ATCO Electric Yukon's Isolated Community Generation

System Interconnection Guidelines

TABLE OF CONTENTS

PART A – TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

The following words and expressions wherever used in these System Interconnection Guidelines have the following meaning:

"**AC**" means alternating current.

"**Accredited Certification Organization**" means an organization that has been accredited by the Standards Council of Canada to operate a certification program for electrical equipment, such as the CSA.

"**AEUC**" means the Alberta Electrical Utility Code.

"**ATCO**" means Yukon Electrical Company Limited, doing business as ATCO Electric Yukon, and its successors and permitted assigns, the utility that owns the Distribution System.

"**CEA**" means the Canadian Electricity Association.

"**CEC**" means the Canadian Standards Association's C22.1 Safety Standard for Electrical Installations Part 1, known as the Canadian Electrical Code.

"**CSA**" means the Canadian Standards Association.

"**DC**" means direct current.

"**Definitive Project Agreement(s)**" means the definitive agreement(s) in respect of the development of a Renewable Generation Facility, which may provide for, among other things: (i) the construction and operation by the IPP of the Renewable Generation Facility, and (ii) the delivery of electrical energy generated by the Renewable Generation Facility to the Distribution System.

"**Distribution System**" means the distribution, protection, control and communication facilities in the Yukon that are or may be used in connection with, or that otherwise relate to, the transmission of electrical energy at 35 kilovolts or less, and includes all additions and modifications thereto and repairs or replacements thereof.

"**EGIA**" means the *Electricity and Gas Inspection Act*, R.S.C., 1985, c. E-4.

"**Generator**" means a device that produces AC power. In the case of inverters, these System Interconnection Guidelines use the term Generator to refer to the AC inverter, not the DC source.

"**Governmental Authority**" means any federal, territorial, local or foreign government or any of their boards or agencies, or any regulatory authority other than ATCO and the IPP and entities controlled by ATCO or the IPP.

"**Hz**" means hertz.

"**IEEE**" means the Institute of Electrical and Electronics Engineers.

"**Interval Meter**" means a meter that measures transmission of electric energy and stores data in 15 minute intervals.

"**IPP**" means the Person which owns or leases the Renewable Generation Facility.

"**Island**" means a condition in which a portion of ATCO's system, which is electrically separated from the rest of ATCO's system, is energized by one or more distributed generators.

"**Laws**" means any and all statutes, laws (including common law), ordinances, rules, regulations, codes, orders, bylaws, policies, directions, standards, guidelines, protocols and other lawful requirements of any Governmental Authority in effect from time to time.

"**Measured Billing Point**" has the meaning given to such term in Section 8.1 of these System Interconnection Guidelines.

"**Micro-grid Controller**" means the equipment and communication mediums utilized for the purpose of annunciation and control of key system electric assets, including generation assets utility and non-utility owned and utility transmission and distribution supply points, which may be installed by ATCO in respect of a Renewable Generation Facility.

"**Parallel Operation**" means the operation of any generation facility while connected to an electric power grid in such a way that both the grid and the generation facilities supply electric power to the loads at the same time.

"**Person**" means an individual, body corporate, firm, partnership, joint venture, trust, legal representative or other legal entity.

"**POI**" or "**Point of Interconnection**" means the point at which ATCO's facilities are connected to the IPP's facilities or conductors, and where any transfer of electric energy between the IPP and ATCO takes place.

"**Public Utilities Act**" means the *Public Utilities Act* (Yukon) and any successor or replacement legislation.

"**Renewable Generation Facility**" means any unregulated electric generator of the IPP connected to the Distribution System through the POI.

"**Single Line Diagram**" means a simplified electrical representation of the power system which identifies electrical equipment with unique identification, which will be attached to the Definitive Project Agreement(s).

"**Stabilized**" means the state of the Distribution System after voltage and frequency has returned to normal range for a period of at least five minutes (or another period of time, as coordinated with ATCO) following a disturbance.

"**System Controller**" means the grid operating authority for dispatching load and generation in real time.

"**System Interconnection Guidelines**" means these ATCO Electric Yukon's Isolated Community Generation System Interconnection Guidelines.

"**Telemetering**" means the transmission of metering data using telecommunication systems.

"**Visible-Break Disconnect**" means a switch or circuit breaker by means of which the generator and all protective devices and control apparatus can be simultaneously disconnected under full load entirely from the circuits supplied by the generator. All blades or moving contacts must be connected to the generator side, and the design of the disconnect must allow adequate visible inspection of all contacts in the open position.

"**YUB**" means Yukon Utilities Board.

PART B – GENERAL INTERCONNECTION INFORMATION

ARTICLE 1
INTRODUCTION

1.1 Purpose of These System Interconnection Guidelines

The purpose and intended use of these System Interconnection Guidelines is to:

(a) inform and provide guidelines for any IPP wishing to connect a Renewable Generation Facility to ATCO's isolated diesel communities; and

(b) assist operators, technical staff, consultants and contractors in determining the technical and operating requirements of a Renewable Generation Facility, including in relation to the interconnection of a Renewable Generation Facility to the Distribution System.

These System Interconnection Guidelines are intended to form part of and be supplementary to the terms and conditions of the Definitive Project Agreement(s).

1.2 Guiding Principles

These System Interconnection Guidelines have been developed in accordance with the following principles:

(a) the interconnection process must provide competitive, fair and equitable access for all IPPs;

(b) the interconnection must not create a safety hazard to other customers, the public or operating personnel;

(c) the interconnection must not compromise the reliability or restrict the operation of the electric system; and

(d) the interconnection must not degrade power quality below acceptable levels.

ARTICLE 2
RESPONSIBILITIES

2.1 IPP Responsibilities

In connection with the development of a Renewable Generation Facility, the IPP is responsible to:

(a) provide technical information to ATCO as specified in Appendix A;

(b) design, engineer, procure, construct, install, commission, operate and maintain the Renewable Generation Facility, including the following in respect of the Renewable Generation Facility:

(i) ensure all necessary designs and drawings are signed and stamped by a licensed, professional engineer;

(ii) have equipment certified by an Accredited Certification Organization; and

(iii) verify that the installation conforms to the current edition of Part I of the CEC;

(c) pay the costs of system interconnection (and any other costs agreed to be borne by the IPP), subject to and in accordance with the Definitive Project Agreement(s);

(d) obtain any permits, certificates, licences, orders, approvals and other authorizations from any Governmental Authorities as may be required for the design, construction, ownership, operation, maintenance and decommissioning of the Renewable Generation Facility, including:

(i) ensuring that the local inspection and enforcement authorities accept the installation, or that the installation falls under the jurisdiction of an accredited corporation under applicable Laws;

(ii) before commissioning and commencing any Parallel Operation:

(A) obtain any approvals required to be obtained from ATCO under these System Interconnection Guidelines and under the Definitive Project Agreement(s); and

(B) comply with the prerequisites and other requirements set out in Part C of these System Interconnection Guidelines in respect joint operational matters, including technical and real time operations;

(iii) obtaining any permits, certificates, licences, orders, approvals and other authorizations from any Governmental Authorities required to connect to the Distribution System; and

(iv) provide copies of any of the foregoing to ATCO upon request;

(e) obtain written approval from ATCO before commencing Parallel Operation and before making any modification to the Renewable Generation Facility; and

(f) coordinate the timing and any testing requirements for the commissioning of the Renewable Generation Facility with ATCO.

2.2 ATCO Responsibilities

In connection with the development of a Renewable Generation Facility, ATCO is responsible to:

(a) complete or direct completion of load flow and system impact studies as needed to successfully integrate the Renewable Generation Facility within a reasonable period;

(b) prepare the Definitive Project Agreement(s);

(c) inform the IPP of ATCO's current standards and practices which are applicable to the interconnection and/or the Renewable Generation Facility and changes thereto made by ATCO from time to time;

(d) ensure metering requirements are met in accordance with Article 8 of these System Interconnection Guidelines; and

(e) provide the IPP with the information specified in Appendix B.

PART C – OPERATING REQUIREMENTS

ARTICLE 3
GENERAL OPERATING REQUIREMENTS

3.1 Operating Authority

In the Definitive Project Agreement(s), ATCO and the IPP must each identify, by name or by job title, the individual within their organizations who is their respective "Operating Authority". The Operating Authority is responsible to, among other things, establish operating procedures and standards within each organization. Each party shall immediately notify the other of any changes in their respective Operating Authority.

