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NEWFOUNDLAND POWER
A FORTIS COMPANY

Net Metering

Interconnection Requirements

Customer Generation Capacity Not Exceeding 100 kW

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Revision History

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1.0 PURPOSE

This document establishes the minimum requirements for safe and effective operation of small-scale generation interconnected with the distribution system of Newfoundland Power Inc. ("the Utility"), and describes the Utility interconnection requirements associated with the provision of Net Metering Service. The document sets out the minimum design standards to which the generator and related equipment associated with a Customer's Net Metering Service (the "Customer Facility") must conform, and outlines a range of normal and emergency system conditions the Customer Facility could encounter while connected to the Utility distribution system.

Specific technical requirements will vary depending on capacity, type, location and the existing distribution infrastructure in the vicinity of the Customer Facility. Customers considering the Net Metering Service Option should therefore discuss project plans with the Utility before purchasing or installing equipment.

The Customer is required to install, operate and maintain the Customer Facility in accordance with manufacturer's recommendations to ensure good working order and fitness for service at all times.

The following assumptions and principles apply to all Customer Facilities:

- The interconnection of the Customer Facility with the Utility distribution system will not appreciably change the distribution system and its characteristics.
- The Customer Facility shall meet the installation requirements of the latest edition of the Canadian Electrical Code ("CEC") Part 1 and the equipment shall be certified to the relevant CEC Part 2 product standard. Compliance with all applicable local and provincial construction and installation regulations is also required.
- The safety of Utility personnel, Customers, and equipment, and safety of the public, shall be primary considerations in the design of Customer Facilities.

Implementing the requirements set out in this document will help ensure that operation of the Customer Facility does not compromise the safe operation, reliability or power quality of the Utility distribution system.

1.1 Customer Generation

A Net Metering Customer may be permitted to operate, in parallel with the Utility distribution system, a Customer Facility consisting of generators with a maximum aggregate capacity of 100 kW and operated at 60 Hz, provided the Customer Facility meets or exceeds the requirements set out in this document. In all cases, establishment of a Net Metering Interconnection Agreement and conformance with the Utility Net Metering Service Option Rules and Regulations is required.

1.2 Limitations

The criteria and requirements of this document are applicable to all renewable generation technologies. Customer Facilities will be interconnected with radial distribution systems at nominal primary voltages of 25,000 VAC or less, and nominal secondary voltages of 600 VAC or less.

Customer Facilities shall be sized to not exceed the annual energy requirements of the buildings or facilities located on the Customer's Serviced Premises.

This document does not apply to emergency backup generators utilizing automatic or manual transfer schemes in which load is transferred between the backup generation and the Utility distribution system in a momentary "break-before-make" operation.

The requirements set out in this document are not intended to address protection of the Customer's equipment. The Customer is fully responsible for protecting their equipment in such a manner that faults or other disturbances on the Utility system do not cause damage to Customer equipment, and the Utility shall not be liable for any such damages.

2.0 GETTING CONNECTED – THE INTERCONNECTION PROCESS

The first step in getting connected is to have the project assessed by the Utility. The process is initiated by completing and submitting a Net Metering Interconnection Application Form. The form may be submitted as follows:

By regular mail:

Newfoundland Power – Planning and Standards
55 Kenmount Road
P.O. Box 8910
St. John's, NL
A1B 3P6

By e-mail:

netmetering@newfoundlandpower.com

The basic steps in the process are as follows:

1. The Utility will acknowledge receipt of the Net Metering Interconnection Application Form and will undertake a review of the interconnection request and the field conditions. Depending on the size, type and location of the proposed Customer Facility, the Utility may require the Customer to pay, in advance, a fee for a technical review. This review will identify any new Utility equipment or upgrades to the existing distribution system that may be necessary to enable interconnection of the Customer Facility.

