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Qulliq Energy Corporation
Société d'énergie Qulliq
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Qulliq Energy Corporation

Technical Interconnection Requirements and Guidelines for Independent Power Producers

Nunavut

Technical Specification
Technical Interconnection Requirements

September 24, 2019

FINAL

REVISION HISTORY

Revision	Document Status – Revision Description	Date
R00	Final	2019-08-16
R01	Final	2019-09-24

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1. PURPOSE AND LIMITATIONS

1.1 Purpose

This document is intended to help Prospective Independent Power Producers (IPP) understand their role, responsibilities and technical requirements when connecting a Renewable Generation Facility to QEC's Power Distribution System.

The intended use of this document is to:

a. inform and provide guidelines;
b. assist operators, technical staff, consultants and contractors or subcontractors in determining the technical and operating requirements of a Renewable Generation Facility;
c. ensure that the interconnections of a Renewable Generation Facility do not adversely impact the safety, quality or reliability of QEC's Power Distribution System and neighboring customers, as well as the safety of QEC's personnel or the general public in and around the Renewable Generation Facility / Power Distribution System; and
d. establish criteria and technical requirements for the interconnection of a Renewable Generation Facility.

The guidelines in this document do not address any liability provisions agreed to elsewhere such as in the Power Purchase Agreement (PPA) between the Prospective IPP and QEC. They are intended to form part of and be supplementary to such agreements.

This document is not intended to provide technical requirements for the protection of the Renewable Generation Facility. It is the responsibility of the IPP to protect the Renewable Generation Facility in such a manner that outages, short circuits or other disturbances do not cause damage to the Renewable Generation Facility or QEC's Power Distribution System.

Finally, this document is not to be considered as an operating agreement and does not address the following:

a. contractual arrangements;
b. planning, design, and operation of the IPP's Renewable Generation Facility.

1.2 Limitations

This Technical Interconnection Requirements (TIR) document does not constitute a design handbook and is not a substitute for compliance with Applicable Law, including, but not limited to, the *Nunavut Electrical Protection Act*. Prospective IPPs who are considering the development of a Renewable Generation Facility to connect to QEC's Power Distribution System are advised to engage the services of a professional engineer / registered consulting firm licensed to provide design and consulting services for engineering projects in Nunavut.

The criteria and requirements in this document are applicable to all Renewable Generation Facility technologies for the addition of a Renewable Generation Facility to QEC's Power Distribution Systems. The requirements for a Renewable Generation Facility shall be met at the point of interconnection although the location of the protective devices may not necessarily be at that point.

The guidelines in this document are minimum requirements for the interconnection of a Renewable Generation Facility. The Prospective IPP may also have to meet additional or modified requirements to address unique situations and to meet all local and national standards and codes. Any exemptions to this requirement shall require QEC's prior written approval.

1.3 Liability

QEC's review of the IPP specifications and detailed plans shall not in any way be construed as confirming or endorsing the design or as guaranteeing the safety, durability or reliability of the IPP's Renewable Generation Facility or shall it be construed to be in lieu of the approvals required by the Relevant Authorities.

QEC, by reason of such review or lack of review, shall not be responsible for the strength, adequacy of design or capacity of equipment built pursuant to such specifications, nor shall QEC or any of its employees or agents be responsible for any injury to the public or workers resulting from the operation of the IPP's Renewable Generation Facility. This guideline does not absolve the IPP of the responsibility to maintain and protect its own equipment and QEC's equipment, as well as to ensure the safety of its own personnel, QEC's personnel and the general public.

2. TERMS, DEFINITIONS, AND ABBREVIATIONS

2.1 Definitions

"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.

"Applicable Law" 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 Relevant Authority in effect from time to time.

"Average Electrical Power Demand" means the annual mean power demand from the community with which the IPP's Renewable Generation Facility will interconnect.

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

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

"Interconnection Study" means a detailed assessment of a project impact on the Power Distribution System. The results of this assessment include a technical report outlining the project feasibility, the technical specifications needed for the project, and the impacts the project would have on the distribution system.

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

"IPP" or **"Independent Power Producer"** means the person/entity who has signed a PPA with QEC to design, construct, develop, install, own, operate and maintain a Renewable Generation Facility.

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

"Parallel Operation" means the operation of any generation facility while connected to an electric power distribution system in such a way that both the distribution system and the generation facility 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 QEC's facilities are connected to the IPP's facilities or conductors, and where any transfer of electric energy between the IPP and QEC takes place. POI is also commonly referred to as the Point of Common Coupling (PCC) in multiple standards.

"Power Distribution System" means the distribution, protection, control and communication facilities in Nunavut that are or may be used in connection with, or that otherwise relate to, the transmission, distribution and delivery of electrical energy at 25 kilovolts or less, and includes all additions and modifications thereto and repairs or replacements thereof.

"PPA" or **"Power Purchase Agreement"** means the legal contract between an IPP and QEC that details each party's legal obligations and rights with respect to the sale of energy from a Renewable Generation Facility to QEC.

"Prospective IPP" means an IPP who is interested in exploring opportunities for renewable energy generation with QEC but has not yet signed a PPA.

"QEC" means Qulliq Energy Corporation, the utility that owns the Power Distribution System that an IPP intends to interconnect with and that will buy power produced by the Renewable Generation Facility.

"Relevant Authority" means any federal, provincial or local authority, hamlet, municipality or any of their boards or agencies, or any regulatory authority other than QEC and the IPP and entities controlled by them.

"Renewable Generation Facility" means any independent electric generator of the IPP connected to QEC's Power Distribution System through the Point of Interconnection.

"SLD" or **"Single-Line Diagram"** means a simplified electrical representation of the power system that identifies electrical equipment and related interconnections, which will be attached to the PPA.

"Stabilized" means the state of the Power Distribution System after voltage and frequency has returned to normal range for a period of five to ten minutes following a disturbance.

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

"TIR" or **"Technical Interconnection Requirements"** refers to the present document establishing the criteria, requirements, guidelines and standards that must be met in order to ensure that Renewable Generation Facility interconnections do not adversely affect the safety, quality or reliability of QEC's Power Distribution System.

"Visible-Break Disconnect" means a switch or circuit breaker by means of which the Renewable Generating Facility can be disconnected under full load entirely from the circuits supplied by the generating facility. All blades or moving contacts must be connected to the generator side, and the design of the disconnecting device must allow adequate visual inspection of all contacts in the open position.

2.2 Abbreviations

Abbreviation	Definition
AC	Alternating Current
AVR	Automatic Voltage Regulation
CEC	Canadian Electrical Code
CSA	Canadian Standards Association
DC	Direct Current
EGIA	Electricity and Gas Inspection Act
EMI	Electromagnetic Interference
GPR	Ground Potential Rise
IEEE	Institute of Electrical and Electronics Engineers
IPP	Independent Power Producer
NEMA	National Electrical Manufacturers Association
OCR	Oil Circuit Recloser
PLC	Programmable Logic Controller
POI	Point of Interconnection
PPA	Power Purchase Agreement
PV	Photovoltaic
QEC	Qulliq Energy Corporation
RDG	Renewable Generation Facility
RGEO	Renewable Generation End-Open
RGIT	Renewable Generation Interconnection Transformer
SCADA	Supervisory Control and Data Acquisition
SLD	Single-Line Diagram
THD	Total Harmonic Distortion
TIR	Technical Interconnection Requirements
TOV	Temporary Over Voltage
VAR	Volt-Ampere Reactive

3. DEFINITION OF RESPONSIBILITIES

The following sections define the responsibility of each party involved in the interconnection of Renewable Generation Facility with QEC's Power Distribution System.

3.1 IPP responsibilities

Safety is a paramount requirement in the generation, transmission and distribution of electricity. The IPP shall be responsible to ensure the Renewable Generation Facility meets all applicable federal, territorial, and local safety codes related to construction, operation and maintenance, including the Canadian Electrical Code, *Electricity and Gas Inspection Act* as well as Nunavut's *Electrical Protection Act* and *Safety Act.*

3.1.1 Design and construction

With regard to the development of a Renewable Generation Facility, the Prospective IPP is responsible for:

1. providing information to QEC as specified in Appendix A;
2. completing load flow and system impact studies as needed to successfully integrate the Renewable Generation Facility within a reasonable period at the expense of the IPP;
3. designing, procuring and supplying, shipping, constructing, installing, commissioning, owning, operating and maintaining the Renewable Generation Facility and distribution line facilities up to the Point of Interconnection (POI), including the following in respect of the Renewable Generation Facility:
    a. ensure all necessary designs and drawings are signed and stamped by a professional engineer licensed to practice engineering in the jurisdiction of Nunavut;
    b. have equipment certified by an Accredited Certification Organization;
    c. construct according to Good Building Practices Guidelines document from the relevant Authority and the Nunavut Government;
    d. verify that the installation conforms to the current edition of Part I (CSA C22.1) of the CEC; and
    e. produce proof of Nunavut Electrical Inspector certification of the Renewable Generation Facility.
4. paying the costs of system interconnection (and any other costs to be borne by the IPP according to QEC), subject to and in accordance with the other agreements between the IPP and QEC;
5. obtaining any permits, certificates, licences, orders, approvals and other authorizations from any Relevant Authorities as may be required for the design, construction, ownership,

operation, maintenance and decommissioning at the end of the service life of the Renewable Generation Facility or on termination of PPA, including the following:

a. ensure that the local inspection and enforcement authorities accept the installation, or that the installation falls under the jurisdiction of an accredited entity under Applicable Laws;

b. obtain and comply with any conditions attached to all regulatory approvals, including, but not limited to, land use and environmental assessment approvals, as necessary, for the construction and operation of the Renewable Generation Facility;

c. inspect and approve all installations by an Electrical Inspector with the Government of Nunavut Safety Services Division;

d. before commissioning and commencing any Parallel Operation:

   i. obtain any approvals required to be obtained from QEC under these Technical Interconnection Requirements and under the PPA; and

   ii. comply with the prerequisites and other requirements set out in this Technical Interconnection Requirements document in respect of joint operational matters, including technical and real time operations.

e. obtain any permits, certificates, licences, orders, approvals and other authorizations from any Relevant Authorities required to connect to the Power Distribution System; and

f. provide copies of any of the foregoing to QEC upon request.

6. obtaining written approval from QEC before making any modification to the Renewable Generation Facility; and

7. coordinating the timing of any testing requirements for the commissioning of the Renewable Generation Facility with QEC.

3.1.2 Maintenance and operation

The IPP shall 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 shall maintain such equipment to accepted industry standards. Failure to do so may result in disconnection of the Renewable Generation Facility.

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

3.1.3 Modification to installations

The IPP is responsible for making changes to their facilities, as required from time to time, stemming from modifications made to QEC's Distribution System. In addition, when advised by QEC, the IPP shall make changes, requested by QEC, to their facilities for compatibility and adaptability with the QEC system. Therefore, the Prospective IPP shall make provision to accommodate such changes.

The IPP shall obtain written approval from QEC before commencing any modification to the generation facility that may affect the Power Distribution Network such as protection systems or capacity. If the change requires the installation or modification of equipment, the IPP shall provide documentation that the new equipment meets the same technical requirements defined in the TIR and the terms and conditions set out in the PPA.