3.2 Operator in Charge

In the Definitive Project Agreement(s), ATCO and the IPP must each identify, by name or by job title, the individual within their organizations who is their respective "Operator in Charge". The Operator in Charge is responsible for, among other things, being familiar with the joint operating requirements set out in the Definitive Project Agreement(s) and being aware of the requirements under applicable Laws in respect of the Renewable Generation Facility. The Operating Authority and the Operator in Charge may be the same person.

3.3 Joint Operating Procedure

The Definitive Project Agreement(s) will contain a joint operating procedure, which will provide for the safe and orderly operation of the interconnection facilities, the Renewable Generation Facility and the Distribution System.

PART D – STANDARDS FOR GENERATOR INTERCONNECTION

ARTICLE 4
PURPOSE OF PART D

4.1 Part 4 of these System Interconnection Guidelines establishes the criteria and technical requirements for interconnecting Renewable Generation Facilities with the Distribution System.

Specifically, it addresses the performance, operation, testing, safety considerations and maintenance requirements of the interconnection.

4.2 The requirements in this Part 4 cover a broad spectrum of interests and requirements. Interconnecting generation facilities to a distribution system may change the system and its electrical response. Attaining a technically sound and robust interconnection mandates diligence on the part of everyone involved, including designers, manufacturers, users, owners and operators of both the generation facilities and the distribution systems. All of the above-mentioned groups need to reach a cooperative understanding of and meet the requirements established herein.

4.3 These System Interconnection Guidelines have been developed with reference to international standards, such as the IEEE Standard 1547 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, and UL Standard 1741 - Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources and its Supplement A. These System Interconnection Guidelines are subject to regular review and revision by ATCO, as necessary to conform to evolving Laws of the Yukon and the federal Laws of Canada and to international standards, such as those developed by the IEEE.

4.4 These System Interconnection Guidelines are not a design handbook. Anyone considering development of a Renewable Generation Facility intended for interconnection to a distribution system should engage the services of individuals qualified to provide design and consulting services for electrical interconnection facilities. Accordingly, ATCO shall not have any liability hereunder to the IPP.

ARTICLE 5
LIMITATIONS

5.1 The criteria and requirements established by these System Interconnection Guidelines are applicable to all renewable technologies and to the primary and secondary voltages of distribution systems. Installation of IPP facilities on the radial primary and secondary distribution systems is the main focus of these System Interconnection Guidelines, although network distribution systems are considered. The requirements must be met at the POI, although the protective devices may not necessarily be located at that point.

5.2 These System Interconnection Guidelines establish the minimum requirements for the interconnection. These System Interconnection Guidelines do not address any liability provisions agreed to elsewhere by both parties in the Definitive Project Agreement(s), or through tariff terms and conditions.

ARTICLE 6
GENERAL INTERCONNECTION AND PROTECTION REQUIREMENTS

The Renewable Generation Facilities and any interconnection facilities must meet all applicable Laws, including federal, territorial and local construction and safety standards and codes. See Appendix C for a complete listing of commonly used codes and standards. Additional requirements may need to be met by both the IPP and ATCO to ensure that the final interconnection design is safe for the intended application.

The IPP is required to install, operate and maintain its electrical equipment and installation in good order and repair at all times. This is to ensure safe Parallel Operations.

The following three Sections, 6.1, 6.2, and 6.3, define the technical requirements for the Distribution System, the Renewable Generation Facility and the interconnection facility, respectively. These requirements promote safe operation and minimize the impact of the interconnection to the Distribution System and its other customers.

These System Interconnection Guidelines are not intended to provide protection for the Renewable Generation Facility. It is the responsibility of the IPP to protect the Renewable Generation Facility in such a manner that Distribution System outages, short circuits or other disturbances, including excessive zero sequence currents and ferro resonant over-voltages, do not cause damage. The IPP's protective equipment must also prevent excessive or unnecessary tripping that could affect the reliability of the Distribution System or power quality to other customers.

Refer to Appendix D for interconnection protective function requirements and testing.

6.1 Distribution System

6.1.1 System Frequency

The Distribution System operates at 60 Hz AC. Frequency variations are typically 59.0 Hz to 61.0 Hz for small contingencies that cause modest disturbances.

Variations of 58 Hz to 66 Hz or greater can occur for larger contingencies.

These variations are system dependent and subject to change by ATCO.

6.1.2 Voltage Regulation

CSA Standard CAN3 C235 83: Preferred Voltage Levels for AC Systems 0 to 50,000V provides general guidance as to appropriate performance.

6.1.3 Power Quality

All interconnected equipment must comply with ATCO's standards for power quality.

The following industry standards may provide guidance as to appropriate performance:

(a) **DC injection**:

- IEEE Std. 1547-2018 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces,

(b) **Harmonics**:

- IEEE Std. 1547-2018 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces,

- IEEE Std. 519-2014 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems,

- CAN/CSA-C61000-3-6-09 - Electromagnetic compatibility (EMC) - Part 3-6: Limits - Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems

- ATCO's *System Standard for the Installation of New Loads*

(c) **Rapid Voltage Changes and Flicker:**

- IEEE Std. 1547-2018 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces,

- CAN/CSA-C61000-3-7:09 - Electromagnetic compatibility (EMC) - Part 3-7: Limits - Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems

- ATCO's *System Standard for the Installation of New Loads*

(d) **Overvoltage Contribution:**

- IEEE Std. 1547-2018 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces,

-

6.1.4 Voltage Unbalance

Distribution systems are typically three-phase systems incorporating single-phase distribution taps. The voltage unbalance on a distribution system under normal operating conditions may reach three percent or higher, due to the unbalanced loading, single-phase regulation, or configuration of the Distribution System. Voltage unbalance will be calculated using the following formula, as derived from NEMA MG1-1993 14.35:

Unbalance (%) = 100 x (maximum phase deviation - average) / (average).

Average voltage being the sum of each phase to phase voltage measured divided by the number of phases in the system.

6.1.5 Fault Levels

Fault levels and maximum allowable fault levels vary significantly through a distribution system and must be considered in the design of the interconnection. Fault levels and X/R ratios must be evaluated for the equipment selected.

6.1.6 System Grounding

Isolated distribution systems are typically operated as ungrounded. Other configurations are occasionally found.

Distribution system grounding must conform to the AEUC.

6.1.7 Fault and Line Clearing

To maintain the reliability of the Distribution System, ATCO utilizes automatic re-closing. The IPP must take this into consideration when designing generator protection schemes to ensure the generator is disconnected from the Distribution System prior to the automatic re-close of breakers. The IPP may reconnect when the Distribution System is Stabilized.

To enhance reliability and safety, with ATCO's approval, the IPP may employ a modified relay scheme with tripping or blocking using communications equipment between the Renewable Generation Facility and the Distribution System.

6.2 Interconnection of Renewable Generation Facility

6.2.1 Mitigation of Adverse Effects

Interconnecting new generation in isolated communities can adversely affect the electric service to existing or future customers. The IPP must work with ATCO to mitigate any adverse effects.

If a Renewable Generation Facility is affecting customers adversely, ATCO may disconnect it until such time as the concern has been mitigated. The IPP is responsible for any costs incurred as a result.

6.2.2 Synchronism

Any Renewable Generation Facility that can create an AC voltage while separate from the Distribution System must have synchronization facilities to allow its connection to the Distribution System.

Inverter-type, voltage-following equipment that cannot generate an AC voltage while separate from the Distribution System does not require synchronization facilities; nor do induction generators that act as motors during start-up, drawing power from the Distribution System before generating their own power.

The IPP is responsible to synchronize and maintain synchronization to ATCO's system. ATCO's system cannot synchronize to the Renewable Generation Facility. A proposed synchronizing scheme shall be included in the Definitive Project Agreement(s).

Distribution systems typically allow for automatic re-closing of electrical circuits after a variable time delay. The IPP is responsible for protecting the Renewable Generation Facility from the impacts of such re-closing.

Renewable Generation can automatically restart following automatic re-closing of Distribution System equipment, if agreed to by ATCO. Renewable Generation that automatically restarts must have a time delay on restart, adjustable up to 60 minutes or as agreed to by ATCO. If required a Micro-grid Controller assigned by ATCO may be installed on the IPP equipment to accommodate synchronizing.

6.2.3 Voltage Regulation and Power Factor

The IPP is responsible to ensure that the voltage levels at the POI are maintained within the guidelines prescribed by ATCO and/or are at least equal to the voltage levels at all feeder load conditions, prior to the interconnection.