2. The Utility will develop specific interconnection requirements and cost estimates for required system additions/upgrades, including any required changes to the Utility revenue metering equipment.
3. The cost estimates for any required system additions or changes will be provided to the Customer for review. Once the Customer accepts the requirements and pays the identified costs, the required construction work can be scheduled to commence. Acceptance of the requirements will constitute approval of the application.
4. The Customer's electrician must obtain an Electrical Permit for the installation of the Customer Facility from the applicable electrical inspection authority and arrange for all required inspections. The Customer Facility must pass all required electrical inspections.
5. Following installation of the generating equipment, the Customer will be required to enter into an Interconnection Agreement with the Utility.
6. After the Interconnection Agreement is signed and the electrical inspections are performed and passed, the Utility will advise the Customer in writing that interconnection of the generator with the Utility system can proceed.
7. The Utility may require that its representatives witness the commissioning and testing of the Customer Facility.

3.0 SAFETY AND ASSOCIATED REGULATORY REQUIREMENTS

3.1. Utility Safety Requirements

Safe work procedures described in the Utility safety codes and operational procedures will be followed by the Utility in providing isolation for work on any part of the interconnected distribution system.

3.2 Public Safety Act and the Canadian Electrical Code

The Customer Facility must meet all applicable national, provincial and municipal electrical construction and safety codes, and inspection and permitting requirements, including, without limitation, the provincial *Public Safety Act* and Electrical Regulations; and, within the City of St. John's, the *St. John's Electrical By-Law*.

Installations must comply with the latest versions of the CEC Part 1, CSA C22.3 No. 9 - Interconnection of Distributed Resources and Electricity Supply Systems, and CSA C22.2 No. 257 - Interconnecting Inverter-based Micro-distributed Resources to Distribution Systems.

Except as expressly permitted by law, all electrical equipment that is part of the Customer Facility must have Canadian Standards Association ("CSA") or equivalent approval.

Installation of wind turbines and associated structures may be a regulated activity requiring approval from various governing authorities. Customers considering wind generation are

required to familiarize themselves and ensure compliance with all applicable regulations and bylaws with respect to the installation of wind turbines.

3.3. Permission to Operate

Under no circumstances shall the Net Metering Customer begin parallel operation of the Customer Facility until final written approval has been received from the Utility.

4.0 INTERCONNECTED SYSTEMS

Once the Customer Facility is connected at a point common with the Utility distribution system, it is considered to be part of an interconnected system, and is effectively an integral part of the Utility distribution system. It must therefore be considered in the electrical protection and operation of the Utility distribution system.

Section 4.1 lists the typical distribution system operating and power quality conditions within which the Customer Facility must operate. It lists representative values of parameters that the distribution system normally maintains and some abnormal conditions that the Customer Facility must be designed to withstand. It is the Customer's responsibility to ensure that the Customer Facility operates correctly in this environment.

4.1 The Utility Distribution System

4.1.1 Distribution System Configuration

The Utility primary distribution system is a 3-phase, 4-wire multi-grounded common neutral system ("effectively grounded-wye") operated at 3 typical voltage levels:

- 4,160 Volts line to line (4 kV)
- 12,470 Volts line to line (12 kV)
- 24,940 Volts line to line (25 kV)

Distribution transformers, which step the primary voltage down to utilization voltages, are mainly single-phase units with primaries and secondaries connected phase to ground. Three phase distribution transformers are normally configured grounded wye-grounded wye. This generally provides a single intentional ground path for short-circuit currents (one zero-sequence path) and has been utilized in the design of short-circuit protection applied to distribution feeder systems. The Utility standard secondary voltages are:

- 120/240 Volts 1-Phase
- 120/208 Volts Solidly Grounded Wye 3-Phase, 4-Wire
- 347/600 Volts Solidly Grounded Wye 3-Phase, 4-Wire

4.1.2 System Grounding

Distribution systems are typically 3-phase 4-wire multi-grounded systems incorporating single-phase distribution taps. They are typically operated as effectively (solidly) grounded.

Following interconnection of the Customer Facility, the distribution system must remain effectively grounded at all locations.

4.1.3 Phasing

Phasing is not standardized across distribution systems. For three-phase generation, the phase sequence and the direction of rotation must be coordinated with the Utility distribution system.

4.1.4 System Frequency

The distribution system operates at 60 Hz. Since the island of Newfoundland is electrically isolated from the North American grid, frequency deviations are typically greater than experienced by the larger integrated North American utility systems.

4.1.5 System Voltage

Customer Facilities must be capable of operating within the extreme voltage level variation limits shown in Table 1.