If the changes require modifications to the protection and control information, the IPP shall obtain approval from QEC for the proposed modifications. To ensure that commissioning tests are performed correctly, QEC may require witnessing the tests and receiving written certification of the results.

3.2 QEC responsibilities

3.2.1 General

QEC is responsible for the operation of the Power Distribution Systems for all Nunavut communities. Interconnecting a Renewable Generation Facility in an isolated community may affect the electric service to existing or future customers. Therefore, if a Renewable Generation Facility is adversely affecting or at risk of adversely affecting customers, QEC maintains the right and responsibility to disconnect it until the concern has been mitigated.

The IPP shall work with QEC to mitigate any adverse effects it has on the QEC Power Distribution

System and is responsible for any costs incurred as a result.

3.2.2 Studies

QEC shall be responsible for reviewing the Prospective IPP's Interconnection Study and, if required, performing a Connection Impact Assessment should the results of the Study not be satisfactory.

After receiving the application for interconnection, QEC shall, if available, provide the Prospective IPP with the information specified in Appendix A, at the Prospective IPP's cost.

3.2.3 Development

In connection with the development of a Renewable Generation Facility, QEC is responsible for:

1. preparing the PPA;
2. informing the Prospective IPP of QEC's current standards and practices that are applicable to the interconnection and/or the Renewable Generation Facility and changes thereto made by QEC from time to time.

3.2.4 Maintenance and operation

For normal scheduled maintenance on QEC's facilities, QEC shall provide a minimum of 24 hours prior notice to the IPP. In order to facilitate the maintenance of QEC's infrastructure the Renewable Generation Facility shall, as requested, discontinue parallel operation until repairs can be performed on the Power Distribution System. If needed, the IPP shall provide QEC with unrestricted access to their switches to facilitate disconnection.

In the event of an emergency repair on QEC's Power Distribution System, the IPP shall disconnect the Renewable Generation Facility and provide the required support to attend to the emergency requirements if the IPP is affected.

4. QEC SYSTEM CHARACTERISTICS

The following section defines some of QEC's Power Distribution System characteristics for reference purposes. This section should be read in conjunction with QEC Distribution Engineering Standards documents provided by QEC as listed in Appendix B.

Sections 5 and 6 describe in more detail the technical requirements for interconnection, protection and control.

4.1 General

QEC operates and maintains 25 isolated power systems across Nunavut. These systems are purely radial distribution grade feeders tied directly to generation bus networks at each power plant. There is no bulk transmission of power over transmission or sub-transmission lines and terminal stations. Isolated stand-alone diesel generation is the only power source for these systems.

Available details of all 25 QEC power plants including plant geographic location, existing installed firm capacity, present maximum demand, present annual energy generation, future maximum demand and load forecast, etc. are provided in Appendix F.

4.2 System frequency

The Power Distribution System operates at 60 Hz AC. Frequency variations typically range from 59.3 Hz to 60.5 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 QEC.

4.3 Power quality

All interconnected equipment shall comply with utility standards for power quality, CAN/CSA C61000-3-6 and CAN/CSA C61000-3-7. QEC has no separate standard for power quality.

4.4 Voltage unbalance

Distribution systems are typically three-phase systems incorporating single-phase distribution taps. The voltage unbalance on a Power Distribution System under normal operating conditions may reach up to 3% or higher on some feeders at specific location, due to the unbalanced loading, single-phase regulation, or configuration of the Power Distribution System. Voltage unbalance shall be calculated using the following formula, as derived from NEMA MG1-2016 14.36.3: Unbalance (%) = 100 x (maximum deviation from average) / (average).

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

4.5 Fault levels

Fault levels and maximum allowable fault levels vary significantly through a Power Distribution System and shall be considered in the design of the interconnection. Fault levels and X/R ratios shall be evaluated for the equipment selected.

4.6 System grounding

QEC distribution facilities are normally operated as effectively grounded with the exception of Resolute Bay, which is resistance grounded. The required short-circuit current contribution from the Prospective IPP shall be evaluated on a case by case basis according to QEC's Power Distribution System.

QEC shall provide relevant data for respective communities to the Prospective IPP upon request.

4.7 Fault and line clearing

To maintain the reliability of the Power Distribution System, QEC utilizes automatic re-closing. The Prospective IPP shall take this into consideration when designing generator protection schemes to ensure that the generator is disconnected from the Power Distribution System prior to automatic re-closing of the breakers. The IPP may be reconnected when the Power Distribution System is stabilized.

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

5. INTERCONNECTION REQUIREMENTS

5.1 General

This section provides the technical interconnection requirements with which the Prospective IPP shall comply in order to be connected with QEC's Power Distribution System.

This document shall be read in conjunction with the IEEE 1547 Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

5.1.1 Safety

Safety of the personnel and general public, as well as the protection of the equipment, is of primary concern in the design and operation of the Renewable Generation facility.

5.1.2 Standards

The Renewable Generation Facility interconnection shall conform to this guideline and to the applicable sections of the codes and standards listed within this document. When the stated version of the following standards is superseded by an approved revision, this revision shall apply.

Specific types of interconnection schemes, Renewable Generation Facility technologies, and Power Distribution Systems may have additional requirements, standards, recommended practices, or guideline documents external to this guideline. The applicability and hierarchy of these factors with respect to the requirements herein are beyond the scope of this guideline. Users of this guideline shall address these concerns. Therefore, the standards listed in this document should not be regarded as all-inclusive.

5.1.3 Site-specific conditions and capacity limitations

Any limitations regarding the proposed interconnection, and any additional system upgrades required, shall be determined in consultation with the Prospective IPP and QEC.

A system impact study shall be necessary to identify any site-specific conditions and capacity limitations of the Power Distribution System. To facilitate the study, QEC and the Prospective IPP shall exchange information concerning load, feeder characteristics, protection philosophies, station layouts, capacities, ratings, and other relevant information of the QEC Power Distribution System.

Any community-specific measures necessary to meet these requirements shall be at the Prospective IPP's cost. QEC shall not provide a new distribution line, transformer or any other equipment for the sole purpose of connecting the Renewable Generation Facility to the Power Distribution System.

It is the IPP's responsibility to match the system voltage and characteristics at the POI depending on the community, as required for interconnection. The IPP shall also provide at its own cost all the necessary switchgear, protection equipment, distribution line extension and accessories, as required for the interconnection.

Under certain circumstances, QEC may limit the size or reconfigure the proposed connection arrangement of the Renewable Generation Facility in order to maintain the integrity of its system.

5.2 Physical interconnection requirements

5.2.1 Point of interconnection (POI)

The Point of Interconnection (POI) means the location where the Renewable Generation Facility will connect to QEC's Power Distribution System. QEC or the IPP may require that their equipment be located on the other side of the POI. In this case, the IPP shall provide the necessary space to QEC with provision of a 120 VAC power service.

The preferred IPP connection with the QEC Power Distribution System is on the distribution system side of the interconnection transformer operating at maximum 25 kV or 4,160 V or 600 V depending on the community location within Nunavut.

The POI and the Measured Billing Point shall be identified in the design and on the Single-Line Diagram, and be subject to any terms of the PPA. It should be noted that:

1. QEC is responsible for the design, construction, maintenance and operation of the facility on the distribution side of the POI; and
2. the IPP is responsible for coordinating 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 shall be met at the POI unless otherwise stated.

The IPP is responsible for any incremental costs to the electrical system caused by the interconnection. QEC shall carry out the engineering, design and construction required for these installations, for which the IPP will bear the costs in accordance with the PPA.

5.2.2 Point of disconnection

The Prospective IPP shall provide an isolation device (disconnect switch) capable of electrically isolating the Renewable Generation Facility from QEC's Power Distribution System.

The disconnect switch shall be located on the high voltage side of the interconnection transformer, as close as physically possible to the POI. When the interconnection involves three-phase generators, the disconnect switch shall be gang operated to simultaneously isolate all three phases.

In case of a high voltage disconnect switch: The disconnect switch on the distribution side of the interconnection transformer (e.g., 25 kV/4.16 kV air break) shall be installed, owned and maintained by QEC and paid for by IPP.

In case of a low-voltage disconnect switch, the disconnect switch on the generation side of the interconnection transformer (e.g. 600 V) shall be installed, owned and maintained by the IPP.

The isolation device shall be a manual, visible break disconnect switch and shall provide safe isolation for QEC's personnel from the Renewable Generation Facility and all other possible customer sources of energy. QEC requires that SF6 gas not be used on either switch.

All low voltage disconnect switches shall:

1. be adequately rated to break the connected generation and load;
2. be located within five meters (horizontal) of the POI, unless otherwise approved by QEC;
3. provide a direct, visible means to verify contact operation;
4. allow simultaneous disconnection of all ungrounded conductors of the circuit;
5. plainly indicate whether the switch is in the "open" or "closed" position;
6. be lockable, in the "open" position, and a visible break type. Keyed interlocks are not permitted;
7. be capable of energization from both sides;
8. be readily accessible to QEC operating personnel and not located in a locked facility or in a hazardous location;
9. be externally operable without exposing the operator to contact with live parts;

10. be capable of closing without risk to the operator when there is a fault on the system;
11. be capable of opening at rated load;
12. bear a warning to the effect that inside parts can be energized from sources on both sides when the disconnect switch is open;
13. be labelled with QEC's switch number; and
14. undergo annual inspections and maintenance.

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

5.2.3 Grounding

Grounding configurations of the IPP shall be designed in accordance with QEC's system grounding to provide suitable fault detection in order to isolate all sources of fault contribution, including the generator, from a faulted line or distribution facility.

The winding coupling of the interconnection transformer for the IPP shall be site specific.

Lightning surge transferred and ground potential rise: The IPP shall ensure that the installation does not increase the lightning surge transfer to QEC's system if the Renewable Generation Facility installation involves wind power generation or/and large scale solar panels. To limit the exposure to lightning for QEC's Power Distribution System, lightning protection grounding shall be electrically separated from the grounding grid of the wind tower and/or solar panels. If the separation is not possible or practical, then the ground grids of the towers and/or solar panels shall be electrically separated from the Renewable Generation Facility ground grid to minimize the transferred lightning surges. The latter can be achieved by ensuring that the wind towers and/or solar panels are not bonded to the station ground grid.

The IPP shall ensure that Ground Potential Rise (GPR) meets step-and-touch potential requirements. Standalone studies are required and the Prospective IPP shall submit the study for QEC records.

5.2.4 Phasing

Conductor phasing is not standardized across QEC's Power Distribution Systems. The Prospective IPP shall coordinate with QEC the phase sequence and direction of rotation during the design phase. The Prospective IPP shall also connect the rotating machines as required to match the phase sequence and direction of rotation of QEC's Power Distribution System.

5.2.5 Interrupting device

An interrupting device (e.g. circuit breaker) is required to automatically disconnect the Renewable Generation Facility from all ungrounded Power Distribution System conductors that the IPP source feeds.

The total interconnected generation, including the Prospective IPP proposed generator, shall respect limitations on the QEC Power Distribution System and should not cause any distribution protective devices and equipment (including, but not limited to, breakers, fuse cut-outs, etc. or QEC customer equipment on the system) to exceed 100% of the short-circuit interrupting capability or TOV conditions.