Synchronous generators connected to the Distribution System must be equipped with excitation controllers capable of controlling voltage. The generator-bus voltage setpoint must be stable at and adjustable to any value between 95 per cent and 105 per cent so that ATCO can maintain CSA voltage limits on the Distribution System.

Induction generators do not have voltage or reactive power control and consume reactive power (VAR). Therefore, the generator must provide reactive compensation to correct the power factor to 0.90 at the POI, subject to any terms which are negotiated with ATCO in connection with the Definitive Project Agreement(s).

Inverter-type generating equipment can control the power factor over a wide range. An inverter-type generator connected to the Distribution System must be capable of adjusting the power factor in the range of +/- 0.9. The IPP may operate outside that range only with prior written authorization or requirement from ATCO.

ATCO will define voltage and reactive power control requirements on a project-by-project basis. Together, ATCO and the IPP must identify the exact transformer ratio to allow optimum voltage regulation on the Distribution System.

In order to coordinate with its existing voltage control devices, ATCO may require the generator to operate in a power factor control mode (i.e., within a constant power factor setpoint range). The voltage/power factor regulator must be capable of controlling the power factor of the generator +/- 0.90. ATCO will determine the actual set point between these limits.

In power factor control mode, the voltage regulator must have a voltage override that causes it to reduce excitation if the voltage at the POI exceeds an upper limit to be specified by ATCO. The normal upper limit is 105 per cent of nominal; however, the voltage regulator must have provision to adjust this upper limit to between 100 per cent and 110 per cent of nominal. The voltage regulator must also have provision for a time delay between sensing an excursion of the upper voltage and initiating control action. The power factor control equipment must have provision to allow for the adjustment of this time delay between 0 and 180 seconds. ATCO will specify the required time delay.

If required, a Micro-grid Controller assigned by ATCO may be installed on the IPP equipment to accommodate voltage and var control.

6.2.4 Frequency Control

An interconnected Renewable Generation Facility must remain synchronously connected for frequency excursions, as identified in these System Interconnection Guidelines and the table below.

Renewable Generation Facilities that serve remote isolated systems must be capable of controlling the frequency of the system to between 59.7 Hz to 60.2 Hz for normal operation. Under-frequency and over-frequency relaying that automatically disconnects generators from the Distribution System must not operate for frequencies in the range of 59.0 to 61.0 Hz.

The frequency of the electric system is controlled by all synchronous generator governor systems that connect to the electric system. Such governor systems respond automatically to changes in system frequency to prevent further deviation.

The load control of synchronous generators and other generators with stand-alone capability will be controlled by ATCO's Micro-grid Controller.

Renewable Generation Facilities connected to the grid that protect for off-nominal frequency operation should have relaying protection that accommodates, as a minimum, under-frequency and over-frequency operation for the time frames specified in the following table. *Note these values are subject to change based on actual system variables at the time of installation.*

Time limits for Frequency

Under Frequency Limit	Over Frequency Limit	Minimum Time (s)
60.0-59.5 Hz	60.0-60.5 Hz	N/A (continuous operating range)
50.0-59.0 Hz	61.0-66.0 Hz	180.0–1000.0
50.0-57.0 Hz	61.8-66.0 Hz	0.16-1000.0

Systems with generators that do not meet the above requirements must automatically trip load to match the anticipated generation loss, at comparable frequency levels.

6.2.5 Voltage Unbalance

Any three-phase Renewable Generation Facility must have a phase-to-phase voltage unbalance not exceeding one per cent, as measured both with no load and with balanced three-phase loading. Voltage unbalance is calculated using NEMA MG1-1993 14.35.

6.2.6 Resonance and Self-Excitation of Induction Generators

(a) The IPP should consider resonance in the design of the Renewable Generation Facility, as certain resonance can cause damage to existing electrical equipment, including the electrical equipment of the IPP. Engineering analysis by the IPP should be a part of the design process to evaluate the existence of, and to eliminate the harmful effects of:

(i) ferro resonance in the transformer; and

(ii) resonance with another customers' equipment.

(b) In the event that an induction generator is used by IPP, the adverse effects of self-excitation of the induction generator during Island conditions must be assessed and mitigated. The intent is to detect and eliminate any self- excited condition.

(c) The engineering analysis of resonance and the assessment of the self-excitation effects of induction generators must be submitted to ATCO for approval or further evaluation.

6.3 Interconnection Facility

6.3.1 Safety

Safety of personnel, the public and equipment is of primary concern in the design of the interconnection facility.

6.3.2 Point of Interconnection

The POI and the Measured Billing Point must be identified in the design and on the Single Line Diagram. Subject to any terms of the Definitive Project Agreement(s): (i) ATCO is responsible to coordinate the design, construction, maintenance and operation of the facility on the distribution side of the POI, and (ii) the IPP is responsible to coordinate the design, construction, maintenance and operation of the facility on the generation side of the POI. All voltage and frequency parameters specified in this section must be met at the POI unless otherwise stated.

The IPP is responsible for any incremental costs to the electric systems caused by the interconnection. ATCO will carry out the engineering, design and construction required for these installations and charge those costs back to the IPP, subject to and in accordance with the Definitive Project Agreement(s). Ongoing operation and maintenance costs incurred on the distribution feeder side will also be recovered by ATCO in accordance with the Definitive Project Agreement(s).

6.3.3 Point of Disconnection

The disconnect switch can be located on the high or low voltage side of the interconnection transformer as determined by ATCO. When the interconnection involves three-phase generators, the disconnect switch must be gang operated to simultaneously isolate all three phases.

High Voltage Disconnect Switch

The disconnect switch on the distribution side of the interconnection transformer (e.g., 25 kV airbreak) must be installed, owned and maintained by ATCO.

Low Voltage Disconnect Switch

The disconnect switch on the generation side of the interconnection transformer must be installed, owned and maintained by the IPP.

The disconnect switch must be a manual, Visible-Break Disconnect that provides safe isolation for ATCO's personnel from the Renewable Generation Facility and all other possible customer sources of energy.

All low voltage disconnect switches must:

(a) be adequately rated to break the connected generation/load;

(b) be located within five meters (horizontal) of the POI, unless otherwise approved by ATCO;

(c) provide a direct, visible means to verify contact operation;

(d) allow simultaneous disconnection of all ungrounded conductors of the circuit;

(e) plainly indicate whether the switch is in the "open" or "closed" position;

(f) be lockable in the "open" position;

(g) be capable of being energized from both sides;

(h) be readily accessible to ATCO operating personnel;

(i) be externally operable without exposing the operator to contact with live parts;

(j) be capable of being closed without risk to the operator when there is a fault on the system;

(k) be labeled with ATCO's switch number;

(l) meet all applicable CSA Part II standards and all applicable codes; and

(m) undergo annual inspections and maintenance.

If the site interconnects multiple generators, one disconnect switch must be capable of isolating all of the generators simultaneously. There may be other means of meeting this requirement; however, ATCO's approval must be obtained before using other means.

6.3.4 Phasing

Phasing is not standardized across distribution systems. Therefore, the phase sequence and the direction of rotation must be coordinated between ATCO and the IPP.

6.3.5 Interconnection Grounding

Grounding configurations must be designed to provide:

(a) a solidly grounded distribution system or an ungrounded distribution system, whichever exists;

(b) suitable fault detection to isolate all sources of fault contribution, including the generator, from a faulted line or distribution facility;

(c) a circuit to block the transmission of harmonic currents and voltages; and

(d) protection of the low voltage side from high fault current damage.

The preferred configuration is a Delta connection on ATCO's side of the transformer. If this configuration is not possible, the configuration chosen must still address the above concerns. The winding configuration for interconnection transformers will be reviewed and approved by ATCO.

6.3.6 Interrupting Device Ratings

The design of the Renewable Generation Facility must consider the fault contributions of both the Distribution System and the Renewable Generation Facility itself, to ensure that all circuit fault interrupters are adequately sized. ATCO will inform the IPP of the present and anticipated future fault contribution from the interconnected electric system.

6.3.7 Phase and Ground Fault Protection

The IPP must install protective devices to detect and promptly isolate the Renewable Generation Facility for faults occurring either in the Renewable Generation Facility itself or on the Distribution System. "Virtual devices" (i.e., computer or programmable-logic controller systems) are acceptable provided they meet standard utility practice for system protection and they have been type tested and approved by an independent testing laboratory.

The protective devices in the Renewable Generation Facility must fully coordinate with the protective relays on the Distribution System unless otherwise agreed. The IPP must calculate the protective device settings and submit the relay characteristics and settings to ATCO for review and approval.

