue to substation review.

#### 4.2 Substation Review

1. Total Substation aggregated DG  $\leq$  50% of minimum load, then
  - DTT and transformer tripping are not required. End of review.
2. Total Substation aggregated DG  $>$  50% of minimum load, and
  - a. Aggregate machine  $\leq$  40% or uncertified DG to total generation ratio is  $<$  10% of the substation aggregate DG (all types), then
    - DTT and transformer tripping are not required continue to transmission line review.

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- b. Aggregate machine > 40% or uncertified DG to total generation ratio is > 10% of the substation aggregate DG (all types), the following is required:
  - Station tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme is required. Continue to transmission line review.

### 4.3 Transmission Line Section Review

1. Total line section aggregated DG  $\leq$  50% of minimum load, then
  - DTT from transmission terminals to feeder breakers is not required. End of review.
2. Total Substation aggregated DG > 50% of minimum load, and
  - a. Aggregate machine  $\leq$  40% or uncertified DG to total generation ratio is < 10% of the line section aggregate DG (all types), then
    - DTT from transmission terminals to feeder breakers is not required. End if review.
  - b. Aggregate machine > 40% or uncertified DG to total generation ratio is > 10% of the line section aggregate DG (all types), then the following is required:
    - DTT from transmission terminals to feeder breakers is required.
    - Reclose blocking at the transmission terminals is required if not installed.

A second flow chart is appended in reference to the requirements in section 4 above.

## 5 Machine Based Generation Substation and Transmission Line Section Review:

The requirements below are subject to the following:

- (1) PG&E at its discretion may still require DTT on any DG system, especially for those that may not trip for end of line faults and has significant fault current contribution.
- (2) If an existing uncertified DG already has DTT this uncertified DG would not count towards the 40% limit for machines or the 10% limit of "Other uncertified DG". This includes existing hardware CB tripping. Other uncertified DG with previously approved protection may still need to be restudied on a case per case basis. The machine generation shall be fixed P/Q type (fixed power factor).
- (3) Excess generation on an ungrounded system could lead to temporary phase to gnd overvoltages during transmission SLG faults, an evaluation will be needed to determine the if overvoltage mitigation is required.

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- (4) Phase and ground fault detection for transmission EOL faults is required via 59N, 51N, 51C, 51V or 21 elements. Small generators may not be able to detect all transmission EOL faults, therefore as long as aggregate gen is < 50% of minimum load, EOL fault detection for all transmission faults is not required. For generation with total SCCR > 0.1 EOL fault detection is required for all transmission faults.

### 5.1 Substation Transformer

1. Transformer aggregated DG  $\leq$  50% of minimum load then
  - a. DTT and transformer tripping is not required. End of review.
2. Transformer section aggregated DG > 50% of minimum load.

If the substation transformer is ungrounded then

- a. Evaluation will be required which may include grounding the transformer or installation of an overvoltage tripping scheme to prevent overvoltage of Transmission equipment on the affected line section.

If the substation transformer is grounded

- b. Aggregate machine generation to total generation ratio is  $\leq$  40% or aggregate uncertified DG to total generation ratio is  $\leq$  10%, then
  - (1) Transformer Aggregate machine generation  $\leq$  50% of minimum load then
    - DTT and transformer tripping are not required continue to substation review.
  - (2) Transformer Aggregate machine generation > 50% of minimum load then
    - DTT and transformer tripping are required continue to substation review.
- c. Aggregate machine generation to total generation ratio is > 40% or aggregate uncertified DG to total generation ratio is > 10%, the following is required:
  - (1) Transformer protection tripping of feeder breakers is required. Tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme would also be required for a single transformer station. Continue to substation review.

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### 5.2 Substation Review

1. Total Substation aggregated DG  $\leq$  50% of station minimum load, then
  - a. DTT and transformer tripping are not required. End of review.
2. Total Substation aggregated DG  $>$  50% of station minimum load, and
  - a. Aggregate machine generation to total generation ratio is  $\leq$  40% or uncertified DG to total generation ratio is  $\leq$  10% of the substation aggregate DG, then
    - (1) Station Aggregate machine generation  $\leq$  50% of minimum load then.
      - Station tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme is not required.
    - (2) Station Aggregate machine generation  $>$ 50% of minimum load then
      - Station tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme is required. Continue to transmission line review.
  - b. Aggregate machine generation to total generation ratio is  $>$  40% or uncertified DG to total generation ratio is  $>$  10% of the substation aggregate DG, the following is required:
    - (1) Station tripping via the HV Bus Differential or Total Overcurrent (TOC) scheme is required. Continue to transmission line review.

### 5.3 Transmission Line Section Review

1. Total line section aggregated DG  $\leq$  50% of minimum line section load, then
  - a. DTT from transmission terminals to feeder breakers is not required. End of review.
2. Total Substation aggregated DG  $>$  50% of minimum line section load, and
  - a. Aggregate machine generation to total generation ratio is  $\leq$  40% or uncertified DG to total generation ratio is  $\leq$  10% of the line section aggregate DG, then
    - (1) Line Section Aggregate machine generation  $\leq$  50% of minimum load then.
      - DTT from transmission terminals to feeder breakers is not required.



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- (2) Line Section Aggregate machine generation >50% of minimum load then
  - DTT from transmission terminals to feeder breakers is t required.
- b. Aggregate machine generation to total generation ratio is > 40% or uncertified DG to total generation ratio is > 10% of the line section aggregate DG, then the following is required:
  - (1) DTT from transmission terminals to feeder breakers is required.
  - (2) Reclose blocking at the transmission terminals is required if not installed

A third flow chart is appended in reference to the requirements in section 5 above.

