Summary of General Technical Requirements for the Interconnection of Distributed Generation (DG) to PG&E's Distribution System

This document is intended to be a general overview of PG&E's current technical requirements for interconnection of distributed generation to PG&E's distribution system. It is not intended to be a substitute for PG&E's Electric Rule 21 or PG&E's Interconnection Handbook and should not be relied on to determine the interconnection requirements for any project. While PG&E has made every effort to ensure that this general overview is accurate and consistent with Electric Rule 21 and PG&E's Interconnection Handbook, where there is any perceived or actual inconsistency, the requirements of Electric Rule 21 and the Interconnection Handbook shall govern. In addition, nothing in this document limits PG&E's rights or obligations to exercise its discretion in individual cases to ensure the safety and reliability of the electric distribution system. Capitalized terms not otherwise defined in this document are defined in Electric Rule 21. Finally, many of these requirements are interim and are evolving as experience accumulates with DG interconnections. They are therefore subject to change.

Two types of technology are commonly used for DG applications: A: Inverter-Based Technology, and B: Rotating Machine Technology. These are discussed separately below.

General DG Technical Requirements:

1. All interconnections must comply with all applicable local, state, federal, and PG&E safety rules.

2. An "accessible, visible, and lockable" disconnect device is required for all interconnecting DG. For detailed definitions and acceptable models, contact your PG&E interconnection representative.

3. An acceptable "anti-islanding" scheme is required for all interconnections. All exporting entities, including inadvertent export and all net metering projects, interconnecting to the PG&E system with existing synchronous generators, on the same Distribution Feeder, will be reviewed on a case-by-case basis to ensure protection adequacy against islanding.

4. All steady-state and transient operating limits for voltage, flicker voltage, frequency, harmonic contents, etc. must comply with PG&E's Electric Rule 2, Rule 21, IEEE standards and all other applicable local, state, or federal regulations.

A: Inverter based Technology

This refers to all projects that have an inverter interface at the interconnection point including high frequency micro-turbines.

A-1: 10 kW or less Net Energy Metering (E-NET) Interconnections

In general, a standard E-NET application is approved for interconnection to PG&E's Distribution System if the following three conditions are met:

1. Approved inverter(s)
2. Approved disconnect switch
3. The aggregate Generating Facility capacity on the Line Section less than 15% of the Line Section peak load.

An inverter is considered approved (certified) if it is on the California Energy Commission's (CEC) "Emerging Renewables Rebate Program" list accessible via the following link:
http://www.consumerenergycenter.org/erprebate/eligible_inverters.html

For those inverters not listed in the CEC's Emerging Renewables Rebate Program" list, proof of certification under UL-1741 will be required.

Multiple units of inverters operating in a "master-slave" configuration are approved provided that the units are individually approved and are all the same model from the same manufacturer (different sizes are allowed).

Similarly, multiple units of inverters of different model and type, operating in parallel configuration are also approved, as long as there is no modification made to the unit such as adding an internal wiring between the units.

Previously tested and PG&E approved units of the same nameplate capacity, model**,** and manufacturer do not require additional tests.

A-2: Greater than 10 kW up to 1000 kW Net Energy Metering (E-NET) Interconnections

In general, a 10 kW up to 1000 kW E-NET application is approved for interconnection to the PG&E system, **as long as it does not have an existing synchronous generator on the same feeder**, if it satisfactorily passes all Rule 21 Initial Review Process (IRP) screens, except for the "Export" screen which is inapplicable to net metering projects.

For these larger E-NET interconnections, an inverter is considered approved (certified) it meets one of the following three criteria:

1. It is UL-1741 certified, and on the CEC's approved inverter list. This list is accessible via the link:
   http://www.energy.ca.gov/distgen/interconnection/certification.html

2. It is on the CEC's "Emerging Renewables Rebate Program" list. This list is accessible via the link:

http://www.consumerenergycenter.org/erprebate/eligible_inverters.html

3. It is approved by PG&E on the basis of NRTL testing. Inverters not meeting the above criteria must have been tested pursuant to the criteria set by Rule 21, Section J.3.a. The tests must be performed by a nationally recognized testing laboratory (NRTL) and test reports submitted for PG&E's approval. Supplemental review guidelines (available on the CEC website) may be consulted for additional testing information.

