Énergie NB Power

TECHNICAL SPECIFICATION FOR INDEPENDENT POWER PRODUCERS

NB Power Customer Service and Distribution

June 2008

Prepared by: _____
Steven Wilcox

Revised by: _____
Steven Wilcox

Énergie NB Power

TECHNICAL SPECIFICATION FOR INDEPENDENT POWER PRODUCERS

TABLE OF CONTENTS

1.0	Introduction	4
2.0	NB Power Policy on Independent Power Production	4
3.0	General Information	5
4.0	Design Requirements	6
4.1	Equipment Certification	6
4.2	Protection and Control	6
4.3	Inverter Based Systems	8
4.4	Disconnecting Means	8
4.5	Location of an IPP	8
4.6	Maximum Capacity of Distributed Generation	9
4.7	Review by NB Power	10
4.8	IPP's Main Circuit Interrupter	10
5.0	Operating Requirements	11
5.1	Affect on Distribution Power Quality	11
5.2	Final Permission to Interconnect	11
5.3	"Islanding"	11
5.4	Generator "Ride-Through"	12
5.5	Distribution Capacitor Bank Switching	13
5.6	Reconnecting Following Restoration by NB Power	13
5.7	Generator Operating Mode	13
5.8	Generator Ramp Rate	13
5.9	Disconnection by NB Power	14
6.0	Design Information	15
6.1	Distribution System Primary	15
6.2	Distribution System Reclosing	15
6.3	Nominal Voltage Levels and Variation Limits	16
6.4	Fault Levels	17
6.5	Phasing Information	17
6.6	Metering	17
7.0	Reactive Power Requirements	17
8.0	Transformation	18

Énergie NB Power

TECHNICAL SPECIFICATION FOR INDEPENDENT POWER PRODUCERS

Appendix “A” - Standby Generation 19

References 20

Énergie NB Power

TECHNICAL SPECIFICATION FOR INDEPENDENT POWER PRODUCERS

1.0 Introduction

An Independent Power Producer (IPP) is defined as a non-utility entity responsible for generation interconnected to the NB Power distribution system for the purposes of supply or export of energy.

This document establishes specifications for an IPP to interconnect with the NB Power distribution system. The requirements outlined in this document do not constitute a complete design or installation specification. Specific requirements will depend on the size, type, and location of the proposed generation and the capacity of NB Power's system at that location. An IPP shall discuss the proposed project with NB Power prior to any purchase or installation of equipment.

This document does not apply to standby generation used to supply a premise's electrical system during loss of utility supply (see Appendix "A").

2.0 NB Power Policy on Independent Power Production

NB Power permits IPP's to operate interconnected generation providing it does not adversely affect the distribution system, its customers, equipment, or characteristics.

An IPP is responsible to design, construct, commission, maintain, and operate all equipment up to the point of common coupling. NB Power will not assume responsibility for protection of an IPP's generator or other electrical equipment.

NB Power reserves the right to witness any part of the work, including, but not limited to, acceptance tests, commissioning tests, trip tests and the initial unit synchronization.

3.0 General Information

Utility lines are subject to outages due to electrical faults or interruption of supply. Utilities install protective equipment to detect abnormal conditions and take corrective action. A generator represents another distribution system source. It must also have protective equipment to detect abnormal conditions on the utility system and, if necessary, disconnect from it.

Abnormal conditions of concern to generation are low impedance faults (overcurrent), frequency excursions, undervoltage, overvoltage, and "islanding", a condition in which a portion of the utility's load becomes isolated from the utility source but remains connected to an IPP's generator. The success of an "islanded" system is a function of the generator's active and reactive power capacity versus the requirements of the island's connected load.

NB Power's review of an IPP's design, protection philosophy, and choice of devices and equipment shall not be construed as confirming or endorsing the design. Nor is any warranty of safety, durability or reliability implied. NB Power shall not, by reason of such review or failure to review, be responsible for the adequacy of the design. An IPP must agree to change its interconnection equipment or protective devices as may be reasonably required by NB Power to meet the changing requirements of NB Power's system.