Table 1
Normal Service Voltage Variation Limits

Nominal System Voltages	Recommended Voltage Variation Limits for Circuits Up to 1000 volts, Applicable at Service Entrance			
	Extreme Operating Conditions			
		Normal Operating Conditions		
	Min	Min	Max	Max
Single Phase				
120/240	106/212	110/220	125/250	127/254
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635
Three Phase 4-Conductor				
120/208Y	110/190	112/194	125/216	127/220
240/416Y	220/380	224/388	250/432	254/440
277/480Y	245/424	254/440	288/500	293/508
347/600Y	306/530	318/550	360/625	367/635
Three Phase 3-Conductor				
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635

Source: CSA CAN3-C235 - Preferred Voltage Levels for AC Systems, 0 to 50 000V

4.1.6 Flicker and Voltage Distortion

The Institute of Electrical and Electronics Engineers (“IEEE”) Standard 519 establishes the quality of power that the Utility is to deliver to the Customer and describes the typical voltage and current waveforms that exist throughout the distribution system. IEEE 519 recommends that the voltage distortion limits, as a percentage of the nominal fundamental frequency voltage, should not exceed 3% for any individual harmonic, and 5% for the total voltage harmonic distortion (“THD”). Transient conditions exceeding the limits may be encountered. Remote sections of the Utility rural distribution system may not meet the limits.

4.1.7 Voltage Unbalance

The voltage unbalance on the distribution system under normal operating conditions is typically under 3%, but may reach 5% due to unbalanced loading and single-phase voltage regulation.

Voltage unbalance is calculated using RMS voltage levels measured phase to phase at the service entrance under no load conditions:

Voltage unbalance (%) = 100 x [(max. deviation from average) / (average)]

4.1.8 Voltage and Current Surges

The distribution system may experience voltage and current surges, which vary by location due to the effects of other types of equipment connected to the distribution system, including switched loads, other generating equipment, switched power factor correction capacitors, and voltage regulation equipment.

4.1.9 Fault and Line Clearing

The Utility power lines are subject to a variety of natural and man-made hazards. These hazards can lead to fault conditions, principally short circuits, grounded conductors, and broken conductors. These fault conditions require that Utility equipment be de-energized as quickly as possible because of the hazards such fault conditions pose to the public and to the operation of the Utility distribution system.

To maintain the reliability of the distribution system, the Utility uses automatic re-closing to automatically re-energize power lines after a fault has occurred. Customer Facility protection schemes must be selected and set up to ensure that the Customer Facility ceases to energize the distribution system before any automatic re-close of the Utility circuit breakers or reclosers can occur.

4.1.10 Fault Levels

Fault levels on distribution circuits will vary depending on circuit configuration. The Utility will provide information on fault levels at a given site when requested by the Customer.

4.2 Generator Types

Although it is anticipated that the majority of generators encountered in the size category permitted by the Net Metering Service Option will be induction or inverter types, synchronous units may also be utilized.

4.2.1 Induction Generators

Induction generators are induction motors that are mechanically driven above synchronous speed to produce electric power. Reactive power supply for induction generators may pose design problems, depending on the generator size. Special considerations for induction generators are:

- Capacitors may be necessary to limit the adverse effects of reactive power flow on the Utility system voltage regulation.
- Self-excitation of the induction generator due to installed capacitors can produce abnormally high magnitude distorted voltages.
- Voltage flicker resulting from the starting of induction generators, particularly on low capacity distribution systems, may be unacceptable to the Utility.

4.2.2 Power Electronic Converter (Inverter) Systems

Inverters convert direct current (dc) power to alternating current (ac) power by means of electronic switching devices. Switching can be controlled by the ac voltage waveform of the Utility supply system (grid-dependent) or by internal electronic circuitry (grid-independent). Inverters are generally not capable of supplying sustained fault current. Grid-independent inverters are capable of supplying load current independently of the Utility supply systems. Excessive harmonic output of power inverters may interfere with other Utility Customers.

4.2.3 Synchronous Generators

Synchronous generators are generally capable of supplying sustained current for faults occurring on the Utility distribution system. Re-closing by the Utility onto synchronous units must be blocked to prevent out-of-synchronous paralleling and to prevent the energizing of a de-energized distribution line.