Multiple units of inverters operating in a "master-slave" configuration are approved provided that units are the same model from the same manufacturer (though different nameplate capacities are allowed).

For example:

1. **In a single facility** where multiple inverters are installed operating in a cluster of master-slave configurations, the inverters are considered approved as long as the individual units are approved and all units are the same model made by the same manufacturer.

2. **In the case of multiple facilities (such as multiple residential homes or subdivision homes),** where a single inverter is installed on each facility, the facilities can be approved as long as each of the invertors are certified - but the inverters do **NOT** have to be the same make and model.

Similarly, multiple units of inverters of different model and type, operating in parallel configuration are also approved, as long as there is no modification made to the unit such as adding an internal wiring between the units.

Previously tested and PG&E-approved non-certified units of the same nameplate capacity, model, and manufacturer will be considered approved and do not require additional approval or tests.

A-3: Non – E-NET Inverter-Based Interconnections

Non-E-NET inverter-based interconnections that do not pass the export screen of Rule 21's Initial Review Process (IRP) must meet the requirements of one of the four options listed in Rule 21, Section I.3.b. A reverse-power relay (device 32), or an under-power relay (device 37), function will be required if either option 1 or 2 (below) is chosen, respectively. Any required relay function external to the inverter must have sufficient redundancy. See section titled "Relay Redundancy" in Section B, below, for additional information.

1. For the reverse-power relay option, the sensing quantities (AC voltages and currents) need to be taken from the generator side of the service transformer. This option MAY NOT be used for projects without an interposing service transformer. Relay and CT ranges must be adequately chosen for the proper Rule 21 setting of this device.

For the under-power relay option, the sensing quantities (AC voltages and currents) may be taken from either side of the "main transformer" or wherever the totalized load and generation output can be measured. This option MAY be used for projects without an interposing "main

transformer." Relay and CT ranges must be adequately chosen to reflect the appropriate Rule 21 setting of this device

For Non-E-NET inverter-based interconnections, an inverter is considered approved (certified) equipment for connection to PG&E's system if it meets one of the following three criteria:

1. It is UL-1741 certified, and on the CEC's approved inverter list. This list is accessible via the link: http://www.energy.ca.gov/distgen/interconnection/certification.html

2. It is on the CEC's "Emerging Renewables Rebate Program" list. This list is accessible via the link: http://www.consumerenergycenter.org/erprebate/eligible_inverters.html

3. It is approved by PG&E on the basis of NRTL testing. Inverters not meeting the above criteria must be tested pursuant to the criteria set by Rule 21, Section J.3.a. The tests must be performed by a NRTL and test reports submitted for PG&E's approval. Supplemental Review Guidelines (available on the CEC website) may be consulted for additional testing information.

For multiple inverter configurations, the same criteria apply as for the 10 kW up to 1000 kW E-NET interconnections. (See Example 2 under Section A-2 above)

Previously tested and PG&E-approved "non-Certified " units of the same nameplate capacity, model, and manufacturer will be considered approved and do not require additional approval or tests.

B: Rotating Machine Technology

Rotating machine technology refers to conventional AC rotating machines operating at power system frequency (e.g., synchronous or induction generators).

General Requirements

Rotating machine technology must comply with the following general requirements:

Breaker Tripping Schemes

As a general rule, PG&E uses and recommends DC shunt tripping via a battery equipped with a charging system. AC tripping schemes may be an acceptable option, however, for projects where "Fault Detection" as defined and prescribed by Rule 21 is NOT a requirement, provided that:

- The scheme uses an "AC Holding Coil" concept, in which the breaker contacts open upon the loss, or a significant collapse of the AC Voltage. The scheme and the associated drawings are subject to review and approval by PG&E.

and

- The customer has been informed about and agrees to the "nuisance-tripping" possibilities associated with this type of schemes.

DC Shunt Tripping

For projects where "Fault Detection" as defined by Rule 21 is a requirement, the main generator breaker (or the main breaker at the PCC, or any other breaker intended for isolation of the unit) must have a shunt tripping scheme via a DC battery that is equipped with a charging system. All required relays must also have a DC power supply and may use the same DC battery system and charging system as for the shunt tripping.

Battery and Charger Criteria

Current PG&E criteria for DC batteries and the chargers will be provided upon request.