Fault contribution from both the Renewable Generating Facility and QEC's Power Distribution System shall be used to adequately size all fault current interrupting devices. QEC may provide, upon request, present and anticipated future fault contribution levels from QEC's Power Distribution System.

It will be the Prospective IPP's responsibility to conduct the necessary research, gather required data, conduct required system studies, and perform the interconnection study. The Prospective IPP shall use all appropriate software to design the systems and provide for all requirements, including the current limiting and power flow control reactors, if required.

5.3 System stability requirements

5.3.1 General system stability and integrity requirements

Small off-grid generation/distribution systems like QEC's community power plants do not have the characteristics and advantages of an infinite bus system. For best fuel efficiency, diesel generator systems are operated at optimum loading to the fullest extent possible, creating low spinning reserves and consequently low fault current levels. Sudden load swings or loss of generation capacity can result in load shedding that impacts customer power quality elements, such as voltage sag, frequency drop, or complete outage time.

When a generation source is suddenly disconnected from the Power Distribution System, the result could be high-speed load shedding to maintain system stability and consequently, result in outage time to the Renewable Generation Facility. The Prospective IPP is required to take note of this for their system design and is expected to have the required systems in place, such as an energy storage system and a controller for larger Renewable Generation Facilities, in order to ensure system stability and adequate spinning reserve.

The Prospective IPP shall justify its selected storage system rating referencing the underlying assumptions and calculations, submit to QEC for review, and install as required. The selected

storage system shall be charged to a minimum level of 50% before the IPP can connect to the grid daily.

QEC's Power Distribution System is designed to operate for unidirectional power flow to the customers and voltage-regulating devices are designed to correctly operate under these conditions. However, with the addition of Renewable Generation Facilities into the system, the power flow can be reversed when these facilities are supplying power, which may inhibit the voltage regulators to properly regulate the voltage on the feeder. If there is a possibility of reverse power flow, regulating devices (line voltage regulators, regulating stations and transformers under load tap changers at the POI on QEC's Power Distribution System) may need to be either upgraded or replaced with suitable devices that allow bidirectional flow. All costs related to required upgrades shall be borne by the IPP.

Compliance in respect of the above is required to ensure the safety, quality and reliability of QEC's Power Distribution System. Failure to maintain industry acceptable protocols and maintenance standards may result in disconnection of the facility from the Power Distribution System, at QEC's sole discretion.

5.3.2 Voltage stability

The IPP shall ensure that the operation of the Renewable Generation Facility does not have an objectionable impact on voltage at the POI or the interconnected feeder, and shall not cause violation of CSA Standard CAN3-C235-83 "Preferred Voltage Levels for AC Systems, 0 to 50,000V Electric Power Transmission and Distribution" along the entire interconnected feeder.

POI voltage shall be maintained within 0.95~1.05 p.u. and shall not be lower than pre-connection voltage. If high-voltage, low-voltage or voltage flicker complaints arise from other customers due to the operation of the Renewable Generation Facility, QEC reserves the right to isolate the Renewable Generation Facility from QEC's Power Distribution System until the problem has been resolved at the IPP's cost, without compensation by QEC.

5.3.3 Frequency stability

The generators at the Renewable Generation Facility shall operate at a nominal frequency of 60 Hz and shall remain synchronously connected over the frequency range presented below.

The generators shall trip in the time required, in accordance with IEEE 1547 requirements for any frequencies beyond what is presented below.

5.3.4 Synchronism

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

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

The IPP is responsible for synchronizing and maintaining synchronization with QEC's system. A proposed synchronizing scheme shall be included with the IPP application.

5.4 Power quality requirements

5.4.1 Voltage regulation and power factor

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

Synchronous generators connected to the Power Distribution System shall be equipped with excitation controllers capable of controlling voltage. The generator-bus voltage setpoint shall be stable at, and adjustable to, any value ranging from 0.95 to 1.05 p.u., so that QEC can maintain CSA voltage limits on the Power Distribution System.

Induction generators do not have voltage or reactive power control and consume reactive power (VAR). Therefore, the generator shall provide reactive compensation to correct the power factor to 0.95 at the POI and be subject to the terms established in the PPA.

Inverter-type generating equipment can control the power factor over a wide range. An inverter-type generator connected to the Power Distribution System shall 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 from QEC.

QEC shall define voltage and reactive power control requirements on a project-by-project basis during the interconnection study.

In power factor control mode, the voltage regulator shall have a voltage override that causes it to reduce excitation if the voltage at the POI exceeds an upper limit that will be specified by QEC. The normal upper limit is 105% of the nominal rated voltage; however, the voltage regulator shall have provision to adjust this upper limit to a value ranging from 100% to 110% of the nominal rated

voltage. The voltage regulator shall also have provision for a delay period between sensing upper voltage excursion and initiating control action. The power factor control equipment shall have provision to allow for the adjustment of this delay period ranging from 0 to 180 seconds. QEC shall specify the required delay period.

5.4.2 Voltage unbalance

Any three-phase Renewable Generation Facility shall have a phase-to-phase voltage unbalance not exceeding 1%, as measured both with no load and with balanced three-phase loading. Voltage unbalance is calculated using NEMA MG1-2016 14.36.2. Single-phase compensation may also be used to locally compensate voltage unbalance if required following the interconnection study.

5.4.3 Harmonics

The Renewable Generation Facility shall not inject harmonic current that causes unacceptable voltage distortion on QEC's Power Distribution System. The Renewable Generation Facility shall follow the requirements of CAN/CSA C61000-3-6. The IPP and/or QEC may be required to implement measures that will mitigate the harmonic distortions caused by the Renewable Generation Facility.

5.4.4 Flicker

The IPP shall not cause excessive voltage flicker on the Power Distribution System. The Renewable Generation Facility shall follow the requirements of CAN/CSA-IEC C61000-3-7. Any exception to the limits specified in the standard shall be approved by QEC.

The IPP shall take flicker measurements using a device that conforms to CAN/CSA-C61000-4-15 or applicable standards as may be amended from time to time. QEC may request this measurement if flicker complaints are received in the surrounding area.

5.4.5 Resonance and self-excitation of induction generators

The Prospective IPP shall consider resonance in the design of the Renewable Generation Facility, as some resonance can cause damage to existing electrical equipment, including the electrical equipment of the IPP. Engineering analysis by the Prospective IPP shall be a part of the design process to evaluate the existence and elimination of the harmful effects of:

1. ferroresonance in the transformer; and
2. resonance with another customer's equipment.

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

The engineering analysis of resonance and the assessment of the self-excitation effects of induction generators shall be submitted to QEC for approval or further evaluation.

5.4.6 Interconnection transformer

The Renewable Generation Interconnection Transformer (RGIT) shall not cause voltage disturbances or disrupt coordination of the Power Distribution System ground fault protection.

The IPP shall ensure that there is no back feed from the RGIT when the generator is out of service and shall be responsible for all consequences resulting from such back feeds. The IPP shall be responsible for ensuring that the design is adequate to handle the unbalance current.

5.4.7 Batteries / DC supply

Batteries shall be provided with the Renewable Generation Facility and shall have adequate capacity to ensure that all protection functions operate when the main source of power fails. They shall remain operational for the time required for protection functions to operate properly and disconnect the Renewable Generation Facility from QEC's Power Distribution System. They shall also be capable of sustaining continuous telemetry about the Renewable Generation Facility connection status and Renewable Generation End-Open (RGEO) signals.

Batteries and chargers shall be connected to the main service supply or by using an uninterruptable power supply with sufficient capacity for the application. The battery voltage shall be monitored and upon failure, the protection scheme shall include an alarm. However, for network reliability concerns, QEC may require tripping the Renewable Generation Facility's generation source and disconnecting it from QEC's Power Distribution System.

Dual station batteries shall not be required for protection and control equipment. Protection systems designed to back each other up, shall be supplied by physically separated and protected (i.e. fused) DC circuits. Circuit breakers and the Renewable Generation Facility's interrupting device shall be powered by separate and dedicated DC circuits. Separate and independent means are to be used for tripping the Renewable Generation Facility's interrupting device and the Renewable Generation Facility's isolation device upon low voltage (DC) conditions.

Capacitors shall not be used as the primary means to store energy in lieu of batteries.

5.4.8 Telecommunication requirements

A telecommunication infrastructure is required for the Renewable Generation Facilities connected to QEC's Power Distribution System to provide protection and real-time operating data. The telecommunication infrastructure shall be real time, secure, reliable, and meet the technical requirements for protection, control and monitoring. QEC may indicate the viable alternative technologies that may be used for telecommunications, which may include licensed/unlicensed microwave radio, optical fibre or carrier-based leased circuits.

The Renewable Generation Facility shall have a communication infrastructure compatible with QEC's SCADA system and include provision for remote trip.

In case of low capacity Renewable Generation Facility, QEC may cancel this requirement.

6. PROTECTION AND CONTROL

Specified in this section are the typical interconnection requirements to safely operate the Renewable Generation Facility in parallel with the Power Distribution System.

The IPP shall be responsible for installing, owning and operating adequate protections for the equipment in the Renewable Generation Facility to protect from damage/ faults or abnormal conditions that may affect the QEC Power Distribution System. The IPP shall be also responsible for protecting their Renewable Generation Facility from QEC Power Distribution System disturbances.

Protection relays shall be “utility grade” and shall meet the requirements specified in the latest edition of IEEE C37.90, “Standard for Relays and Relay Systems Associated with Electrical Power Apparatus.” “Industrial grade” relays are not permitted for the interconnection protection.

Protection functions shall remain operational after disturbances or loss of supply from the Power Distribution System.

It should be noted that there may be specific interconnection locations and conditions that require more restrictive protective settings or hardware. QEC shall make these deviations known to the Prospective IPP as soon as possible. The Prospective IPP shall work closely with QEC to determine whether interconnection and operation within a specific network system is possible.

6.1 Maximum generator power to be exported

The capacity of the Renewable Generation Facility shall not exceed the load-carrying capacity of the interconnection transformer at the POI, or the capacity of the Power Distribution System feeder connected to the interconnection facility, or the instantaneous Power Distribution System load.

The IPP's ability to export energy may be further limited to ensure that the voltage at the POI or the Power Distribution System does not exceed the limits specified in CAN3 C235 83.

6.2 Interconnection protection approval

The Prospective IPP shall provide QEC with the complete documentation of the proposed interconnection protection scheme for review against the requirements of the Technical Interconnection Requirements, and for potential impacts to QEC's system.

The documentation should include:

1. an overall description of how the protection will operate;
2. a detailed single-line diagram of the Prospective IPP facility up to the POI;
3. the identification details of the protection components (i.e., manufacturer, model, etc.);
4. the protection component settings (i.e., trigger levels and time values); and
5. the identification details of the disconnect switch (i.e. manufacturer, model and associated certification).

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

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

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

6.4 Protective requirements

6.4.1 Three-phase synchronous generators

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

The IPP shall be solely responsible for properly synchronizing its generator with QEC's system.

