Commissioning Verification Form

(For >10kW to 500kW Inverter-based Generators)

This commissioning verification form (CVF) is required for small or mid-size generators applying for a Connection Agreement with Alectra Utilities. This document must be signed and sealed by a licensed Ontario Professional Engineer (P.Eng.). A system commissioning report must be submitted in addition to this commissioning verification form.

Site Information

Project Address	
Reference Number (IESO or Other if applicable)	
Project Nameplate Capacity [kW]	

Commissioning Test Contact Information

Name	
Title	
Mailing address	
Telephone	
Email	

Commissioning Tests

1. Anti-Islanding Test (if applicable):

a) Turn Off Utility-Side DG Disconnect:

Verification	Yes/No	Initials	Date	Comments
Did the inverter indicate a loss of the utility grid?				
After a loss of the utility grid, is there voltage on the output of the inverter?				
Did the inverter shut down as required?				

b) Turn On Utility-Side DG Disconnect:

Verification	Yes/No	Initials	Date	Comments
Did the inverter turn back on upon reconnection with the utility grid?				
Did the inverter return to its normal operating state?				

2. WiMax Provision Confirmation (if applicable):

a) Provisions for Remote Monitoring:

Verification	Yes/No	Initials	Date	Comments
Does the inverter support multiple masters?				
Does the inverter support DNP3 or Modbus over Ethernet?				

b) Provisions for Transfer Trip (if applicable):

Verification	Yes/No	Initials	Date	Comments
Does the inverter support a remote shut down command via the data port				

3. Generator Protective Relay Settings

The inverter-based generator must confirm that the inverter equipment meets the IEEE 1547 over/under frequency and over/under voltage protection requirements indicated below.

a. Over Frequency/Under Frequency Protection:

Table 1 – Over/Under Frequency Protection Set Points and Clearing Times

Generator Size	Frequency Range (Hz)	Clearing Times(s)*
≤ 30 kW	> 60.5	0.16
	< 59.3	0.16
> 30 kW	> 60.5	0.16
	< (59.8 – 57.0) - adjustable	Adjustable – 0.166 to 300
	< 57.0	0.16

Source: IEEE 1547

***Generators ≤ 30kW – Maximum clearing time**
***Generators > 30kW – Default clearing time**

b. Overvoltage/Undervoltage Protection:

Table 2 - Over/Under Voltage Protection Setting and Clearing Time

Voltage Range (% of base voltage)	Clearing Time(s)*
V < 50	0.16
50 ≤ V < 88	2.00
110 < V < 120	1.00
V ≥ 120	0.16

Source: IEEE 1547

***DG ≤ 30 kW – Maximum clearing time**
***DG > 30 kW – Normal clearing time**

By signing this form, the Commissioning Test Representative acknowledges that all required verifications Specified under this commissioning verification form have been completed and inverter equipment meets the IEEE 1547 protection requirements outlined in the Generator Protective Relay Settings section of this document.

The Commissioning Test Representative acknowledges that the embedded generator meets the minimum standards for facility design, construction and operation of generation facilities connected to a distribution system as per the latest revision of the Distribution System Code Appendix F.2- Technical Requirements (attached).

_____ **(Must affix P.Eng. seal)**
Signature of Commissioning Test Representative (Must be a P.Eng.)

_____
Name (Print)

_____
Title

_____
Date

Return the completed document by email to:
DER@alectrautilities.com

Check List:
Please ensure the following items are completed prior to submission. Your application will not be processed if any part is omitted or incomplete:

- ☐ Commissioning Verification Form, stamped by a Professional Engineer (P.Eng.)
- ☐ System Commissioning Report

F.2 Technical Requirements

LIST OF ACRONYMS

CSA Canadian Standards Association

ESA Electrical Safety Authority

IEC International Electrical Code

IEEE Institute of Electrical and Electronic Engineers

OESC Ontario Electrical Safety Code

Technical Requirements for Generator Connection

Point of Connection

The point of connection (also may be referred to as point of common coupling) will be identified in the design and on the single line diagram. The distributor will co-ordinate design, construction, maintenance and operation of the facilities on its side of the point of connection. The applicant is responsible for the design, construction, maintenance and operation of the facilities on its side of the point of connection unless described otherwise in an interconnection agreement.