For this type of generator, synchronizing equipment must be provided by the Customer to ensure proper synchronizing of the Customer Facility to the distribution system.

Sufficient time must be allowed to ensure the Utility system has stabilized following a reclose or protection system operation.

5.0 GENERAL REQUIREMENTS FOR INTERCONNECTION

5.1 Isolation

As per CEC Part 1 – Section 84, a manual disconnecting device for isolation purposes must be provided by the Customer. The form of this switch will vary with the service voltage and capacity. In all cases, the device must be capable of: (i) providing a visible break (air gap) that can be confirmed via visual inspection; (ii) opening all phases simultaneously (gang-operated); and (iii) being locked in the open position. The device must be accessible at all times to Utility personnel. Location and form of the device is subject to approval by the Utility.

In addition, the Customer Facility must be equipped with an automatic disconnect device that will automatically operate, as required, by protection functions to disconnect the Customer Facility from the distribution system.

The Customer shall install warning labels at the revenue meter location and at the manual disconnect device as required by CEC Part 1 – Section 84. A single-line, permanent, legible diagram of the Customer Facility shall be installed in a conspicuous place at the disconnect device. Where instrument transformers are used for revenue metering, the revenue meter and the instrument transformer enclosure shall each be supplied with the warning label required by CEC Part 1 – Section 84.

5.2 Grounding

The equipment comprising the Customer Facility must be grounded in accordance with the most stringent requirements of the manufacturer's recommendations, the CEC, and the normal practices of the Utility.

Interconnection of 3-phase transformers, and transformer grounding systems on 3-phase distribution systems, shall be coordinated with the Utility and shall not cause voltage disturbances or disrupt coordination of the Utility distribution system ground fault protection.

5.3 Protection

The Customer Facility shall be equipped with protective functions or devices designed to:

- Ensure the Customer Facility cannot, in any circumstance, energize a de-energized Utility distribution system;
- Prevent parallel operation of the Customer Facility with the Utility distribution system unless the voltage and frequency are within normal limits;
- Prevent isolated operation of the Customer Facility (islanding) with any part of the Utility distribution system; and
- Automatically interrupt the maximum available fault current at the point of connection with the Utility distribution system.

6.0 INTERCONNECTION PROTECTION REQUIREMENTS

6.1 Response to Abnormal Voltage Levels

Every interconnected generator requires under/over voltage protection.

Three-phase generator systems shall automatically disconnect from the Utility distribution systems when any individual phase-to-neutral voltage on a grounded-wye system or any individual phase-to-phase voltage on an ungrounded-wye or delta system goes outside the normal range of operation indicated in Table 2. Single-phase inverter systems shall detect the phase-to-neutral voltage if connected to neutral. Single-phase equipment connected line-to-line, but not to the neutral conductor, shall detect the line-to-line voltage.

When any voltage is outside the normal range indicated in Table 2, the Customer's generating equipment shall disconnect from the Utilities' distribution system within the maximum clearing time indicated by the table.

Table 2
Response to Abnormal Voltage Levels

Voltage Range		**Maximum Clearing Time**	
On 120V Base	**% Of Base Voltage**	**Cycles**	**Seconds**
V ≤ 60	V ≤ 50%	Instantaneous	Instantaneous
60 < V < 106	50% < V < 88%	120 cycles	2 sec.
106 ≤ V ≤ 132	**88% ≤ V ≤ 110%**	**"Normal Range" of Operation**	
132 < V < 144	110% < V < 120%	60 cycles	1 sec.
V ≥ 144	V ≥ 120%	Instantaneous	Instantaneous

6.2 Response to Abnormal Frequencies

Every interconnected generator requires under/over frequency protection.

When a system frequency is outside the range indicated in Table 3, the Customer's equipment shall automatically disconnect from the Utility distribution system. Adjustable under frequency settings shall be coordinated with the Utility.

Table 3
Response to Abnormal Frequencies

Utility Voltage Condition	Frequency Condition (Hz)	Maximum number of cycles to disconnect	Seconds
Normal Voltage	>60.5	10	0.16
Normal Voltage	<59.3	10	0.16

6.3 Over-current Protection

The Customer's interconnection equipment must detect and disconnect for over-current fault conditions.