The IPP shall also be responsible for ensuring that the interconnection protection device settings coordinate with QEC's own protective device settings.

6.4.2 Three-phase induction generators and three-phase 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 QEC's side at the Point of Interconnection 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 shall meet the applicable criteria in IEEE 1547 and be certified to UL 1741 and CSA 22.2 no. 09.

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

6.5 Phase and ground fault protection

The IPP shall install protective devices to detect and promptly isolate the Renewable Generation Facility for faults occurring either in the Renewable Generation Facility itself or on QEC's Power Distribution System.

"Virtual devices" (i.e., computer or PLC systems) are acceptable, provided they meet standard utility practices for system protection and have been tested and approved by an independent testing laboratory.

The Renewable Generation Facility's system shall be grounded in accordance with applicable codes, including Section 10 of the Canadian Electrical Code Part 1 and the Government of Nunavut Safety Services Division. The Prospective IPP shall note the permafrost conditions and QEC grounding and bonding requirements, and provide compatible grounding system.

The protective devices in the Renewable Generation Facility shall be coordinated with the protective relays on the Power Distribution System unless otherwise agreed upon with QEC. The Prospective IPP shall calculate the protective device settings and submit the relay characteristics and settings to QEC for review.

The Renewable Generation Facility shall detect the following situations and isolate itself from the Power Distribution System:

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

2. a short circuit between the phase(s); and
3. the loss of any phase(s).

The ground fault protection system shall also:

1. not cause overvoltage that exceeds the rating of equipment connected to QEC's Power Distribution System and ensure that TOV limits are not exceeded;
2. not disrupt the coordination of existing ground fault protection of QEC's Power Distribution System;
3. be per manufacturer's recommendation; or
4. not cause the Neutral to Earth Voltage (NEV) that exceeds CSA requirements.

6.6 Over-voltage and under-voltage protection

The Renewable Generation Facility shall be disconnected from QEC's Power Distribution System at abnormal voltage levels. QEC system voltages for all 25 community power plants are listed in Appendix G.

The IPP shall operate its Renewable Generation Facility in such a manner that the voltage levels on QEC's Power Distribution System are in the same range as if the Renewable Generation Facility was not connected.

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

The protection of the interconnection facility shall cause the Renewable Generation Facility to cease energizing QEC's system within the trip times indicated in Table 1. The trip times listed in this table are the time periods between the start of the abnormal condition and the moment the interconnection device ceases to energize QEC's system. It should be noted that these values are subject to change based on the actual system variables at the time of installation.

Table 1: Time limits for protection responses to abnormal voltages

RMS voltage	Trip time(s)
V < 50%	6 cycles (0.1 s)
50% < V < 88%	120 cycles (2 s)
110%<V<120%	20 s
120% < V < 137%	120 cycles (2 s)
V > 137%	2 cycles (0.033 s)

The IPP may reconnect when the Power Distribution System is stabilized (i.e. when voltage and frequency have returned to a normal range for a time specified by QEC).

6.7 Over-frequency and under-frequency protection

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

Under-frequency and over-frequency relaying that automatically disconnects generators from the Power Distribution System shall be time delayed, in accordance with frequency stability requirements found in this document. The IPP may reconnect when the Power Distribution System is stabilized.

Table 2: Generator trip frequency limits (as per IEEE 1547)

Frequency range (Hz)	
Low range	High range
57.0 – 59.8	60.5

6.8 Over-current protection

An overcurrent protection device is required to automatically disconnect the IPP from QEC's Power Distribution System for faults on the Renewable Generation Facility or the connection up to the POI.

The overcurrent protection device shall:

1. account for present and future anticipated fault levels.
2. coordinate with the timed elements of upstream protective devices, and be sensitive enough to operate at minimum QEC infeed faults.
3. locate the overcurrent protection device as close to the POI as is practical. It can either be on the first or second pole after the POI.
4. locate fault indicators visible from the POI with directional functionality for each phase between the POI and the first pole on the IPP's new line.

6.9 Automatic re-closing

QEC's Power Distribution System uses automatic re-closing as a part of the overall protection scheme. During a fault situation, the Renewable Generation Facility shall be disconnected from QEC's Power Distribution System prior to the first automatic re-close. It is the IPP's responsibility to collect all required information, adapt to the required protection system settings, and relay coordination for satisfactory performance.

6.10 Anti-islanding

It is an essential requirement that the Renewable Generation Facility have a built-in anti-islanding functionality compatible with the IEEE-1547-2018 standard. The anti-islanding functionality shall not have the ability to be re-programmed or disabled.

In essence, the Renewable Generation Facility shall be equipped with protective hardware and software designed to prevent the Renewable Generation Facility from being connected to a de-energized circuit owned by QEC.

In most cases, the Renewable Generation Facility shall routinely operate as 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 QEC's customers). The resulting irregularities in power quality could cause damage for other customers.

To prevent this possibility, the IPP shall use tele-protection signals from the Power Distribution System or another reliable means to separate the generator from the Power Distribution System in the event of islanding. If other means are used to detect islanding, the scheme shall 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, QEC will require the addition of transfer trip communication facilities to remotely trip off the IPP's generation source upon opening the distribution feeder main circuit breaker or circuit re-closer.

The Renewable Generator shall cease to energize QEC’s system within two seconds of the formation of islanding on the Power Distribution System.

6.11 Synchronization

The act of paralleling the IPP Generator to the Power Distribution System can cause voltage fluctuation on the Power Distribution System, which should be restricted to a value of ± 3%.

Systems that can generate and control alternating current (AC) voltage independent of the Power Distribution System require synchronization capabilities in order to connect to the Power Distribution System. For these types of generating systems, the synchronizing controls shall only be connected when the differences between the IPP Renewable Generation Facility and the Power Distribution System voltage waveform are within the following limits:

1. Frequency difference less than + 0.5 Hz;
2. Voltage magnitude difference less than +2%; and
3. Phase angle difference less than a 5-degree lag.

6.12 Telemetry

Where a source of generation could adversely affect the Power Distribution System (e.g. by providing inflow into a fault), the IPP shall have systems in place to inform QEC of the protective operations that occurred or failed to occur.

In cases where the installed IPP capacity is deemed to be significant, telemetering may be required to facilitate transfer trip or other functionalities. Presently, the “significant IPP capacity” is defined as 20% or greater than the average load. In sensitive areas, a “significant IPP capacity” may be lower, as determined by QEC at its sole discretion.

6.13 Transfer trip protection

Where required, the transfer trip protection shall ensure that the Renewable Generation Facility does not experience islanding in the event of substation breaker or intermediate re-closer operation. The generator lockout shall be within 0.6 seconds of the breaker or re-closer operation.

The Prospective IPP’s responsibility of transfer trip protection shall be determined by QEC.

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

6.14 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 Prospective IPP needs to be aware that unbalanced conditions can occur in the Power Distribution System, especially under system fault conditions. This situation shall be taken into account in the design of the interconnection facility.

6.15 Inadvertent energization of QEC's facilities

The IPP’s generator shall not energize QEC's facilities when these are de-energized.

6.16 Protection from electromagnetic interference

The Renewable Generation Facility interconnection shall have the capability to withstand EMI environments in accordance with: a) ANSI/IEEE Std. C37.90.2, “IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers”; or

b) CAN/CSA-CEI/IEC 61000-4-3, using Level X, 35 V/m, in accordance with IEEE C37.90.2. The Renewable Generation Facility Owner shall provide documentation to show compliance with the above standards.

6.17 Surge withstand performance

The protection, control and communication equipment of the Renewable Generation Facility interconnection system shall not fail, cause operational issues, or provide misinformation due to voltage or current surges. The interconnection system shall have the capability to withstand voltage and current surges in accordance with the environments defined in the following standards: IEEE/ANSI Std. C62.41.2, "IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits" or IEEE Std. C37.90.1, and "IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus – Description."

To minimize the impact on QEC's Power Distribution System, the Renewable Generation Facility shall also provide adequate protection against lightning and switching surges. Surge arresters shall be located as close as possible to the equipment they protect and shall have adequate ratings to withstand the TOV during single-line-ground faults. Insulation coordination shall conform to CAN/CSA C71-1-99-1 and CAN/CSA C71- 1-99-2.

7. METERING

7.1 General

All Metering equipment in respect of a Renewable Generation Facility shall be provided, installed, owned, operated and maintained by QEC, paid for by the IPP, and shall be subject to the terms of the PPA.. The IPP shall provide the required space to QEC for energy metering devices installation. The meters shall be readily accessible by QEC at all times without restrictions and not located in a hazardous location. The location of the metering system installation and logistics for access shall be approved by QEC in writing.

The Renewable Generation Facility exporting power to the Power Distribution System shall be equipped with bi-directional meters with four-quadrant measurement capability.

The generation side (i.e. the side connected to the Renewable Generation Facility) of the interconnection transformer is the "Measured Billing Point" for all energy imported and exported from the Renewable Generation Facility and shall be subject to the terms of the PPA. QEC shall adjust the value of energy delivered to the distribution system for billing purposes based on transformer losses at the generation facility.

The metering equipment shall be:

1. compliant with applicable Measurement Canada requirements;
2. suitable for use in the environmental conditions that are reasonably expected to occur at the installation site over the course of a typical year; and

3. appropriate for the power system characteristics that are reasonably expected to exist at the installation site under all power system conditions and events.

7.2 Interval meter requirements

An interval meter shall be installed by QEC at all Renewable Generation Facility sites at the expense of the IPP and shall:

1. meet Measurement Canada requirements for revenue metering devices and be Measurement Canada-approved under Section 9(1), Section 9(2) or Section 9(3) of the *EGIA*;
2. be verified and sealed in accordance with the *EGIA*, and be subject to the terms and conditions of any applicable dispensation(s);
3. be capable of maintaining the interval boundaries within 60 seconds of the hour and every quarter hour thereafter;
4. measure all quantities required to determine active energy and reactive energy transferred in the required directions at the Measured Billing Point;
5. 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;
6. retain readings and, if applicable, all clock functions for at least 14 days in the absence of line power; and
7. have an accuracy class rating for active and reactive energy measurements that equals or exceeds the values specified in Table 3:

Table 3: Equipment accuracies for active and reactive energy measurements

WATThour meter accuracy class	VARhour meter accuracy class
0.5%	1.0%

7.3 Measurement transformers

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

1. meet Measurement Canada requirements for revenue metering devices and be Measurement Canada-approved under Section 9(1), Section 9(2) or Section 9(3) of the *EGIA*;
2. be burdened to a degree that does not compromise the accuracy required by these Technical Interconnection Requirements;
3. meet the requirements of CSA-C61869 or IEEE C57.13; and
4. have an accuracy class rating that equals or exceeds 0.3 %.

7.4 Remote communications equipment

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

7.5 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.

7.6 Safety requirements

The installation shall conform to:

1. Measurement Canada Standard Drawings;
2. CSA Standard C22.2; and
3. ANSI/IEEE C57.13-1983 IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

8. TESTING

8.1 General

The IPP shall notify QEC in writing at least three weeks prior to initial energization and start-up testing of the Renewable Generation Facility. QEC may witness the testing of any equipment and protective systems associated with the interconnection. The tests and testing procedures shall generally align with the requirements specified in IEEE P1547.