Note: On the generator's side of the point of connection the equipment shall be approved in accordance with rule 2-004 of the Ontario Electrical Safety Code (OESC).

1. Isolation at the Point of Connection

A means of isolation must be provided by the generator and must be in compliance with the OESC. The distributor's practice may require its own additional means of disconnection on the distributor's side of the point of connection.

2. Interconnection Grounding

Generation facilities and the associated interconnection systems must be grounded as per manufacturer's recommendations and the OESC, as well as taking into account the normal practices of the distributor.
Interconnection of three phase transformers, and transformer grounding systems on three phase distribution systems shall be co-coordinated with the distributor and shall not cause voltage disturbances or disrupt co-ordination of distribution system ground fault protection.

3. Voltage Regulation, IEEE 1547, CSA Standard CAN3-C235-83

CSA Standard CAN3-C235-83 provides general guidance as to appropriate distribution system steady state service voltage levels. The generation facility must operate satisfactorily within the extreme voltage level variation limits shown in these standards. Voltage regulation is the responsibility of the distributor.

3.1 Steady-State Voltage, CSA Standard CAN3-C235

Customers connected to the feeder must be supplied with adequate voltage levels, as per CSA Standard CAN3-C235 for the following situations: with and without the generation facility generating power for minimum and maximum feeder loading conditions.

3.2 Voltage Fluctuation, CSA CAN3-325-83, IMO Requirements for Facilities of 10 MW and Larger

Adequate voltage regulation shall be maintained under a variety of operating conditions. During normal operation, and whenever possible, the generation facility shall be loaded and unloaded gradually to allow adequate time for regulating devices to respond.

3.2 Synchronization, IEEE 1547 and/or IMO Requirements for Facilities of 10 MW and Larger

The generator shall parallel with the distribution system without causing a voltage fluctuation or flicker greater than those specified by the above standards at the point of connection.
Note: OESC rule 84-006 covers the synchronization of parallel generators.

3.2 Voltage Unbalance

Where the distribution system supplies single-phase loads, some unbalances are inevitable. The generation facility should be capable of operating under these conditions and shall not cause further deterioration of existing unbalance conditions.

4. Power Factor, IEEE 1547, CSA C107.1

The generator's system is not required to be capable of adjusting the power factor but shall operate in the preferred range of 0.9 lag to 0.95 lead. If the generation facility disturbs the distribution system voltage levels at the point of connection then the generator may be required to operate its facility within a smaller range or take other compensatory measures. Field settable fixed and dynamic power factor correction techniques may be used if consultation with the distributor reveals no adverse effect on the distribution system. For generators that are IMO inactive, the reactive power compensation at the generating units should be sufficient so as not to cause any material increase in the reactive power requirements at the transmission system transformer station due to operation of the units, at any distribution feeder load conditions.
For inverter based generator facilities power factor limits will be as given in the MicroPower Connect guidelines.

5. Equipment Ratings and Requirements

The generation facility interface equipment must be compatible with LDC equipment ratings at the connection voltage (maximum voltage, basic impulse limit, short circuit ratings, capacity etc.) and the incorporation of the added generation facility must not result in any distribution system equipment operating beyond the distribution system's operational rating. A distributor shall review the equipment ratings for the purpose of assessing integration of the generation facility with the distribution system. The equipment ratings that shall be reviewed include, but are not limited to, the following.

5.1 Equipment Thermal Loading

All existing distributor's equipment in distribution and transmission stations shall not be overloaded beyond acceptable limits under all operating conditions of the generation facility. This equipment includes feeder conductor, line voltage regulators, regulating stations, reclosers, circuit breakers and transformers.