The Renewable Generation Facility must be able to detect the following situations and isolate itself from the Distribution System:

(a) a short circuit between any phase(s) and ground (if system is a grounded system);

(b) a short circuit between phase(s); and

(c) loss of any phase(s).

6.3.8 Over-Voltage and Under-Voltage Protection

The IPP must operate its Renewable Generation Facility in such manner that the voltage levels on ATCO's system are in the same range as if the Renewable Generation Facility was not connected.

The IPP must install necessary relays to trip the IPP's circuit breaker when the voltage, measured phase-to-ground, is outside predetermined limits. Under-voltage relays should be adjustable and should have a settable time delay to prevent unnecessary tripping of the generator on external faults. Over-voltage relays should be adjustable and may be instantaneous.

The interconnection facility must cause the Renewable Generation Facility to cease to energize ATCO's system within the trip times indicated in the following table. "Trip time" is the period of time between the start of the abnormal condition and the moment the interconnection device ceases to energize ATCO's system. *Note these values are subject to change based on actual system variables at the time of installation.*

Time limits for Protection Response

Response to Abnormal Voltages	
RMS Voltage	**Trip Time (s)**
RMS Voltage: V=<60 (V=<50%) Trip time: 0.16	
RMS Voltage: 60<V<107 (50%<V<88%) Trip time: 2.0	
RMS Voltage: 107=/<V=/<127 (88%<V<110%) Normal Operation	
RMS Voltage: 127<V<144 (110%<V<120%) Trip time: 1.0 cycles	
RMS Voltage: V>=144 (V>=120%) Trip time: 0.16	

The IPP may reconnect when the Distribution System is Stabilized (i.e., when voltage and frequency have returned to normal range for a time as identified by ATCO).

6.3.9 Over-Frequency and Under-Frequency Protection

The IPP must install frequency selective relays to separate the Renewable Generation Facility from ATCO's system in cases of extreme variations in frequency.

Under-frequency and over-frequency relaying that automatically disconnects generators from the Distribution System must be time delayed, in accordance with ATCO's requirements as per section 6.2.4. The IPP may reconnect when the Distribution System is Stabilized.

6.3.10 Anti-Islanding

The Renewable Generation Facility must be equipped with protective hardware and software designed to prevent the Renewable Generation Facility from being connected to a de-energized circuit owned by ATCO.

In most cases, the Renewable Generation Facility will routinely operate as a part of the interconnected system. A problem on the system could lead to the generator becoming Islanded (i.e., the generator becomes the sole supplier of power to one or more of ATCO's customers). The resulting irregularities in power quality could cause damage for other customers.

To prevent this possibility, the IPP must use teleprotection signals from the Distribution System or another reliable means to separate the generator from the Distribution System in the event of Islanding. If other means are used to detect Islanding, the scheme must consist of reliable primary and backup functions using different quantities.

Where there could be a reasonable match between the IPP's generation and the Islanded load, conventional methods may not be effective in detecting the Islanded operation. In this case, ATCO will require the addition of transfer trip communication facilities to remotely trip-off the IPP's generation upon opening the distribution feeder main circuit breaker or circuit recloser.

6.3.11 Telemetry

Where a source of generation could adversely affect the Distribution System (e.g., by providing inflow into a fault) the IPP must have systems in place to inform ATCO of the protective

operations that occurred or failed to occur. *Note: ATCO's Micro-grid Controller may accomplish this task.*

In cases where the installed IPP capacity is deemed to be significant, Telemetering may be required to facilitate transfer trip or other functionality. Presently, "significant IPP capacity" is defined as 20% or greater of the smallest dispatchable (diesel) generator on the distribution circuit. In sensitive areas "significant IPP capacity" may be lower, as determined by ATCO in its sole discretion.

6.3.12 Requirements for Transfer Trip

Where transfer trip protection is required, the transfer trip protection must ensure that the Renewable Generation Facility does not Island in the event of substation breaker or intermediate OCR operation. General requirements are:

(a) generator lockout within 0.6 seconds of breaker or OCR operation; and

(b) fail-safe lockout within 6 seconds of communication loss.

IPP responsibility of transfer trip protection will be determined by ATCO and may be carried out by the Micro-grid Controller or IPP equipment.

Transfer tripping requirements are also applicable to induction generators, unless the IPP can demonstrate that that there is no potential for self-excitation.

6.3.13 Special Interconnection Protection

In some cases, provision for generator-specific protection and controls will be necessary, such as out-of-step or loss of synchronism.

Additionally, the IPP needs to be aware that unbalanced conditions can occur in the Distribution System, especially under system fault conditions, and the design of the interconnection facility should take this into account.

For Star-Delta interconnection transformers, the unbalance fault current could damage the interconnection transformer under certain fault conditions. This is a result of the circulating current, which occurs in the Delta winding of the interconnection transformer in an attempt to balance the fault current. Protection for the transformer may be required to address this issue.

6.3.14 Flicker

The IPP must not cause excessive voltage flicker on the Distribution System. The flicker must not exceed the limits contained in IEEE Standard 1547-2018 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

6.3.15 Harmonics

The IPP harmonic injection must not exceed the limits contained in IEEE Standard 1547-2018 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

6.3.16 Inadvertent Energization of ATCO's Facilities

The IPPs generator must not energize ATCO's facilities when ATCO's facilities are de-energized.

6.3.17 Protection from Electromagnetic Interference

The influence of electromagnetic interference (EMI) must not result in a change in state or misoperation of the interconnection facility.

6.3.18 Surge Withstand Performance

The interconnection facility must have the capability to withstand voltage and current surges in accordance with the environments described in IEEE/ANSI C62.41 or C37.90.1.

6.3.19 Synchronization

Connection must be prevented when a synchronous generator and/or power system is operating outside of the following limits:

Aggregate Ratings of Generation (kVA)	Frequency Difference (Hz)	Voltage Difference (%)	Phase Angle Difference (degrees)
0-500	0.3	10	20
>500 – 1500	0.2	5	15
>1500	0.1	3	10

6.4 Typical Interconnection Requirements

Typical interconnection requirements for safely operating the Renewable Generation Facility in parallel with the Distribution System are specified below. There may be specific interconnection locations and conditions which require more restrictive protective settings or hardware, especially when exporting power to ATCO's system.

ATCO must make these deviations known to the IPP as soon as possible. An example of one such restrictive area for IPP interconnection is with utility secondary network systems. The IPP will need to work closely with ATCO to determine whether interconnection and operation within a specific network system is possible.

6.4.1 Single-Phase Generators

Inverter-type generators must meet the criteria established in IEEE Standard 1547 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, and be certified to UL 1741 SA and CSA 22.3 no.09.

6.4.2 Three-Phase Synchronous Generators

Table 1 (included below in Article 14) shows the protective function requirements for three-phase synchronous generators of various sizes.

The IPP's generator circuit breakers must be three-phase devices with electronic or electromechanical control.

The IPP is solely responsible for properly synchronizing its generator with ATCO's system.

The IPP is also responsible for ensuring that the interconnection protection device settings coordinate with ATCO's protective device settings.

6.4.3 Three Phase induction Generators and Three-Phase Inverter Generators

Table 1 (included below in Article 11) shows the protective function requirements for three-phase induction and inverter generators.

Induction generators may be connected and brought up to synchronous speed (as an induction motor) if it can be demonstrated that the initial voltage drop measured on ATCO's side at the POI is within the flicker limits. Otherwise, the IPP may be required to install hardware or utilize other techniques to bring voltage fluctuations to acceptable levels.

Inverter generators must meet the applicable criteria in IEEE 1547 and be certified to UL 1741 SA and CSA 22.3 no.09.

Line-commutated inverters do not require synchronizing equipment. Self-commutated inverters, whether of the utility-interactive type or stand-alone type, must be used in parallel with ATCO's system only with synchronizing equipment. DC generation must not be directly paralleled with ATCO's system.

6.4.4 Generators Paralleling for Six Cycles or Less (Closed Transition Switching)

Table 2 (included below in Article 14) shows the protective function requirements for generators which parallel with ATCO's system for six cycles or less.

Any Renewable Generation Facility meeting this description must apply for Parallel Operation and comply with all other requirements of these System Interconnection Guidelines in respect of Parallel Operation.

6.4.5 Mitigation of Protection Scheme Failure

Relays with self-diagnostic features provide information on the integrity of the protection scheme and should be used whenever possible.

