# Draft Interconnection Requirements at Voltages 72 kV and Greater:

# Non-Synchronous Generation - Wind

*SaskPower*

2017 July 04

These draft requirements supplement SaskPower's Non-Utility Generation Interconnection Requirements at Voltages 72 kV and Above. They provide supplemental requirements for owners of non-synchronous wind generation (Facilities owner) interconnecting to the SaskPower Transmission System. These requirements are being posted in draft form before being finalized, and are subject to revision.

# 1. INTERCONNECTION AND GENERATING FACILITIES REQUIREMENTS

## 1.1 Operating Voltage Requirements[1]

The design and operation of the Interconnection and Generating Facilities (the Facilities) shall be compatible and coordinated with the SaskPower Transmission System's intact and post contingency operating voltage range. These 60 Hz voltage values are shown in Table 1.1, along with the corresponding time durations.

**Table 1.1 SaskPower Transmission System - Intact and Post Contingency System Operating Voltages (60Hz)**

| | Existing Equipment | | | | | | New Equipment |
|---|---|---|---|---|---|---|---|
| **Nominal Voltage (kV)** | **Typical System Intact Steady State Operating Voltage Range (kV)** | **Post Contingency Maximum Transient Voltage (kV)** | **Post Contingency Transient Voltage Range (kV)** | **Post Contingency Transient Voltage Range (kV)** | **Post Contingency Steady State Temporary Range (kV)** | **Post Contingency Steady State Operating Range (kV)** | **Maximum Continuous Voltage Rating (kV)** |
| 230 | 207 - 253 | 322 | 161 - 276 | 195 - 265 | 207 - 253 | 207 - 253 | 253 |
| 138 | 124.2 - 145 | 193 | 97 - 166 | 117 - 159 | 124 - 152 | 124 - 145 | 152 |
| 72 | 64.8 - 76 | n/a | n/a | n/a | 65 - 76 | 65 - 76 | 79 |
| Per Unit | | | | | | | |
| 230 | 0.90 - 1.10 | 1.40 | 0.70 - 1.20 | 0.85 - 1.15 | 0.90 - 1.10 | 0.90 - 1.10 | 1.10 |
| 138 | 0.90 - 1.05 | 1.40 | 0.70 - 1.20 | 0.85 - 1.15 | 0.90 - 1.10 | 0.90 - 1.05 | 1.10 |
| 72 | 0.90 - 1.05 | n/a | n/a | n/a | 0.90 - 1.05 | 0.90 - 1.05 | 1.10 |
| Time Duration | Continuous | 8 cycles | 2.5 seconds | 5 seconds | 30 minutes | Continuous | Continuous |

## 1.2 Power Quality Requirements[2]

The design and operation of the Facilities shall not result in deterioration of the power quality on the SaskPower Transmission System.

### 1.2.1 Voltage Fluctuation

The Facilities shall be designed and operated to not cause unacceptable voltage fluctuations or flicker on the SaskPower Transmission System. The Voltage Fluctuation and Voltage Flicker limits are defined in the SaskPower Electric Service Requirements (ESR) document. The measurement point will be the location where the Facilities connect to the SaskPower Transmission System – the dead end insulators on the substation.

### 1.2.2 Voltage Distortion

The voltage distortion limits shall meet with the general requirements in the most recent version of the applicable ANSI/IEEE standards. To facilitate the design of the Facilities to control voltage fluctuations, SaskPower will provide equivalent Transmission System impedances for the existing transmission upon request.

The design and operation of the Facilities shall account for the on-going effects of planned and future changes to the SaskPower Transmission System. SaskPower will provide updated equivalent transmission system impedances upon request.

1 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 2.4 SaskPower Transmission System Characteristics – Steady State Voltage Levels.

2 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 4.9 NUG Facilities Requirements – Power Quality.

### 1.3 Fault (Short Circuit) Contribution Requirements

The design and operation of the Facilities may require limiting the fault contribution to the SaskPower Transmission System. To be determined by SaskPower.

The fault contributions from the Facilities at the high voltage side of the step up transformer to the Transmission System for the following time frames shall be provided to SaskPower:

- Momentary peak (immediately after fault inception)
- Sub-transient peak (1 fundamental frequency cycle after fault inception).
- Transient peak (0.3 seconds after fault inception)

### 1.4 Protection From Abnormal Conditions: Resonance and Self Excitation Assessment Requirements[3]

The design and operation of the Facilities shall account for the effects and mitigation of potential resonance conditions such as:

- Ferro-resonance
- Sub-synchronous resonance or control interactions
- Harmonic resonance

The design and operation of the Facilities shall ensure that self excitation will not occur under any operating conditions (including temporary islanding), and that the effects of any possible resonance conditions do not result in any unacceptable impacts to the SaskPower Transmission System.