Assuming that under existing operating conditions there is no overloaded equipment, the study will be conducted for minimum load conditions and maximum generation, including all existing generation facilities already existing on the feeder. The load flow study will identify the potential overload of the existing equipment.

5.2 Impact of Generation Facility Fault Contribution on Equipment Rating

The generation facility will contribute to the total fault current. The distribution system's interrupting devices shall be able to interrupt the maximum fault current that will flow through the devices. All the distribution system's electrical equipment has to be able to withstand the fault current passing through it for the required time for the protection to clear the fault.

The fault interrupting rating of the existing interrupting devices and the fault withstanding rating of the electrical equipment shall be higher than maximum fault current possible to flow through the equipment.

Where the generator causes these limits to be exceeded, distribution system equipment replacement or fault current limiting devices may be required.

5.3 Voltage Regulating and Metering Devices

The distributor's system has been designed for unidirectional flow of power, from source (i.e., station) to the customer. Therefore, the voltage regulating and metering devices are designed to correctly operate in these conditions. The connection of generating facilities to the distribution feeder could cause the power to flow to be reversed through the power equipment, which will create difficulties to properly regulate the voltage or to measure the energy, respectively.

Where it is possible for power to flow in reverse through the existing voltage regulating devices and/or the metering points, the regulating devices and metering devices shall be suitable for such bi-directional flow.

The study will be conducted for minimum load and maximum generation condition. The direction of the power flow through voltage regulating devices connected between the generation facility and the transformer station will be verified including line voltage regulators, regulating stations and transformers' under load tap changer, at the distribution station and transformer station. Also all metering devices, either for billing purpose or monitoring reasons, will be verified.

6. Cease to Energize

The distributor will review the generator's design to ensure that the facility will cease to energize automatically from the distribution system's supply under the conditions identified in this section.

Important considerations in this design review:

As per IEEE 1547

To maintain the reliability of the distribution system, the distributor may use automatic re-closing. The applicant needs to be aware of line re-closing when designing the system protection schemes to ensure that it deenergizes the distribution system prior to automatic re-close of the distribution system's breakers or line reclosers. The distributor must review to ensure that the generator's design will deenergize the generation facility prior to auto-reclose operation of feeder tripping devices.

As per IEEE 1547 and OESC 84-008(b)
After a disturbance on the distribution system, no reconnection shall take place until the distribution system voltages and frequency are within the limits specified in CSA CAN3-C235 standard.
The generator's interconnection system shall include an adjustable delay (or a fixed delay of 5 minutes) that may delay reconnection for up to 5 minutes after the distribution system's steady state voltage and frequency are restored to the ranges identified above.

6.1 Loss of LDC Supply Resulting in the Formation of an Island, IEEE 1547 CSA C22.2 No. 107.1, OESC 84-008 (Loss of Supply Authority Voltage)

6.1.2 Unplanned islanding

The applicants system shall cease to energize the distribution system following the formation of an unintentional island.

6.1.3 Planned islanding

Where planned islanding is allowed, the generator and the distributor will jointly agree to all requirements.

6.4 Over-Current Protection Coordination Due to Generation Facilities Fault Contribution IEEE 1547 and OESC 84-014 (System Protection Devices)

Any element of the interconnection system external to the generation facility, but ahead of the point of connection, should be installed in a fail-safe manner with self-checking features or redundant protection functions for large generators.

Equipment and conductors shall be provided with overcurrent protection from each source of supply. The generation facilities protection system shall be capable of automatically isolating the generator from the distribution system for the following:

- internal faults within the facility; and/or
- external faults within the distribution system.

The protective device selectivity and sensitivity have to be maintained over the range of minimum to maximum fault currents with infeed from the generator.
Where the primary connection of the generation facility transformer is Wye- (Y) grounded, the sensitivity of the ground fault protections could become deficient, as zero sequence current will have an additional ground path through the transformer to the distribution system. The ground fault occurring within the protected zone has to be "seen" by the ground fault protections with and without the transformer connected.

