

GUIDELINES FOR
OPERATING, METERING,
AND PROTECTIVE RELAYING
FOR
NET METERED SYSTEMS UP TO 50 kW
AND BELOW 750 VOLTS

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1. INTRODUCTION

These guidelines state the minimum requirements for safe and effective parallel operation of the FortisBC system with customer owned generation. Both customers and FortisBC personnel should be guided by this document when planning installations of other than FortisBC owned generation. It is emphasized that these requirements are general and may not cover all details in specific cases. The customer should discuss project plans with FortisBC at the conceptual stage, well in advance of purchasing or installing equipment.

1.1 Policy on Customer Generation

It is the policy of FortisBC to permit any customer to operate generating equipment in parallel with its electric system whenever this can be done provided the guidelines in this document are adhered to and there will be no adverse effects on the general public, or to FortisBC equipment/personnel.

FortisBC will not assume any responsibility for design, installation or settings of the protective device required for the protection of the customer's generator(s), or of any portion of the customer's electrical equipment. FortisBC is responsible solely for the protection of its own equipment, therefore, the customer is fully responsible for operating and protecting his equipment in such a manner that faults or other disturbances on the FortisBC system do not cause damage to the customer's equipment. Specific requirements for protection equipment are outlined in section 3.

1.2 Generation Sources and Methods

The customer may elect to use any of a variety of clean or renewable resources that are constantly renewed by natural processes, such as water power, solar energy, wind energy, geothermal energy, wood residue energy, and energy from organic municipal waste.

The end conversions for connection to the utility's system must be into 60 Hz alternating current.

Once the method of generating is chosen, the type of generator must also be chosen. There are three major types of generators:

a) Synchronous Generators:

A synchronous generator has a constant speed and draws its power from a supply that is independent from the utility it is interconnected with. These generators can run in parallel with the utility or islanded from the utility.

b) Induction Generators:

Induction generators produce electrical power when their shaft is rotated faster than the synchronous frequency of the equivalent induction motor. Induction generators are often used in wind turbines due to their ability to produce useful power at varying rotor speeds. Induction generators are mechanically and electrically simpler than other generator types. They are also more rugged, requiring no brushes or commutators. Also, induction generators are self-exciting, meaning they require an external supply (utility) to produce the initial rotating magnetic flux, however once they start to produce electricity, they can run independent from the utility.

c) Inverter Systems:

Inverter Systems are very similar to induction generators, and most requirements are the same for both options. Also, induction systems have the capability to self excite. This means that, not unlike induction generators, an inverter system can run on its own power once it has been given some start-up power to begin working. This can sometimes cause problems and must be watched carefully.

The customer may elect to run his/her generator in parallel in the utility or as a separate system with the capability of non-parallel load transfer between the two independent systems. .

Separate systems will not be discussed further in this document as they are not relevant to the Net Metering Program. Customers who intend to connect such a system should contact FortisBC in advance of planning any installation.

1.3 Parallel Operation

A parallel system is defined as one in which the customer's generation can be connected to a bus common with the utility's system. A transfer of power between the two systems is a direct and often a desired result. A consequence of such parallel operation is that the parallel generator becomes an electrical part of the utility system which must be considered in the electrical protection of the utility's facilities.

The protective devices and other requirements in the following sections are intended to provide protection against the hazards that FortisBC has foreseen, by showing when and where a problem occurs. FortisBC can then quarantine the problem until it is remedied.

2. GENERAL REQUIREMENTS

2.1 Design Requirements and Information

2.1.1 FortisBC will connect on receipt of appropriate approvals from national, provincial and local construction and safety authorities.

2.1.2 Protective devices (relays, circuit breakers, etc.) for the protection of FortisBC's system, metering equipment, and synchronizing equipment must be installed when required by FortisBC. The protective devices and the installing party may differ with the size of the installation. See section 3 for specific requirements. Certain requirements regarding liability and indemnity differ depending upon the ownership of the devices (see 2.2.3).