### 1.5 Station Service - Back-Up Power Requirements[4]

The design and operation of the Facilities shall account for back-up power for heat, marker lighting, or generator parking during periods when the interconnection to the SaskPower Transmission System is out of service. Need for a redundant utility supply for station service shall be identified to SaskPower.

### 1.6 Reactive Power Requirements

The design and operation of the Facilities' continuous reactive power capability shall meet the following:

- Reactive power output (in MVArs) equivalent to a power factor range of +0.95 (overexcited) to -0.95 (underexcited) or larger, measured at rated output and at the high voltage terminals of the Facilities' main substation step up transformer connected to the SaskPower Transmission System. This amount of reactive power (in MVArs) shall be available down to 10% of the operating range of the Facilities and may vary no more than in direct proportion to voltage or the number of wind turbines in-service. Below 10% the amount or reactive power may vary with the power factor.

At least 70% of the Facilities' reactive power capability is required to be dynamic (fast response, continuous, and variable). Up to 100% of the reactive power capability may be required to be dynamic as determined by SaskPower to meet system performance criteria. The additional capability may be made up of short term capability. This short term capability must be available for a period equal or greater than two seconds. Higher levels of reactive power capability may be required, if determined necessary, by SaskPower.

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3 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 3.10.3 Interconnection Facility Requirements – Protection From Abnormal Conditions.

4 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 4.5 NUG Facilities Requirements – Station Service.

Reactive power capability may be supplied by an auxiliary source. It is the Facilities owner responsibility to demonstrate that this will not result in any overvoltage violations following generation rejection, as a result of generator self excitation, or due to any other condition. The Facilities owner is responsible for providing any needed redundancy for the auxiliary source of reactive power, sufficient to avoid impacts to its generation availability. If the auxiliary source of reactive power is off-line, the Facilities will be required to operate at a reduced MW output or be disconnected. If other equipment is out of service that affects the reactive power capability of the Facilities, the Facilities may be required to operate at a reduced MW output or be disconnected.

The Facilities owner shall provide SaskPower a reactive power capability curve (including voltage dependency) for the Facilities over its operating range at the high voltage terminals of the Facilities' main substation step up transformer.

## 1.7 Voltage Regulation Requirements

The design and operation of the Facilities shall be capable of regulating the high voltage bus or the low voltage bus of the Facilities' main substation step up transformer connected to the SaskPower Transmission System. The regulating point and voltage set point to be determined by SaskPower.

## 1.8 Voltage Unbalance/Negative Sequence Requirements[5]

The design and operation of the Facilities shall withstand the effect of voltage unbalance on the SaskPower Transmission System. The voltage unbalance under normal operating conditions is designed to be less than 3 percent, as defined by ANSI/NEMA MG1-14.36 and ANSI/NEMA MG1-20.24, 2014. During faults, single-pole auto-reclosing dead-time, or other abnormal temporary conditions the unbalance is not restricted, and will be significantly higher.

The design and operation of the Facilities shall withstand the effect of negative sequence current resulting from disturbances on the SaskPower Transmission System. The most common cause of system unbalance on the SaskPower Transmission System will be unbalanced faults and single-pole tripping and reclose; however, other factors which may result in negative sequence current, such as steady state system voltage unbalance, etc.

The design and operation of the Facilities shall withstand or protect against the effects of normal or delayed clearing of faults, voltage surges or imbalances, off nominal frequency or voltage conditions and any other abnormal Transmission System conditions.

The design and operation of the Facilities shall ensure loss of synchronism with the SaskPower Transmission System or other modes of instability do not result in equipment damage. SaskPower will not be responsible for damage within the Facilities, due to out-of-phase reclosing or other conditions that cause the Facilities to lose synchronism with the SaskPower Transmission System.

5 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 2.4 SaskPower Transmission System Characteristics – System Voltage Unbalance and Section 4.10 NUG Facilities Requirements – System Unbalance/Negative Sequence.

## 1.9 Governor (or Equivalent Controls) Operation and Frequency Control Requirements[6]

### 1.9.1 Primary Frequency Response Requirements

The design and operation of the Facilities shall be capable of providing primary frequency control (frequency response) to frequency deviations from 60 Hz and contribute to frequency control on the SaskPower Transmission System.

For over-frequency events on the SaskPower Transmission System, the Facilities shall provide a primary frequency response. For under-frequency events on the SaskPower Transmission System, the Facilities shall provide a primary frequency response only if requested by SaskPower.

The primary frequency response shall be capable of being adjusted by adjusting the slope of a droop characteristic. The automatic control system design shall have a frequency control setting equivalent to a droop setting in a conventional synchronous unit that is adjustable from 1 to 10 percent. Setting to be determined by SaskPower.

Controls must be able to be tuned for stable steady state and transient response and shall be capable of immediate and sustained response to frequency excursions greater than +/- 0.036 Hz. The deadband for an over-frequency response should be settable between 0.036 Hz and 1 Hz. Deadband settings to be determined by SaskPower.