6.4 Harmonics

Harmonic current injection by the Customer's equipment into the Utility distribution system shall not exceed the limits listed in Table 4 below.

Table 4
Current Harmonic Limits

Individual Harmonic Order "n" (odd)[1]	n<11	11≤n<17	17≤n<23	23≤n<35	35≤n≤50	Total Demand Distortion (TDD)
Percent (%)	4.0	2.0	1.5	0.6	0.3	5

[1] Even harmonics are limited to 25% of the limits shown in the table.

6.5 Flicker

The Customer Facility shall not create objectionable flicker for other Customers served from the Utility distribution system. Flicker is a site-dependent condition. In this regard, voltage flicker and deviation is governed by the flicker curve attached to this document as Appendix A. Appendix A shows the permissible voltage fluctuation and frequency based on the annoyance factor of lamp flicker.

6.6 Fault Clearing

Following an outage on the Utility distribution system, the Customer Facility shall reconnect only when the distribution system voltage and frequency return to normal range (Tables 2 & 3) and are stabilized for a period of at least 5 minutes.

6.7 Synchronizing

The Customer Facility must be capable of synchronizing with the Utility distribution system. It shall synchronize to the distribution system while meeting the flicker requirements of Section 6.5 and without causing voltage variation at the point of interconnection of greater than 5%. The Customer Facility shall synchronize to the Utility distribution system only if the distribution system is stable and operating within the normal limits of Table 2 and Table 3 for a period of at least 5 minutes following an outage.

6.8 Islanding

Islanding is not permitted.

The Customer Facility shall be equipped with an approved non-islanding protection function designed to prevent the generator from being connected to the Utility distribution system when the Utility distribution system is not energized. Alternatives to this protection function will be considered at the discretion of the Utility.

All inverters shall be “non-islanding type” as defined by CSA C22.2 No. 107.1.

6.9 Voltage Control

The Customer Facility shall not actively regulate the voltage on the local distribution system and shall not cause the voltage level of the local distribution system to be sustained outside the limits of Table 1, Normal Operating Conditions Range, measured at the point of interconnection.

The Customer Facility is not required to be capable of adjusting the power factor, but each generating unit shall be capable of operating within a range of 0.95 power factor lag to 0.95 power factor lead.

6.10 Inverter Protection Capabilities

Inverters that meet each of the following technical requirements comply with the protection requirements of Tables 2, 3 and 4:

- Output rating of inverter is less than 30 kW.
- Systems are rated and connected at a secondary voltage level (i.e. less than 600V nominal, measured line to line).
- Systems meet CSA C22.2 No.107.1 - Standard “Power Conversion Equipment” and are so marked.

6.11 Protection Requirements Summary

Table 5
Protection Requirements Summary

Guide Section	Device Category	ANSI Protection Element
5.1	Manual Disconnect Device (lockable, accessible, visible)	-
5.1	Automatic Disconnect Device	52
6.1	Over-Voltage Trip	59
6.1	Under-Voltage Trip	27
6.2	Over/Under Frequency Trip	81O/81U
6.8	Anti-Islanding	AI
6.3	Overcurrent Trip/Shutdown	50/51
6.7	Synchronizing/Synch Check*	25
*** Synchronous Types Only**		

7.0 METERING

7.1 Customer Requirements

To permit suitable access by the Utility, the Customer is required to provide and install, at their own expense, meter sockets and metering cabinets at the Customer Facility in a location satisfactory to the Utility. The equipment and installation shall be in accordance with the Utility metering standards.

7.2 Bi-directional Metering

Additional revenue-class metering will be installed so that kWh (in) and kWh (out) are separately recorded. The Customer shall pay all costs to upgrade the metering equipment for Net Metering Service if the existing electrical meter at the Serviced Premises is not capable of safely and reliably measuring both the energy supplied to the Customer by the Company and the energy supplied to the Company by the Customer.

7.3 Meter Testing

All revenue metering equipment is routinely tested in accordance with Measurement Canada requirements. At any time, either the Customer or the Utility may request a test of the accuracy of the revenue metering equipment at their own expense. The results of meter calibrations or tests shall be available for examination by both parties at all times. If the meter accuracy disclosed by the requested test is not within Measurement Canada's allowable limits, the Utility shall correct the inaccuracy or replace the meter as soon as possible and, if the Customer requested and paid for the test, reimburse the Customer for the reasonably-incurred cost of the test. If the meter is found to be within allowable limits, no adjustment or reimbursement will be required.