2.1.3 Because most short circuits on overhead power lines are of a temporary nature, it is FortisBC's practice to re-close the circuit breaking devices on such lines without intentional delay or within a few seconds after they have automatically tripped. This practice improves continuity of service to all customers. The protective relays specified by FortisBC for parallel generation interfaces are intended to disconnect the generation from faulty or isolated lines before re-closing occurs.

Should the customer desire additional protection against the possibility that reclosing might occur with his generator still connected to the line (a potentially damaging occurrence for synchronous generators), FortisBC may delay reclosing further, provide "Hot Line Reclose Blocking" or provide single shot sectionalizers at the necessary points on its system. Note that FortisBC may be obligated to avoid such equipment because of the possible adverse effects on service continuity and the problems of moving or rearranging the equipment to accommodate system changes. Also note that all costs associated with installing, maintaining, and/or rearranging such equipment will be borne by the customer(s) requesting the equipment.

2.1.4 Customers with three-phase generators should be aware that certain conditions in the utility system may cause negative sequence currents to flow in the generator. It is the sole responsibility of the customer to protect his equipment from potential excessive negative sequence currents.

2.1.5 The design and installation of the customer's facility must adhere to the latest version of sections 50 and 84 of the Canadian Electrical Code. Regarding

Harmonics, power quality and voltage flicker, the customer must adhere to the latest edition of IEEE 519.

2.1.6 The distribution system operates at 60 Hz. Frequency deviations are typically 59.5 Hz to 60.5 Hz for small contingencies that cause modest disturbances, i.e. where the Distributed Generation (DG) system continues connection to the distribution system. For large contingencies, broader frequency variations can occur. These variations can be experienced under severe distribution system loads, load variations, or when major generation or transmission is lost, or FortisBC load shedding schemes are employed.

2.1.7 CSA Standard CAN3 C235-95, Preferred Voltage Levels for AC Systems 0 to 50,000V, provides recommended Canadian utility distribution system steady state service voltage levels. DG systems must operate satisfactorily within the extreme voltage level variation limits shown in table 1 and may continue to operate beyond these limits (per 3.2.7) to allow the utility automatic voltage regulation equipment time to function. Voltage regulation is a utility responsibility and voltage regulation schemes should not be employed by DG systems except under agreement with FortisBC.

Table 1: Recommended Steady State Service Voltage Variation Limits for Canadian Utilities

Nominal System Voltages	Recommended Voltage Variation Limits for Circuits Up to 1,000 Volts, Applicable at Service Entrance			
	Extreme Operating Conditions			
	Normal Operating Conditions			
Single Phase 120/240	106/212	110/220	125/250	127/254
Three Phase 4-Conductor 120/208Y 347/600Y	110/190 306/530	112/194 318/550	125/216 360/625	127/220 367/635

Source: Preferred Voltage Levels for AC Systems, 0 to 50,000V- Canadian Standards Association

2.1.8 The voltage unbalance on the distribution system under normal operating conditions is typically under 3 percent but may reach 5 percent due to the

unbalanced loading and single phase voltage regulation. Voltage unbalance is included in the FortisBC service voltage range of Table 1 in section 2.1.8.

2.1.9 A disconnecting means to provide a point of isolation between the DG system and the distribution system is required. Low voltage disconnecting means must meet the intent of the Canadian Electrical code, section 84. The purpose of the disconnecting means is to provide safe isolation between the distribution system and the DG system for safe work purposes. FortisBC may require additional warning tags or labels to be placed at the DG site. A lockable, manual visible-break disconnecting device which can be opened for line clearances must be provided. The form of this device will vary with the service voltage and capacity. Acceptable manual disconnect switch equipment includes commercially available disconnect switches that are:

- a) CSA certified
- b) Have a provision for locking in the open position
- c) Provide visual indication of open position (either by a viewing window or by a door/cover prior to installing the lock)