The installation shall meet the requirements of the Canadian Electrical Code and the *New Brunswick Electrical Installation and Inspection Act*. In New Brunswick, the Code and the *Act*, including wiring permits, plan approvals and inspections, are under the jurisdiction of NB Department Public Safety, Technical Inspection Services.

4.0 Design Requirements

4.1 Equipment Certification

Electrical installation and construction is governed by the *New Brunswick Electrical Installation and Inspection Act*. Under the *Act,* all electrical equipment must be approved by a certification organization recognized in the province of New Brunswick. The *Act* is enforced by the Inspection Authority - NB Department Public Safety, Technical Inspection Services.

4.2 Protection and Control

Protective devices and synchronizing equipment shall be installed as required by NB Power. Protection requirements will differ with the size and location of the installation and whether or not energy is to be exported to NB Power.

Each proposal will be individually assessed. If the review yields a sense of confidence and the recommended settings can be applied to the proposed protection, then no further Utility-owned protection will be installed. If, however, unique protection or operating circumstances require Utility-owned protection to be installed, the cost will be borne by the IPP.

The Utility-IPP interconnection shall be made with a 12kV (or 25kV where required) relay-controlled circuit breaker or a recloser having an external control.

Synchronous generation larger than 100kW shall have automatic synchronizing equipment. Smaller units shall supervise the closing of the main interconnection device by a synchronism check relay.

Typical interconnection protection includes sensing of over and under-voltage, over and under-frequency, phase and ground overcurrent, and an “islanded” condition.

NB Power will direct an IPP with respect to setting voltage and frequency relays. Maximum clearing times during abnormal voltage or frequency events will be as stated in IEEE Standard 1547 (latest revision) “Standard for Interconnecting Distributed Resources with Electric Power Systems”. Protective devices shall have the pick-up and time delay setting ranges specified in IEEE 1547.

Directional or “reverse power” protection can be installed to detect generator motoring or a power export violation. Where power export to the NB Power system is not anticipated, instantaneous reverse power tripping of the main incomer will be sufficient.

Exciter protection is the responsibility of the IPP.

Where required, generator protection must be able to accept a remote Transfer Trip signal.

All interconnection protection, synch-check and automatic synchronizer settings will be reviewed and approved by NB Power.

A certain amount of current and voltage imbalance will always be present on the distribution system. Severe imbalance may exist following the operation of single phase protection. Unbalanced voltage has a negative sequence component which can cause negative sequence current to flow in the generator.

It is the sole responsibility of the IPP to protect the generator from or derate the generator for negative sequence current. The IPP should follow the equipment manufacturer's recommendation.

4.3 Inverter Based Systems

Interconnected inverter based systems shall be of the sinusoidal output waveform type or the voltage-follower type.

Sinusoidal output waveform inverters shall utilize protection and synchronizing equipment similar to synchronous generation of an equivalent capacity.

Certified grid-dependent inverters (those requiring the presence of distribution system voltage to regulate their frequency) do not require additional protection or synchronizing equipment.

4.4 Disconnecting Means

Disconnecting devices must be approved by NB Department Public Safety, Technical Inspection Services, and meet the requirements of section 84 of the Canadian Electrical Code. NB Power does not require a disconnect switch for generation at 600V and below when connected via a certified grid-dependent inverter.

4.5 Location of an IPP

Prior to the purchase or installation of equipment, an IPP will contact NB Power Customer Service Engineering to discuss the location of the proposed project. NB Power will assess the system capacity with respect to the proposed generator capacity.

The optimum location for the maximum tolerable generator capacity is typically very near a distribution substation. Normally, as distance from the substation increases, voltage rise along the distribution feeder may become problematic when attempting to transfer a large magnitude of power.

The cost of modifications to the feeder's existing voltage regulation scheme and equipment will be borne by the IPP.