The protection scheme must be designed by a qualified engineer or a competent technical person, working with ATCO's engineers, to ensure that the self-diagnostic feature is integrated into the overall protection scheme for the safe and reliable operation of the Distribution System.

Where relays with the self-diagnostic feature do not trip the appropriate breaker(s), sufficient redundant or backup protection must be provided for the Distribution System. The malfunctioning relay must also send a signal to notify operating personnel to investigate the malfunction.

Design of protection and control schemes must be of a fail-safe nature to maintain the integrity of the protection in the event there is a malfunction.

6.4.6 Maximum Generator Power to be Exported

The capacity of the Renewable Generation Facility must not exceed the load-carrying capacity of the interconnection transformer at the POI, or exceed the capacity of the Distribution System connected to the interconnection facility. Also, the IPP's ability to export energy may be further limited to ensure that the voltage at the POI or the Distribution System does not exceed those limits as put forth in CAN3-C235-83.

6.4.7 Interconnection Protection Approval

The IPP must provide ATCO with complete documentation of the proposed interconnection protection scheme for review against the requirements of these System Interconnection Guidelines, and for potential impacts to ATCO's system.

The documentation should include:

(a) a completed application form;

(b) an overall description of how the protection will function;

(c) a detailed Single Line Diagram;

(d) identification details of the protection components (i.e., manufacturer, model, etc.);

(e) the protection component settings (i.e., trigger levels and time values); and

(f) identification details of the disconnect switch (i.e. manufacturer, model and associated certification).

The IPP must revise and re-submit the protection information for any proposed modification.

ARTICLE 7
CONSTRUCTION

7.1 General

The Renewable Generation Facility must be constructed and installed to meet all applicable Laws. All permitting and safety code requirements must be completed and copies of inspection reports provided to ATCO prior to energizing the POI, if required by ATCO.

All Single Line Diagrams provided to ATCO must be drawn in accordance with IEEE standards and conventions, and stamped by a licensed, professional engineer assuming responsibility for the design.

ARTICLE 8
METERING

8.1 General

Metering equipment in respect of a Renewable Generation Facility will be installed, owned, operated and maintained by ATCO, subject to the terms of the Definitive Project Agreement(s).

The metering equipment will measure power, active energy and reactive energy flowing from the Distribution System into the Renewable Generation Facility. The metering equipment will also measure the same parameters for energy out of the Renewable Generation Facility that is delivered to the Distribution System.

The primary side (i.e., the side connected to the Distribution System) of the interconnection transformer is the "**Measured Billing Point**" for all energy imported and exported from the Renewable Generation Facility, subject to the terms of the Definitive Project Agreement(s).

The metering equipment must be:

(a) compliant with applicable Measurement Canada requirements;

(b) suitable for use in the environmental conditions reasonably expected to occur at the installation site over the course of a typical year; and

(c) appropriate for the power system characteristics reasonably expected to exist at the installation site under all power system conditions and events.

8.2 Interval Meter Requirements

An Interval Meter must be installed at all Renewable Generation sites.

The Interval Meter must:

(a) be Measurement Canada-approved under Section 9(1), Section 9(2) or Section 9(3) of the EGIA;

(b) be verified and sealed in accordance with the EGIA, subject to the terms and conditions of any applicable dispensation(s);

(c) be capable of maintaining the interval boundaries within 60 seconds of the hour and every quarter hour thereafter;

(d) measure all quantities required to determine active energy and reactive energy transferred in the required directions at the Measured Billing Point;

(e) provide a separate register to maintain the continuously cumulative readings of the active energy and reactive energy transferred in the required directions at the Measured Billing Point;

(f) retain readings and, if applicable, all clock functions for at least 14 days in the absence of line power;

(g) have an accuracy class rating for active energy measurement that equals or exceeds the values specified in Appendix E, Schedule 1, for non-dispensated metering equipment and Schedule 2 for dispensated metering equipment; and

(h) have an accuracy class rating for reactive energy measurement that equals or exceeds the values specified in Appendix E, Schedule 1 for non-dispensated metering equipment and Schedule 2 for dispensated metering equipment.

8.3 Measurement Transformers

The applicable winding(s) of the current and potential instrument transformers must:

(a) be Measurement Canada approved under Section 9(1), Section 9(2) or Section 9(3) of the EGIA;

(b) be burdened to a degree that does not compromise the accuracy required by these System Interconnection Guidelines; and

(c) have an accuracy class rating that equals or exceeds the values specified in Appendix E, Schedule 1 for non-dispensated metering equipment.

8.4 Remote Communications Equipment

Remote communications equipment may or may not be an integral part of the meter or the recorder, but must incorporate protocol schemes suitable for the type/nature of the communications media/path that will prevent data corruption during interval data transmission.

8.5 Password Protection

Two or more levels of password protection are required for each meter data collection agency: one for full access to set time functions; and one for read-only access to interval data, the event log and meteorological quantities.

8.6 Safety Requirements

The installation must conform to:

(a) Measurement Canada Standard Drawings;

(b) CSA Standard C22.2; and

(c) ANSI/IEEE C57.13-1983 IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

ARTICLE 9
INSPECTION

9.1 Quality Control And Inspection Program

The IPP must maintain a quality control and inspection program in respect of the Renewable Generation Facility which meets or exceeds industry best practices and must make any information available for review in connection with such program if requested by ATCO.

9.2 Attendance of ATCO Personnel During Progress of Work

In addition to the IPP's normal inspection procedures, ATCO reserves the right to the following in relation to the Renewable Generation Facility (in each case at ATCO's discretion):

(a) witness the manufacturing or fabrication of, or any work involving, the subject equipment;

(b) inspect materials, documents, manufacturing operations and installation procedures;

(c) witness tests and to evaluate the results of non-destructive examinations.

The IPP must upon request supply ATCO with a complete set of detailed drawings to assist ATCO in its inspection of equipment during testing.

ARTICLE 10
TESTING

10.1 General

The IPP must notify ATCO in writing at least three weeks prior to the initial energization and start-up testing of the Renewable Generation Facility, and ATCO may witness the testing of any equipment and protective systems associated with the interconnection. The tests and testing procedures must generally align with the requirements specified in 1547.1 - Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces.

10.2 Description of Testing Categories

Type testing is performed or witnessed once by an independent testing laboratory for a specific protection package. Once a package meets the type testing criteria described in this section, the design is accepted by ATCO. If any changes are made to the hardware, software, firmware or verification test procedures, the manufacturer must notify the independent testing laboratory to determine what, if any, parts of the type testing must be repeated. Failure of the manufacturer to notify the independent testing laboratory of any changes may result in withdrawal of approval and disconnection of units installed after the change was made.

Verification testing is site-specific, periodic testing to assure continued acceptable performance.

These testing procedures apply only to devices and packages associated with protection of the interconnection between the generation facility and ATCO's system. Interconnection protection is usually limited to voltage relays, frequency relays, synchronizing relays, reverse current or power relays and anti-islanding schemes. Testing of relays or devices associated specifically with protection or control of the Renewable Generation Facility is recommended, but not required unless the devices impact the interconnection protection.

Protection testing must include procedures to functionally test all protective components of the protection scheme, up to and including tripping of the Renewable Generation Facility and/or the POI. The testing must verify all protective set points and relay/breaker trip timing.

At the time of production, all interconnecting equipment and discrete relays must meet or exceed the requirements of ANSI /IEEE C62.41.2 Recommended Practices on Surge Voltages in Low Voltage AC Power Circuits or IEEE Standard C37.90.1-2012 - IEEE Standard for Surge Withstand Capability (SWC)

Tests for Relays and Relay Systems Associated with Electric Power Apparatus. If C62.41.2 is used, the surge types and parameters must be applied to the equipment's intended insulation location, as applicable.

The manufacturer's verification test and the appropriate dielectric test specified in UL 1741 must also be performed.

10.3 Type Testing

All interconnection equipment must include a type testing procedure as part of the documentation. The type testing must determine if the protection settings meet the requirements of these System Interconnection Guidelines.

Prior to type testing, all batteries must be disconnected or removed for a minimum of 10 minutes. This test will verify the system has a non-volatile memory and that the protection settings are not lost. A test must also be performed to determine that the failure of any battery used to supply trip power will result in an automatic shutdown.

All inverters must be non-islanding, as defined by IEEE 1547. Inverters must, at the time of production, meet or exceed the requirements of IEEE 1547 and CSA C22.2 No. 257.

