

BGE
STRATEGIC CUSTOMER ENGINEERING

DISTRIBUTED GENERATION

GUIDELINE FOR PARALLEL INTERCONNECTION
OF CUSTOMER-OWNED SYNCHRONOUS GENERATION
TO THE BGE DISTRIBUTION OR TRANSMISSION SYSTEM

GUIDE SPECIFICATION CSR-6

REVISION - 0 – JANUARY, 2005

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1. Definitions:

- 1.1. **Distributed Generation:** is defined by EPRI as the integrated or stand-alone use of small modular resources by utilities, utility Customers, and third parties in applications that benefit the electric system, specific Customers, or both.
- 1.2. **Distribution-Automation Equipment (DA):** Telemetry equipment which provides BGE with a means of monitoring the generator's operation and output, the position of significant circuit breakers, and any other information necessary to ensure the safety, reliability, and stability of BGE's distribution system. All generators that operate in parallel with BGE's distribution system will require DA equipment. Costs for the design, installation, testing, and inspection of DA equipment will be paid by the generation customer.
- 1.3. **Generator Circuit Breaker:** The circuit breaker(s), which isolates a generator from the balance of the customer's electrical system. The generator circuit breaker shall be equipped with synchronizing facilities if it is used to parallel with another generator or the utility system.
- 1.4. **Interconnection Circuit Breaker:** The circuit breaker(s), which isolates the customer's system, or a portion of that system, with its connected generation, from the utility supply. If it is intended to parallel with the utility or another source through the interconnection breaker, this circuit breaker shall be equipped with synchronizing facilities.
- 1.5. **Islanding:** The use of distributed generation equipment to supply a section of a BGE distribution feeder when the normal utility source is not available. Islanding of distributed generation equipment is not permitted by BGE, and protective relaying equipment shall provide anti-islanding protection.
- 1.6. **PJM:** shall mean the Pennsylvania-New Jersey-Maryland interconnected power pool operated under the PJM Agreement.
- 1.7. **Point of Common Coupling:** will be used to refer to the point where BGE's electrical conductors are connected to the Customer's conductors and where any transfer of electrical power between BGE and the Customer takes place.
- 1.8. **Point of Interconnection:** shall mean, with respect to each Station, each physical point of interconnection where capacity, energy and ancillary services are transferred between the respective Station and the BGE's Electrical System.

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2. Scope:

2.1. Customers seeking to install new electrical generation in the State of Maryland are required to file an “*Application for Commission Approval to Construct a Generating Station*” with the Maryland Public Service Commission. This application must be filed for

- 2.1.1. Emergency Generators
- 2.1.2. Base Load Synchronized Generators
- 2.1.3. Interconnected Generators for Export

2.2. The application is available as follows:

Maryland Public Service Commission
William Donald Schaefer Tower
6 Saint Paul Street, 16th Floor
Baltimore, MD 21202-6806

2.3. This guide specification defines the minimum requirements to provide protection of other BGE customers from customer-owned generation during abnormal system conditions.

2.4. These requirements outline additional relay systems, which are required to protect customer-owned, paralleled generation from abnormal but necessary operations on BGE’s distribution system such as momentary outages and subsequent feeder reclosing operations.

2.5. These requirements are applicable to customer-owned sources of generation, which meet the following conditions:

- 2.5.1. The customer is supplied at primary voltage from either the BGE 13.2 or 33kV distribution system.
- 2.5.2. The generator is a three-phase, synchronous machine in excess of 200kW, which operates in parallel with BGE, either normally or during switching for periods exceeding 1 second.

2.6. Customers desiring to operate their generators in parallel with BGE’s distribution system are required to process a “Maintenance and Operations Agreement” with BGE.

2.7. Customers who operate their generators in parallel with BGE’s distribution system and who further desire to export power for sale on the wholesale electrical grid are required to file an “*Interconnection Request*” with PJM Interconnection, LLC. BGE, being the Regional Transmission Owner will support PJM in performing studies to determine the generator’s impact on the electrical system. For these generators a three party “Operating Agreement” is required.

