Generation Interconnection Requirements at Voltages 34.5 kV and Below

2021 September

Table of Contents

1. INTRODUCTION

1.1. Intent

This document:

- Defines the technical requirements for connecting generation to SaskPower facilities which have an operating voltage of 34,500 volts or lower.
- Does not constitute a guide or design handbook. Generation Owners who are considering the development of a generation facility intended for connection to the SaskPower distribution system should engage the services of individuals qualified to provide design and consulting services for electrical interconnection facilities.

1.2. Purpose

The purpose of the interconnection guideline is to facilitate the technical assessment of interconnection requirements for parallel operation of generation facilities. The information provided in this document should allow potential Generator owners to conduct feasibility studies to assess the technical requirements for interconnection.

This document contains information pertaining to the characteristics of SaskPower's distribution system and identifies potential issues, such as safety, power quality, protection coordination, reliability, and operation, which should be considered at various stages of the project. This document also outlines the major steps in the process of connecting a generator to SaskPower's distribution system.

This document does not constitute an offer to or express an interest in purchasing capacity and energy from generation projects. It does not set out the basis for commercial agreements related to the delivery of electrical energy and capacity from generation projects. Please refer to the most recent version of SaskPower's Generation Policy for this information.

1.3. Scope

The scope of this document covers generation which is connected to and operates in synchronism with SaskPower's distribution system. This document does NOT cover interconnection to SaskPower facilities that operate at voltages above 34.5 kV. For interconnection to the transmission system refer to SaskPower's document "Non-Utility Generation Interconnection Requirements at Voltages 72kV and Above".

The use of the term "Distribution System" within this document is specific only to this document. The use of these terms and definitions is not intended to define SaskPower facilities other than for the purposes described above.

This document covers three-phase generation at single site installations with a total installed capacity of up to 1000 kW and single-phase generation at single site installations with a total installed capacity of up to 100 kW. Three phase generation projects greater than 1000 kW will be considered, but the complexities of such installations are such that they cannot be addressed in a general requirements document such as this. Installations with an installed capacity greater than 1000 kW may be considered and proponents should contact SaskPower to discuss the specifics of these types of projects.

This document is a set of general guidelines and requirements, but the actual generation integration study will determine specific requirements, which may superceed the general requirements. The study may recommend a variation on some requirements in this document (i.e. grounding requirements, voltage control, etc).

1.4. Ownership and Payment for Facilities

SaskPower will own, maintain and operate all facilities on SaskPower's side of the point of delivery. The Generator Owner is responsible for the supply, installation, ownership, maintenance, testing (including periodic re-testing) and operation of all facilities on the generation side of the point of delivery. The exception to this may be provision of communication and SCADA facilities as noted in Sections 3.3 and 3.4. The aforementioned division in responsibilities does not extend to the responsibility for costs associated with the interconnection facilities. **The Generator Owner is responsible for the total cost of the Interconnection Facilities required to integrate the Generation Facilities into the SaskPower distribution system. The Generator Owner is also responsible for the costs of future changes to the Generation Facilities as may be required by SaskPower.**

1.5. Agreements, Approvals, and Permits

1.5.1. Agreements:

Prior to the connection of Generation Facilities to the SaskPower distribution system, the Generator Owner agrees to:

1. For generators 100 kW and less in size, sign an Interconnection Agreement For Small Generators.
2. For generators greater than 100 kW in size, sign an Interconnection Agreement and a Service And Supply Agreement with SaskPower.
3. Sign an Operating Agreement with SaskPower which agreement shall outline standard operating practices. Please refer to Appendix "D" for a detailed outline of the requirements of the Operating Agreement.
4. Attend an operations meeting upon notice from SaskPower for the purpose of establishing procedures and permits for the initial electrical connection between the Generation Facilities and the SaskPower distribution system.

1.5.2. Approvals and Permits:

Notwithstanding subsection 3(2)(a) (i) of *The Electrical Inspection Act, 1993,* the Generator Owner agrees to complete the following:

1. Ensure that the design of the generation facilities and equipment installed is compliant with the Canadian Electrical Code;
2. Submit for inspection its interconnection facilities by SaskPower's Electrical Inspection Division;
3. Pay to SaskPower's Electrical Inspection Division any inspection rate or fees established by the Electrical Inspection Division as compensation for the inspection of the interconnection facilities;

In addition, the Generator Owner shall be responsible for determining requirements for, and obtaining any licenses, permits or approvals necessary to ensure compliance with any federal, provincial or municipal statutes and regulations.

The Generator Owner shall comply with any other instructions issued by SaskPower respecting safety, system protection, operating procedures and schedules, testing of all or portions of the facility as part of the operation and maintenance of the Generation Facility.

1.6. Waiver

The Generator Owner acknowledges and agrees that the above requirements, including any reviews conducted by SaskPower or the SaskPower Electrical Inspection Division, are done at the sole risk and expense of the Generator Owner.

1.7. Changes to Facilities

Prior to undertaking changes to any generation interconnection facilities, which would alter the performance of the interconnection, agreement must be obtained from SaskPower.

1.8. Interconnection Process (Technical Assessment)

The following outlines the general process to be followed for dealing with the technical issues associated with all requests to operate generation in parallel with SaskPower's system.

- Generator proponent submits an Interconnection Service Request - Generation (information requirements are set out in Appendix B).
- SaskPower will conduct the detailed Integration Studies to confirm the connection configuration and identify any additional or special requirements. It should be noted that for projects requiring new power lines, there may be a significant lead time requirement. SaskPower will assess a fee for conducting the Integration Studies.

The purpose of the Integration Studies carried out by SaskPower is to identify the interconnection facilities required to be added to SaskPower's system to accommodate the proposed Generation project, along with the associated cost. The Integration Studies also assess whether the proposal by the Generation proponent meets SaskPower's technical requirements for interconnection. The Integration Studies carried out by SaskPower do not replace the design studies that must be carried out by the Generation proponent.

1.9. Information

The information contained within this document is subject to change. An updated copy of this document is available upon request. Contact SaskPower at 2025 Victoria Avenue, Regina, Saskatchewan S4P 0S1, and direct your inquiry to the Vice President of the Transmission and Distribution Business Unit or visit www.saskpower.com.

2. SASKPOWER DISTRIBUTION SYSTEM CHARACTERISTICS

The following information describes the characteristics of the SaskPower distribution system and identifies a number of aspects that must be taken into consideration in the design of any generating facility to be interconnected with SaskPower's distribution system.

For the purposes of this document, the term 'Distribution System' may mean SaskPower's three phase 34.5 kV, 25 kV, and 14.4 kV systems, single phase 14.4 kV system, or 120/240 volt single phase secondary distribution system.

2.1. General System Configuration

The majority of SaskPower's primary three-phase distribution system operates at a nominal voltage of 25 kV phase-to-phase. SaskPower also utilizes three-phase, 14.4 kV phase-to-phase as a primary distribution voltage in some urban areas and operates a three phase, 34.5 kV phase-to-phase system as a wind generation collector system. The SaskPower primary distribution system is supplied from substations which are equipped with two winding step-down transformers, which are Δ Y connected (solidly grounded Y on the 14.4 kV or 25 kV winding). The primary distribution system operates as a radial feeder system with a single point of supply. Some feeders may have alternate points of supply, but they will be operated with both points of supply closed only momentarily during switching operations. The 25 kV system is used to supply an extensive single-phase, ground-return primary distribution system that operates at 14.4 kV phase-to-ground.

In some communities, SaskPower also utilizes three-phase primary distribution systems that operate at 2.4 kV and 4.16 kV phase-to-phase. The application of these systems is limited. Information on the characteristics of these systems can be obtained from SaskPower.

In urban environments, SaskPower provides 120/240 volt single phase secondary distribution. The ability of the secondary distribution system to integrate distributed generation is limited.

2.2. Frequency and Frequency Variation

The nominal frequency of the SaskPower system is 60 Hz. During steady state operation, frequency deviations are within $\pm$ 0.02 Hz. Frequency excursions outside of the above range will occur during disturbances.

2.3. Voltage Variation

The SaskPower operating voltages vary from nominal for a number of reasons including load variation, and contingency situations. During normal operating conditions, the voltage at the point of delivery on the 25 kV and 14.4 kV three phase systems and 14.4 kV single phase system can vary from 94% to 106% of nominal voltage. During normal operating conditions, the voltage at the service entrance on secondary distribution systems, <1000 V, can vary from 91.6% to 104.2% of nominal voltage. During abnormal conditions, the voltage variation on all systems can temporarily exceed these values.

2.4. Abnormal Voltages

The distribution system is subject to temporary abnormal voltages. Aside from the voltage unbalance conditions described in Section 2.5, voltage transients and swells can occur on the distribution system. These can be caused by such phenomena as lightning strikes, single phase to ground faults and the loss or switching of customer load. The project Generator Owner must ensure that the insulation levels, or protective apparatus (surge arresters, etc.) employed in their facilities are capable of withstanding typical abnormal voltages on a distribution system.

2.5. System Voltage Unbalance

Phase to phase voltage unbalance can be expected on the primary distribution system. During normal steady state operation, phase to phase voltage unbalance is normally less than 3%. In some rural locations, unbalances may be higher. The Generator Owner should check with SaskPower to obtain site specific details. Voltage unbalance is defined as follows:

$$Unbalance\ (\%) = \frac{100\%\ x\ (maximum\ deviation\ from\ average\ phase\ to\ phase\ voltage)}{(average\ phase\ to\ phase\ voltage)}$$

as derived from NEMA MG1-1993 14.3.5.

During faults on SaskPower's system and within single pole reclosing cycles, the momentary unbalance may be greater than defined above. SaskPower will not be responsible for damage to the generation facilities due to voltage unbalance.

2.6. Fault Clearing

Where reference in this document is made to fault clearing times, it shall mean the time from the inception of the fault until interruption of the fault current.

The time required to clear faults on the Distribution System varies. For the 25 kV and 14.4 kV systems, line to ground faults, which constitute a large portion of the faults, the time to clear a fault will normally be less than 1.0 second. For phase to phase faults and high impedance ground faults, the clearing time could be up to 3 seconds. The addition of a generation source on these systems, which are radial systems, may require an improvement (shortening) of fault clearing time or recoordination of SaskPower's protection systems.

The fault clearing times suggested above are based on the equipment operating as designed; however, if faults are cleared by backup protection, the clearing time in all instances would be expected to increase.

2.7. Auto Reclosing

The SaskPower 25 kV three phase and 14.4 kV single phase Distribution System utilizes multi-shot auto-reclose to clear non-permanent faults. Reclose dead times can vary from instantaneous reclose to 5 seconds. Interrupting devices may trip a single phase or all three phases, depending on the application. In the event of a permanent fault, all three phases of the interrupting device will be tripped regardless of whether it is a single phase or three-phase fault.

Single phase tripping and reclose on interrupting devices may cause unbalanced loading and / or shock loading during the trip / reclose cycle.

2.8. Frequency of Power Interruptions

As is normal practice in the utility industry, SaskPower's primary distribution system utilizes unshielded construction with insulation levels appropriate to withstanding expected power frequency voltages. As such, direct lightning strikes to distribution power lines, or nearby ground lightning strokes will usually result in a flash over of the insulators on the power line, resulting in tripping by SaskPower's protection systems. If the fault is temporary, service may be restored by SaskPower's auto reclose system.

Because of the type of construction, and the length of some of the primary distribution feeders in SaskPower's system, the frequency of power interruptions, whether they are momentary (successful auto reclose), or sustained (permanent fault), can be high. The Generator Owner should take this into consideration when assessing:

- the requirement for staffing the facility,
- the requirement for monitoring and remote control of the facility,

- the requirement for auto restart,
- the impact of trips on the reliability of the facility, and
- the economics of the project.

2.9. System Grounding

The SaskPower distribution system has been designed to operate as “effectively grounded”.

2.10. System Fault Levels and System Impedances

The fault levels on the SaskPower systems, which are influenced by numerous factors, including location, generation pattern, and contingencies, vary within a broad range of values. Future fault levels will also be influenced by system expansion. Generation proponents must design their facilities to withstand the fault contribution from SaskPower’s system. The expected fault contribution from SaskPower’s distribution system along with the SaskPower system impedance for a site being considered for a Generation project can be obtained from SaskPower

3. 3. GENERAL REQUIREMENTS FOR ALL GENERATION PROJECTS

The following general requirements apply to all generation projects interconnected with SaskPower’s Distribution System.