4.6 Maximum Capacity of Distributed Generation

NB Power will determine the maximum capacity for installed generation based on assessment of the following:

a) area load – maximum allowable generation will be equal to a portion of the feeder or substation annual minimum load - typically 50%-100% - depending on the type of generation and the sophistication of the protection system.

b) the ability to properly regulate voltage along the entire length of the feeder. This includes observing the "Recommended Voltage Variation Limits" of CSA Standard CAN3 C235-83 – "Preferred Voltage Levels for AC Systems 0 to 50,000V" both during steady state operation and for the temporary voltage sag that occurs when the generator trips. Customers on the feeder shall not be subjected to severe voltage sag following a generator trip; therefore, sudden loss of a generator while at full load shall not cause the primary voltage to sag below 0.95pu.

c) the ability to protect and coordinate for all fault types and abnormal system conditions.

d) distribution system losses – distributed generation shall not increase distribution system electrical losses. Locating distributed generation very near the substation will produce a negligible affect on losses; exporting large amounts of power back toward the substation from the remote end of the feeder may result in increased losses.

e) whether or not export from the Distribution system to the Transmission system will be permitted. Such permission will be on a case-by-case basis.

4.7 Review by NB Power

All IPP's shall submit a completed Embedded Generation Interconnection application form.

An IPP shall submit all design documentation and schematics relevant to the generator's synchronization and protection equipment. Any changes required by NB Power shall be made prior to final issue and NB Power shall be provided with final copies of the revised drawings.

NB Power will review only the portion of the design which applies to protection of NB Power's system. NB Power may comment on other areas which appear to be incorrect or deficient but will not assume responsibility for protection of an IPP's system.

4.8 IPP's Main Circuit Interrupter

The circuit's main interrupter must be adequately sized to interrupt the greater of the generator fault level or the distribution system fault level.

5.0 Operating Requirements

5.1 Affect On Distribution Power Quality

The interconnection of IPP generation with the NB Power system shall not deteriorate the quality of electrical service provided to other customers.

Poor voltage or frequency regulation, harmonic voltage, flicker, abnormal interruptions or transients will not be permitted.

Mitigation of any power quality issue as determined by the Utility, including, but not limited to the aforementioned, will be the responsibility of the IPP. NB Power adopts the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 519 with respect to harmonic distortion limits on the distribution system.

IEC standard 61000-4-15 and the P_{st}, P_{lt} Method (Perception short/long time) of measuring and assessing Flicker will apply.

Where starting or changing load on induction generators causes an adverse impact on NB Power system voltage, additional voltage regulation may be required. All costs will be borne by the IPP.

5.2 Final Permission to Interconnect

An IPP shall not commence interconnected operation of the generator until NB Power has granted written permission.

5.3 “Islanding”

An IPP will not be permitted to serve NB Power load while isolated from the NB

Power supply. Additionally, an IPP will not be permitted to energize a de-energized NB Power circuit.

In Constant Power Factor mode the generator is operated with fixed power output typically at a constant leading power factor, absorbing reactive power from the power system. If an islanded condition occurs, the generator cannot revert to supplying reactive power to maintain system voltage; a generator output voltage collapse ensues and the generator will trip on undervoltage. This is a passive method of preventing Islanding.

Another method of island prevention is for Utility protection equipment to send a trip signal to the generator. This is known as Transfer Trip and requires communication infrastructure from the Utility substation to the IPP site. All costs associated with Transfer Trip scheme will be borne by the IPP.

5.4 Generator "Ride-Through"

A distribution system fault will cause undervoltage along the feeder. Normally generator overcurrent protection will detect this condition and initiate tripping of the unit. Undervoltage protection associated with the generator may also sense and operate for this condition. If, however, the undervoltage is due to a fault on an adjacent feeder, the generator undervoltage protection will ideally "ride-through" the event and maintain stable operation. In other words, distributed generation should not trip for faults for which it need not be tripped.