Fault Detection

Rule 21 requires "Fault Detection" when the aggregate Short Circuit Contribution Ratio (SCCR) exceeds 10%. Since the 10% criteria is an aggregate value, it is possible that units seeking interconnection at a later date may be subject to the "Fault Detection" criteria, while earlier, similarly-configured units on the same system were exempted.

Relay Redundancy

All required relays except for devices 15/25 (auto-synchronizer and the sync-check relay) must have sufficient redundancy. This means:

1. Three, single-phase relays (one for each phase) must have sufficient redundancy.

2. Two, three-phase relays (such as electronic or microprocessor types) must have sufficient redundancy.

The relay functions imbedded in Rule 21 Certified controllers will satisfy one level of redundancy as long as the set points can be field-verified and tested. A second level of relay functions must be provided by an additional multi-function relay.

Rule 21 Certified controllers with two independent levels of required relay functions may have sufficient redundancy, but must be reviewed and approved by PG&E. (Currently, none of the rotating machine Certified controllers, have independently redundant relay functions).

Master-Slave Operation

Certification for any equipment is generally done for a particular mode of operation (usually for independent operation of units). Master-slave configurations (or any additional wiring changes

between the controllers) will invalidate certification, and thus new certification or testing performed by an NRTL will be required, or the units will be treated as non-Certified.

PG&E Approved Relays

All required relays must either be selected from the PG&E approved list specified by Tables DG2-4 and DG2-5 of the Distribution Interconnection Hand Book (DIHB) or be tested by a NRTL based on the criteria set by Appendix "R" of the DIHB, and test results submitted to PG&E two weeks in advance for approval. **It is recommended that the approval be finalized prior to purchase of systems that are not on the PG&E-approved list.**

Stabilizing Transformer

A stabilizing transformer (similar to a grounding transformer) is required for projects interconnecting to a 4-wire system if significant over-voltage conditions can occur. Over-voltage conditions will depend on the connection type of the DG main transformer winding.

If a grounding transformer is required for ground fault detection reasons, then the same transformer serves as a stabilizing transformer.

B-1: Induction Generators

In addition to standard generator protection (such as voltage and frequency relays), the following additional requirements may be applicable:

Fault Detection Schemes

Phase and ground fault detection schemes to detect faults on PG&E's system may be required as determined by Rule 21's Initial Review Process (IRP).

A relay with phase and ground fault detection features is required. A reverse-power relay function (device 32) or an under-power relay function (device 37) is unacceptable as a substitute for fault detection.

Direct Transfer Trip

If adequate fault detection cannot be accomplished by conventional relaying schemes, then a direct transfer trip scheme may be required. An acceptable communication channel is required for the direct transfer trip scheme. PG&E will provide the criteria for the type and acceptability of the channel if needed.

B-2: Synchronous Generators

In addition to standard generator protection (such as voltage and frequency relays), the following additional requirements may be applicable for synchronous generators:

Synchronization

Acceptable means of automatic synchronization, as set forth in Rule 21 Section D.3.a.1, is required for all synchronous generators. All settings must be field-verifiable by a PG&E inspector at the time of pre-parallel inspection. The automatic synchronizer (device 15/25) must either be Rule 21 Certified (currently none are Certified), on the PG&E-approved list, or supervised by a synch-check (device 25) relay from the PG&E-approved list.

Fault Detection Schemes

Phase and ground fault detection schemes to detect faults on PG&E's system may be required as determined by Rule 21's Initial Review Process (IRP).

A relay with phase and ground fault detection features is required. A reverse-power relay function (device 32) or an under-power relay function (device 37) is unacceptable as a substitute for fault detection.

Direct Transfer Trip

If adequate fault detection cannot be accomplished by conventional relaying schemes, then a direct transfer trip scheme may be required. An acceptable communication channel is required for the direct transfer trip scheme. PG&E will provide the criteria for the type and acceptability of the channel if needed

Reclose Blocking

Reclose Blocking is needed on any PG&E automatic reclosing devices upstream of the generator if the aggregate nameplate capacity of the generation exceeds 15% of the peak load of that automatic reclosing device. Automatic reclosing devices on the PG&E distribution system are limited to line reclosers and feeder breakers. The purpose of reclose blocking is to reduce the safety risks to the customer, the public, and PG&E employees which could result from the synchronous machine closing into out-of-phase conditions.