IPP's testing shall not impact the existing QEC Power Distribution System at any given time.

8.2 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 QEC. If any changes are made to the hardware, software, firmware or verification test procedures, the manufacturer shall notify the independent testing laboratory to determine which, 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 the withdrawal of approval and disconnection of the units installed after the change has been made.

Verification testing consists in conducting site-specific periodic tests to ensure acceptable performances on a continuous basis.

These testing procedures apply only to devices and packages associated with protection of the interconnection between the generation facility and QEC'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 shall 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 shall verify all protective setpoints and relay/breaker trip timing.

At the time of production, all interconnecting equipment and discrete relays shall meet or exceed the requirements of ANSI /IEEE C62.41-1991 Recommended Practices on Surge Voltages in Low Voltage AC Power Circuits or C37.90.1 1989 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems. If C62.41-1991 is used, the surge types and parameters shall be applied to the intended insulation location of the equipment, as applicable.

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

8.3 Verification and commission testing

All interconnection equipment shall include verification testing of the transformer (voltage and turn ratio) as part of the documentation. There shall also be P&C commission testing to determine if the protection settings are adequate and meet the intent of the Technical Interconnection Requirements.

Prior to protection and control commissioning, all batteries shall be disconnected or removed for a minimum of 10 minutes. This test shall verify that the system has a non-volatile memory and that the protection settings are not lost.

All inverters shall be non-islanding, as defined by IEEE 1547. Inverters shall, at the time of production, meet or exceed the requirements of IEEE 1547 and C22.2-257.

8.4 Verification testing

Prior to Parallel Operation of a Renewable Generation Facility, or whenever the interconnection hardware or software is changed, verification testing shall be performed. The verification test shall 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. QEC reserves the right to witness the verification test or to require written certification that the test was performed.

All verification tests prescribed by the manufacturer or developed by the IPP, and agreed to by QEC, shall be performed. The IPP is responsible for maintaining updated sets of verification test reports for inspection by QEC.

Inverter generator operation shall 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 shall be checked for proper voltage and logged monthly. Once every four years, the battery shall either be replaced or a discharge test performed.

8.5 Protective function testing

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

The non-islanding function, if available, shall 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 delay period after the switch is closed.

A reverse power or minimum power function, if used to meet the interconnection requirements, shall 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.

8.6 Verification of final protective settings test

If protective function settings have been adjusted as part of the commissioning process, the IPP shall confirm that all devices are set to QEC'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, shall be undergo an in-service test during commissioning. This test shall 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.

8.7 Hardware and software changes

Retesting of the potentially affected function shall be done whenever changes are made to interconnection hardware or software that may affect any one of the functions listed below:

1. Over-voltage and under-voltage;
2. Over-frequency and under-frequency;
3. Non-islanding function (if applicable);
4. Reverse or minimum power function (if applicable);
5. Inability to energize dead line;
6. Restart period after QEC outage;
7. Fault detection, if used; or
8. Synchronizing controls (if applicable).

The above list of potentially affected functions is not exhaustive. QEC may request testing any other function it deems necessary.

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

8.8 Switchgear and metering

QEC reserves the right to witness testing of installed switchgear and metering. The IPP shall notify QEC at least 15 days in advance of any testing.

Appendix A: Information Required from the Prospective IPP

INFORMATION REQUIRED FROM IPP		
	REQUIRED AT PROPOSAL STAGE	REQUIRED AT DETAIL DESIGN STAGE
1. Independent Power Producer Contact Information		
1.1. Company Name	X	
1.2. Company Address	X	
1.3. Commercial Contact		
1.3.1. Commercial Contact Name	X	
1.3.2. Commercial Contact Phone	X	
1.3.3. Commercial Contact Email	X	
1.3.4. Commercial Contact Address	X	
1.4. Engineering Contact		
1.4.1. Engineering Contact Name	X	
1.4.2. Engineering Contact Phone	X	
1.4.3. Engineering Contact Email	X	
1.4.4. Engineering Contact Address	X	
1.5. Operating Contact		
1.5.1. Operating Contact Name	X	
1.5.2. Operating Contact Phone	X	
1.5.3. Operating Contact Email	X	
1.5.4. Operating Contact Address	X	
2. Project Overview		
2.1. Land Location	X	
2.2. Legal Location Description	X	
2.3. Proposed In-Service Date	X	
2.4. General Description	X	
3. Generator Data		
3.1. Type	X	
3.2. Manufacturer / Model	X	
3.3. Prime Mover Type	X	
3.4. Number of generators	X	
3.5. Generator Nominal Rated kW	X	
3.6. Generator Nominal Rated kVA	X	
3.7. Generator Nominal Rated kV	X	
3.8. Power factor at rated output	X	

INFORMATION REQUIRED FROM IPP		
	REQUIRED AT PROPOSAL STAGE	REQUIRED AT DETAIL DESIGN STAGE
3.9. Maximum Authorized Real Power (MARP)		X
3.10. Leading and Lagging Reactive Power at MARP		X
3.11. Generator Grounding		X
3.12. Annual Energy Production (MWh-yr)		X
3.13. Production capacity range (MW)		X
4. Transformer Data		
4.1. Transformer kVA Ratings	X	
4.2. Transformer kV Ratings	X	
4.3. Cooling Type (ONAN, ONAF)	X	
4.4. Winding Connection	X	
4.5. Grounding Impedance (Ohms), if applicable	X	
4.6. Positive Sequence Impedance (% at ONAN base)	X	
4.7. Zero Sequence Impedance (% at ONAN base)	X	
4.8. On-Load Tap Range		X
4.9. On-Load Tap Size		X
4.10. Off-Load Tap Range		X
4.11. Off-Load Tap Range		X
4.12. Factory Test Reports		X
5. Drawings		
5.1. Preliminary Substation Layout	X	
5.2. Preliminary Protection and Metering Single Line Diagram	X	
5.3. Complete Protection and Control Diagrams		X
5.4. Complete Single Line Diagrams		X
5.5. Major Equipment Nameplates (Transformer, Generator, etc.)		X
6. Voltage Regulator		
6.1. Voltage Regulator Range (V)		X
6.2. Accuracy Tolerance (%)		X
7. Compliance with Electrical Inspector		
7.1. Permit or Equivalent Compliance		X

INFORMATION REQUIRED FROM IPP		
	REQUIRED AT PROPOSAL STAGE	REQUIRED AT DETAIL DESIGN STAGE
8. Metering Requirements		
8.1. Metering Type (2 Element, 3 Element)		X
8.2. Metering Service Provider		X
8.3. Metering Data Provider		X
8.4. Asset ID Number		X
9. Other information		
9.1.		
9.2.		
9.3.		
9.4.		
9.5.		
9.6.		
9.7.		
9.8.		

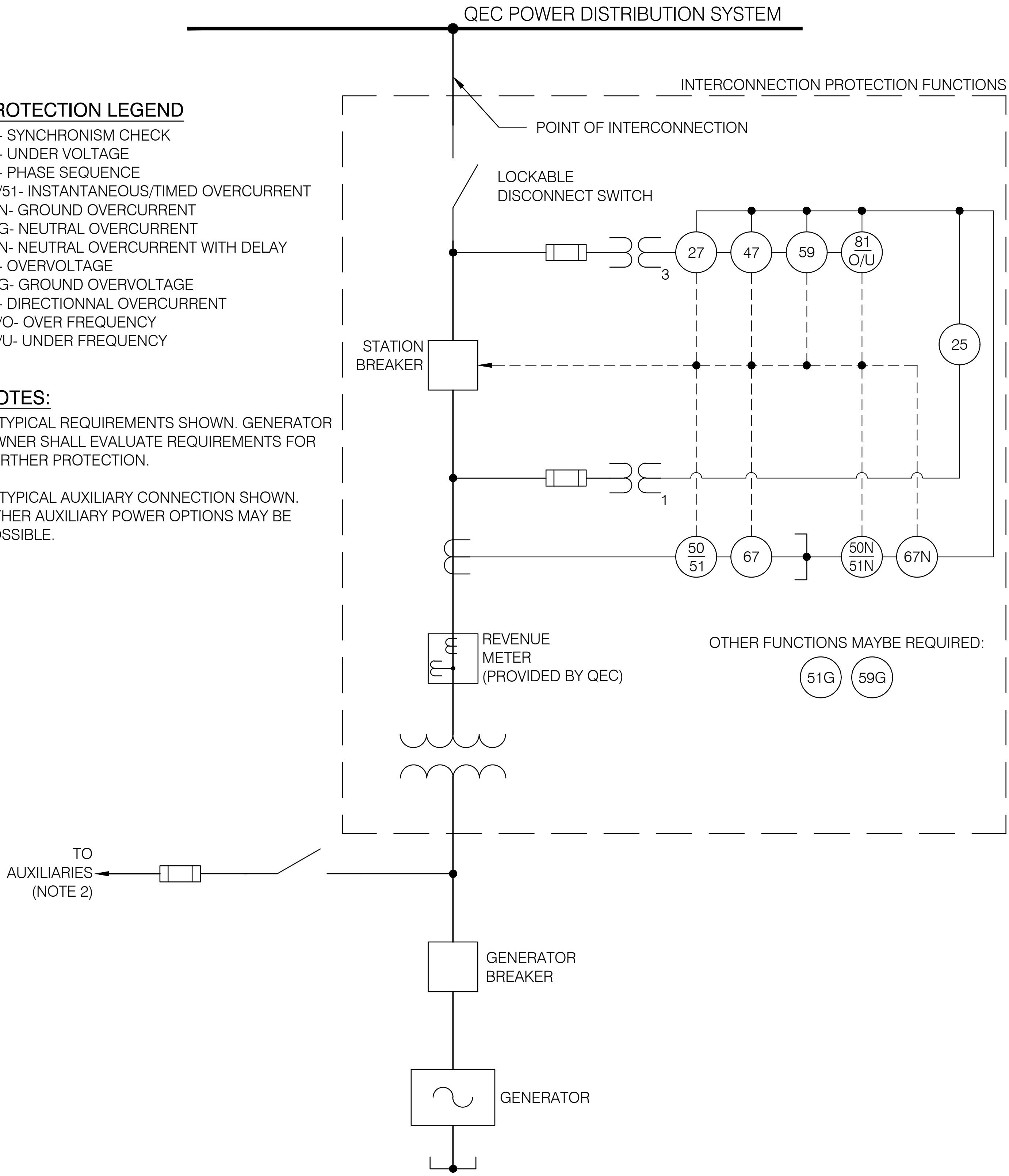
Appendix B: Information Provided by the Utility

After receiving the application for interconnection, QEC shall provide the following information to the IPP, if available:

1. Single-line diagrams or maps of the Distribution System to the POI;
2. Maximum and minimum, normal and emergency system operating voltage ranges at the POI;
3. Harmonic impedance envelope at the POI if available;
4. Planning, operating and reliability criteria, standards and policies;
5. Results of a study (interconnection 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;
10. QEC Distribution Engineering Standards document.