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- 2.8. Requests to install customer generation which operates in parallel with BGE's distribution system are reviewed on a case-by-case basis. The capacity of installed generation may be limited by the service voltage, type of distribution feeder (radial or customer feeder), the location on the feeder, or the number or type of other customers on the feeder.
- 2.9. Costs for distribution system modifications to accommodate customer generation will be billed to the customer.

3. General Requirements:

- 3.1. The Customer's generator shall include automatic voltage regulating equipment capable of maintaining power factors in the range of 0.90 lagging to 0.95 leading. The Customer shall also maintain such automatic voltage regulating equipment in service at all times in accordance with the Code of Maryland Regulations. The voltage regulating equipment shall control voltage at the generator's point of interconnection consistent with the range of voltages from 120 to 125 volts using a nominal voltage of 120 volts. The voltage regulation shall not cause voltage flicker to be greater than 2%.
- 3.2. The Customer's generator shall not produce a total voltage harmonic distortion (THD) that exceeds 5% as measured at the generator's terminals when the generator is not paralleled with the BGE's electrical system.
Because harmonic distortion is additive, multiple generators on a feeder may cause unacceptable levels of THD. Therefore, in specific locations the requirement may dictate a lower percentage of THD. In all cases, THD at the point of interconnection shall conform to IEEE Standard 519 –1992
- 3.3. The following design information must be submitted to BGE for approval:
- 3.3.1. Fault and Coordination Studies
 - 3.3.2. Single-Line Diagrams
 - 3.3.3. AC and DC elementary wiring diagrams
 - 3.3.4. Relay settings and programmable logic if applicable
 - 3.3.5. Generator Impedance and Time Constants

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4. Interconnection Requirements:

4.1. Equipment

4.1.1. The Customer shall design, provide, and install all facilities for interconnecting to BGE's electrical system, except the In and Out revenue meters. Certain devices, including synchronizing circuit breaker, interrupting device, disconnect switch, power transformer, metering, protective relays, etc., will be required and must be approved by BGE.

4.2. Synchronizing Equipment

4.2.1. If a Customer wishes to interconnect with BGE's electrical system with a synchronous generator, then the Customer shall be required to provide proper synchronizing facilities. These facilities shall include automatic or manual synchronizing equipment with relay supervision, voltage regulation and power factor control. Special protective equipment must be installed to prevent "islanding" to ensure public safety and to

prevent possible damage to other Customer's equipment, or to the distributed generation Customer's equipment during momentary outages or reclosing operations.

4.3. Interconnection Circuit Breaker

4.3.1. The Customer must select an interconnection breaker with sufficient capability for opening and closing under all operating conditions, including energizing and de-energizing the interconnection substation and fault clearing.

4.3.2. The protection applied at the interconnection point will be designed to automatically separate the Customer's system from the BGE electrical system for the following conditions:

4.3.2.1. For faults or other abnormal conditions on BGE's electrical system within the zone of protection encompassing the interconnection point.

4.3.2.2. For faults or other abnormal conditions on the Customer's system.

4.3.2.3. Whenever the BGE incoming feeder is de-energized, either by the opening of its circuit breakers(s) at the BGE source substation, or by any other means.

4.3.3. The customer shall have, as a minimum, an interrupting device sized to meet all applicable local, state, and federal codes and operated by over and under voltage protection (installed in each phase and wired to ground), as well as additional loss of phase protection. The

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interrupting device shall also be operated by over and under frequency protection. The interrupting device shall:

- 4.3.3.1. Automatically initiate a disconnect sequence from BGE's electrical system within six cycles if the voltage falls below 60V RMS phase to ground (nominal 120V base on any phase).
 - 4.3.3.2. Automatically initiate a disconnect sequence from the utility system within two seconds if the voltage rises above 132V RMS phase to ground or falls below 104V RMS phase to ground (nominal 120V RMMS base) on any phase.
 - 4.3.3.3. Automatically initiate a disconnect sequence from BGE's electrical system within two cycles if the voltage rises above 165V RMS to ground (nominal 120V RMS base) on any phase.
 - 4.3.3.4. Automatically initiate a disconnect sequence from BGE's electrical system within six cycles if the frequency rises above 60.3Hz or falls below 59.3Hz.
- 4.3.4. Additional protective equipment may be required by BGE on a case-by-case basis, depending on the generation capacity and interconnection location on BGE's distribution system. Any protective equipment or settings must not be changed or modified at any time by the Customer without written consent from BGE.
- 4.3.5. To avoid out-of-phase reclosing, the design of the Customer's protection and control scheme shall recognize BGE's practice of automatically reclosing the feeder without synchronism check as quickly as 12 cycles after tripping.
- 4.3.6. Failure of the Customer's interconnection protection equipment, including loss of control power, shall open the interrupting device, thus, disconnecting the generation from BGE's electrical system.

4.4. Protective Relaying

- 4.4.1. The design and application of the required protective relaying shall be based on a "Single Contingency" philosophy. Sufficient relaying redundancy must be included so that the failure of any single component in the proposed power system, including any one protective relay or communication channel, will not prevent proper operation of the protective relay system.
- 4.4.2. The Customer's control power source, which operates its protective devices must be reliable and not interrupted during fault periods. A DC battery/charger system provides the most reliable control power source.

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- 4.4.3. The Customer is fully responsible for protecting its equipment in such a manner that automatic or manual circuit reclosing, phase or ground faults, or any other disturbance (under/over frequency, negative phase sequence (single phasing), motoring, etc.) on the BGE or Customer's system does not cause damage to its equipment. The Customer's generator controls must include automatic voltage regulation equipment that is inherently self-protecting under all operating conditions.
- 4.4.4. All relay setting calculations and coordination at the interconnection point will be approved by BGE.
- 4.4.5. BGE reserves the right to inspect, within twenty-four hours notice, all protective equipment, including relays, circuit breakers, etc., at the interconnection substation. Inspection may include test tripping of the interconnection breaker by the protective relays.
- 4.4.6. For generator installations used for export power, the relay protection scheme at the interconnection station will require communication channels for transfer-trip of the interconnection circuit breaker. Depending on the site location, the communication channel may be leased telephone circuits, power line carrier, spread spectrum radio, fiber optic, or other approved means.

4.5. BGE or Other Customer Facility Equipment

- 4.5.1. Dedicated supply feeders, or changes to the customer's supply may be required for specific generator installations. Costs for system modifications will be passed on to the distributed generation Customer.
- 4.5.2. Distributed generation fault contributions cannot be allowed to over-duty existing BGE or other Customer's equipment. The effect of fault contributions from the distributed generation Customer's equipment must be taken into account. Costs for system modifications (changing fuses or protective devices) necessitated by the generator's fault contribution will be passed on to the distributed generation Customer.
- 4.5.3. Customer's wishing to export power must file an "Interconnection Request" with PJM Interconnection, LLC. This request will initiate a series of studies paid for by the Customer, which will determine the point of interconnection, supply voltage, and system modifications required for the interconnection.

5. Service-Tariff/Rider Applicability:

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5.1. The following service-tariff/rider provisions cover customer-owned generators equipped and connected for continuous parallel operation with BGE’s distribution system:

5.1.1. Standby Service – Rate Schedule “S”

5.1.1.1. Requires the installation of generator metering, distribution automation equipment, and power quality metering. This equipment will be furnished and installed by BGE at the Customer’s expense.

5.1.2. Load Response Program – Rider 24

5.1.2.1. It is recommended that generator metering be installed for this mode of operation. This metering will be furnished and installed by BGE at the Customer’s expense.