3.1. System Unbalance

In the presence of voltage unbalance, generator output may have to be reduced to avoid overloading the generator. The Generation Owner must take into consideration that most locations on SaskPower’s distribution system have a degree of continuous voltage unbalance (as specified in Section 2.5), and specify the rating of their generator appropriately to allow them to deliver planned output. The generator must also be able to withstand the effect of voltage unbalances resulting from system disturbances. The most common cause of system unbalance on the distribution system resulting from disturbances will be unbalanced powerline faults and single pole tripping and reclose.

3.2. Frequency Variation

The generator shall be able to operate over a frequency range of 59.5 Hz to 60.5 Hz without tripping.

3.3. Power Islanding

Power islanding is the condition where the generation facilities and a portion of SaskPower’s distribution system have become isolated from the rest of SaskPower system, and continue to operate in an isolated mode. SaskPower’s requirement is that the generation facilities connected onto SaskPower’s distribution system not be permitted to operate as a power island connected with SaskPower customers. All generation facilities shall be equipped with protection systems, which detect a power island condition and cause the generator to cease to deliver power to the SaskPower distribution system, within 2 seconds. In some circumstances this may require modification to SaskPower’s facilities and / or, the installation of special communication and protection schemes to send direct trips to the generator.

3.4. Protection of Equipment and Detection of Faults

The proper detection of all types of faults, which occur either on SaskPower’s distribution system or within the generation facilities and the disconnection of the generation facilities from SaskPower in such events is critical for reasons of safety and protection of equipment. The generation owner is responsible to ensure that the generation facilities are equipped with protection systems that will detect and isolate the generation facilities from SaskPower’s

distribution system during such events.

Fault clearing time requirements for faults on SaskPower's distribution system shall be determined on an individual case basis. The generation facilities may be required to be equipped with protection systems that are zoned or time graded to facilitate coordination with SaskPower's protection systems for faults on adjacent facilities to which the generation interconnection facility is not directly connected. At SaskPower's determination, dedicated communication facilities to the generation site may be required, at the cost of the generation owner, to facilitate timely clearing of faults. Dedicated secure communications may also be required to remove the fault infeed from the generation for faults on adjacent lines in the event of a breaker failure at a remote location.

3.5. Protection Coordination

The generation facility protection systems shall coordinate with the SaskPower protection systems. The generation owner shall submit proposed fuse types or relay settings to SaskPower for review and acceptance. Any subsequent relay setting changes shall also be submitted to SaskPower

3.6. Protection From Abnormal Conditions

Generation interconnection facilities shall be adequately protected from, or able to withstand abnormal conditions on SaskPower's distribution system. This may include, but is not limited to:

- frequency excursions due to disturbances on SaskPower's distribution system,
- partial or complete loss of load as a result of disturbances on the SaskPower's distribution system
- voltage unbalances due to the loss of single phase loads, single phase tripping or an "open phase" condition on the SaskPower system.
- transient overvoltages as a result of lightning, or switching events, and
- overvoltages due to resonance conditions, healthy phase voltage rise during faults, self excitation, loss of load

The generation facility must be self-protecting to prevent damage as a result of the normal or abnormal operation of the SaskPower grid. The generation owner is accountable for the execution of studies to identify potential abnormal conditions and the cost of mitigating against the effects of abnormal conditions.

3.7. Voltage Variations (Flicker)

The Generation Owner is required to ensure that the operation of the generation facility will not cause voltage variations on SaskPower's system that could result in excessive lamp flicker for SaskPower's customers. If the generation facility utilizes a prime mover that has a fluctuating power output (wind power, slow speed reciprocating engine, etc.), the Generation Owner must ensure that the fluctuations in power output do not cause voltage variations which exceed SaskPower's acceptable limits. The voltage variation limits, as measured at the point of delivery, are defined in the SaskPower Electric Service Requirement, Section 3

The Generation Owner must ensure that the generation facility can tolerate the voltage variation that is permitted on SaskPower's distribution system as defined in the SaskPower Electric Service Requirements, Section 3.

3.8. Voltage Distortion

If the Generator Owner plans to utilize a synchronous generator, the limit on the distortion of the voltage waveform generated shall be in accordance with the general requirements for synchronous machines as described in ANSI G50.10 1990 or most recent update.

3.9. Harmonic Currents

The harmonic content of the current that flows at the Point of Delivery shall fall within the limits specified in SaskPower's Electric Service Requirements.

3.10. Low Voltage Ride through Capability

Even though the Generation facilities are to be interconnected to SaskPower's distribution system, they may impact the low voltage ride through capability of the transmission system and as such there may be additional requirements that must be met, in addition to the requirements identified in this document.

3.11. Provision for Future Changes

The Generation Owner is responsible for making required changes to the generation facilities in response to meet new or revised standards or due to system changes, and therefore make provision to accommodate changes efficiently. The Generator Owner shall be responsible for the cost of any required changes, including those changes requested to be made by SaskPower.

4. INTERCONNECTION REQUIREMENTS FOR GENERATION PROJECTS UP TO AND INCLUDING 100 kW IN SIZE

The following sets out the requirements for distribution connected generating facilities, with a total installed capacity up to 100 kW (total installed capacity at the site). Installations with a total installed capacity greater than 100 kW, or which use a synchronous generator of any size, must meet the requirements set out in Section 5 of this document.

4.1. Generator Type and Size Limits

Single-phase and three-phase generators may be connected to the primary distribution system. The maximum permissible size for single-phase generators connected to SaskPower's primary distribution system is **100 kW**. Depending on the location of the facility, there may be other restrictions that limit the maximum size of a single-phase generator. Generators larger than 5 kW are unlikely to be able to connect to an urban secondary distribution (120/240V) system where that system serves more than one customer (i.e. on an urban underground residential distribution URD system that typically serves 8-20 homes). The primary concern is voltage flicker and over-voltage on the secondary system if the reverse power flows get too high. The maximum size for single-phase installations connected to the secondary distribution system is **5 kW,** however, generators larger than 5 kW will be considered.

SaskPower requires that generators up to 100 kW in size not be able to operate in an isolated power island connected with SaskPower customers, or contribute sustained (beyond 10 cycles) fault current to the SaskPower system during a fault on SaskPower's primary or secondary distribution system. Synchronous generators up to and including 100 kW in size must meet the requirements set out in Section 5 of this document. Generators that are part of packaged stand-by or portable power plants are addressed in Section 6.

4.2. Point of Delivery

For generation facilities connected to SaskPower's primary distribution system, the point of delivery will be SaskPower's side of the high voltage isolating switch. For generation facilities connected to SaskPower's secondary distribution system, the point of delivery will be the metering point at the service entrance.

4.3. Generation Interconnection Facility

The generation interconnection facility shall comply with the requirements of SaskPower's Electric Service Requirements. Where conflicts exist between SaskPower's Electric Service Requirements and this document, this document shall generally prevail, however, exceptions are possible.

4.4. Generation Facility Isolating Device

4.4.1. For Generation Facilities Connected to SaskPower's Primary Distribution System

Maintenance, safety, and system considerations require a visible break disconnect device to disconnect the generation interconnection facilities from SaskPower's facilities. The proponent's disconnect device shall be in accordance with the requirements of the Canadian Electric Code. SaskPower will utilize its own devices for purposes of isolating and locking out. SaskPower personnel will not operate the Generator owner's isolating device.

4.4.2. For Generation Facilities Connected to SaskPower's Secondary Distribution System

The generation facilities shall be provided with a disconnect switch which must isolate all current-carrying conductors (including neutral). The disconnect switch shall be in accordance with the requirements of the Canadian Electrical Code.

4.4.3. For Non-Export Generation Facilities

In addition to the main disconnect switch in 4.4.1 or 4.4.2, customers with non-export generation may elect to provide a second isolating switch for their generator to avoid an outage to their load. This second switch shall be visual break, accessible and lockable by SaskPower staff. It will not be operated by SaskPower personnel. Switches on generation facilities where H_2S or other hazardous material is present shall be located outside of the hazardous area.

4.5. Generation Facility Fault Interrupting Device

4.5.1. For Generation Facilities Connected to SaskPower's Primary Distribution System

The generation facility shall be equipped with a fault interrupting device on the SaskPower side of the transformer which, in the event of a fault within the transformer or the generation facilities, is capable of interrupting the fault current and isolating the generation facilities from SaskPower's distribution system. Fuses are acceptable for this application. The proponent should assess the risk of damage resulting from single phasing of the transformer in the event of a single fuse failure. Where fused protection is used on the high side of the transformer, the generation substation shall be equipped with a low voltage circuit breaker or contactor for tripping the generator.

The Generator Owner is responsible for ensuring that the high voltage fault-interrupting device coordinates with SaskPower's feeder protection. The Generator Owner shall submit proposed relay or fuse settings to SaskPower for review of protection coordination.

4.5.2. For Generation Facilities Connected to SaskPower's Secondary Distribution System

All generation facilities connected to the secondary distribution system require a device, which in the event of a fault within the generation facility is capable of interrupting the fault current and isolating the facility from SaskPower's system. A dedicated generation facility will require fuses or a molded case type circuit breaker. This may be located on the generator side of the metering point. Generation facilities in which the power source is integrated into an existing electrical service may rely on the molded case circuit breakers within the service panel.

4.6. Transformer Requirements

Inverter Generation: For three phase installations, the transformer winding configuration shall be Grounded Wye / Grounded Wye. Low voltage transformers between the Point of Delivery and the Inverter must also be Grounded Wye / Grounded Wye.

Non-Inverter Generation: For three phase installations, the transformer winding configuration shall be grounded Wye on the 25 kV system with a grounded or ungrounded Wye on the low voltage side. The grounded Wye connection on the low voltage side is only acceptable if the generator has a Delta, ungrounded Wye winding connection

4.7. Metering Requirements

Refer to SaskPower's Electrical Service Requirements.

4.8. Required Protection

The generator shall be equipped with the protection set out in Sections 4.8.1 through 4.8.4. The Generator Owner shall submit proposed settings for all required protection to SaskPower for review of protection coordination. In the following sections, the term 'relay' is used in a general sense. It is recognized that some generation technologies may utilize packaged protection systems that integrate the protection functions into one device, rather than utilizing individual 'relays'. These protection packages must be fail safe.

4.8.1. Over current Protection

All generation projects shall be equipped with over current protection to trip the generator off in the event of a fault on SaskPower's system or a fault within the generator.

4.8.2. Over and Under Frequency Protection

The generator shall be equipped with two over-frequency protection functions and two under-frequency protection functions and apply them simultaneously, with default and adjustable ranges of allowable settings as described in IEEE Std 1547-2018 section 6.5.1 Mandatory frequency tripping requirements.

4.8.3. Over and Under Voltage Protection

The generator shall be equipped with two over-voltage protection functions and two under-voltage protection functions and apply them simultaneously, with default and adjustable ranges of allowable settings as described in IEEE Std 1547-2018 section 6.4.1 Mandatory voltage tripping requirements. Default settings shall be used unless interconnection study states otherwise. It may be advantageous to provide a separate instantaneous or very high speed over voltage protection for the detection of self-excitation or ferroresonance conditions.

4.8.4. Power Flow Relay

Generation Owners who are generating to displace load, but do not have a service agreement covering the provision of standby service from SaskPower, shall have a power flow relay which isolates the load and generation from SaskPower's system in the event of power flow into the customer's facility. A time delay of up to 5 seconds on this relay is permissible to minimize nuisance trips.

4.9. Additional Protection

The Generation Owner is responsible to evaluate the requirement for protection schemes to be applied to the generator. In addition to the required protection set out in Section 4.8, it is recommended that the Generation Owner evaluate the requirement for the following protection schemes:

4.9.1. No-volts Auto-Reclose Protection

SaskPower applies auto-reclose to its primary distribution system. If the generator cannot withstand the reacceleration that will occur following reclose, it is recommended that the generator be equipped with a no-volts relay that trips the generator off during the reclose dead time.

4.9.2. Unbalance Relay

For three phase generators, it is recommended that an unbalance or negative sequence relay be installed that trips the generator off on excessive unbalance. This is particularly important if fused protection is used on the primary of the generator transformer.