### DOCUMENT APPROVER

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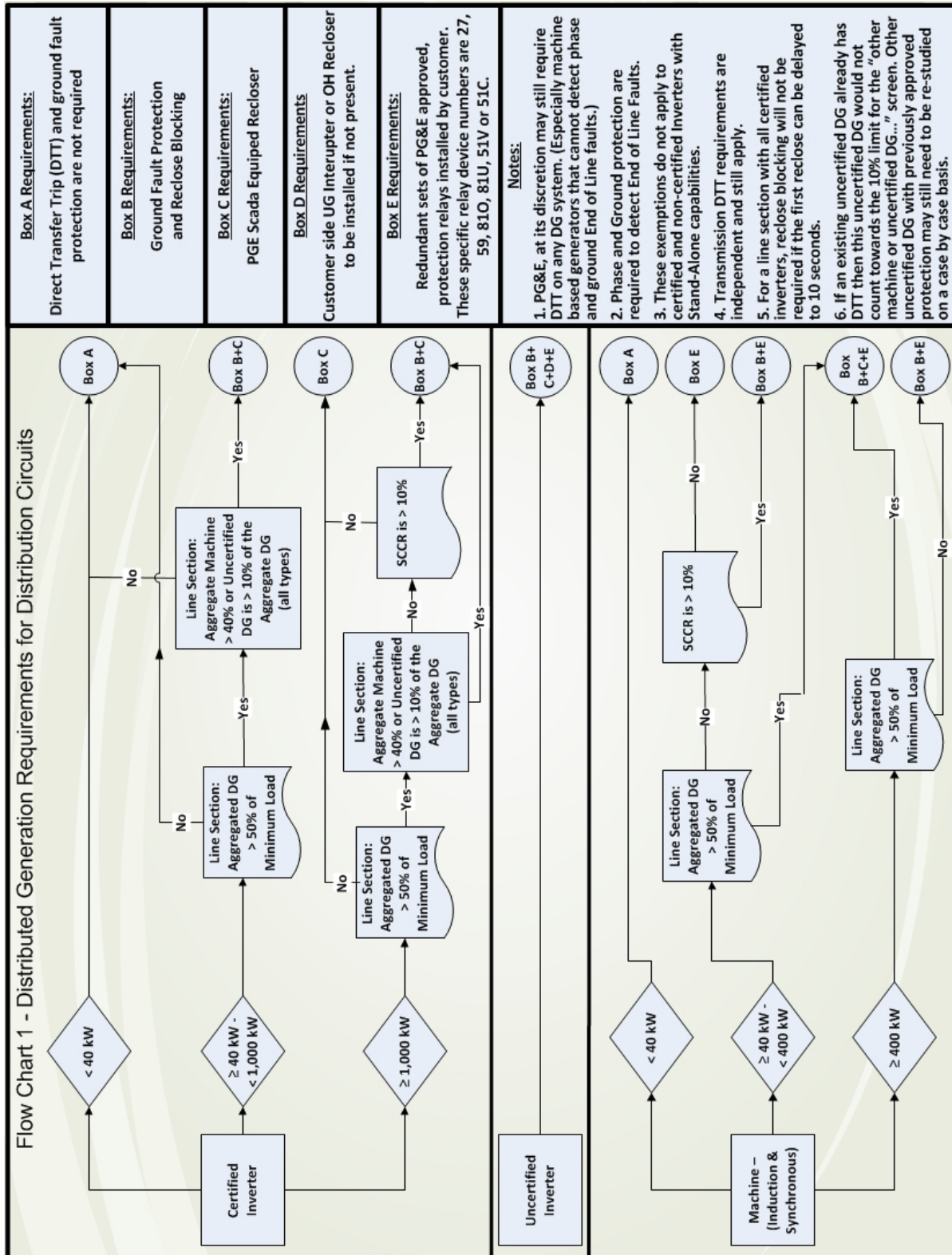
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### INCLUSION PLAN

This bulletin will reside on the [DIH](#) webpage without an inclusion plan at this time.

## Distributed Generation Protection Requirements



**Box A Requirements:**  
 Direct Transfer Trip (DTT) and ground fault protection are not required

**Box B Requirements:**  
 Ground Fault Protection and Reclose Blocking

**Box C Requirements:**  
 PGE Scada Equipped Recloser

**Box D Requirements**  
 Customer side UG Interrupter or OH Recloser to be installed if not present.

**Box E Requirements:**  
 Redundant sets of PG&E approved, protection relays installed by customer. These specific relay device numbers are 27, 59, 810, 81U, 51V or 51C.

**Notes:**

1. PG&E, at its discretion may still require DTT on any DG system. (Especially machine based generators that cannot detect phase and ground End of Line faults.)
2. Phase and Ground protection are required to detect End of Line Faults.
3. These exemptions do not apply to certified and non-certified Inverters with Stand-Alone capabilities.
4. Transmission DTT requirements are independent and still apply.
5. For a line section with all certified inverters, reclose blocking will not be required if the first reclose can be delayed to 1.0 seconds.
6. If an existing uncertified DG already has DTT then this uncertified DG would not count towards the "10% limit for the "other machine or uncertified DG..." screen. Other uncertified DG with previously approved protection may still need to be re-studied on a case by case basis.



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