10.4 Verification Testing

Prior to Parallel Operation of a Renewable Generation Facility, or whenever the interconnection hardware or software is changed, verification testing must be performed. The verification test must be performed by a qualified individual in accordance with the manufacturer's published test procedure. Qualified individuals include: licensed, professional engineers; factory-trained and certified technicians and licensed electricians experienced in testing protective equipment. ATCO reserves the right to witness the verification test or to require written certification that the test was performed.

Verification testing must be performed annually. All verification tests prescribed by the manufacturer or developed by the IPP and agreed to by ATCO must be performed. The IPP is responsible to maintain the verification test reports for inspection by ATCO.

Inverter generator operation must be verified annually, by operating the load break disconnect switch and verifying that the generation facility automatically shuts down and does not restart for five minutes after the switch is closed.

Any system that depends on a battery for trip power must be checked for proper voltage and logged monthly. Once every four years, the battery must either be replaced or a discharge test performed.

10.5 Protective Function Testing

Protection settings that have been changed after factory testing must be field-verified to show that the device trips at the measured (actual) voltage and frequency. Tests must be performed using secondary injection, applied waveforms or a simulated utility. Alternatively, if none of the preceding tests can reasonably be done, a settings adjustment test can be performed if the unit provides discrete readouts of the settings.

The non-islanding function, if available, must be checked by operating a load break switch to verify that the interconnection facility ceases to energize its output terminals and does not restart for the required time delay after the switch is closed.

A reverse power or minimum power function, if used to meet the interconnection requirements, must be tested using secondary injection techniques. Alternatively, this function can be tested by means of a local load trip test or by adjusting the IPP output and local loads to verify that the applicable non-export criterion (i.e., reverse power or minimum power) is met.

10.6 Verification of Final Protective Settings Test

If protective function settings have been adjusted as part of the commissioning process, then, at the completion of the adjustment, the IPP's Operating Authority must confirm all devices are set to ATCO's approved settings.

Interconnection protective devices that have not previously been tested as part of the interconnection facility with their associated instrument transformers, or that are wired in the field, must be given an in-service test during commissioning. This test is to verify proper wiring, polarity, sensing signals, CT/PT ratios and operation of the measuring circuits.

For protective devices with built-in metering functions that report current and voltage magnitudes and phase angles or magnitudes of current, voltage, and real and reactive power, the metered values can be compared to the expected values. Alternatively, calibrated portable ammeters, voltmeters and phase-angle meters may be used.

10.7 Hardware and Software Changes

Whenever changes are made to interconnection hardware or software that can affect the functions listed below, the potentially affected functions must be retested:

(a) over-voltage and under-voltage;

(b) over-frequency and under-frequency;

(c) non-islanding function (if applicable);

(d) reverse or minimum power function (if applicable);

(e) inability to energize dead line;

(f) time delay restart after ATCO outage;

(g) fault detection, if used; and

(h) synchronizing controls (if applicable).

To ensure that commissioning tests are performed correctly, ATCO may at its discretion witness the tests and receive written certification of the results.

Refer to Appendix E for an example of a protective settings commissioning document.

10.8 Switchgear

ATCO reserves the right to witness the testing of installed switchgear.

The IPP must notify ATCO at least 15 working days in advance of any testing.

ARTICLE 11
DATA REQUIREMENTS

The following table identifies the drawings and data the IPP is required to submit to ATCO when applying for interconnection to the Distribution System.

Drawing/Data	Proposal	Approval*	Verified
Manufacturer's equipment data sheet			X
Control schematic		X	X
Single Line Diagram indicating proposed protection settings	X	X	X
Description of protection scheme	X	X	X
Generator nameplate schedule		X	X
Fuse and protective relay coordination study & settings		X	X
Current transformer characteristic curve		X	X
Commissioning report c/w protection settings			X
Plot plan showing location of lockable, visible disconnect switch	X	X	X

*The minimum time requirement for reviewing this information is generally 15 working days.

ARTICLE 12
MARKING AND TAGGING

The nameplate of the electrical equipment must include:

(a) the manufacturer's name; and

(b) the manufacturer's serial number.

ARTICLE 13
MAINTENANCE

The IPP will be responsible for the maintenance of all equipment and facilities comprising the Renewable Generation Facility and any interconnection facilities up to the POI.

The IPP must maintain such equipment to accepted industry standards, CEC for example. Failure to do so may result in disconnection of the Renewable Generation Facility.

The IPP must present the planned maintenance procedures and a maintenance schedule for the interconnection protection equipment to ATCO and keep records of such maintenance.

Maintenance procedures for ATCO's system up to the POI must be in compliance with good utility practice and ATCO's policies and practices, as applicable.

ARTICLE 14
TABLES

Table 1:

Interconnection Protective Function Requirements[5]
Three-Phase Connected to Secondary or Primary System

Device #			
	Disconnect Device		X
	Generator Disconnect Device		X
25	Synchronizing Check (note 1)		Y Auto.
		Qty.	(1)
27	Under-Voltage Trip		Y
		Qty.	(3)
32	Power Direction/Reverse Power		Y (note 3)
		Qty.	(1)
46	Negative Phase Sequence Overcurrent		X
	(Phase unbalance, reverse phase sequence)	Qty.	(1)
51V	Overcurrent, voltage restrained		X
	(Optional, to provent nuisance trips)	Qty.	(1)
50/51	Inst/Timed Overcurrent		X
		Qty.	(3)
50N	Instantaneous Neutral Overcurrent		X
		Qty.	(1)
	Ground over-Voltage Trip (note 6) Or		X
51G	Ground Over-Current Trip (note 6)	Qty.	(1)
TT	Transfer Trip (note 4)		Y (note 4)
	(Based on impact to IPP and utility)		
	Telemetry data communication		Y (note 4)
	Automatic Voltage Regulation (AVR) (note 2)		X
		Qty.	
59I	Instantaneous Over-Voltage Trip		Y
	(For ferroresonance conditions)	Qty.	(3)
59T	Over-Voltage Trip		Y
		Qty.	(3)
60	Voltage Balance Relay		
67/67N	Directional Overcurrent		Y (note 2)
		Qty.	(3)/(1)
81/O, 81/U	Over/Under Frequency Trip		Y
		Qty.	(3)
	(3) Anti-islanding for inverters		Y
	IEEE 1547 and CSA C22.2-257		

Notes:
1. For synchronous and other types of generators with stand-alone capability.
2. IPPs required by ATCO
3. If exporting, frequency blocks under voltage trip with agreement of ATCO.
4. Transfer trip with fail-safe design required for synchronous machines.
5. Exporting to ATCO may require additional operational/protection devices and coordination of operations with ATCO.
6. Selection depends on grounding system, if required by ATCO.
7. Quantity shown in brackets below (e.g., (3)).
8. Both X and Y are required by this guideline X is IEEE Std 242 Protection Requirement.
9. Three-directional overcurrent relays may be substituted for reverse power relay.
10. Above to be in accordance with the Canadian Electrical Code

Table 2:

Interconnection Protective Function Requirements
Generators Connected to Secondary or Primary System

For 6 cycles or less (Closed Transition Switching)

Interconnect Disconnect Device	X
Generator Disconnect Device	X
Over-Voltage Trip	X
Under-Voltage Trip	X
Over/Under Frequency Trip	X
Overcurrent	X
Ground Over-Voltage Trip[1] Or Ground Over-Current Trip[1]	X
Synchronizing Check[2] Automatic	

Notes:
1 Selection depends on grounding system, if required by ATCO.
2 For synchronous and other types of generators with stand-alone capability.

LIST OF APPENDICES

Appendix A: Information Required From IPP

The IPP must submit detailed information for ATCO to design, construct, operate and maintain their portion of the interconnection. The required information may include the following:

Information Requirements	Required at Application	Required During Design
1) IPP'S CONTACT NAMES AND ADDRESSES		
a) Company name	**X**	
b) Contact for **commercial terms:**	**X**	
Name/Title _____		
Address _____		
Phone/Fax _____		
c) Contact for **engineering design:**	**X**	
Name/Title _____		
Address _____		
Phone/Fax _____		
d) Contact for **operating terms:**	**X**	
Name/Title _____		
Address _____		
Phone/Fax _____		
2) GENERAL INFORMATION		
a) Detailed map showing the proposed plan location		
☐ Attached	**X**	
b) Site plan showing the arrangement of major equipment		
☐ Attached	**X**	
c) Single Line Diagram showing the voltage and current rating of each component		
☐ Attached	**X**	

3) OPERATING CHARACTERISTICS

a) Indicate how the facility will operate. **X**

☐ The facility is intended to sell electric energy to the ATCO Electric Yukon.