8.0 OPERATING REQUIREMENTS

8.1 Interconnection Agreement

Prior to operation of the Customer Facility, an Interconnection Agreement shall be established between the Customer and the Utility.

Once the Interconnection Agreement has been established, the Customer shall not be permitted to modify or make additions to the Customer Facility without the prior written consent of the Utility.

8.2 General Operating Requirements

When necessary to ensure safety, reliability or serviceability of the Utility distribution system, the Utility may require the Customer to provide it with operational control over the Customer Facility interconnection equipment.

8.3 Testing

Prior to interconnection, all protective devices or functions supplied to satisfy the requirements of Section 6 shall be tested by qualified personnel at the Customer's expense. Reports and findings of this testing shall include the "in service" settings. Test reports will promptly be made available to the Utility.

Additional tests may also be requested from time to time by the Utility to investigate apparent mis-operations of the Customer Facility that may have had an adverse effect on the Utility distribution system. The Customer shall conduct, or allow the Utility to conduct, such tests. The cost of such tests will be at the Customer's expense. Should a test disclose no fault, irregularity or mis-operation of the Customer Facility, the Utility will reimburse the Customer for the reasonably incurred cost of the test.

9.0 RESPONSIBILITY FOR COSTS

The Customer is responsible for all capital, operating and maintenance costs of all equipment on the Customer side of the point of delivery.

Where upgrades and/or revisions are required to the existing Utility system to accommodate the interconnection of the Customer Facility, the Customer shall be required to pay the actual cost of the installation/changes. The Customer shall also be required to pay a capital contribution for any required line extensions necessary to extend the Utility distribution system to the point of interconnection.

10.0 APPENDICES

Appendix A: Standard Voltage Flicker Curve

Appendix A:

Standard Voltage Flicker Curve

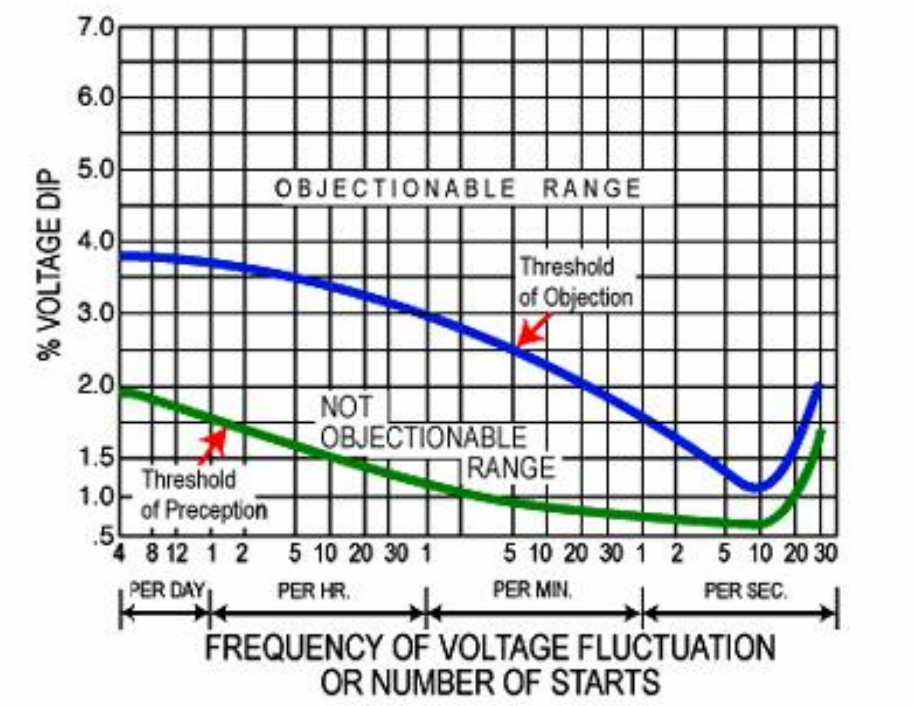

Figure 1: Flicker Curve