FortisBC Safety Practice Regulations

- a) The customer installs an accessible, load break disconnect switch, lockable in the open position with a visible break, near the utility meter. This switch is installed between the inverters AC output and the customers service entrance AC circuit breaker. This disconnect switch is also required under rule 84-026 of the Canadian Electrical Code, part 1. A low- voltage safety switch, where the cover can be opened when the switch is in the open position, thus providing visual verification that the contacts are open is acceptable.
 - b) An operating order will be prepared by the FortisBC System Control Center, for signature by the DG owner. This document defines such items as the switching authority boundary between FortisBC and the DG, the procedure for either party to obtain a Guarantee of isolation from the other party, and personnel contact names and phone numbers for FortisBC and the DG owner.
- 2.1.10 DG systems must be grounded as per manufacturer's recommendations, the Canadian Electrical Code, and take into account that FortisBC electric service conductors/cables are grounded.

- 2.1.11 The DG system must detect and promptly cease to energize for over current fault conditions in the DG system
- 2.1.12 The DG system shall meet the anti-islanding requirements of CSA standard C22.2 No. 107.1-01, General Use Power Supplies, section 15, and cease energizing the distribution system within a time no greater than two seconds after the formation of an unintentional island.
- 2.1.13 When single phase DG units are connected in multiple units, if three phase service is available, then approximately equal amounts of generation capacity should be applied to each phase of a three phase circuit.
- 2.1.14 DG systems that can generate an AC voltage waveform independent of the distribution system shall be connected in parallel with FortisBC only in combination with synchronizing capabilities. The DG system shall synchronize to the distribution system while meeting the flicker requirements and without causing voltage variation at the PODR of greater than 5 percent. The DG system may synchronize when the distribution system is stabilized.

Induction generators do not require synchronization since there is no generated voltage prior to connection to FortisBC. The generator's speed is brought to within 0.5 percent of its rated value then connected. Induction generators may be started on induction motors using power from the FortisBC system provided that these units do not cause unacceptable voltage flicker on start up or on connect/disconnect. Induction generators shall be compensated in the DG system to a full load power factor of 90 percent or better.

For synchronous generators, an approved automatic synchronization device must be provided in all cases where the plant is to be operated unattended. If the plant is attended, the generator may be equipped with a manual synchronization device with relay supervision. The operator on site must have sufficient training to perform the function safely. Synchronization controls shall satisfy the following conditions:

- a) The generator speed should be matched to within 0.5 percent of its rated speed or a frequency difference within +/-0.5Hz,
- b) The phase angle difference between the generator and FortisBC should be less than 15 degrees,
- c) The RMS voltage magnitude difference between the two systems should be less than 4 percent to avoid excessive currents,
- d) Field current hold should not be applied until the generator speed is at least 85 percent of its nominal value.

2.2 General Operating Requirements

- 2.2.1 The interconnection of the customer's generating equipment with the FortisBC system shall not cause any reduction in the quality of service being provided to other customers. Abnormal voltages, frequencies, or causing of interruptions will not be permitted. If high or low voltage complaints or flicker problems result from operation of the customer's generation, such generating equipment shall be disconnected until the problem is resolved.
- 2.2.2 The customer may not commence parallel operation of generator(s) until final written approval has been given by FortisBC. FortisBC reserves the right to inspect the customer's facility and witness testing of any equipment or devices associated with the interconnection. Except for emergency situations, FortisBC will attempt to arrange a time suitable to both the customer and the Company to conduct such inspections.
- 2.2.3 The customer shall indemnify and hold FortisBC harmless for all damages and injuries to FortisBC or others arising out of customer's use, ownership, or operation of customer's facilities. The customer is solely responsible for providing adequate protection for customer's facilities operating in parallel with FortisBC system and shall release FortisBC from any liability for damages or injury to the customer's facilities arising out of such parallel operation, unless caused solely by FortisBC negligence.
- 2.2.4 The customer will not be permitted to energize a circuit de-energized by FortisBC.
- 2.2.5 For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the FortisBC system. The generator voltage-var schedule, voltage regulator, and transformer ratio settings will be jointly determined by FortisBC and the customer to ensure proper coordination of voltages and regulator action. Customers are encouraged to generate their own var requirements to minimize power factor adjustment charges and enhance generator stability.