☐ The facility will consume electric energy services from the electric system.

4) GENERATORS

a) Type **X**

☐ Synchronous ☐ Induction ☐ Inverter

b) Manufacturer Model **X**

c) Nominal rating **X**

kW
kVA
_____ Volts

d) ☐ Single-Phase ☐ Three-Phase **X**

e) Governor droop _____% **X**

f) Generator connection configuration **X**

☐ Delta ☐ Wye

g) Generator grounding **X**

h) Impedances (positive, negative and zero sequence) **X**

Direct axis transient _____
Direct axis subtransient _____
Quadrature axis transient _____
Quadrature axis subtransient _____

5) PRIME MOVER

a) Type _____ **X**

b) Manufacturer _____ **X**

c) Model _____ **X**

d) Rating _____ **X**

e) Inertia constant _____ **X**

6) POWER FACTOR REGULATOR

a) Limits of range of reactive power **X**

Lagging (out) _____ Var

Leading (in) _____ Var

b) Accuracy tolerance of setting **X**

7) VOLTAGE REGULATOR

a) Voltage regulator setting range _____ to _____ Volts **X**

b) Voltage regulator setting tolerance _____% **X**

8) COMPENSATOR (IF APPLICABLE)

a) Type of input(s) _____ **X**

b) Compensating resistance(s) reactance(s) **X**

9) INTERCONNECTION PROTECTION

a) Complete and accurate protection diagrams **X**

☐ Attached

b) Description of the proposed protection schemes **X**

☐ Attached

c) Diagrams **X**

☐ Single line

☐ Schematic

☐ Wiring

d) Interconnection **X**

☐ Verify interconnection functionality

☐ Site test and settings

e) Maintenance plans for the: **X**

☐ Interconnection protection devices

☐ Interconnection interrupting devices

10) COMPLIANCE WITH ELECTRICAL INSPECTOR

☐ Permit or equivalent	**X**

Modeling Information

In some cases, a generator (or the aggregate generation on a line) is large enough that adjacent customers or the dynamic stability of the Distribution System could be affected. Subject to the terms of the Definitive Project Agreement(s), the IPP is responsible for the cost of any required transient or dynamic stability studies, and the studies must be done in a manner suitable to, and approved by, ATCO.

The IPP is responsible for ensuring that any data submitted by it provides an adequate mathematical representation of the Renewable Generation Facility's electric behavior. If the data is not available prior to purchasing equipment, it must be submitted as soon as it becomes available.

The studies must accurately determine:

1. the impact of the IPP's facility on adjacent customers of ATCO; and
2. the dynamic stability, in aggregate, of ATCO's system.

Data may be supplied by the manufacturer or acquired directly by testing. It must include generator characteristics (i.e., speed, reactance, resistance, excitation system etc.) and governor characteristics (i.e., lead time/lag time constants, valve or gate opening data etc.).

The information requirements vary for induction generators and inverter generators, and for hydro or steam systems.

Appendix B: Information Provided by ATCO

After receiving the application for interconnection, ATCO must provide the following information to the IPP, on request:

1. Single Line Diagram or maps of the Distribution System to the POI.
2. Minimum and maximum 60 Hz source impedances (positive-sequence, negative- sequence and zero-sequence) at the POI.
3. Maximum and minimum normal and emergency system operating voltage ranges at the POI.
4. Planning, operating and reliability criteria, standards and policies.
5. The results of a planning study documenting the availability of the requested amount of system capacity.
6. Cost estimates and time schedule to build the upstream facilities.
7. Clearing and reclosing times for single-phase and multiple-phase faults occurring on the Distribution System.
8. Characteristics and settings of protection on the Distribution System.
9. Costs of studies and any required changes to the Distribution System.

Some or all of this information will be required by the IPP to properly design the interconnection protection. ATCO will identify when the costs of producing this information are to be assigned to the IPP.

Appendix C: Applicable Codes and Standards

The Renewable Generation Facility and the interconnection facilities must conform to these System Interconnection Guidelines and to the applicable sections of the codes and standards listed below. When the stated version of the code or standard is superseded by an approved revision, then that revision shall apply.

Specific types of interconnection schemes, IPP technologies, and distribution systems may be subject to additional requirements, standards, recommended practices or guidelines in addition to those set out in this Appendix C and otherwise contained in these System Interconnection Guidelines. Determining the applicability and hierarchy of those requirements in relation to the requirements herein is beyond the scope of these System Interconnection Guidelines. Therefore, the following list of codes and standards is not to be regarded as an exhaustive or all-inclusive list, and users of these System Interconnection Guidelines must address related concerns.

Power Quality Standards

1. ANSI C84.1-2016 American National Standards for Electric Power Systems and Equipment Ratings (60 Hertz). Establishes nominal voltage ratings and operating tolerances for 60 Hz electric power systems from 100 V through 230 kV.
2. IEEE Std. 493-2007 IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book). Chapter 9 deals specifically with voltage sag analysis and methods of reporting sag characteristics graphically and statistically.
3. IEEE Std 519-2014 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.
4. IEEE Std. 1100-2005 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book).
5. IEEE Std 1159-2009 IEEE Recommended Practice for Monitoring Electric Power Quality.
6. IEEE Std 1250-2011 IEEE Guide for Identifying and Improving Voltage Quality in Power Systems.

In addition to the power quality standards, the following standards are applicable to the interconnection of the Renewable Generation Facility to the Distribution System:

7. IEEE Std 315-1975 (Reaffirmed 1993) ANSI Y32.3-1975 (Reaffirmed 1989) CSA Z99-1975 Graphic Symbols for Electrical and Electronics Diagrams (including Reference Designation Letters).

   .
8. C37.1 ANSI/IEEE Standard Definitions, Specifications and Analysis of Systems Used for Supervisory Control, Data Acquisition and Automatic Control.
9. C37.2 IEEE Standard Electrical Power System Device Function Numbers.
10. C37.18 ANSI/IEEE Standard Enclosed Field Discharge Circuit Breakers for Rotating Electric Machinery.
11. C37.20.1 ANSI/IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breakers Switchgear.
12. C37.20.3 ANSI/IEEE Standard for Metal-Enclosed Interrupter Switchgear.
13. C37.24 ANSI/IEEE Standard for Radiation on Outdoor Metal-Enclosed Switchgear.
14. C37.27 ANSI/IEEE Standard Application Guide for Low-Voltage AC Non-integrally Fused Power Circuit Breakers (Using Separately Mounted Current-Limiting Fuses).
15. C37.29 ANSI/IEEE Standard for Low-Voltage AC Power Circuit Protectors Used in Enclosures.
16. C37.50 ANSI Standard Test Procedures for Low-Voltage AC Circuit Breakers Use In Enclosures.

17. C37.51 ANSI Standard Conformance Test Procedure for Metal Enclosed Low- Voltage AC Power Circuit-Breaker Switchgear Assemblies.
18. C37.52 ANSI Standard Test Procedures for Low-Voltage AC Power Circuit Protectors Used in Enclosures.
19. C57.12 IEEE Standard General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers.
20. C57.12.13 Conformance Requirements for Liquid Filled Transformers Used in Unit Installations including Unit Substations.
21. C57.13.1 IEEE Guide for Field Testing of Relaying Current Transformers.
22. C57.13.2 IEEE Standard Conformance Test Procedures for Instrument Transformers.
23. C37.58 ANSI Standard Conformance Test Procedures for Indoor AC Medium- Voltage Switches for Use in Metal-Enclosed Switchgear.
24. C37.90 ANSI/IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
25. C37.90.1 ANSI/IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
26. C37.90.2 ANSI/IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
27. C37.95 IEEE Guide for Protective Relaying of Utility Consumer Interconnections.
28. C37.98 ANSI/IEEE Standard for Seismic Testing of Relays.
29. IEC 61000-3-3 Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
30. IEC 61000-3-5 Electromagnetic compatibility (EMC) - Part 3-5: Limits - Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 75 A.
31. UL1008 Transfer Switch Equipment.
32. IEEE 1547 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.
33. Canadian Electrical Code, CSA no. C22-1, latest version.
34. C22.2 No. 31-18 Switchgear Assemblies.
35. Can/CSA - C22.2 No. 107.1-16 Power Conversion Equipment.
36. Can/CSA - C22.2 No. 1010.1-92 Safety Requirements For Electrical Equipment for Measurement, Control and Laboratory Use.
37. Can/CSA - C22.2 No. 144-16 - Ground Fault Circuit Interrupters.
38. C22.2 No. 193-M1983 (R2014) High-Voltage Full-Load Interrupter Switches.
39. C22.2 No. 201-M1984 (R2014) Metal Enclosed High-Voltage Busways.
40. C22.2 No. 229-17 (R1994) Switching and Metering Centres.
41. CSA Standard CAN3 C235 83 Preferred Voltage Levels for AC Systems 0 to 50,000V.
42. Alberta Electrical and Communication Utility Code (formerly the Alberta Electrical and Communication Utility System Regulation 44/1976 or future amendments).
43. Measurement System Standard / Transmission Administrator Metering Standard GC301 Practices for Management and Transfer of Metered Data.
44. C37.04-1999 IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).