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

Appendix C: Typical Interconnection Single-Line Diagrams



PROTECTION LEGEND

25- SYNCHRONISM CHECK
27- UNDER VOLTAGE
47- PHASE SEQUENCE
50/51- INSTANTANEOUS/TIMED OVERCURRENT
50N- GROUND OVERCURRENT
51G- NEUTRAL OVERCURRENT
51N- NEUTRAL OVERCURRENT WITH DELAY
59- OVERVOLTAGE
59G- GROUND OVERVOLTAGE
67- DIRECTIONNAL OVERCURRENT
81/O- OVER FREQUENCY
81/U- UNDER FREQUENCY

NOTES:

1- TYPICAL REQUIREMENTS SHOWN. GENERATOR OWNER SHALL EVALUATE REQUIREMENTS FOR FURTHER PROTECTION.

2- TYPICAL AUXILIARY CONNECTION SHOWN. OTHER AUXILIARY POWER OPTIONS MAY BE POSSIBLE.

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PROFESSIONAL STAMP	PERMIT STAMP	TECHNICAL INTERCONNECTION REQUIREMENT	
		SINGLE LINE DIAGRAM FOR TYPICAL INTERCONNECTION	
		AUTHORIZED BY XXXX	DRAWN BY XXXXX
		DATE: XXXXXX	STANDARD NO. XXXXXX

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Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

SCALE	SHEET	REV
NTS	1 OF 1	3

Appendix D: Application Guidelines

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1. PURPOSE AND LIMITATIONS

1.1 Purpose

This document is intended to help Prospective Independent Power Producers (IPP) understand the process they must undergo in order to apply for the connection of a Renewable Generation Facility to one of QEC's Distribution Systems.

The intended use of this document is to:

a. inform and provide guidelines;
b. give context of the expectations from the Prospective IPP and QEC;
c. define the required documentation and information and a sequence of events for the application process.

The guidelines in this document do not address any liability provisions agreed to elsewhere, such as in the Power Purchase Agreement (PPA) between the Prospective IPP and QEC.

The document is also not intended to provide technical requirements for the interconnection of a new Renewable Generation Facility.

1.2 Limitations

The application guideline is a minimum requirement for the application process. The Prospective IPP may also have to meet additional or modified requests to address unique situations as deemed necessary by QEC.

1.3 Liability

Neither QEC nor any of their employees or agents shall be or become agents of the IPP.

QEC's review of the specifications and detailed plans shall not in any way be construed as confirming or endorsing the design or as warranting the safety, durability or reliability of the IPP's facilities nor shall it be construed to be in lieu of the approvals required from the relevant authorities.

QEC, by reason of such review or lack of review, shall not be responsible for the strength, adequacy of design or capacity of equipment built pursuant to such specifications, nor shall QEC, or any of its employees or agents, be responsible for any injury to the public or workers resulting from the operation of the IPP Renewable Generation Facilities. This guideline does not absolve the IPP of the responsibility to maintain and protect its own equipment and QEC's equipment, as well as to ensure the safety of its own personnel, QEC's personnel and the general public.

2. TERMS, DEFINITIONS, AND ABBREVIATIONS

2.1 Definitions

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

"Interconnection Study" is a detailed assessment of a project impact to the grid. The results of this assessment include a technical report outlining the project feasibility, the technical specification needed for the project, and the impacts the project would have on QEC's Power Distribution System.

"IPP" or **"Independent Power Producer"** means the person/entity who has signed a PPA with QEC to design, construct, develop, install, own, operate and maintain a Renewable Generation Facility.

"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 QEC's facilities are connected to the IPP's facilities or conductors, and where any transfer of electric energy between the IPP and QEC takes place. POI is also commonly referred to as the Point of Common Coupling (PCC) in multiple standards.

"Power Distribution System" means the distribution, protection, control and communication facilities in Nunavut that are or may be used in connection with, or that otherwise relate to the distribution of electrical energy at 25 kilovolts or less, and includes all additions and modifications thereto and repairs or replacements thereof.

"PPA" or **"Power Purchase Agreement"** is a legal contract between an IPP and QEC that details each party's legal obligations and rights with respect to the sale of energy from a Renewable Generation Facility to QEC.

"Prospective IPP" means an IPP who is interested in exploring opportunities for renewable energy generation with QEC but has not yet signed a PPA.

"QEC" means Qulliq Energy Corporation, the utility that owns the Power Distribution System that IPP intends to interconnect with and that will buy power produced by the Renewable Generation Facility.

"Renewable Generation Facility" means any independent electric generator of the IPP connected to QEC's Power Distribution System through the Point of Interconnection.

"SLD" or **"Single-Line Diagram"** means a simplified electrical representation of the power system that identifies electrical equipment with related interconnections, which will be attached to the PPA(s).

"TIR" or **"Technical Interconnection Requirements"** refers to the TIR document, which establishes criteria, requirements, guidelines and standards that must be met in order to ensure that Renewable Generation Facility interconnections do not adversely affect the safety, power quality or reliability of QEC's Power Distribution System.

2.2 Abbreviations

Abbreviation	Definition
AC	Alternating Current
DC	Direct Current
DG	Distributed Generation
IPP	Independent Power Producer
PCC	Point of Common Coupling
POI	Point of Interconnection
PPA	Power Purchase Agreement
QEC	Qulliq Energy Corporation
SLD	Single-Line Diagram
TIR	Technical Interconnection Requirements

3. GENERAL

It will be the Prospective IPP's responsibility to ensure that the Renewable Generation Facility is designed for an interconnection that meets the requirements defined in the Technical Interconnection Requirements and Guidelines (TIR) document.

It should be noted that some local QEC Distribution Systems and/or QEC power plants may require upgrades in order to allow interconnecting a Renewable Generation Facility. Some communities have older installations that were not originally designed to accommodate additional generation sources. It will be the IPPs' responsibility to determine the feasibility and upgrade requirements for their projects and all such costs will be borne by the IPP.

For all interconnections, the Prospective IPP will go through five stages:

- Stage 1 – Exploratory
- Stage 2 – Preliminary Estimates
- Stage 3 – Interconnection Study

- Stage 4 – Agreement
- Stage 5 – Construction and Commissioning

4. INTERCONNECTION APPLICATION STAGE GATES

4.1 Stage 1 – Exploratory

Any proponent developing a Renewable Generation Facility with the intention of selling energy to QEC as a Prospective IPP at any of the 25 communities, shall consult with QEC at the project conceptual stage before making any investment. In order to be considered for interconnection with QEC's Power Distribution System, IPP shall first obtain a written confirmation from QEC that the Prospective IPP's project is feasible.

Following the initial contact by the Prospective IPP seeking to interconnect a Renewable Generation Facility with the QEC Power Distribution System, a QEC representative shall be designated to work with the Prospective IPP throughout the interconnection process. The assigned QEC representative shall act as the primary contact and coordinate all communications and correspondence between the Prospective IPP and QEC.

During this stage, the following activities shall be performed:

1. The Prospective IPP shall submit to QEC the proposed Renewable Generation Facility specifications, including:
    a. Location of the proposed Renewable Generation Facility;
    b. Generator capacity, type (wind, solar, hydro, geothermal, etc.), energy output profile;
    c. Proposed SLD of generator interconnection; and
    d. Proposed POI.
2. The Prospective IPP shall submit an initial grid impact study;
3. The QEC representative shall review the Prospective IPP technical proposal;
4. QEC and the Prospective IPP shall hold an exploratory meeting) to discuss:
    a. The application process and interconnection request;
    b. The proposed Renewable Generation Facility;
    c. The proposed interconnection:

i. Technical requirements;

ii. Electrical permits and inspection; and

iii. PPA and Operating Procedures.

d. The power purchase process and agreements:

i. Terms of payment;

ii. Compensation during pre-commercial testing; and

iii. Metering.

As part of the exploratory stage, QEC, in its sole discretion, will determine the suitability and acceptability of the Prospective IPP's proposed interconnection and grant permission to continue with the proposed installation. The above discussions will also help guide the Prospective IPP and better approximate the cost that the Prospective IPP will pay to interconnect.

4.2 Stage 2 – Preliminary estimates and interconnection study

Once it has received permission to move forward from QEC, the Prospective IPP shall provide a written notice to QEC of its decision to proceed. This decision will then prompt QEC to begin estimating the preliminary interconnection costs to be incurred by the Prospective IPP.

The written notice from the Prospective IPP shall also include the following information:

1. Agreed upon Renewable Generation Facility location;
2. Single-Line Diagram ('SLD');
3. Agreed upon Generator capacity, type (wind, solar, hydro, geothermal, etc.), energy output profile;
4. Agreed upon POI;
5. Energy output profile of the Renewable Generation Facility; and
6. Interconnection study.

Once submitted to QEC, any change in the Renewable Generation Facility design or location will be considered a new interconnection inquiry and may be returned to Stage 1 for further analysis by QEC.

Within 120 calendar days of receiving the written request, QEC shall review the Interconnection Study results and provide preliminary estimates of the construction costs to interconnect the

Prospective IPP Renewable Generation Facility. Preliminary estimates shall be approximately 25% of the actual construction costs.

<u>QEC retains the right to perform a Connection Impact Assessment</u>, should it determine that the results of the study are insufficient to demonstrate without any doubt that the proposed Renewable Generation Facility is safe to operate on the QEC Distribution Network without causing adverse effects. If this is the case, QEC will provide a Connection Impact Assessment Application Form to the Prospective IPP, requesting technical details of the proposed Renewable Generation Facility. All costs for this assessment will be borne by the Prospective IPP. After payment has been made, QEC will complete the assessment and provide the preliminary estimates of the construction costs to interconnect within 180 calendar days.

The Prospective IPP shall, within a reasonable time after receipt of all information from QEC as contemplated in this Stage, advise QEC in writing that it intends to proceed to Stage 3 (the “Agreement Stage”).

4.3 State 3 – Agreement

QEC may permit the Prospective IPP to delay proceeding to the Agreement Stage for up to 60 days following receipt by the Prospective IPP of the Interconnection Study and cost estimates for the interconnection, provided that the delay does not materially affect the interconnection request. If QEC determines, in its sole discretion, that the interconnection request is materially affected by the delay, the interconnection request shall be rejected. If the Prospective IPP subsequently wishes to proceed with the interconnection, it must return to Stage 1 of these interconnection procedures.

Within 90 days of the written notification by the Prospective IPP that it intends to proceed, QEC will forward the PPA to the prospective IPP.

The details to be found in the PPA shall include, among other things, the construction responsibilities of the Prospective IPP, obligations related to operating and maintaining the Renewable Generation facilities, insurance requirements, creditworthiness requirements and delineates the rights of the parties on termination of the interconnection.

4.4 Stage 4 – Construction and commissioning

It shall be the responsibility of the Prospective IPP to undertake and complete all activities related to the construction and commissioning of the Renewable Generation Facility while complying with the applicable codes and standards and ensuring compatibility between the Renewable Generation Facility and QEC systems. The Prospective IPP shall, at least two weeks prior to final inspection of its facility, notify QEC that such inspection will be taking place. QEC shall have the right to have a representative present at the final inspection.

Immediately prior to commissioning and every five years thereafter, performance data (as defined in the TIR) of the Renewable Generation Facility shall be provided to QEC by the Prospective IPP, which will be verified against the Interconnection Study.