4.9.3. Rate-of-Change of Frequency Relay

The application of a rate-of-change of frequency relay may be a suitable means of detecting a power island condition. The Generator Owner shall submit proposed settings to SaskPower for review.

4.10. Auto Resynchronization

Following the trip of the feeder to which the generator is connected, the generator may automatically restart and resynchronize following successful restoration of **normal** voltage to the distribution circuit. If auto resynchronization is to be attempted, the generator must be equipped with a relay that senses the presence of normal voltage for a period of time, typically 5 minutes. Normal voltage is defined as being within 94% to 106% of nominal. The time period must be adjustable between 1-60 minutes and will be determined by SaskPower. If multiple generators exist on any one distribution feeder, SaskPower reserves the right to stagger generator automatic restart times.

4.11. Voltage Deviations Caused by Generation Facility

SaskPower sets requirements in terms of limiting the voltage sags, swells, and flicker caused by the operation of customer equipment. The Generation Owner must design its equipment and control its operation to ensure that it does not exceed these limits.

Induction generators are unable to generate power before they are connected to the utility system and therefore, synchronization is not required. The induction generator may be used as a motor to accelerate the prime mover to operational speed. If the generator is to be brought up to speed using ‘across the line’ starting from SaskPower’s system, the maximum voltage drop during starting at the Point Of Delivery must be limited to 8% or less as per the Electric Service Requirements. This is assuming that the generator is started less frequently than once per day. For more frequent starts refer to the voltage variation limits set out in SaskPower’s Electric Service Requirements. As an alternative to ‘across the line’ starting, the generator may be closed onto the SaskPower system after it has been brought up to near synchronous speed using the prime mover. The voltage deviation that results from the connection of the generator to SaskPower’s system using this starting technique must also meet the limits defined by the Electric Service Requirements.

The voltage change that results from the disconnection of the generator from SaskPower’s system must be limited to 8% or less at the Point Of Delivery. This is assuming that the generator is disconnected (planned disconnection or unplanned trips) less frequently than once per day. If more frequent trips are anticipated, or actual experience indicates that trips are more frequent, the acceptable voltage deviation will be defined by the voltage variation limits in SaskPower’s Electric Service Requirements. To minimize disturbances to other customers, SaskPower requires that for planned shutdown (not initiated by a protection system) of the generator, the output of the generator should be reduced to zero before the generator is disconnected from SaskPower’s system.

SaskPower’s limits on voltage deviation may determine the maximum size of generator that can be installed in a particular location.

4.12. Power Factor / Voltage Control Requirements

The Generator shall not cause sustained voltage at any point in the SaskPower System to go outside of ranges specified in 3.2.2 of SaskPower's Electric Service Requirements.

Generating at unity power factor may result in voltage outside of upper limits. The capabilities below can be used to reduce the voltage by consuming reactive power and/or limiting active power when required. Additional or alternative measures may also be required.

All inverter generation connected to the SaskPower distribution system requires the following as per IEEE Std 1547-2018 (Section 5, Category B):

1) Reactive power capability of 44% of nameplate apparent power, both sourcing and consuming VARs. (equivalent to +/- 90% power factor).
2) Capable of the following mutually exclusive modes of reactive power control functions: Constant Power Factor mode, Voltage – Reactive Power mode, Active Power – Reactive Power mode, and Constant Reactive Power mode.
3) Capable of the active power control function: Voltage – Active Power.

The Generator Owner may opt to size the Generation Site components such that kW output will not be curtailed (limited) due to reactive power requirements above.

Non inverter-based generation requirements will be determined during the interconnection study, but will likely require IEEE Category A.

4.13. Power Island Operation via Self Excitation of the Generator

Self-excitation of an induction generator is a condition where there is sufficient capacitance connected to the terminals of the generator to provide excitation current to the generator which will maintain a voltage on its terminals after it has been isolated from the power system. This exciting current can be provided by local power factor correction capacitors or, if the generator is isolated along with a portion of SaskPower's distribution system (a power island), the feeder line capacitance and any capacitors on SaskPower's system.

The Generator Owner must ensure that its facility will not sustain a power island through self-excitation of its generator. Aside from the danger to SaskPower staff of an unexpected power island, the voltages that occur in a power island resulting from self-excitation are uncontrolled, and may result in apparatus damage.

For generation installations that are 100 kW or less in size, local protection schemes at the generation facility are normally acceptable for the detection of, and subsequent isolation from, power island conditions.

Unless the Generation Owner can demonstrate through the execution of analytical studies, that there is no risk of self-excitation of the generator, the Generation Owner must demonstrate, to SaskPower's satisfaction:

- that the generation protection systems are capable of detecting a power island condition,
- that in the event self-excitation, isolation of the generation will occur quickly enough to preclude damage to other customers or SaskPower's system from the abnormal voltages that may occur, and
- that the interrupting device used to separate the generator from SaskPower's power system is capable of operating at the elevated voltages which may occur following self-excitation,

Failure to meet the preceding requirements may mean that the Generation Owner is responsible for the cost of installing special protection schemes. This may include a direct trip signal from SaskPower's source substation to the Generation Owner's facility or other generation facilities on the feeder whenever there is a trip on the feeder to which the generator is connected.

In assessing the opportunity for a self-excited power island, the total amount of capacitance on the feeder to which the generator is connected must be taken into consideration. This includes power factor correction capacitors at the generation site, discrete capacitors on the feeder, and the distributed capacitance of the feeder itself. The assessment must also take into consideration the presence of existing generators on the same feeder along with the minimum load likely to be connected to the feeder. SaskPower will provide information on load, feeder characteristics, and the location of capacitors on its system to facilitate assessment of the risk of self-excitation. Such details are site specific.

5. INTERCONNECTION REQUIREMENTS FOR GENERATORS GREATER THAN 100 kW IN SIZE

The following sets out the requirements for generators that are greater than 100 kW and up to 1000 kW in size.

5.1. Generator Type and Size Limit

Only three-phase generators are permitted above 100 kW.

SaskPower's objective is to minimize the impact of distributed generation connected on the operation of its distribution system. It is also SaskPower's objective to minimize or avoid the use of apparatus, communication systems, or protection schemes that are not normally applied at distribution voltages. **Therefore, SaskPower strongly recommends against the use of synchronous generators or other generator technologies that can act as voltage sources**. Synchronous generators act as sustained sources of fault current which complicates, or may preclude the coordination of, the protection systems on the distribution system. Synchronous or voltage source generators can support power islands, which is an unacceptable operating condition. To deal with the adverse impact of synchronous or voltage source generators will likely require the application of communication or protection schemes that are not normally applied at the distribution level. Aside from their complexity, the cost of these schemes is likely to be excessive relative to the cost of the generation project, which may adversely affect the economics of the project.

5.2. Point of Delivery

For generation facilities connected to SaskPower's primary distribution system, the point of delivery will be SaskPower's side of the high voltage isolating device.

5.3. Generation Interconnection Facility

The generation interconnection facility shall comply with the requirements of Electric Service Requirements. Where conflicts exist between Sections 4.1, 4.2, and 4.4 of SaskPower's Electric Service Requirements and this document, this document shall generally prevail, however exceptions may be made.

5.4. Generation Substation High Voltage Isolating Devices

Maintenance, safety, and system considerations require a visible break disconnect device to disconnect the Generation interconnection facilities from SaskPower's facilities. The disconnect device shall be between the Point of Delivery and the metering transformers. The device shall be in accordance with the requirements of the Canadian Electric Code. SaskPower will utilize its own devices for the purposes of isolating and locking out. SaskPower personnel will not operate the Generator owner's isolating device.

Those customers engaging in self-generation who purchased stand-by service from SaskPower may elect to provide a secondary, visible break, isolating switch for their generator to avoid an outage to their load. This shall be in addition to the primary isolating switch. The

switch shall be accessible and lockable by SaskPower staff, but will not be operated by SaskPower personnel. Switches on Generation facilities where H_2S is present shall be located outside of the hazardous area.

5.5. Generation Substation High Voltage Fault Interrupting Device

Generation projects shall be equipped with a three-phase circuit breaker or recloser on the high voltage side of the interconnection transformer. Single phase operations are not permitted. The breaker or recloser shall:

1) Interrupt fault current from the SaskPower distribution system in the event of a fault on the Supplier's system, AND

2) Interrupt fault current from the interconnection facility in event of fault on the SaskPower distribution system (See section 5.8 for details)

3) Perform other protective functions as determined by SaskPower interconnection studies, which may include the need for high side voltage sensing in addition to current sensing.

Fusing in series with the breaker or recloser is not permitted. The Generation Owner is responsible for ensuring that the breaker or recloser coordinates with SaskPower's feeder protection. The Generation Owner shall submit proposed breaker relay or recloser controller settings to SaskPower for review to ensure protection coordination. The required fault interrupting time of the interrupting device may be specified by SaskPower during interconnection studies.

5.6. Transformer Requirements

5.6.1 Winding Configuration for Induction Generators

SaskPower requires that there be no zero sequence current contribution from induction generator based facilities during faults on SaskPower's 25 kV system so that the presence or operation of the generation facility does not affect the coordination of fused protection or single-phase taps with the main feeder protection. To achieve this objective, the generation transformer connection must be:

- Delta on the 25 kV system with a grounded Wye on the low voltage side, or
- Grounded Wye on the 25 kV system with a grounded or ungrounded Wye on the low voltage side. The grounded Wye connection on the low voltage side is only acceptable if the generator has a Delta or ungrounded Wye winding connection.

5.6.2 Winding Configuration for Synchronous Generators

Any interconnecting transformer configuration that provides an effectively grounded system can be used except a solidly grounded Wye connected high voltage winding with a delta low voltage winding. An impedance grounded neutral connection may be acceptable. (See section 5.6.4 – Ground Source Requirements)

The SaskPower electrical system is designed as an "effectively grounded" system. All generation projects that utilize synchronous generators must provide a ground current source. (See section 5.6.4 – Ground Source Requirements)

Traditional IEEE grounding standards can be used for synchronous generators. To qualify as effectively grounded and limit impact to SaskPower's ground fault protection, the following conditions must be met:

1) The ratio of the zero sequence reactance to the positive sequence reactance, X_0/X_1, as seen looking into the generation facilities at the point of delivery from SaskPower's system (with the generator operating) shall be between 2.0 and 2.5. The IEEE effective grounding condition of $X_0/X_1 < 3$ does not address ground fault protection considerations. SaskPower may require a different ratio as determined by the Interconnection Study.

2) The ratio of the zero sequence resistance to the positive sequence reactance R_0/X_1 is not greater than 1.

For the purposes of calculating these ratios, the generation owner shall use the generator's direct axis subtransient (X_d") reactance.

5.6.3 Winding Configuration for Inverter Generators

Any interconnecting transformer configuration that provides an effectively grounded system can be used except a solidly grounded Wye connected high voltage winding with a delta low voltage winding, unless it has an impedance grounded neutral connection.
There are two key issues for inverter generators: fault current contribution to faults on the SaskPower System and Temporary Overvoltage (TOV).

Fault Current Contribution
UL 1741 / IEEE 1547 Inverters generally operate as current sources and cannot contribute significant fault current well above their rating. IEEE C62.92.6-2017 suggests the majority of inverters do not contribute significant zero sequence current (very high impedance). For these reasons, protection desensitization due to current flowing from the generation to faults is typically not an issue but will be confirmed by the Interconnection Study.

Temporary Overvoltage
This could occur if the system is not effectively grounded. All inverter-based generation projects will require a ground source. (See section 5.6.4 – Ground Source Requirements). On rare occasions, existing load on the SaskPower system may provide sufficient ground source. The Interconnection Study will determine requirements.

5.6.4 Ground Source Requirements

There are four methods to achieve the required ground source. All methods require analysis to meet the following two requirements: (1) an effectively grounded system and (2) negligible impact on SaskPower's ground fault protection.

1. Grounding Transformer:
   When a grounding transformer is used, the required impedance must be calculated to ensure an effectively grounded system.
   The various transformer configurations have different requirements for the location of the grounding transformer:
   - A solidly grounded, or impedance grounded Wye connected high voltage winding with a solidly grounded, or impedance grounded Wye secondary winding can utilize a high or low voltage side grounding transformer.
   - A delta high voltage side winding requires the grounding transformer to be connected to the high voltage terminals of the interconnecting transformer.
   - A transformer configuration with an ungrounded Wye winding on either the high voltage side or the low voltage side requires the grounding transformer to be connected to the high voltage terminals of the interconnecting transformer.