6. Protective Relaying Matrix:

6.1. Required Protection

6.1.1. The Customer must equip each generator with a multifunction protective relay or discrete relays, which provides the following:

Protective Function	Set to Detect	Equipment Tripped	Remarks
Definite Time Over and Under Frequency – Device 80/81	Separation from the utility system	Generator Circuit Breaker	May be supervised by interconnection circuit breaker status
Definite Time Over and Under Voltage – Device 59/27	Separation from the utility system	Generator Circuit Breaker	May be controlled by interconnection breaker status
Voltage Controlled or Directional Phase Inverse Time Overcurrent – Device 51V	Phase Faults on the utility system	Generator Circuit Breaker	Selection is dependent on generator and transformer grounding

Generator Neutral Time	Ground faults on	Generator Circuit	Selection is dependent
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Overcurrent or Generator Neutral Time Overvoltage or Utility System Zero Sequence Time Overvoltage – Device 51N	the utility system	Breaker	on generator and transformer grounding
Negative Sequence Time Overvoltage and/or Negative Sequence Time Overcurrent – Device 46	Utility Open-Phase conditions	Generator Circuit Breaker	
Underpower Relay Device 37	Separation from the utility system	Generator or Interconnection Circuit Breaker	Cannot be used on “export” generator installations
Sync-Check Device 25	Synchronism of generator with source	Block closing of Interconnection or Generator Circuit Breaker for out-of-phase conditions	Dead line detection can be used to block closing of Interconnection Circuit Breaker

6.2. Special Protection

6.2.1. Under certain conditions, direct transfer trip and/or reverse power protection may be required. Conditions requiring special protection include systems where installed generating capacity approaches or exceeds the customer’s connected load, or when the connected generating facility needs to remain operable and independent on its own generation following a utility feeder fault.

Protective Function	Set to Detect	Equipment Tripped	Remarks
Receive Direct Transfer Trip	Circuit opening operation at a remote BGE substation	Generator or Interconnection Circuit Breaker	Applicability to be determined by BGE. Selection of breaker to trip by customer.
Reverse Power – Device	Excessive Power Flow from Customer to Utility	Interconnection Circuit Breaker	Applicability to be determined by BGE

6.3. Relay Settings

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6.3.1. Settings for all protective functions must be submitted to BGE for approval.

6.4. **Relay Trouble Alarms**

6.4.1. Protective system alarms, including relay failure alarms, must be continuously monitored.

7. Generator Revenue Metering:

- 7.1. Additional revenue metering equipment must be installed on generators that operate in parallel with BGE. BGE will furnish and install the instrument transformers and meters for this metering at the customer's expense. The customer must furnish the required equipment for installing the BGE supplied equipment.
- 7.2. For low voltage installations (480 volts or less), the customer must furnish and install a CT cabinet to accommodate the BGE current transformers. Ideally, this should be located on a common bus where the generator bus connects to the load bus.
- 7.3. For medium voltage installations (2.4kV through 33kV), the customer must furnish and install a standard switchgear metering cubicle for the instrument transformers. This metering cubicle is covered in either guide specification CSR-1 for Metal-Enclosed Switchgear, or CSR-2 for Metal-Clad Switchgear.
- 7.4. To facilitate remote metering of the generator system, the customer must furnish a dedicated phone line to the location of the generator metering cabinet. This generator revenue metering will provide the following Operational/Statistical Metering" data:

7.4.1. **Distribution-Automation Equipment**

BGE will install Distribution-Automation Equipment at the customer's location to relay generator status information and operational data to the BGE control room. To monitor the status of the generators, the customer must provide auxiliary contacts at the interconnecting and or Synchronizing circuit breakers which will indicate that the generator(s) are paralleled to the distribution system. The DA equipment will be furnished and installed by BGE at the customer's expense. Operational data will be obtained from the Generator Revenue Metering equipment. The customer must furnish a dedicated 20A, 120VAC circuit to the location of the DA equipment.

7.4.2. **Automatic-Transfer Blocking**

For customer locations where the medium voltage switchgear is equipped with automatic-

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transfer facilities to restore service upon loss of a BGE feeder, protection shall be provided to block this transfer while the generator(s) are paralleled to the system. This eliminates the possibility of an out-of-phase condition, which could damage the generators and/or switchgear.

7.4.3. **Power Quality Metering**

Where generators can be paralleled to BGE's distribution system, BGE will furnish and install Power Quality Metering equipment at the customer's service entrance switchgear. This equipment will be furnished and installed by BGE at the customer's expense.