5. ADHERENCE TO TIMELINES

If QEC is unable to complete the required Interconnection Study or Agreements within a reasonable time, QEC shall notify the Prospective IPP and provide an estimated completion date along with an explanation as to why additional time is required.

The Prospective IPP may also request reasonable extensions of any deadline set forth in these interconnection procedures. A reasonable extension shall be granted if in the judgment of QEC the extension does not cause any additional burden/costs to QEC. Any request for an extension shall be made in writing by the Prospective IPP to the QEC representative.

Appendix E: Operating Procedures

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1. PURPOSE AND LIMITATIONS

1.1 Purpose

This document outlines the steps to be taken or procedures to be followed to ensure a reliable and safe operation and interconnection between the IPP's Renewable Generation Facility and QEC's Power Distribution System through a variety of circumstances.

1.2 Liability

Under no circumstances shall QEC be liable for the actions of the IPP, the IPP's employees or agents.

2. TERMS, DEFINITIONS, AND ABBREVIATIONS

2.1 Definitions

"Operating Authority" means the organizational unit, which is assigned the responsibility for the operation of a portion of the electrical system.

"POI" or **"Point of Interconnection"** means the point at which QEC's facilities are connected to the IPP's facilities or conductors, and where any transfer of electric energy between the IPP and QEC takes place. POI is commonly referred to as the Point of Common Coupling (PCC) in multiple standards.

"Power Distribution System" means the distribution, protection, control and communication facilities in Nunavut that are or may be used in connection with, or that otherwise relate to, the distribution of electrical energy at 25 kilovolts or less, and includes all additions and modifications thereto and repairs or replacements thereof.

"QEC" means Qulliq Energy Corporation, the utility that owns the Power Distribution System that an IPP intends to interconnect with and will buy power produced by the Renewable Generation Facility.

"Renewable Generation Facility" means any independent electric generator of the IPP connected to QEC's Power Distribution System through the Point of Interconnection.

2.2 Abbreviations

Abbreviation	Definition
AC	Alternating Current
DC	Direct Current
DG	Distributed Generation
IPP	Independent Power Producer
PCC	Point of Common Coupling
POI	Point of Interconnection
PPA	Power Purchase Agreement
QEC	Qulliq Energy Corporation
SLD	Single-Line Diagram
TIR	Technical Interconnection Requirements

3. OPERATIONAL INFORMATION

3.1 Contact information

<QEC Community Name> Power Plant – Phone (867) XXX-XXXX

Contact Name	Title	Phone Number
		(867) XXX-XXXX
		(867) XXX-XXXX
		(867) XXX-XXXX
		(867) XXX-XXXX
		(867) XXX-XXXX

3.2 Circuit breaker identification

List circuit breakers providing interconnection between the IPP and the utility.

3.3 Interlocks

List identified circuit breaker interlocks with sequence information.

3.4 Normal operation

Under normal operating conditions, the IPP facility will be connected to the utility grid. The breaker status under normal operating conditions is as follows:

Breaker	Status
<Breaker ID>	Open / Closed
<Breaker ID>	Open / Closed
<Breaker ID>	Open / Closed
<Breaker ID>	Open / Closed
<Breaker ID>	Open / Closed

4. OPERATING PROCEDURES

4.1 Line isolation

Isolation of line <XXX> requires the minimum notification defined in Section 4.3, with the exception of emergency repairs.

QEC will provide a Condition Guarantee, which shall be used in all communications between external parties for breaker <Breaker ID>. It is a formal method of communication to ensure that switching has been completed and that the status of the breaker will not change until the work is completed, the lock out/tag out is surrendered and all workers are clear.

4.2 Voltage support

Based on the power quality conditions defined in the TIR document and system security requirements, QEC may request voltage support. Voltage support can be provided by placing the IPP generation source on line, or by other means such as capacitor banks or transformer tap changing. If such support is part of the operating procedure then:

1. When the IPP has a generation source on line, the generators regulate the generator bus voltage ranging from 100% to 105% of the nominal voltage, and QEC shall have control of this setpoint. The generators reactive output will be adjusted by the utility in real time, to regulate the system voltage, by pulsing the AVR voltage setpoints. The IPP sets the acceptable range within which the utility can adjust voltage.

2. QEC shall have full SCADA visibility of the IPP substation and control of critical elements.

4.3 Remote monitoring

All IPP requests shall be communicated and approved by QEC.

QEC shall have monitoring of the incoming line breaker <Breaker ID> at the IPP facility and have visual indication of the IPP breakers, generator status, capacitor status and electrical measurement information for the IPP facility.

QEC control shall be limited to:

1. Approving requests from the IPP to connect and disconnect from the utility system;
2. Approving requests from the IPP for changes in the generation output;
3. Requesting the IPP to disconnect from the utility system for operational, reliability and safety reasons.

5. OPERATIONAL NOTIFICATIONS

5.1 Daily operating communications

Under normal operating conditions, the IPP will be supplying <XXX> kW to the QEC Power Distribution System. Generation changes of more than <XXX> kW must be communicated and approved by QEC.

The transition from winter to summer and conversely summer to winter generation levels must be established with QEC with a minimum of 30-days' notice.

5.2 IPP facility planned maintenance and scheduling

The IPP shall operate under QEC's approved maintenance procedures.

To meet changing operating conditions and coordinate maintenance efforts, maintenance shutdowns by the IPP need to be communicated to QEC at least 24 hours in advance. Changes in the availability and capacity of the onsite generation sources shall be communicated to QEC.

5.3 Distribution maintenance and scheduling

QEC performs annual line maintenance on its distribution lines; during this maintenance, the grid power to the IPP facility may be curtailed or suspended. QEC shall provide a minimum of 24 hours' notice before the intended start date as well as provide the expected duration of the work that will curtail or otherwise interrupt the supply of grid power to the IPP facility.

Appendix F: QEC Power Plant General Information

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1. BACKGROUND

1.1 Introduction

The Qulliq Energy Corporation (QEC) owns and operates 25 standalone diesel power generating stations throughout Nunavut. These power generating stations have engine/generator sets (“Genset”) ranging in various capacities as mentioned below as per community energy requirement and load growth projected. Genset ratings for Grise Fiord and Cape Dorset plants are for new plants that were commissioned in Dec 2018.

1.2 Plant Description - Baffin Region

1.2.1 Iqaluit - 701

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	3,000 (Wartsila 9R32) Sr No 5880	720	9,707 kW 59,646 MWh (2017) 10,946 kW 65,901 MWh (2025) Average generation 2017 - 4,901,305 kWh	63°44'55” N 68°31'11” W
G2	2,500 (EMD20V645) Sr No 75C1042	900		
G3	3,300 (CAT D3612) Sr No 9RC114	720		
G4	2,000 (Wartsila 12V200) Sr No 120071	1,200		
G5	4,300 (Wartsila 12V32) Sr No 5337	720		
G6	5,000 (Wartsila 12V32) Sr No 227817	720		
G7	5,000 (Wartsila 12V32) Sr No 227818	720		
G8	330 (Series 60 Detroit Diesel) Sr No 06R0874156	1,800		
G9 - EM	320 (D 3406 CAT) Sr No 1LS01153	1,200		
Total	**25,430**			

1.2.2 Pagnirtung – 702

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	1,100 (Cummins DQGAF) QSK-50-G5 Sr No 25415690	1,800	1,208 kW 6,418 MWH (2017) 1,302 kW 6,720 MWH (2025)	66°08'52" N 65°41'58" W
G2	1,100 (Cummins DQGAF)QSK-50-G5 Sr No 25415035	1,800		
G3	680 (Cummins DQGAA)QST-30-G5 Sr No 37268145	1,800		
G4 - EM	550 (C27 Caterpillar MJE03777 Sr No C27HGDGS00402	1,800		
Total	**2,880**			

1.2.3 Cape Dorset Power Plant – 703

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	1,100 (16V4000G73 MTU)	1,200	1,488 kW 5,509 MWH (2017) 1,600 kW 6,087 MWH (2025)	64°13'54" N 76°32'25" W
G2	1,100 (16V4000G73 MTU)	1,200		
G3	525 (8V4000M63 MTU)	1,200		
G4	830 (12V4000G73 MTU)	1,200		
Total	**3,555**			

1.2.4 Resolute Bay power plant – 704

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	320 (Series 60 Detroit Diesel) Sr No 06R1025516	1,800	829 kW 4,580 MWH (2017) 810 kW 4,419 MWH (2025)	74°41'51" N 94°49'56" W
G2	350 (F2895 Waukesha) F2895 Sr No 230803	1,200		
G3	500 (8V400 Detroit Diesel) 8V4000 Sr No 524101744	1,200		
G4	320 (CAT D3406E) Sr No 17300670	1,200		
G5	320 (CAT D3406E) Sr No 9NN00445	1,200		
Total	**1,810**			

1.2.5 Pond Inlet power plant – 705

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	720 (CAT D 3512) Sr No 67Z00917	1,200	1,168 kW 6,402 MWH (2017) 1,356 kW 7,170 MWH (2025)	72°41'57" N 77°57'33" W
G2	850 (Detroit 12V4000) Sr No 5262011374	1,200		
G3	550 (Gauscor F360TA) Sr No 76937	1,200		
G4	550 (Gauscor SF360TA) Sr No 76936	1,200		
Total	**2,670**			

1.2.6 Igloolik power plant – 706

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	850 (Detroit Diesel 12V4000) Sr No 5262011373	1,200	1,247 kW 6,771 MWH (2017) 1,471 kW 7,759 MWH (2025)	69°22'34" N 81°47'58" W
G2	480 (CAT D 3508) Sr No 70Z00838	1,200		
G3	720 (CAT D 3512) Sr No 67Z01250	1,200		
G4 - EM	320 (Series 60 Detroit Diesel) 06R0842989	1,800		
Total	**2,050**			

1.2.7 Hall Beach power plant – 707

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	165 (CAT D3406) 90U15752	1,200	681 KW 3374 MWH (2017) 764 KW 3831 MWH (2025)	68°46'38" N 81°13'27" W
G2	550 (D3508B) Sr No CTC00294	1,200		
G3	330 (Series 60 Detroit Diesel) 06R1010847	1,800		
G4	550(CAT 3508B) Sr No 2HW00394	1,200		
Total	**1,525**			

1.2.8 Quikitarjuq power plant – 708

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	300 (MTU8V1600B3OS) Sr No 1HTMMAA2AH261600	1,800	1,100 kW 2,765 MWH (2017) 1,195 KW 3,029 MWH (2025)	67°33'29" N 64°01'29" W
G2	550 (CAT D3508B) Sr No S2A00177	1,200		
G3	550 (CAT D3508B) Sr No S2A00178	1,200		
G4	370 (CAT C15) Sr No FTH04668	1,800		
Total	**1,770**			

1.2.9 Kimmirut – 709

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	360 (Volvo TAD 1344GE) Sr No 201333041	1,800	385 kW 2,004 MWH (2017) 389 kW 1,985 MWH (2025)	62°50'48" N 69°52'07" W
G2	300(Series 60 Detroit Diesel) Sr No 06R0793390	1,800		
G3	330 (CAT D 3412) Sr No 81Z11897	1,200		
G4	350 EM (CAT D3406) 1DZ03760	1,200		
Total	**990**			