   When the grounding transformer is installed on the high voltage side it shall be connected directly to the interconnecting transformer terminals without an isolating device. The grounding transformer shall be in the same zone of protection as the interconnecting transformer.

   When the grounding transformer is installed on the low voltage side it need not be in the same zone of protection as the interconnection transformer provided there is fail safe protection that ensures that generation breaker(s) are open when the grounding transformer is not in service. The grounding bank can be taken out of service when the generation is offline, unless otherwise specified.

   The grounding transformer shall be able to withstand fault current for 10 seconds. The grounding transformer shall also be sized to handle currents from System Voltage Unbalance, see section 2.5 for details.

2. Impedance grounded neutral on interconnection transformer (applicable only to impedance grounded Wye high side winding and Delta low side winding):

   When an impedance grounded neutral is used, the required impedance must be calculated to ensure an effectively grounded system and have negligible impact to SaskPower's ground fault protection.

3. Solidly grounded or impedance grounded generator (applicable only to a grounded Wye connected high voltage winding with a grounded Wye low voltage winding):
   This method relies on the ground source of the generator(s) when there is a current carrying connection between its neutral and ground. This is rarely possible with inverters.

4. Surrounding loads on the SaskPower distribution system:
   This method is only applicable to inverter generation projects with very high zero sequence impedance. This method is site specific, as it is dependent on the amount of grounded load in the area, as well as the proposed generation to load ratio.
   This can only be used as an option at SaskPower's discretion during the interconnection study process.

5.6.5 Transformer Rating

The transformer shall be sized to deliver rated kW and kVar. Rated kVar shall be based upon 0.98 power factor full load operation for induction generators and 0.9 power factor full load operation for synchronous generators and inverter generators.

The Generation Owner must take into consideration the presence of unbalanced loads on SaskPower's distribution system. If a Wye (SaskPower) - delta (Generator) transformer is proposed, it needs to accommodate the continuous zero sequence currents that will flow in the transformer as a result of this load unbalance.

5.7. Metering Requirements

All metering apparatus shall be installed on the Generator side of the disconnect switch at the Point of Delivery. Refer to SaskPower's Electrical Service Requirements.

5.8. Required Protection

The generator shall be equipped with the protection set out in Sections 5.8.1 through 5.8.4. The Generation Owner shall submit proposed settings for all required protection to SaskPower for review of protection coordination. In the following sections, the term 'relay' is used in a general sense. It is recognized that some generation technologies may utilize packaged protection systems that integrate the protection functions into one device, rather than utilizing individual 'relays'.

5.8.1. Over current Protection

All generation projects shall be equipped with over current protection to trip the generator off in the event of a fault on SaskPower's system or a fault within the generator. Some generation installations may require the application of more sophisticated protection schemes such as distance type protection in order to achieve coordination with SaskPower's protection systems. Voltage restrained over current protection (51V) may facilitate better coordination with SaskPower's protection systems.

If the Generator Facility inverters are UL 1741 compliant and the Generator Facility (including ground sources) contributes negligible fault current at the Point of the Delivery, overcurrent protection for the high side breaker / recloser (5.5) may have a time delay up to 5 seconds such that the SaskPower overcurrent protection will generally operate first. In this case, the 5 second time delay implies that this protection is backup protection. Fault current may be deemed negligible based on a SaskPower Study, which factors in all Generators on the local SaskPower system.

5.8.2. Over and Under Frequency Protection

The generator shall be equipped with two over-frequency protection functions and two under-frequency protection functions and apply them simultaneously, with default and adjustable ranges of allowable settings as described in IEEE Std 1547-2018 section 6.5.1 Mandatory frequency tripping requirements.

5.8.3. Over and Under Voltage Protection

The generator shall be equipped with two over-voltage protection functions and two under-voltage protection functions and apply them simultaneously, with default and adjustable ranges of allowable settings as described in IEEE Std 1547-2018 section

6.4.1 Mandatory voltage tripping requirements. Default settings shall be used unless interconnection study states otherwise. It may be advantageous to provide a separate instantaneous or very high speed over voltage protection for the detection of self-excitation or ferroresonance conditions.

5.8.4. Non-exporting Generation ("behind the meter") and Reverse Power Flow Protection

Generation owners who are generating to displace load and not supply energy to the SaskPower shall have protection which isolates the generation from SaskPower's system in the event of power flow out of the customer's facility. A time delay of up to 2 seconds on this relay is permissible to minimize nuisance trips.

5.9. Additional Protection

The Generation Owner is responsible to evaluate the requirement for protection schemes to be applied to the generator. In addition to the required protection set out in Section 5.8, it is recommended that the Generation Owner evaluate the requirement for the following protection schemes:

5.9.1. No-volts Auto Reclose Protection

SaskPower applies auto reclose to its primary distribution system. If the generator cannot withstand the reacceleration that will occur following reclose, it is recommended that the generator be equipped with a no-volts relay that trips the generator off during the reclose dead time.

5.9.2. Unbalance Relay

It is recommended that an unbalance or negative sequence relay be installed that trips the generator on excessive current unbalance.

5.9.3. Broken Delta Protection (59G)

A grounded wye (primary) – broken delta (secondary) voltage transformer with a 59G over voltage relay connected across the terminals of the broken delta can facilitate detection of ground faults.

5.9.4. Rate-of-Change of Frequency Relay

The application of a rate-of-change of frequency relay may be a suitable means of detecting a power island condition. The Generation Owner shall submit proposed settings to SaskPower for review.

In the preceding sections, the term 'relay' is used in a general sense. It is recognized that some generation technologies may utilize packaged protection systems that integrate the protection functions into one device, rather than utilizing individual 'relays'.

5.10. Auto Resynchronization

For generation projects which have an installed capacity in excess of 100 kW, the acceptability of the auto start up and resynchronization of generators following the trip of the feeder to which the generator is connected will be assessed by SaskPower on a case by case basis. If permitted, the generator must be equipped with a relay that senses the presence of normal voltage for a period of time, typically five minutes. Normal voltage is defined as being within 94% to 106% of nominal. The time period must be adjustable between 1-60 minutes and will be determined by SaskPower. If multiple generators exist on any one distribution feeder, SaskPower reserves the right to stagger generator automatic restart times.

5.11. Induction Generator Requirements

The following requirements apply to induction generators

5.11.1. Voltage Deviations

SaskPower sets requirements in terms of limiting the voltage sags, swells, and flicker caused by the operation of customer equipment. The Generator Owner must design the equipment and control its operation to ensure that it does not exceed these limits.

Induction generators and inverters are unable to generate power before they are connected to the utility system and therefore, there is no real synchronization required. The induction generator may be used as a motor to accelerate the prime mover to operational speed. If the generator is to be brought up to speed using across the line starting from SaskPower's system, the maximum voltage sag during starting at the Point of Delivery must be limited to 8% or less. This is assuming that the generator is started less frequently than once per day. For more frequent starts refer to the voltage flicker limits set out in Section 1.2.10 b) of SaskPower's Electric Service Requirements. As an alternative to across the line starting, the generator may be closed onto the SaskPower system after it has been brought up to near synchronous speed using the prime mover. The voltage deviation that results from the connection of the generator to SaskPower's system using this starting technique must also meet the preceding limits.

The voltage sag that results from the tripping of the generator from SaskPower's system must be limited to 8% or less at the PCC. This is assuming that the generator trips less frequently than once per day. If more frequent trips are anticipated, or actual experience indicates that trips are more frequent, the acceptable voltage deviation will be defined by the voltage flicker limits in SaskPower's Electric Service Requirements. To minimize disturbances to other customers, SaskPower requires that for planned shutdown (not initiated by a protection system) of the generator, the output of the generator should be reduced to zero before the generator is disconnected from SaskPower's system.

5.11.2. Voltage Control / Power Factor Control Requirements

For the purposes of clarification, leading power factor operation of a generator means that the generator is drawing reactive power from the distribution system.

Voltage regulation on distribution circuits is required in order to maintain the service supply voltage for end-use customers within acceptable limits. Uncompensated induction generators and inverters are seen by the distribution system as a reactive power load, which affects voltage control on the distribution system. Unless SaskPower indicates otherwise, induction generators and inverters must be equipped with power factor correction equipment to be installed at the Generation Owner's expense.

A generation facility using an induction generator must normally be equipped with sufficient power factor correction capacitors to correct the full load power factor to at least 0.97 leading. The power factor correction capacitors must normally be provided in steps to follow the output of the generator. Sufficient steps shall be provided to maintain the power factor of the generator between 0.97 leading and 1.00 over the expected power output range. The power factor at very low generator outputs (less than 5% of rated output) may drop below 0.97 leading. The capacitor switched in at start up shall be sized to meet the voltage deviation requirements set out in Section 5.11.1 of this document.

The power factor controller shall have a voltage override that causes it to switch out capacitors if the voltage at the Point of Delivery exceeds an upper limit to be specified by SaskPower. The normal upper limit is 105% of nominal; however, the power factor control equipment shall have provision to adjust this upper limit between 100 and 110% of nominal. The generator power factor control equipment shall also have provision for a time delay between sensing an excursion of the upper voltage and initiating control action. The power factor control equipment shall have provision to allow for the adjustment of this time delay between 0 and 180 seconds. SaskPower will specify the required time delay.

5.11.3. Power Island Operation via Self Excitation of the Generator

Self-excitation of an induction generator is a condition where there is sufficient capacitance connected to the terminals of the generator to provide excitation current to the generator which will maintain a voltage on its terminals after it has been isolated from the power system. This exciting current can be provided by local power factor correction capacitors or, if the generator is isolated along with a portion of SaskPower's distribution system (a power island), the feeder line capacitance and any capacitors on SaskPower's system.

The Generator Owner must ensure that their facility will not sustain a power island through self-excitation of their generator. Aside from the danger to SaskPower staff of an unexpected power island, the voltages that occur in a power island resulting from self- excitation are uncontrolled and may result in apparatus damage.

Local protection schemes at the generation facility may be acceptable for the detection of, and subsequent isolation from power island conditions.

Unless the Generator Owner can demonstrate through the execution of analytical studies, that there is no risk of self-excitation of the generator, the Generator Owner must demonstrate, to SaskPower's satisfaction:

- that the generation protection systems can detect a power island condition,
- that in the event self-excitation in a power island condition, isolation of the generation will occur quickly enough to preclude damage to other customers or SaskPower's system from the abnormal voltages that may occur, and
- that the interrupting device used to separate the generator from SaskPower's power system is capable of operating at the elevated voltages which may occur following self-excitation,

Failure to meet the preceding requirements may mean that the Generator Owner is responsible for the cost of installing special protection schemes. This may include a direct trip signal from SaskPower's source substation to the Generator Owner's facility or other generation facilities on the feeder whenever there is a trip on the feeder to which the generation is connected.

In assessing the opportunity for a self-excited power island, the total amount of capacitance on the feeder to which the generation is connected must be taken into

consideration. This includes power factor correction capacitors at the generation site, discrete capacitors on the feeder, and the distributed capacitance of the feeder itself. The assessment must also take into consideration the presence of existing generators on the same feeder along with the minimum load likely to be connected to the feeder. SaskPower will provide information on load, feeder characteristics, and the location of capacitors on its system to facilitate assessment of the risk of self-excitation. Such details are site specific.

5.12. Inverter Generator Requirements

The following requirements apply to inverter generators

5.12.1 Voltage Deviations

SaskPower sets requirements in terms of limiting the voltage sags, swells, and flicker caused by the operation of customer equipment. The Generator Owner must design the equipment and control its operation to ensure that it does not exceed these limits.

The maximum voltage sag during starting at the Point of Delivery must be limited to 8% or less, once per day. Refer to the voltage flicker limits set out in Section 1.2.10 b) of SaskPower's Electric Service Requirements.

The voltage sag that results from the tripping of the generator from SaskPower's system must be limited to 8% or less at the PCC. This is assuming that the generator trips less frequently than once per day. If more frequent trips are anticipated, or actual experience indicates that trips are more frequent, the acceptable voltage deviation will be defined by the voltage flicker limits in SaskPower's Electric Service Requirements. To minimize disturbances to other customers, SaskPower requires that for planned shutdown (not initiated by a protection system) of the generator, the output of the generator should be reduced to zero before the generator is disconnected from SaskPower's system.