In cases where starting or load changing on an induction generator will have an adverse impact on FortisBC system voltage, step-switched capacitors or other techniques may be required to bring the voltage changes to acceptable levels.

If, under any circumstances unacceptable voltage regulation, as defined by FortisBC, is expected to occur or does occur specifically because of the

customer's generator, the customer's generation will be disconnected or not allowed to be connected until the unacceptable voltage has been corrected.

- 2.2.6 The customer shall maintain his/her equipment in good working order. FortisBC reserves the right to inspect the customer's facilities at any time or whenever it appears that the customer may be operating in a manner hazardous to system integrity. Except for emergency situations, FortisBC will attempt to arrange a time suitable to both the customer and the Company to conduct such inspections.
- 2.2.7 The Customer shall discontinue parallel operation when requested by FortisBC. FortisBC will provide due notice and will only request a shutdown when absolutely necessary.
- 2.2.8 Operation of the customer's generator shall not cause adverse harmonics to appear on the FortisBC system. There are voltage and current harmonics, each requiring separate analysis. The effects are dependent on the magnitude and frequency of the harmonic and the characteristics of the electrical system.

The potential magnitude and frequency of the harmonics produced by a line-commutated inverter could adversely affect other utility customers and, when numerous line-commutated inverters are installed, could adversely affect the utility's system. Therefore, utility limitations regarding harmonics are required. If a problem occurs, the generation will be disconnected or prevented from connecting until the harmonic problem is resolved.

- 2.2.9 The customer must adhere to the latest version of IEEE Section 519 in reference to harmonics, voltage flicker, and power quality. FortisBC will review the design of the installation to confirm that the design meets the requirements outlined in the aforementioned document.

3. SPECIFIC REQUIREMENTS

FortisBC is committed to continuing to serve its other customers safely and reliably after the customer's facility is up and running. In order to achieve this, FortisBC mandates that all facilities will be equipped the appropriate protection equipment, purchased and installed at the cost of the customer. This is an essential part of the interconnection, and no interconnection will be granted without proper protection equipment installed.

FortisBC may inspect DG system equipment, documents and installation procedures, and witness field tests. The DG owner shall notify FortisBC at least 2 weeks before the initial energizing and start up testing of the DG system. Whenever practical, inspection timing and scheduling shall be mutually agreed by the DG owner and FortisBC.

For DG systems rated >5 kW, step by step energizing and commissioning procedures shall be provided to FortisBC prior to DG system commissioning. The DG owner shall make available to FortisBC a complete set of manuals for use during inspection, testing and commissioning. The documentation requested is required to ensure that the facility does not impact the safety or reliability of the interconnected utility system. If the applicant does not have direct documentation available, then typical or assumed data may be considered acceptable if it is signed and approved by a Professional Engineer. If the applicant is unable to provide any of the necessary data then another option is to operate the site independent from the utility as a non-interconnected installation.

Once the interconnection application is received, FortisBC will assess the facility and its need for additional protective equipment. FortisBC will then provide the customer with a list of all of the additional protective equipment needed. The customer is responsible for the purchasing and installation of this equipment. Interconnection will not begin until the additional equipment is installed.

FortisBC must approve the settings and timing applied to over current and power quality protection relays.

The DG system owner has full responsibility for commissioning and periodic maintenance of the interconnection equipment. Commissioning and maintenance must be performed by competent personnel from the DG owner or a recognized service consultant. A copy of the commissioning and maintenance test reports signed by the person in charge shall be retained by the DG owner.

Any electrical equipment in the DG system shall be certified and approved by the appropriate regulatory agency.

3.1 Protection Requirements for Net Metered Systems up to 50 kW and below 750 Volts

All installations in this class require FortisBC review of the protective functions to be provided. Note that certain requirements regarding liability and indemnity apply to installations using customer-owned protection.

The following requirements for smaller generators are based on an assumed low density of parallel generation customers on the serving circuit. Other conditions may be imposed should the density exceed a tolerable limit.