5.5 Distribution Capacitor Bank Switching

In the presence of generation, feeder capacitor banks can increase the possibility of overvoltage or overcompensation and the possibility of Islanding. If the IPP's proposed location is presently within the zone of influence of a feeder capacitor bank, the bank shall be fitted with automated switching. The cost of automated switching shall be borne by the IPP.

5.6 Reconnecting Following Restoration by NB Power

Following any system condition or disturbance for which distributed generation trips, it may be reconnected to NB Power's distribution system five minutes after the restoration of normal voltage and frequency. This recommendation is an industry standard found in IEEE 1547. Five minutes is longer than accumulated typical reclose times and long enough for grid frequency excursions to stabilize.

5.7 Generator Operating Mode

It is industry standard practice at this time that distributed generation not assist in controlling the feeder voltage. Therefore, distributed generation shall be required to operate in the Constant Power Factor mode at unity or a slightly leading power factor, absorbing reactive power (VArs) from the power system.

5.8 Generator Ramp Rate

To eliminate abrupt voltage sags and swells, tapping operations of Utility voltage regulating equipment should be independent, each waiting its own time delay and altering the voltage by only 5/8% per time delay. To achieve this end, a

ramp rate – kW per minute - will be calculated for each generator installation. It shall be observed both when coming-on or when going-off line or when changing the output set point.

5.9 Disconnection by NB Power

NB Power will discontinue parallel operation with an IPP:

a) To facilitate upgrade, maintenance, testing, or repair of utility facilities. The IPP, as an alternative, can be isolated from the NB Power system and continue operation.

b) During system emergencies.

c) When IPP generating equipment is interfering with other customers on the system, causing poor power quality indices, or threatening the integrity or reliability of the NB Power system.

d) When an inspection of the IPP's generating equipment or maintenance records reveals a condition hazardous to the NB Power system. NB Power reserves the right to inspect an IPP's facility whenever it appears that the IPP is operating in a manner hazardous to the integrity of NB Power's system.

6.0 Design Information - NB Power System

6.1 Distribution System Primary

NB Power's primary distribution system is three-phase four-wire with a multi-grounded neutral. The nominal voltage is 12.47kV except that 24.94kV is used in specific areas. The system operates at 60Hz. Certain areas are served by only single or two phase primary.

6.2 Distribution System Reclosing

Distribution systems employ fast automatic reclosing without blocking or permissives based on the fact that approximately 80% of distribution faults are temporary in nature and the system traditionally had a single source; therefore, the system needed to be de-energized only long enough to ensure that the fault's arc has extinguished. With other sources on the feeder, ensuring the arc has extinguished involves delaying reclosing until all other sources have tripped.

From the Utility's perspective, delaying or eliminating the fast reclose has a negative impact on the system's reliability and power quality. If the generator does not go off line during the reclosing's initial open interval, the arc will not extinguish. Upon reclose of the Utility breaker and the fault still present, the trip-reclose sequence will advance one step closer to locking out. This increases the probability of a temporary fault resulting in a permanent interruption. Also, reclosing onto a synchronous generator can cause thermal damage to the generator windings, damage to the exciter due to high voltages induced in the rotor, and excessive tortional forces on the generator shaft as the power system pulls the generator back into step.

There are 3 main ways to ensure the generator has tripped;

a) Passively - by ensuring the generator cannot provide sufficient active power and reactive power to the load; hence, the generator will trip on underfrequency and undervoltage, respectively.

b) The Utility reclosing device can check for line side voltage prior to reclosing. This is known as a “dead line check” permissive prior to reclosing.

c) Transfer a trip signal to the generator from the Utility protective device whose operation indicates an Islanded condition.

d) The interconnecting technology is certified as “anti-islanding”; this mostly refers to electronic-inverter connected generation.

IEEE 1547 – “Standard For Interconnecting Distributed Resources with Electric Power Systems”, states that the generator must trip within 2 seconds for an Island. NB Power may require a faster clearing time.