5.12.2 Power Factor / Voltage Control Requirements

The Generator shall not cause sustained voltage at any point in the SaskPower System to go outside of ranges specified in 3.2.2 of SaskPower's Electric Service Requirements.

Generating at unity power factor may result in voltage outside of upper limits. The capabilities below can be used to reduce the voltage by consuming reactive power and/or limiting active power when required. Additional or alternative measures may also be required.

All inverter generation connected to the SaskPower distribution system requires the following as per IEEE Std 1547-2018 (Section 5, Category B):

4) Reactive power capability of 44% of nameplate apparent power, both sourcing and consuming VARs. (equivalent to +/- 90% power factor).
5) Capable of the following mutually exclusive modes of reactive power control functions: Constant Power Factor mode, Voltage – Reactive Power mode, Active Power – Reactive Power mode, and Constant Reactive Power mode.
6) Capable of the active power control function: Voltage – Active Power.

The Generator Owner may opt to size the Generation Site components such that kW output will not be curtailed (limited) due to reactive power requirements above.

5.12.3 Power Island Operation

The Generator Owner must ensure that their facility will not sustain a power island. Aside from the danger to SaskPower staff of an unexpected power island, the voltages that occur in a power island are uncontrolled and may result in apparatus damage.

Inverters must by certified to UL 1741 or the most recent version of this standard. This standard results in anti-islanding protection within 2 seconds for most islanding scenarios.

The interconnection study may require a communication-based direct transfer-trip scheme which will trip the Generator.

5.13. Synchronous Generator Requirements

5.12.1. Synchronizing Facilities

The generation facility is required to have facilities to facilitate synchronization of its units to the SaskPower system. These facilities will typically consist of a synchronizing relay and a sync check relay. The settings on these relays must be submitted to SaskPower for review to ensure that they will not adversely affect the operation of SaskPower's system. The generation operator is responsible for synchronizing its generator to SaskPower's system following instructions as set out in the operating agreement.

5.12.2. Voltage Regulation Requirements

For the purposes of clarification, leading power factor operation of a generator means that the generator is drawing (consuming / absorbing) reactive power from the distribution system.

SaskPower requires that the generator shall be capable of operating continuously with a terminal voltage between 95 and 105 percent of the rated generator voltage. Synchronous machines shall be capable of delivering rated output power at a power factor of +0.9 (lagging or injecting) to -0.95 (leading or absorbing).

Synchronous machines shall be equipped with a voltage regulator and exciter with the capability to control the terminal voltage of the generator continuously between 80% and the upper limit of the rated voltage of the generator from no-load to full-load. SaskPower shall determine the actual set point. The regulator shall be capable of controlling the generator terminal voltage to within 0.5% of the set point without hunting.

In order to coordinate with its existing voltage control devices, SaskPower may require that synchronous generators operate in a power factor control mode. The voltage / power factor regulator shall be capable of controlling the power factor of the generator between +0.95 and -0.95 from no-load to full-load. SaskPower shall determine the actual set point. The regulator shall be capable of controlling the power factor to within 0.5% of the set point without hunting.

In power factor control mode, the voltage regulator shall have a voltage override that causes it to reduce excitation if the voltage at the Point Of Delivery exceeds an upper limit to be specified by SaskPower. The normal upper limit is 105% of nominal; however, the voltage regulator shall have provision to adjust this upper limit between 100 and 110% of nominal. The voltage regulator shall also have provision for a time

delay between sensing an excursion of the upper voltage and initiating control action. The power factor control equipment shall have provision to allow for the adjustment of this time delay between 0 and 180 seconds. SaskPower will specify the required time delay.

The excitation system shall not trip, and shall continue to operate during faults on SaskPower's distribution system, and shall recover and return to normal operation immediately following the fault. Controls should continue to operate down to generator terminal voltages approaching 20% of rated voltage, and shall continue to operate during the extremely unbalanced voltage conditions that could occur during fault conditions on SaskPower's distribution system.

5.12.3. Self-Excitation

Self-excitation of a synchronous generator can occur if the generator plus a portion of the SaskPower system becomes isolated from the rest of SaskPower's system, resulting in a power island. In a power island condition, self-excitation of the generator will take place if the reactive load on the generator resulting from line capacitance or capacitors on SaskPower's system exceeds the capability of the generator and its excitation / voltage regulator system to control the voltage. The voltage rise following the onset of self-excitation in a synchronous machine can be very rapid and may only be limited by saturation effects. Self- excitation is exacerbated by the over-frequency that may follow a partial loss of load. The over-voltages resulting from self-excitation can be very high and may result in apparatus damage.

Unless the Generator Owner can demonstrate through the execution of analytical studies, that there is no risk of self-excitation of the generator, the Generator Owner must demonstrate, to SaskPower's satisfaction:

- that the generation facility has protection systems to detect a self-excitation condition,
- that the interrupting device provided by the Generator Owner is be capable of switching the anticipated leading power factor current at the anticipated elevated voltages, and
- that isolation of the generation will occur quickly enough to preclude damage to other customers or SaskPower's system from the abnormal voltages that may occur.

Failure to meet the preceding requirements may mean that the Generator Owner is responsible for the cost of installing special protection schemes. This may include a direct trip signal from SaskPower's source substation to the Generator Owner's facility or other generation facilities on the feeder whenever there is a trip on the feeder to which the generation is connected.

In assessing the risk of self-excitation, the total amount of capacitance on the feeder to which the generation is connected must be taken into consideration. This includes discrete capacitors on the feeder, and the distributed capacitance of the feeder itself. The assessment must also take into consideration the presence of existing generators on the same feeder along with the minimum load likely to be connected to the feeder. SaskPower will provide information on load, feeder characteristics, and the location of capacitors on its system to facilitate assessment of the risk of self-excitation. Such details are site specific.

5.12.4. Power Island Operation

Operation of a synchronous generator connected with SaskPower load in a power island is not permitted. Unless the Generator Owner can demonstrate through the execution of analytical studies, that there is no risk of creating a power island, the Generator Owner must demonstrate, to SaskPower's satisfaction that the generation

protection systems are capable of detecting a power island condition (note that a power island condition may or may not be accompanied by self-excitation of the generator). Failure to meet the preceding requirements may mean that the Generator Owner is responsible for the cost of installing special protection schemes. This may include a direct trip signal from SaskPower's source substation to the Generator Owner's facility or other generation facilities on the feeder whenever there is a trip on the feeder to which the generation is connected.

5.12.5. Synchronous Compensator Operation

Synchronous compensator operation is not required for synchronous generators connected to the distribution system.

5.12.6. Governor Operation and Frequency Control

All synchronous generators shall be required to have speed governors on their prime movers. Synchronous generators that are 1000 kW or less in size and are connected to SaskPower's distribution system are not required to contribute to frequency control on the SaskPower system.

6.1.1. Open Transition Switching

Stand-by generators which utilize open transition switching (“break before make” transfer switches) are not required to apply to SaskPower prior to installation, as these generators are not able to operate in parallel with SaskPower’s distribution system

6.1.2. Closed Transition Switching

In order to allow for uninterrupted transfers of loads between standby generators and the SaskPower system, closed transition switching (“make before break” transfer switches) are used.

Standby generators which utilize closed transition switching, and have a transition time of > 6 cycles (> 100 msec) are considered to be operating in parallel with the SaskPower distribution system, and as such must meet the requirements in Sections 3 to 5 of this document.

Generators which utilize closed transition switching, and have a transition time of ≤ 6 cycles (≤ 100 msec) are not required to meet the requirements identified in Sections 3 to 5, but rather must meet the following items.

6.1.2.1 Protection Requirements:

The standby generating system must have the following protection functions:

Over/under voltage

Overcurrent

Over/under frequency

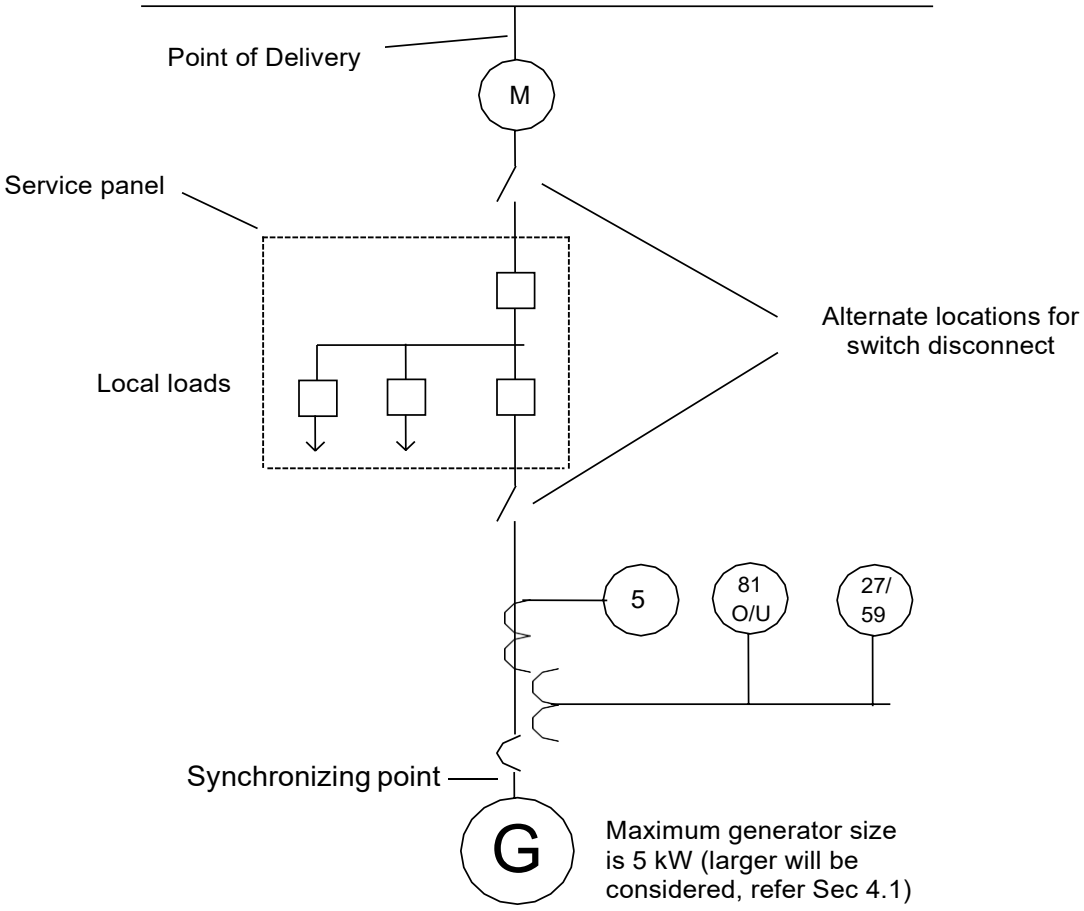
Synchronizing Check

6.1.2.2 Interconnection Agreement:

The proponent must also sign an interconnection agreement prior to interconnecting to the SaskPower distribution system. The purpose of this agreement is to ensure that the proponent understands that the requirements being imposed are based on a transition time of ≤ 6 cycles.