1.2.10 Arctic Bay – 710

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	480 (CAT D3508) Sr No 70Z00908	1,200	690 KW 3,361 MWH (2017) 759 KW 3,661 MWH (2025)	73°02'11" N 85°09'09" W
G2	290 (CAT D 3406) Sr No 9FF01874	1,200		
G3	330 (Series 60 Detroit Diesel) Sr No 06R0976524	1,800		
G4 - EM	320 (Series 60 Detroit Diesel) Sr No 06R0984997	1,800		
Total	**1,100**			

1.2.11 Clyde River – 711

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	480 (CAT 3508B) Sr No 70Z00857	1,200	796 kW 3,792 MWH (2017) 886 kW 4,319 MWH (2025)	70°28'26" N 68°35'10" W
G2	550 (CAT D 3508B) Sr No 2HW00389	1,200		
G3	330 (Series 60 Detroit Diesel) Sr No 06R1043819	1,800		
G4 - EM	550 (CAT D 3508B) Sr No 2HW00390	1,800		
Total	**1,910**			

1.2.12 Grise Fiord power plant – 712

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	255 TAD1344GE- WDC255D6CSW	1,800	168 kW 1,251 MWH (2017) 173 KW 1,067 MWH (2025)	76°25'03" N 82°53'38" W
G2	255 TAD1344GE- WDC255D6CSW	1,800		
G3	225 TAD1344GE- WDC255D6CSW	1,800		
G4	170 TAD1350GE- HCI434DIH	1,800		
Total	**905**			

1.2.13 Sanikiluaq – 713

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	330 (Series 60 Detroit Diesel) Sr No 06R1043819	1,800	725 kW 3,837 MWH (2017) 804 kW 4,112 MWH (2025)	56°32'34" N 79°13'30" W
G2	550 (CAT D 3508B) Sr No 2HW00388	1,200		
G3	550 (CAT 3508B) Sr No CTC00281	1,200		
Total	**1,430**			

1.3 Plant Description - Kivalliq Region

1.3.1 Rankin Inlet power plant – 601

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	950 (CAT D3516) Sr No 73Z00621	1,200	3,348 kW 18,490 MWH (2017) 3,344 kW 18,749 MWH (2025)	62°48'35” N 92°05'58” W
G2	1500 (CAT D3606) Sr No 8RB01008	900		
G3	1450 (EMD 8V710) Sr No 06- E1- 1030	900		
G4	2150 (EMD L12V710) Sr No 01- L1- 10130	900		
G5 - EM	820EM (Detroit 12V4000) Sr No 5262003102	1,200		
Total	**6,870**			

1.3.2 Baker Lake power plant – 602

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	1100 (Cat D 3516B) Sr No GZT00177	1,200	1,100 KW 8,906 MWH (2017) 2,055 kW 9,224 MWH (2025)	64°19'05” N 96°01'03” W
G2	850 (Cat D 3512B) Sr No CTB00184	1,200		
G3	1050 (Cat D 3516B) Sr No CTA00152	1,200		
G4	550(Cat D 3508B) Sr No CTC00295	1,200		
Total	**3,550**			

1.3.3 Arviat power plant – 603

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	850 (CAT D 3512B) Sr No LE600186	1,200	1613 kW 8,661 MWH (2017) 1988 kW 10,348 MWH (2025)	61°06'29" N 94°03'25" W
G2	550 (CAT D 3508B) Sr No CTC0292	1,200		
G3	1100 (CAT D 3516B) Sr No GZT00178	1,200		
G4	800 (CAT D 3512B) Sr No 9GZ00571	1,200		
Total	**3,300**			

1.3.4 Coral Harbor Power plant – 604

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	480 (CAT D 3508) Sr No 70Z00877	1,200	731 kW 3,541 MWH (2017) 780 kW 3,915 MWH (2025)	64°08'13" N 83°09'51" W
G2	420 (CAT D 3508) Sr No CTF00265	1,200		
G3	420 (CAT D 3508) Sr No CTF00264	1,200		
Total	**1,320**			

1.3.5 Chesterfield Inlet power plant – 605

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	320 (Detroit Series 60) Sr No 06R0793235	1,800	400 KW 2,066 MWH (2017) 412 KW 2,169 MWH (2025)	63°20'27" N 90°42'22" W
G2	320 (Detroit Series 60) Sr No 06R01043820	1,800		
G3	400 (CAT D 379) Sr No 34Z00683	1,200		
Total	**1,040**			

1.3.6 Whale Cove – 606

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	300 (CAT D 3412) Sr No 81Z11643	1,200	380 kW 1,931 MWH (2017) 441 kW 2,153 MWH (2025)	62°10'22" N 92°34'46" W
G2	300 (CAT D 3412) Sr No 81Z11653	1,200		
G3	150 (CAT D3406) Sr No 2WB10298	1,200		
G4	320 (Detroit Series 60 Sr No 06R1043818	1,800		
Total	**1,070**			

1.3.7 Naujaat – 607

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	550 (CAT D 3508B) Sr No CTC00282	1,200	871 kW 4,315 MWH (2017) 1,014 kW 5,014 MWH (2025)	66°31'19" N 86°14'06" W
G2	550 (CAT 3508B) Sr No 2HW00391	1,200		
G3	550 (CAT D 3508B) Sr No CTC00280	1,200		
G4 - EM	550 kW Modular unit (CAT 3508B) Sr No 2HW00393	1,200		
Total	**1,650**			

1.4 Plant Description - Kitikmeot Region

1.4.1 Cambridge Bay – 501

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	1100 (Detroit 16V4000) Sr No 5272003461	1,200	2,265 kW 12,902 MWH (2017) 2,453 kW 13,803 MWH (2025) Average generation 2017 1,010,792 kWH	69°07'02" N 105°03'11" W
G2	550 (CAT D 3508B) Sr No CTC00266	1,200		
G3	1100 (CAT D 3512B) Sr No GZT00174	1,200		
G4	1100 (Detroit 16V4000) Sr No 5272003468	1,200		
G5	1100 (Detroit 16V4000) Sr No 5272001410	1,200		
Total	**4,950**			

1.4.2 Gjoa Haven – 502

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	720 (CAT D3512) Sr No 67Z- 00764	1,200	1,100 kW 5,851 MWH (2017) 1,195 kW 6,642 MWH (2025)	68°37'33" N 95°52'30" W
G2	500 (MTU8V4000M63) Sr No 524101864	1,200		
G3	550 (Gauscor SF360TA) Sr No 76934	1,200		
G4	550 (CAT 3508B)	1,200		
Total	**2,320**			

1.4.3 Taloyoak – 5031

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	370 (CAT C15) Sr No FTH04674	1,800	730 kW 3,923 MWH (2017) 851 kW 4,478 MWH (2025)	69°32'13" N 93°31'36" W
G2	550 (CAT 3508B) Sr No S2A00179	1,200		
G3	550 (CAT 3508B) Sr No S2A00180	1,200		
G4	370 (CAT C15) Sr No FTH04673	1,800		
Total	**1,840**			

1.4.4 Kugaaruk power plant – 504

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	320 (Detroit Series 60) Sr No 6R0753348	1,800	669 kW 2,829 MWH (2017) 796 kW 3,330 MWH (2025)	68°31'59" N 89°49'36" W
G2	550 (CAT D 3508B) Sr No CTC00284	1,200		
G3	550 (CAT D 3508B) Sr No CTC00283	1,200		
Total	**1,420**			

1.4.5 Kugluktuk power plant – 505

Genset	Rating (kW) and Make	RPM	Peak Load & Generation 2017 & Forecast 2025	Geographic Location
G1	875 (Detroit DD4000) Sr No 5262000511	1,800	1,077 KW 5,796 MWH (2017) 1,155 KW 6,318 MWH (2025)	67°49'32" N 115°05'42"W
G2	320 (Detroit Series 60) Sr No 6R0649412	1,800		
G3	320 (Detroit Series 60) Sr No 6R0812721	1,800		
G4	720 (CAT D 3512) Sr No 67Z- 00939	1,200		
Total	**2,235**			

NOTE: This is a live document, as equipment configuration will change with time as per community needs and life cycle of the equipment. New plants may be built with different equipment configuration and location at the same community. All above information provided by QEC is to be verified by the proponent for admissibility, accuracy and updated as required at the time of use. Load and capacity projections also need to be further extrapolated and extended for the projected life of the new power plant based on the trend and data to be collected by the Proponent. QEC does not guarantee the accuracy of the information provided.

Appendix G: QEC Distribution Systems Voltages

Community	Community No.	System Voltage	System Configuration
Arctic Bay	710	4.16 kV/12.5 kV	3Ø, 4W, Y
Arviat	603	4.16 kV	3Ø, 4W, Y
Baker Lake	602	4.16 kV	3Ø, 4W, Y
Cambridge Bay	501	4.16 kV	3Ø, 4W, Y
Cape Dorset *	703	4.16 kV	3Ø, 4W, Y
Chesterfield Inlet	605	4.16 kV	3Ø, 4W, Y
Clyde River	711	4.16 kV	3Ø, 4W, Y
Coral Harbour	604	4.16 kV/12.5 kV	3Ø, 4W, Y
Gjoa Haven	502	4.16 kV	3Ø, 4W, Y
Grise Fiord	712	4.16 kV	3Ø, 4W, Y
Hall Beach	707	4.16 kV	3Ø, 4W, Y
Igloolik	706	4.16 kV	3Ø, 4W, Y
Iqaluit	701	4.16 kV	3Ø, 4W, Y
Kimmirut	709	4.16 kV	3Ø, 4W, Y
Kugaaruk	504	4.16 kV	3Ø, 4W, Y
Kugluktuk	505	4.16 kV	3Ø, 4W, Y
Pangnirtung	702	4.16 kV	3Ø, 4W, Y
Pond Inlet	705	4.16 kV	3Ø, 4W, Y
Qikiqtarjuaq	708	4.16 kV	3Ø, 4W, Y
Rankin Inlet	601	4.16 kV	3Ø, 4W, Y
Repulse Bay	607	4.16 kV	3Ø, 4W, Y
ResoluteBay*	704	12.5 kV/2.4 kV	3Ø, 4W, Y/3Ø, 3W, Δ*
Sanikiluaq	713	4.16 kV	3Ø, 4W, Y
Taloyoak	503	4.16 kV	3Ø, 4W, Y
Whale Cove	606	4.16 kV	3Ø, 4W, Y

* Cape Dorset: Distribution system will be converted to 12.5 kV in near future

* Resolute Bay: Distribution System will be converted to 3 PH, 4W, Y in near future. Target Sept. 2019.

PERMIT HOLDER	PROFESSIONAL STAMP	DISTRIBUTION STANDARDS	
		COMMUNITY DISTRIBUTION SYSTEM VOLTAGES	
		AUTHORIZED BY: C.WILLCOTT	DRAWN BY: J.AMORES
		DATE: 2016/02/01	STANDARD NO. D-03-03

Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

SCALE	SHEET	REV
NTS	1 OF 1	1