NB Power will determine how the generator protection is to coordinate with system reclosing. Costs for the associated equipment will be the responsibility of the IPP.

6.3 Nominal Voltage Levels and Variation Limits

NB Power adopts Canadian Standards Association (CSA) Standard CAN3 C235-83 – “Preferred Voltage Levels for AC Systems 0 to 50,000V” and its “Recommended Voltage Variation Limits”. NB Power’s nominal secondary

system voltages are 120/240V single phase, and 120/208V and 347/600V three phase.

6.4 Fault Levels

NB Power can provide primary distribution system fault levels at the point of common coupling.

6.5 Phasing Information

NB Power will provide information on phasing and phase rotation.

6.6 Metering

Metering requirements and the point of delivery will be negotiated for each IPP installation. Typically, metering with hourly kW demand and power factor is required where net export generation equals or exceeds 500kW. The IPP is responsible for costs associated with metering and metering communications.

7.0 Reactive Power Requirements

For synchronous generators, sufficient generator reactive power capability shall be provided to withstand normal voltage changes on the NB Power system. The generator voltage volt-amperes reactive (VAr) schedule, voltage regulator, and transformer ratio settings will be jointly determined by NB Power and the IPP to ensure proper coordination of voltage regulation. IPP's are encouraged to generate their own VAr requirements to minimize power factor adjustment charges and to enhance generator stability. For generation of 100kW or less, NB Power will in most cases supply the VAr requirements from the distribution system.

8.0 Transformation

The IPP will be responsible to supply, own and maintain the step-up unit transformer to transform the generator output voltage to 12.47/7.2kV or 24.94/14.4kV.

The generator's main output transformer winding configuration may be either delta, wye, or grounded wye on the generator side. The advantages and disadvantages of each can be discussed with the IPP's consultant.

The default Utility-side winding is the solidly grounded wye. This configuration ensures the transformer will act as a current source for Utility system L-G faults.

With special permission a delta winding on the Utility-side may be allowed if another method of detecting L-G faults is installed such as a grounded-wye/open delta bank with overvoltage relaying.

Notwithstanding, IPP generation of less than or equal to 100kW may be connected through a dedicated NB Power-owned distribution transformer. The purpose of the dedicated transformer is to eliminate the possibility of the generator causing high voltage on other loads or becoming isolated with other secondary load. It will also help attenuate the effect of harmonics beyond the IPP's own system.

Appendix "A"-

Standby Generation

Standby or back up generation is not interconnected with the NB Power system at any time. Load transfer between the two systems must be done in a break-before-make fashion.

Canadian Electrical Code (CEC) Rule 14-612 - Transfer Equipment for Standby Power Systems – states *"transfer equipment for standby power systems shall prevent the inadvertent interconnection of normal and standby sources of supply in any operation of the transfer equipment".* This is to ensure the safety of utility personnel, the public and the customer-owned generating equipment.

The use of solid state devices as isolating switches is covered in the CEC rules 14-700 and 14-702.

Standby power systems are governed by the *New Brunswick Electrical Installation and Inspection Act* and the Canadian Electrical Code, under the jurisdiction of NB Department Public Safety, Technical Inspection Services. NB Power is not be responsible for designing, endorsing or approving customer-owned standby generation or its associated equipment and assumes no responsibility for its operation or maintenance.

Énergie NB Power

TECHNICAL SPECIFICATION FOR INDEPENDENT POWER PRODUCERS

References

Canadian Standards Association Standard C22.3 No. 9 – “Interconnection of Distributed Resources with Electricity Supply Systems” (latest revision).

Institute of Electrical and Electronics Engineers, Inc. Standard 519 – “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems” (latest revision).

Institute of Electrical and Electronics Engineers, Inc. Standard 1547 - “Standard for Interconnecting Distributed Resources with Electric Power Systems” (latest revision).

Canadian Standards Association Standard CAN3 C235-83 – “Preferred Voltage Levels for AC Systems 0 to 50,000V” (latest revision).