Attachments

Attachment 1:
Technology Specific Requirements

The following requirements are intended for specific technologies having a PG&E interim interconnection approval or having a long term operational history within PG&E system.

Specific Technical Requirements for Interconnection to PG&E's Radial Distribution System of Induction Generators Below 100kW, Certified Under Rule 21 for Anti-Islanding and Not Subject to Fault Detection Requirements.

For interconnection applications involving induction generators certified under current provisions of Rule 21 for anti-islanding (including Tecogen Cogeneration Module models CM-60H, CM-60L, CM-75H, and CM-75L) and qualifying for "Simplified Interconnection"[1] under current Rule 21 Section I,[2] the following requirements shall be met when interconnecting to PG&E's Radial Distribution System. Different requirements may be applicable to network interconnections. The following requirements are subject to change in future versions of Rule 21 as adopted by the CPUC, and are subject to any modifications or changes PG&E deems reasonable as PG&E gains additional knowledge and experience with such interconnections. If any of these requirements are changed by PG&E, or if new requirements are added by PG&E which a customer or developer believes are unreasonable, or unlawful, the customer or developer retains the right to file a complaint before the California Public Utilities Commission. All applications will be processed under then-current requirements.

1. A single PG&E-approved multifunction AC-powered relay per application, such as a Beckwith 3410A (or PG&E approved equivalent) relay including at least the four relay functions of under voltage, over voltage, under frequency, and over frequency, sensing incoming voltage to the new "anti-islanding certified" induction generator(s) but not necessarily at the Point of Common Coupling ("PCC").
2. The "NormallyClosed[3]" contact of this AC-powered Beckwith (or PG&E approved equivalent) relay will be wired to supervise the "MainContactor" AC-powered "Hold Coil" mechanism of the "anti-islanding certified" induction generator(s) below 100 kW per unit. This is to ensure contactor opening under either of the following cases: a) collapse of AC voltage due to a system fault in the vicinity of the generator(s), or b) operations initiated by the Beckwith (or PG&E approved equivalent) relay. Opening of

[1] Qualifying for "Simplified Interconnection" under the current version of Rule 21 means that the generator passes Screens 1, 2, 3, 4, 5, 7, and 8 contained in Section I (Note: Screen 6, the 11 kW size screen, is not relevant to qualifying in the cases considered as part of this agreement). Requirements for Simplified Interconnection are subject to change in future versions of Rule 21. All applications will be processed under then-current requirements.

[2] Version effective February 27, 2003, Advice Letter 2281-E-A.

[3] "Normally Closed" contacts refer to contacts that are closed under normal operating conditions. When the relay initiates a "Trip" command, the Normally-Closed contacts will be "Opened".

the relay's NormallyClosed contacts upon sensing faults or any abnormal conditions shall also de-energize all electric power to the anti-islanding certified induction generator's controller and associated relays. Additionally, this action shall simultaneously stop all fuel flow to the engine(s), disconnect engine ignition power, and de-energize the contactor holding coil, thereby isolating the generator(s) from the bus. Relay reset can only take place after the incoming AC voltage has been successfully restored for a sufficient pre-described duration as prescribed in Rule 21.

3. The relay described in (1.). above will provide the redundant voltage and frequency functions required under Rule 21. For anti-islanding certified induction generators below 100 kW, reverse-power or under-power protection at the PCC will not be required, nor will a DC "shunt trip" of the breaker using batteries and a charging system be required.
4. Multiple-generator sites will require a single AC-powered Beckwith 3410A (or PG&E-approved equivalent) relay, with its Normally-Closed contact wired such that all units will be safely stopped upon tripping of the) relay or loss of utility AC voltage.
5. For the "anti-islanding" certified induction generators below 100 kW, the above requirements are independent of the specific options chosen under Rule 21's Section I.3.b's "Export Screen" (e.g. Option 3) and will hold true as long as: 1) the generators are "Rule 21 certified" for "anti-islanding", and 2) fault detection is not a requirement, and 3) no other Rule 21 Initial Review Process screens are failed.
6. All other lawful requirements for interconnection, including those under Rule 21, also apply.
7. Interconnection Applications that fail one or more of the Rule 21's Section I screens during the Initial Review Process, it will be handled by the process specified in Rule 21.