APPENDIX A: Typical Arrangements

SaskPower's Secondary Distribution System

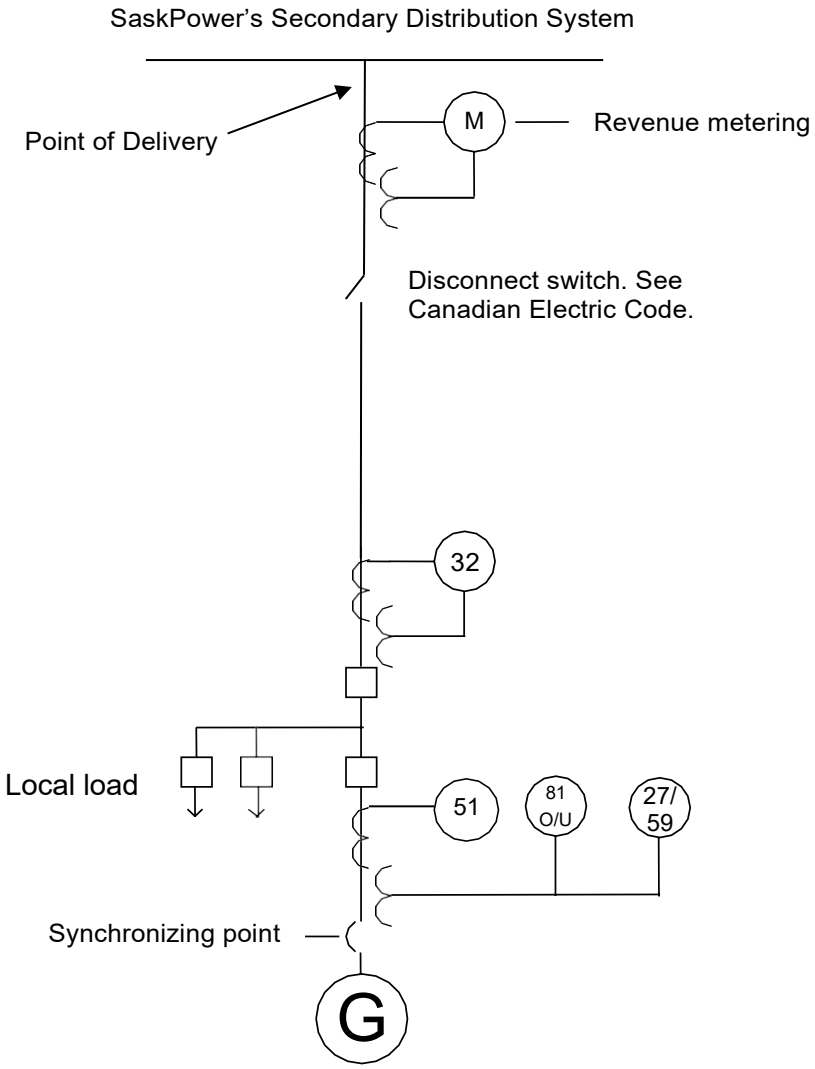


Protection Functions:

51	Overcurrent protection
81O/U	Over / under frequency
27/59	Under / over voltage
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #1
TYPICAL SINGLE PHASE GENERATOR INSTALLATION CONNECTED TO SASKPOWER'S SECONDARY DISTRIBUTION SYSTEM

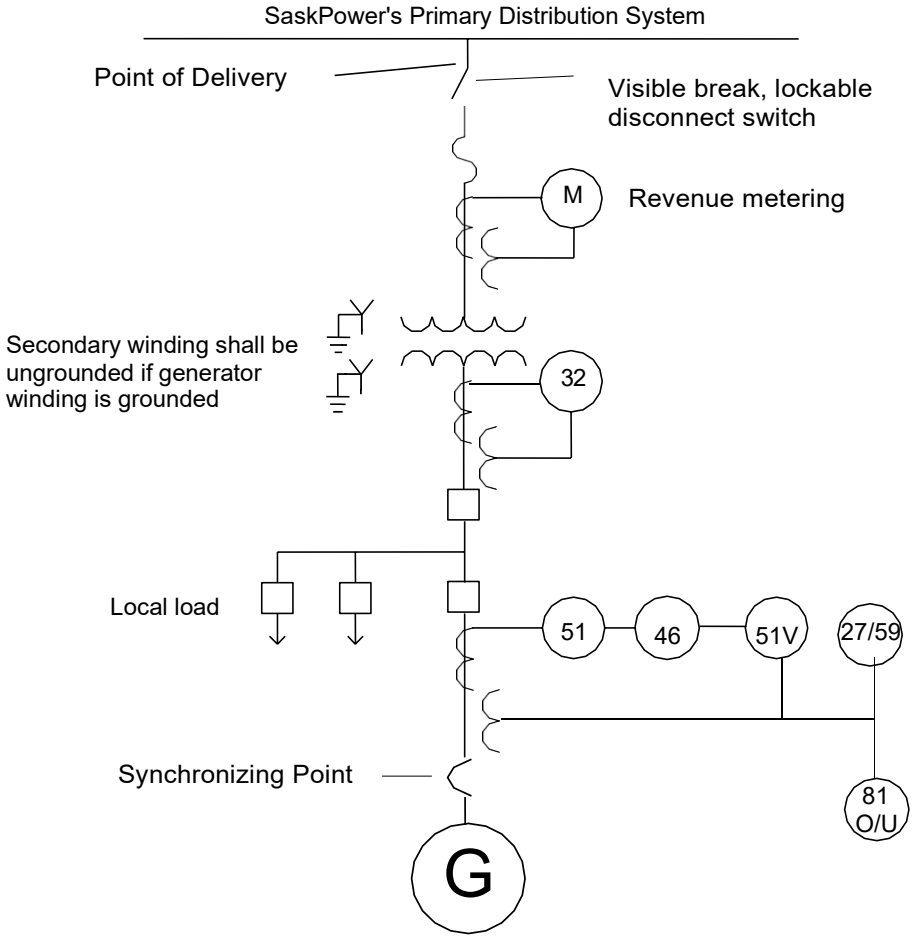


Protection Functions:

51	Overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #2
TYPICAL SINGLE PHASE INDUCTION AND INVERTER GENERATOR INSTALLATION UP TO 100 KW

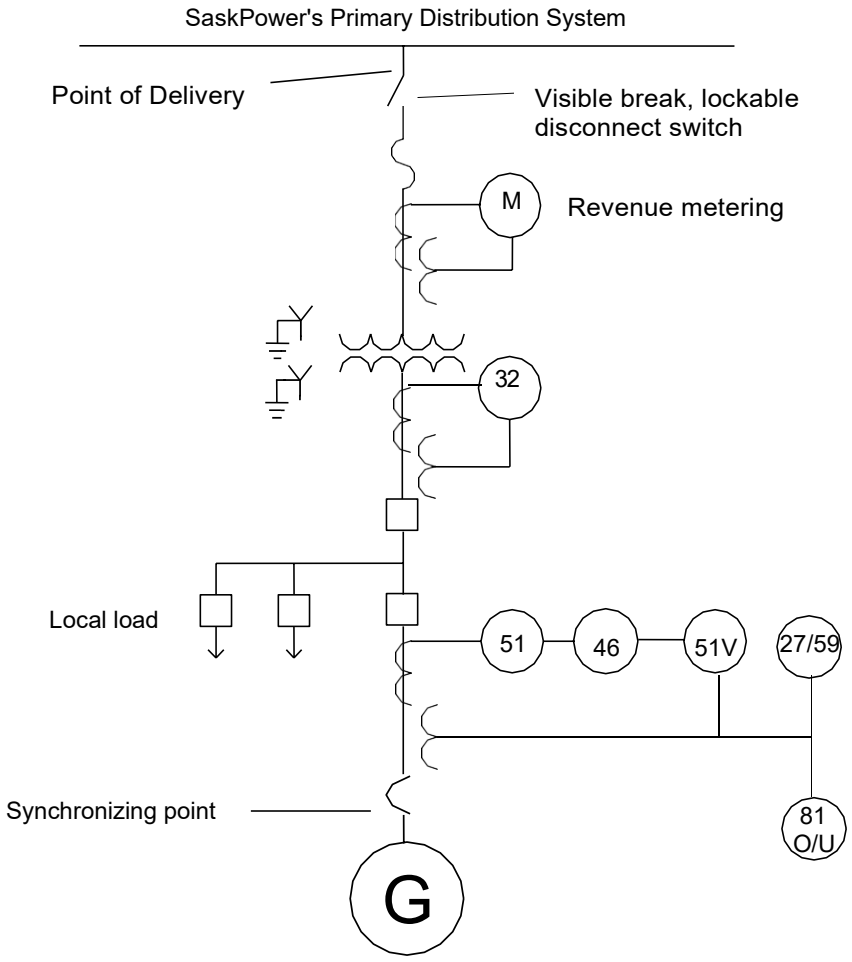


Protection Functions:

51	Overcurrent protection
51V	Voltage restrained overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection M
	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #3
TYPICAL THREE PHASE INDUCTION GENERATOR INSTALLATION UP TO 100 KW



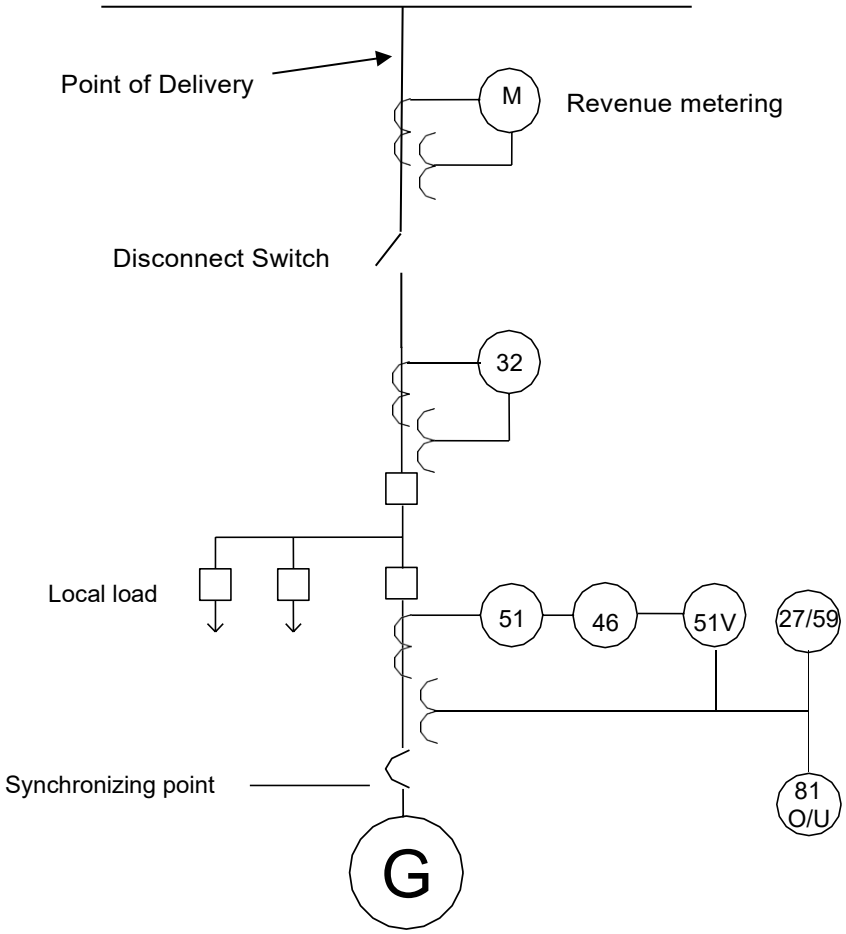
Protection Functions:

51	Overcurrent protection
51V	Voltage restrained overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #4
TYPICAL THREE PHASE INVERTER GENERATOR INSTALLATION UP TO 100 KW, POINT OF DELIVERY = PRIMARY VOLTAGE

SaskPower's Secondary Distribution System

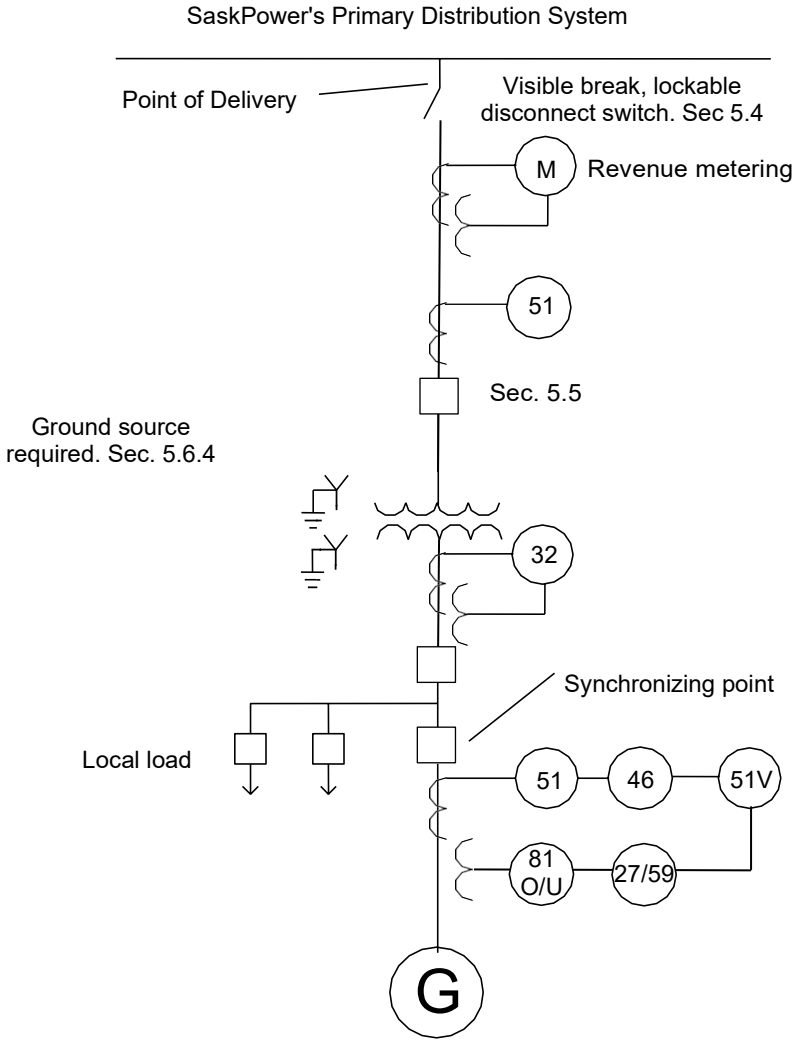


Protection Functions:

51	Overcurrent protection
51V	Voltage restrained overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #4B
TYPICAL THREE PHASE INVERTER GENERATOR INSTALLATION UP TO 100 KW, POINT OF DELIVERY = SECONDARY VOLTAGE

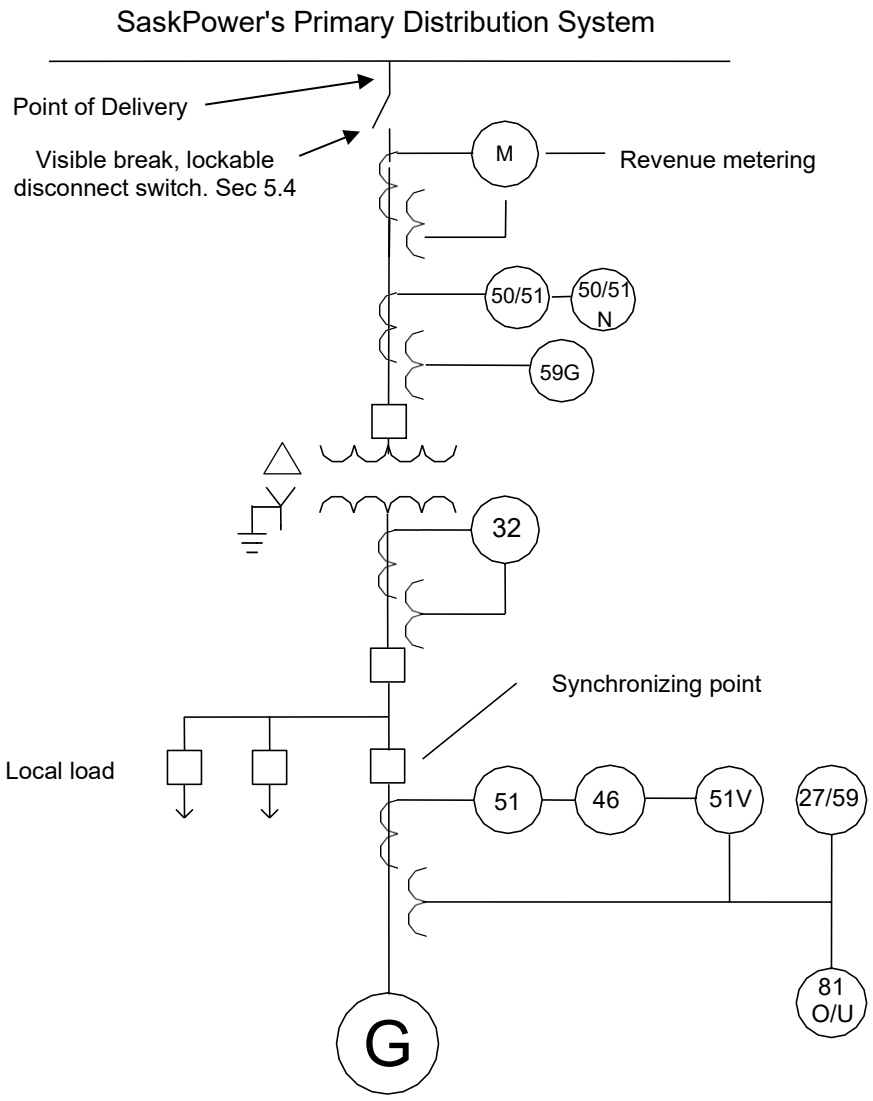


Protection Functions:

51	Overcurrent protection
51V	Voltage restrained overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #5
TYPICAL THREE PHASE INVERTER GENERATOR INSTALLATION, ≥ 100 KW
WITH GROUNDED WYE / GROUNDED WYE TRANSFORMER

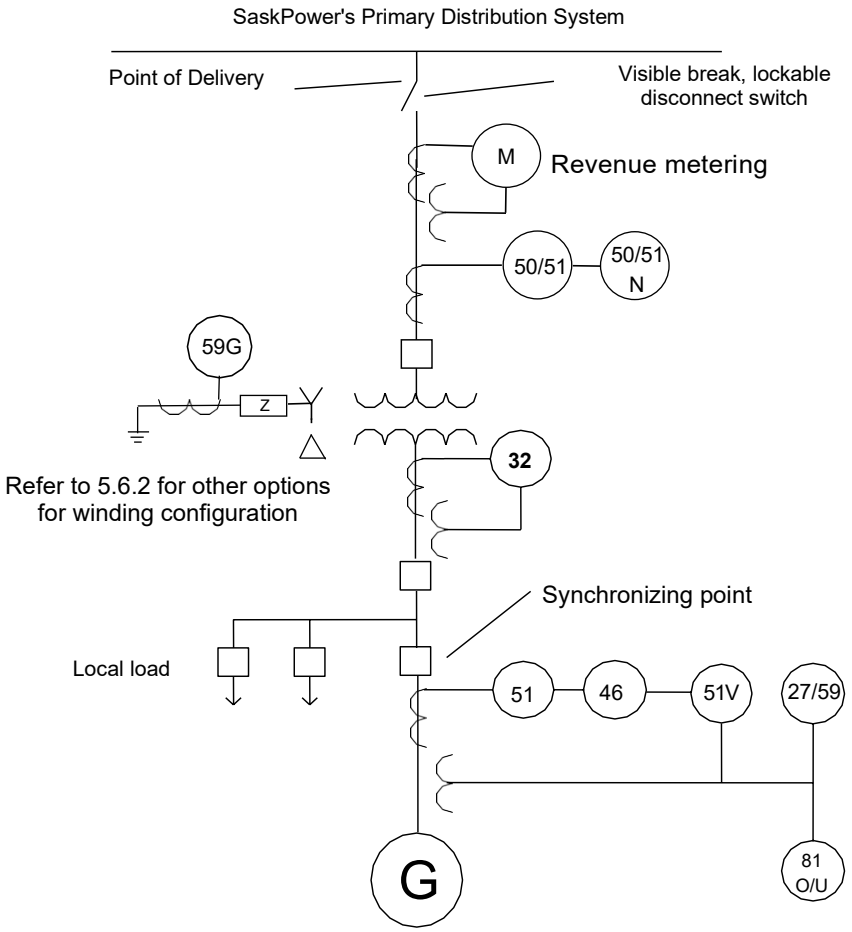


Protection Functions:

50/51	Overcurrent protection
51V	Voltage restrained overcurrent protection
59G	Broken delta overvoltage protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection
M	Revenue metering

Note:
- Typical requirements shown. Generator owner shall evaluate requirements for further protection
- Secondary winding shall be ungrounded if generator winding is grounded

FIGURE #6
TYPICAL THREE PHASE INDUCTION GENERATOR INSTALLATION, ≥ 100 KW WITH DELTA TRANSFORMER PRIMARY WINDING



Protection Functions:

50/51	Overcurrent protection
51V	Voltage restrained overcurrent protection
51G	Ground overcurrent protection
32	Reverse power protection (required for non-export generators operating in parallel with SaskPower)
81O/U	Over / under frequency protection
27/59	Under / over voltage protection
46	Phase unbalance protection
M	Revenue metering

Note: Typical requirements shown. Generator owner shall evaluate requirements for further protection

FIGURE #7
TYPICAL SYNCHRONOUS GENERATOR INSTALLATION (ALL SIZES)

Interconnection Service Request - Generation

Requestor to represent and warrant that the data submitted in this exhibit is complete and accurate. Preliminary or manufacture design modeling data is acceptable. Data submitted must be complete and accurate before assessment will start. Any errors or omissions are the responsibility of the submitter. Changes to submitted information will require a new interconnection service request be submitted.

Submitted by: _____

Title: _____

Date: _____

INTERCONNECTION CONTACT	
Company Name: **OR** SaskPower Department:	
Project Description (Optional)	
Contact Name:	
Mailing Address:	
E-mail Address:	
Telephone Number:	

SERVICE REQUESTED	
Type of Interconnection Service: • Network Resource • Energy Resource • Load Customer Self-Supply • Modification of Facilities	

SITE LOCATION AND PROPOSED IN-SERVICE DATES:	
Proposed Location of Project: (Section-Township-Range-Meridian or provide UTM coordinates, or provide name of site if this is a capacity increase to an existing generating facility.)	
Proposed Commercial Operation Date for Generating Facility:	
Proposed In-Service Date for Interconnection Facilities: (Proposed date by which the facilities needed to interconnect to the SaskPower system are in-service.)	

GENERATING FACILITY[1] DATA:		
Number of units (include # of generating units/wind turbines/inverters):		
Type (synchronous, induction, doubly-fed induction, back-to-back convertor, inverters etc.):		
Rated Output (MVA, MW, MVAr):		
Reactive Power capability (+/-MVAr):		
Power factor at rated output of facilities (in per unit):		
Rated output capability of facilities:	Nominal/ISO rating: (MW@ rated power factor)	
	Summer rating: (40°C) (MW@ rated power factor)	
	Absolute maximum reduced ambient rating: (MW@ rated power factor)	
Production capacity range of facilities (Gross):	Maximum (MW)	
	Minimum (MW)	
Net output to SaskPower System (Cumulative production capacity range for total facility):	Maximum (MW)	
	Minimum (MW)	
Station Power Requirements: (MW, MVAr)	At Maximum Production:	
	At Minimum Production:	
Energy Source: (steam turbine, gas/combustion turbine, wind turbine, hydro turbine, solar, etc.)		

[1] Generating Facility means supplier's generating power plant including any associated facilities and equipment required to deliver energy to the point of interconnection (point of change of ownership).

Modes of operation: (base-load, peaking, synchronous condense, intermittent, etc.)	