45. C37.06-2009 - IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis--Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V.
46. C37.09-1999 IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).
47. C37.010-2016 IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
48. C37.011-2011 IEEE Application Guide for Transient Recovery Voltage for AC High- Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
49. C37.012-2014 - IEEE Application Guide for Capacitance Current Switching for AC High-Voltage Circuit Breakers Above 1000 V.
50. IEEE 62271-37-013:2015 - IEEE/IEC International Standard for High-voltage switchgear and control gear -- Part 37-013: Alternating-current generator circuit-breakers.
51. C37.015-2017 - IEEE Application Guide for Shunt Reactor Switching.
52. C37.081-1981 (Reaffirmed 2007) - Guide for Synthetic Fault Testing of AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
53. C37.11-2014 - IEEE Standard Requirements for Electrical Control for High-Voltage (> 1000V) Circuit Breakers.
54. C37.13-2015 - IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
55. C37.14-2015 - IEEE Standard for Low-Voltage DC (3200 V and below) Power Circuit Breakers Used in Enclosures.

    .
56. C37.20.2-2015 - IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear.
57. C37.23-2015 - IEEE Standard for Metal-Enclosed Bus.
58. C37.30-2011 - IEEE Standard Requirements for High-Voltage Air Switches Rated Above 1000V.
59. C37.42-2016 –IEEE Standard Specifications for High-Voltage (>1000 V) Fuses and Accessories.
60. C37.54-1996 American National Standard for Switchgear--Indoor Alternating-Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear Assemblies--Conformance Test Procedures.
61. C37.55-1989 American National Standard for Switchgear--Metal-Clad Switchgear Assemblies--Conformance Test Procedures.
62. C37.57-1990 American National for Switchgear--Metal-Enclosed Interrupter Switchgear Assemblies--Conformance Testing.
63. C37.66-1969 (Reaff 1988) American National Standard for Requirements for Oil- Filled Capacitor Switches for Alternating-Current Systems.
64. C37.81-1989 (R1992) IEEE Guide for Seismic Qualification of Class 1E Metal- Enclosed Power Switchgear Assemblies.
65. C37.85-1989 (R1998) American National Standard for Switchgear--Alternating- Current High-Voltage Power Vacuum Interrupters-Safety Requirements for X- Radiation Limits.
66. ANSI/IEEE C37.90-1989 Surge Withstand And Fast Transient Tests.
67. 120-1989 (Reaff-1997) IEEE Master Test Guide for Electrical Measurements in Power Circuits.
68. 1291-1993 IEEE Guide for Partial Discharge Measurement in Power Switchgear.
69. IEEE Std C62.23-1995 Application Guide for Surge Protection of Electric Generating Plants.

70. ANSI /IEEE C62.41-1991 Recommended Practices on Surge Voltages in Low- Voltage AC Power Circuits.

71. C57.13-1993 IEEE Standard Requirements for Instrument Transformers.

72. C57.13.3-1983 (R1991) IEEE Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases.

73. C57.98-1993 IEEE Guide for Transformer Impulse Tests.

74. C57.19.100-1995 (R1997) IEEE Guide for Application of Power Apparatus Bushings.

75. C57.110-1986 (R1992) IEEE Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents.

76. C62.92.4-1991 IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part IV – Distribution.

77. IEEE Std 242-1986 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

78. ANSI C12.20 Electricity Meters 0.2 And 0.5 Accuracy Classes.

79. ANSI C62.1 Surge Arresters for AC Power Circuits.

80. ANSI C62.11 Metal-Oxide Surge Arresters for AC Power Circuits.

81. NEMA CC-1 Electric Power Connectors for Substations.

82. NEMA LA-1 Surge Arresters.

83. NEMA MG-1 Motors.

Appendix D: Protective Settings Commissioning Document

PROTECTIVE SETTINGS COMMISSIONING DOCUMENT

(Set applicable protection to the most conservative values or as agreed to by ATCO)

OVER VOLTAGE PROTECTION PARAMETERS

	Phase Voltage to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip ▌ - N	106% to 120% 1% Increments						30 Cycles					
Fast Trip ▌ - N	144% to 120% 1% Increments						100 ms					

UNDER VOLTAGE PROTECTION PARAMETERS

	Phase Voltage to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip ▌ - N	50% to 90% 1% Increments						120 Cycles					
Fast Trip ▌ - N	Less than 50% 1% Increments						100 ms					

NON ISLANDING FUNCTION TEST

Loss of Utility Voltage	100 ms		
Generator Restart Delay after Utility Voltage Failure	5 min Minimum		
Dead Bus Test	Fail to Start Successful (Y or N)		

OVER FREQUENCY PROTECTION PARAMETERS

	Frequency to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip	60.5 to 61.5 Hz 1% Increments						3 minutes					
Fast Trip	61.5 to 61.7 Hz 1% Increments						30 seconds					

UNDER FREQUENCY PROTECTION PARAMETERS

	Frequency to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip	59.5 to 58.5 Hz 1% Increments						3 minutes					
Second Trip	58.5 to 57.9 Hz 1% Increments						30 seconds					
Third Trip	57.9 to 57.4 Hz 1% Increments						7.5 seconds					
Fourth Trip	57.4 to 56.9 Hz 1% Increments						45 cycles					
Fifth Trip	56.9 to 56.5 Hz 1% Increments						7.2 cycles					
Fast Trip	Less than 56.4 Hz						100 ms					

REVERSE AC CURRENT PROTECTION FUNCTION

	Current to Trip						Duration to Trip					
	DESIGN LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	DESIGN VALUE	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip												

SYNCHRONIZATION LIMITS FOR SYNCHRONOUS GENERATORS

	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET
Frequency Difference	+ 0.2 Hz		
Voltage Difference	5%		
Phase difference	10 Deg		

WIRES PHASE & GROUND FAULT PROTECTION FUNCTION

	Maximum Current or Volts to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Phase Current							200 ms					
Neutral Current							200 ms					

TRANSFER TRIP PROTECTION

	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET
Generator Lockout	0.6 seconds		
Fail Safe Lockout	6 seconds		

TEST CERTIFICATION AND HISTORICAL DATA

TYPE OF TEST

ORIGINAL COMMISSIONING TEST		PROTECTION SYSTEM RE-TEST	

DATE OF TEST

ATCO REPRESENTATIVE TITLE

IPP OWNER REPRESENTATIVE

DATE

TITLE

GENERATOR LOCATION & IDENTIFICATION NUMBER

Appendix E: Accuracy Schedules for Metering Equipment

Schedule 1: Non-Dispensated Metering Equipment

Schedule of Accuracies for Metering Equipment Approved Under Section 9(1) of the Electricity and Gas Inspection Act

Metering Point Capacity (MVA)	Watthour Meter Accuracy Class	Varhour Meter Accuracy Class	Measurement Transformers Accuracy Class
10 and Above	0.2%	0.5%	0.3%
Below 10	0.5%	1.0%	0.3%

Notes:
1. This schedule applies to requirements set out in Article 8 of these System Interconnection Guidelines.
2. If an alternate measurement is used to determine reactive energy, the accuracy class of the alternate measurement must be equal to or better than the accuracy class set out for reactive energy.

Schedule 2: Dispensated Metering Equipment

Schedule of Accuracies for Meters Approved Under Section 9(2) or 9(3) of the Electricity and Gas Inspection Act

Meter Accuracy		
Metering Point (MVA)	Points of Delivery	Points of Supply
10 and Above	1.0 %	1.0 %
Below 10	1.0 %	1.0 %

Notes:
1. This schedule applies to requirements set out in Article 8 of these System Interconnection Guidelines.
2. If an alternate measurement is used to determine reactive energy, the accuracy class of the alternate measurement must be equal to or better than the accuracy class set out for reactive energy.