- 3.1.1 A manual disconnecting device must be provided at a suitable location. This device is to permit FortisBC to disconnect the customer generation from its system while working on the lines. This device must be lockable by FortisBC and provide a visible break to confirm the contacts are open.
- 3.1.2 Customer generator controls are to be equipped with a line voltage relay or contactor, which will prevent the generator from being connected to a de-energized source. This relay is to disconnect the generator from a de-energized utility line and prevent its reconnection until the line is re-energized by FortisBC.
- 3.1.3 The customer may be served through a dedicated distribution transformer that serves no other customers. The purpose of the dedicated transformer is to reduce the possibility of the generator becoming isolated with a small amount of other customer load. It also helps to confine any voltage fluctuations or harmonics produced by the generator to the customer's own system.
- 3.1.4 In order to reduce the possibility of self-excited operation, all reactive current requirements for the induction generators or power inverters shall be approved by FortisBC. Except in unusual situations, this var supply will be from general utility sources and no specific charge shall be made to the customer for the reactive current. Any required power factor correction must be located on the generator side of the generator switch.
- 3.1.5 It is required that the customer's facility be equipped with a bi-directional meter (or a meter approved by a FortisBC designer).

- 3.1.6 Customers should expect multiple reclosing into his/her service and take necessary precautions to protect his/her equipment.
- 3.1.7 Customer shall install, at his/her expense, items that are required for the installation.
- (1) Visible Disconnect – a visible break isolating switch, serviceable by FortisBC lock.
 - (2) Generator Switch – suitable single or multi-phase contactor or circuit breaker with holding coil or trip coil for protective tripping and isolation of generator by means of item (3) and (4).
 - (3) Protective Relay(s) – relay(s), acceptable to FortisBC, capable of promptly removing any contribution into faults in the Authority's system. This shall consist of a minimum of:
 - 1 – over current relay per phase
 - 1 – under and over voltage relay per phase (+/- 15 Volts)
 - 1 – under and over frequency relay per phase (+/- 15 Hz)
 - 1 – synchronizing relay (inverters and synchronous machines only)
 - (4) Anti-islanding protection (Anti-islanding protection will not typically be required for induction generators.)

3.2 Additional Requirements

The following are cases that apply to parallel generation.

- 3.2.1 Certain protective relays, circuit breakers, etc., as described in previous sections, must be purchased, installed and maintained by the customer at any location where the customer desires to operate generation in parallel with the FortisBC system. The purpose of these devices is to disconnect promptly the customer's generating equipment from the FortisBC system whenever faults or abnormal operation occur. Other modifications to FortisBC electrical system configuration or protective relays may be required in order to accommodate parallel generation.
- 3.2.2 Accidental Isolation is defined as a situation where a portion of the utilities load becomes isolated from the utility source but still connected to the parallel generation. In this condition, the voltage may collapse or the isolated system may continue to operate independent of the utility. FortisBC will assess the likelihood of Accidental Isolation and plan for protection accordingly.

3.2.3 In all installations where the customer is to provide protective devices for the protection of FortisBC's system, the customer shall submit a single-line drawing of this equipment to FortisBC for approval of the protective functions. Any changes required by FortisBC shall be made prior to final issue and FortisBC shall be provided with the final copies of the reviewed drawings. FortisBC will approve only those portions of the drawings which apply to protection of FortisBC's system. If FortisBC finds faults/defects that do not pertain to the FortisBC system, they may point these flaws out to the customer, but are not responsible for correcting them.

4. MAINTENANCE AND OPERATION

The DG owner has full responsibility for routine maintenance of the DG system and shall keep maintenance records according to the equipment manufacturer recommendations and accepted industry standards, in particular Canadian Electrical Code, Part 1, paragraph 2-300.

DG system protection function operation shall be verified according to the manufacturer's recommended schedule, or at least annually if there is no manufacturer recommendation. Operating the disconnection means and verifying that the DG system automatically ceases to energize the distribution system and does not resume energizing until the distribution system is stabilized after the disconnecting means is closed is an acceptable verification method.

Failure to maintain Canadian Electrical Code and industry accepted maintenance standards can result in disconnection of the DG system.