GENERATOR/TURBINE/INVERTER DATA (to be filled out separately for each different type of generator)		
GENERATOR/INVERTER DATA – CHARACTERISTICS:		
Type of generator: (Synchronous, Induction Generator, back-to-back convertor, inverter, etc.)		
Make & Model:		
Generator rating (MVA):		
Power factor at rated output (in per unit):		
Generator rated terminal voltage:		
Voltage control range (in per unit):		
Capability of generator/prime mover:	Nominal/ISO rating: (MW@ rated power factor)	
	Summer rating (40°C) (MW@ rated power factor)	
	Absolute maximum reduced ambient rating (MW@ rated power factor)	
Production capacity range of individual generators (Gross):	Maximum (MW)	
	Minimum (MW)	
Attach reactive capability curve (include voltage dependency):		
PSS/E[2] power flow and short circuit models representing the individual generator or the generating facility (including generator/inverter/turbine and auxiliary equipment)[3].		
PSS/E short circuit data representing the individual generator or the generating facility (include sequence impedances of generator/inverter/turbine and auxiliary equipment). • Unsaturated values are required. Saturated values should also be provided if available.	Positive sequence resistance (R_1)	
	Positive sequence reactance (X_1)	
	Negative sequence resistance (R_2)	
	Negative sequence reactance (X_2)	
	Zero sequence resistance (R_0)	

2 Request current version format from SaskPower

3 Not required for generating facility<1MW.

	Zero sequence reactance (X_0)	
	Max. initial symmetrical short-circuit current (Amperes)	
PSS/E dynamic models representing the individual generator or the generating facility (including generator/inverter/turbine and auxiliary equipment)[4].	The Interconnection Customer must provide a model suitable for use in dynamics studies using the PSS/E engineering simulation program. The proponent must provide evidence that any non-standard models (user-defined) have been validated through testing.	
Data Required for Synchronous Machines[5]: • Impedances expressed in per unit on machine base. • Unsaturated values are required. Saturated values should also be provided if available.	Rating of generator (MVA):	
	Power factor at rated output (%)	
	Speed (RPM)	
	Inertia constant (H) (Generator and prime mover)	
	Direct axis synchronous reactance (x_d)	
	Direct axis transient reactance (x'_d)	
	Direct axis sub-transient reactance (x''_d)	
	Quadrature axis synchronous reactance (x_q)	
	Quadrature axis transient reactance (x'_q)	
	Quadrature axis subtransient reactance (x''_q)	
	Open circuit direct axis transient time constant (T'_{do})	
	Short circuit direct axis transient time constant (T'_d)	
	Open circuit direct axis sub-transient time constant (T''_{do})	
	Short circuit direct axis sub-transient time constant (T''_d):	
	Quadrature axis transient time constant (T'_{qo})	
	Quadrature axis sub-transient time constant (T''_{qo})	
	Armature Resistance (R_a)	
	Stator leakage reactance (X_l)	
	Armature short circuit time constant (T_a)	

4 For a generating facility <1MW, dynamic model submission is not required until the commercial operation date.

5 Not required for inverter based (e.g., PV solar, wind) generation

	Saturation factor at 1.0 per-unit flux	
	Saturation factor at 1.2 per-unit flux	
Data Required for Induction Machines[6]: • Impedances expressed in per unit on machine base.	Rating of generator (MVA):	
	Power factor at rated output (%)	
	Speed (RPM)	
	Inertia constant (H) (Generator and prime mover)	
	Synchronous reactance (x)	
	Transient reactance (x')	
	Sub-transient reactance (x'')	
	Leakage reactance (x_l)	
	Open circuit transient time constant (T')	
	Open circuit sub-transient time constant (T")	
	Per-unit flux (E_1)	
	Open Circuit Saturation Factor (E_1)	
	Per-unit flux (E_2)	
	Open Circuit Saturation Factor (E_2)	

GENERATOR/INVERTER DATA: VOLTAGE/POWER FACTOR CONTROL:			
Power factor or voltage regulator control range:		To	
Power factor or voltage regulator setting tolerance (%):			
For synchronous generators provide[7]:	1. A description of the excitation system (rotating brushless, static, etc.)		

6 Not required for inverter based (e.g., PV Solar, wind) generation

7 Not required for inverter based (e.g., PV Solar, wind) generation

	2. An AVR/Exciter Laplace-domain control block diagram showing all control blocks with all time constants greater than 0.02s, completely specifying the transfer function from the generator terminal voltage, and field current, to the generator field voltage[8]
For Inverter based generator provide[9]:	Dynamic model(s) representing voltage and power factor control

GENERATOR/INVERTER DATA: GOVERNOR/ACTIVE POWER/FREQUENCY CONTROL:	
For synchronous generators provide[10]:	1. A description of the proposed governor system
	2. A Laplace-domain control block diagram showing all control blocks with all-time constants greater than 0.02s, completely specifying the transfer function for the prime mover/governor system[7]
For Inverter based generator provide[11]:	Dynamic model(s) representing active power and frequency control
For sites with fluctuations (such as wind, solar, etc.) in prime mover output provide:	1. A description of expected, and maximum frequency and magnitude variations in power output
	2. Rate at which unit output can increase or decrease

GENERATOR STEP-UP TRANSFORMER DATA:		
Rating ONAN/ONAF (MVA):		
Winding voltage and connections:	HV winding	
	LV winding	
Positive sequence impedance: (% on ONAN base):		
Zero sequence impedance: (% on ONAN base):		
On-load tap range (if equipped):		
On-load tap step size (%):		
Off-load tap range:		
Off load tap step size (%):		

8 Specify excitation system, power system stabilizer, and governor data in PSS/E format. If they cannot be modeled as PSS/E standard model, the Interconnection service requestor will have a model suitable for dynamics studies created for the PSS/E engineering simulation program.

9 For a generating facility <1MW, dynamic model submission is not required until the commercial operation date.

10 Not required for inverter based (e.g., PV Solar, wind) generation.

11 For a generating facility <1MW, dynamic model submission is not required until the commercial operation date.

GENERATOR SUBSTATION MAIN STEP-UP TRANSFORMER[12] DATA (if applicable):		
Rating ONAN/ONAF (MVA):		
Winding voltage and connections:	HV winding	
	LV winding	
Positive sequence impedance: (% on ONAN base):		
Zero sequence impedance: (% on ONAN base):		
On-load tap range (if equipped):		
On-load tap step size (%):		
Off-load tap range:		
Off load tap step size (%):		
GENERATOR SUBSTATION INTERRUPTING DEVICE:		
Type of primary interrupting device (circuit breaker, fuses, etc.):		
Interrupting rating (Amperes):		
Rated Interrupting Time (cycles):		

DRAWINGS:
General site location map showing land location of the generation plant facilities.
Site plan showing the station location, layout, and the point of interconnection (point of change of ownership) to the SaskPower system.
Station layout drawing for generation plant facilities.
Electrical single-line diagram of the generation plant electrical equipment and other associated facilities.
Protection and metering single-line drawing for generation plant facilities.
Plot of generator reactive capability curves (MVAr output vs. MW output) for plant and units. • Generator capability curves to account for any variation due to temperature or other dependent variables, if applicable. • Generator capability curves for plant and units to include rough operating zones or no operation zones, if applicable. • Generator capability curves to identify automatic generation control capability or limitations, if applicable, if applicable.
Plot of V curves for all synchronous generators[13].
Plot of generator air-gap and open-circuit saturation curves and short circuit characteristic for all synchronous generators[14].
Plot of off-nominal frequency capability and V/Hz characteristic for all generator/wind turbines/inverters.

12 Transformer(s) stepping the high voltage side of the GSU to the voltage level at the point of interconnection, if applicable.

13 Not required for inverter based (e.g., PV Solar, wind) generation

14 Not required for inverter based (e.g., PV Solar, wind) generation

Plot of off-nominal voltage capability for all generators/wind turbines/inverters.

OTHER DATA:	
Any other relevant information for the purpose of facilitating interconnection to the SaskPower system. For example, operating and maintenance scenarios, backup generation/load requirements, load/generation interdependencies, processes etc.	
Information regarding any temporary interconnections to the SaskPower system.	
For inverter-based resources, confirm whether inverters are certified with IEEE 1547 standard (2018 revision)?	Yes ☐ No ☐

Generation facilities must comply with applicable SaskPower standards, including but not limited to SaskPower's generation interconnection requirements[15], Electric Service Requirements[16], and adopted NERC standards in Saskatchewan[17].

[15] http://www.oasis.oati.com/woa/docs/SPC/SPCdocs/non_utility_interconnection_requirements_72kV.pdf

[15] https://www.oasis.oati.com/woa/docs/SPC/SPCdocs/Wind_Interconnection_Requirements_72kV__Above_-_Rev1a.pdf

[16] https://www.saskpower.com/accounts-and-services/permits-and-inspections/electrical-permits/electric-service-requirements

[17] http://www.sera-sk.ca/resources/

APPENDIX C: OPERATING AGREEMENT

In addition to the Service and Supply Agreement or Interconnection Agreement for Small Generators, the proponent will be required to negotiate and sign an agreement covering standard operating practices. Specific items to be addressed within the agreement will include but are not limited to the following:

- Definition of maintenance and operating interface devices.
- Establish Generator “lock out” procedures.
- Establish communication procedures for normal contact and emergency contact.
- Identification of safety procedures, protective equipment requirements, or other procedures for SaskPower staff entering the generation facilities
- Alarm and fault reporting procedures;
- Protection settings, including procedures for making changes and verification of changes;
- Voltage scheduling and control;
- Restoration procedures (synchronization)
- Initial synchronization.
- Initial synchronization following maintenance.
- Synchronization following disconnection due to:
- Fault on SaskPower system,
- Fault on generation system,
- System request,

TERMS AND DEFINITIONS

ANSI	American National Standards Institute or any successor organization or assigns.
AVR	Automatic Voltage Regulator
CEA	Canadian Electrical Association
CSA	Canadian Standards Association or any successor organization or assigns.
Effectively Grounded System	System grounded through a sufficiently low impedance such that the coefficient of grounding (COG) does not exceed 80% (IEEE Std C62.92.1). The COG is the ratio between line to ground and line to line voltage on the unfaulted phases. 80% COG means the line to ground voltage on the unfaulted phases will not rise to more than 80% of the line to line voltage (i.e., no more than 139% of normal line to ground voltage.)
Generation	Generation means any device which produces electrical energy including devices which release stored electrical energy (storage means stored for greater than 16 ms). Parallel or synchronous operation means operation of any generator whose output terminals are connected directly or through any intermediary facilities to SaskPower's transmission system.
GCC	Grid Control Centre
Integration Studies	Studies carried out by SaskPower is to identify the interconnection facilities that have to be added to SaskPower's system to accommodate the proposed generation project along with their cost. The studies also assess whether the proposal by the proponent meets SaskPower's technical requirements for interconnection.
Interconnection Agreement for Small Generators	An agreement, for generation projects up to 100 kW, between SaskPower and the Generator Owner covering the technical requirements for interconnection of the Generation Facilities with SaskPower's system and the sale of energy to or the purchase of energy and other services from SaskPower.
Interconnection Facilities	This includes but is not limited to: ■ Electric power lines required to connect the generation to the SaskPower transmission system. ■ Apparatus at both the Generation and SaskPower substations including current transformers (CTs), potential transformers (PTs), high voltage isolating switch complete with visible break and suitable for locking, a high-voltage fault interrupting device, and ground switch suitable for locking.

	■ Generator step-up transformer complete with on-load tap changer. ■ Communications, protection and control facilities. ■ Metering equipment. ■ Special protection systems.
NEMA	National Electrical Manufacturers Association or any successor organization or assigns.
Generation	Generation connected to the SaskPower transmission system which may or may not be exclusively owned by SaskPower. This includes: ■ Co-Generation - the simultaneous generation in one plant of electricity and useful thermal or mechanical energy. ■ Independent Power Production (IPP) - investor-owned facilities dedicated exclusively to the generation of electrical energy. ■ Self-Generation – customer-owned generation which is used to supply load at the customer site. This may include energy produced from on-site co-generation facilities.
Generation Facilities	Generation facilities consist of the generating equipment; the substation, complete with transformer; and all associated equipment at the site.
Service and Supply Agreement	An agreement, for generation projects in excess of 100 kW, between SaskPower and the Generator Owner covering the technical requirements for interconnection of the Generation Facilities with SaskPower's system and the sale of energy to, or the purchase of energy and other services from SaskPower.
Generator Owner	The owner of the generation facilities.

BIBLIOGRAPHY

CAN3-C308-M85 - "Principles and Practices of Insulation Coordination".

CAN/CSA F418-M91 - "Wind Energy Conversion Systems (WECS) Interconnection to the Electric Utility"

CEA - "Guide to the Characteristics, Performance, and Hardware Requirements in the Specification of Excitation Systems" by B. A. Hughes and W. O. Moll, both of Ontario Hydro, editing and presentation at the 1983 Spring Meeting - Vancouver

CEA 91-D-44-1991 - "Technical Requirements to Connect Parallel Generators to the Ontario Hydro Distribution Electricity System" by D. Kundu of Ontario Hydro

CEA 128-D-767 - 1994 - "Connecting Small Generators to Utility Distribution Systems" by A. B. Sturton Consultants Inc. Monte St. - Hilaire, PQ and Acres International Ltd., Toronto, Ontario

IIEEE C37.102-1987 - "IEEE Guide For AC Generator Protection"

IEEE 1001-1988 - "IEEE Guide For Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems"

IEEE 88TH0224-6-PWR - IEEE - "Inter-tie Protection of Consumer Owned Sources of Generation, 3MVA or Less"

PROJECT IEEE - 4191DS - "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"

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

SaskPower Electric Service Requirement