6.5 System Voltage Changes Beyond the Over or Under Voltage Range, IEEE 1547

Over and under voltage and over and under frequency protection is required at the generation facilities interconnection point.

The set points and clearing times for over or under voltages and over or under frequencies are dependent upon the magnitude of voltage and frequency variations and generator size. For details see relevant clauses of IEEE 1547. Generator equipment should be approved to CSA 107.1 or other acceptable standard.

Note: OESC rule 84-014 states that each parallel power generation facility installation shall be provided with such additional devices that are required for system stability and equipment protection.

7. Revenue Metering

Revenue Metering shall be in accordance with Canada's Electricity and Gas Inspection Act, R.S. 1985, C.E-4.

8. Feeder Relay Directioning

The existing over-current protections in distribution system are typically designed to clear line and ground faults occurring downstream from their location, as the source feeding the fault is only the transformer station. Connecting a generating facility provides another source supplying the fault, and the fault contribution from the facility might cause protection to operate non-selectively for reverse faults, out of the protected zone.

If the maximum reverse fault current through a non-directional fault-interrupting device exceeds the setting of the device, the fault-interrupting device shall be provided with a directional feature to prevent tripping for reverse fault current flow. The phase protection could be replaced with an impedance relay (21) if required.

The main concern is the infeed from the generation facility with Wye- (Y) grounded connection on the HV of the interface transformer for faults on the adjacent feeders. The generator may consider adding a reactor <5 ohm in the neutral of the generator's transformer, within the constraints of the overvoltages.

9. Monitoring, IEEE 1547, OESC and/or IMO & Transmitter Requirements for Facilities of 10 MW and Higher,

A generation facility connected to the point of connection, rated at greater than 250 kVA, shall have provision for monitoring connection status, real power output, reactive power output, and voltage either at the point of connection or aggregate connection, as required by the distributor. The monitoring equipment shall either be installed, or there shall be adequate provision in the design, to allow future installation of such equipment if not required at time of interconnection. When implementation of data telemetry is required, the distributor and the generator will mutually agree upon communication media options.

Note: At the generator's side of the point of connection the equipment shall be approved as per rule 2-022 of the OESC. The installation shall be inspected as per rule 2-004 of the OESC.

10. Power Quality

The generator shall not significantly impact the power quality of the system. If there are negative impacts once the generation facility is in service, they will be required to disconnect until appropriate

measures have been taken to prevent negative impacts to the distribution system and the customers it serves.

10.1 Flicker, IEEE1547, IEC 61000-3-7

The generation facility shall not cause objectionable flicker on the distribution system. It is recognized that flicker is a site dependent condition. Loss of synchronism protection may be required to be incorporated by the generator, if necessary, to limit flicker.

10.2 Harmonics, IEEE1547, IEC 61000-3-6

Inverter connected generation facilities are expected to comply with CSA 22.2 No. 107.1 current distortion limits.

For inverters only capable of operating in voltage follower mode, voltage harmonic distortion limits are not specified, but may be addressed by the distributor. Inverters certified to CSA 107.1 are considered to meet these requirements. The CSA standard excludes current harmonics due to voltage distortions in the distribution system.

10.3 Limitation of DC Injection, IEEE1547

The generation facility shall not inject a d.c. current greater than 0.5% of the unit rated output current after a period of six cycles following energizing of the distribution system.

10.4 Protection from Electromagnetic Interference (EMI), IEEE 1547, C37.90

The influence of EMI should not interfere with operation of the generation facility's interconnection system.

10.5 Surge Withstand Performance, IEEE 1547, C62.41.2 or C37.9.90, OESC 84-014

The interconnection system shall have the capability to withstand voltage and current surges.

10.6 Paralleling Device, IEEE 1547

The interconnection system paralleling-device shall be capable of withstanding 220% of the interconnection system rated voltage.