### 1.9.2 Fast Frequency Response (Synthetic Inertia) Requirements

The design and operation of the Facilities shall be capable of providing a fast frequency or synthetic inertial response. For large under frequency events, the power output of the Facilities shall increase in the range of 5% to 10% of the rated turbine power. The duration of the power increase is on the order of several seconds. Settings to be determined by SaskPower.

Facilities that cannot technically provide fast frequency response shall submit a written request to SaskPower explaining the technical infeasibility. At SaskPower's sole discretion, those facilities may be granted an exemption from the requirement. If SaskPower grants the exemption, SaskPower may require the design and operation of the Facilities to include alternate measures that are technically feasible and would approximate fast frequency response to measurable events.

### 1.9.3 Active Power & Ramp Rate Control Requirements

The design and operation of the Facilities shall have the control capability to limit the active power output at the point of connection by set point control and ramp rate control. The active power control limit must be adjustable from the minimum operating output to the maximum authorized active power, at an average resolution of one (1) MW.

The design and operation of the Facilities shall be capable of limiting the ramp rate as specified by SaskPower in the Operating Requirements section. The ramp rate settings are to be determined by SaskPower.

6 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 4.12 NUG Facilities Requirements – Governor Operation and Frequency Control.

## 1.10 Short Term Off-Frequency Operation Requirements[7]

The design and operation of the Facilities shall have a short-term capability for off-frequency operation and must not trip, for the frequency values illustrated within the Eastern Interconnection of the No Trip Zone in the Attachment 1 of NERC PRC-024-2, Off Nominal Frequency Capability Curve, for the Eastern Interconnection. Note this characteristic is not a required trip threshold. Actual capabilities to be provided to SaskPower.

## 1.11 System Voltage Ride Through Requirements

The design and operation of the Facilities shall meet the voltage ride through capability in Attachment 2 of NERC PRC-024-2.

## 1.12 Overvoltage Withstand Requirements

The design and operation of the Facilities shall withstand temporary overvoltages, without damage or loss of life, at levels that are consistent with the SaskPower design requirements in the Electric Service Requirements (ESR) document.

### 1.12.1 Impulses

The design and operation of the Facilities shall account for exposure to lightning impulses and applicable equipment shall be insulated at levels consistent with the design requirements in the SaskPower Electric Service Requirements (ESR).

### 1.12.2 Switching Surges

The design and operation of the Facilities shall withstand switching surge voltages which may reach 3 times nominal supply voltage values and may persist for several cycles (60 Hz time basis).

### 1.12.3 Dynamic Overvoltages

The design and operation of the Facilities shall withstand 60 Hz dynamic overvoltages from full load generation rejections of the Facilities.

## 1.13 Protection Requirements[8]

The design and operation of the Facilities shall install protective systems that meet location specific functional requirements. SaskPower will provide the functional requirements of protection systems that impact the SaskPower Transmission System.

## 1.14 Data Requirements – PSS/E and PSCAD Models[9]

PSS/E power flow, short circuit and dynamic models and PSCAD electromagnetic time domain transient simulation models representing the Facilities (including generators, turbines, and auxiliary equipment) shall be provided to SaskPower for ongoing use in its planning and operating studies.

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7 This section supersedes SaskPower's Non-Utility Generation Interconnection Requirements Section 4.12.1 NUG Facilities Requirements – Short Term Off-Frequency Operation.

8 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 3.10 Interconnection Facility Requirements – Protection of Equipment and Detection of Faults and Section 4.11 NUG Facilities Requirements – Generator Protection.

9 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Appendix B Final Generator Connection Data Requirements.

If the PSS/E models are proprietary, non-proprietary models that represent the Facilities shall also be provided to SaskPower.

Model updates compatible with current and new releases of PSS/E and PSCAD shall be provided to SaskPower on an on-going basis. The Facilities owner is responsible for any costs associated with providing on-going updates.

## 2. MONITORING AND CONTROL REQUIREMENTS[10]

### 2.1 Control System

2.1.1. The design and operation of the Facilities shall include an aggregate Facilities' SCADA system which will allow individual wind turbine monitoring and control, as well as aggregate control of the Facilities' operating parameters to meet the specific requirements outlined in SaskPower's Interconnection Requirements.

2.1.2. The design and operation of the Facilities' SCADA system shall be capable of providing and accepting information required for the operation of the Facilities via a SaskPower RTU within the conditions described in these Interconnection Requirements.

2.1.3. The design and operation of the Facilities' SCADA system shall include the connection to SaskPower's SCADA system via the SaskPower RTU, the Facilities' main substation, all the Facilities' met towers and individual wind turbines, aviation lighting, etc.

2.1.4. Each turbine, met tower, etc. shall be equipped with a controller/IED (Intelligent Electronic Device) or similar equipment to interface with the Facilities' aggregate SCADA system. In the event of a communications network failure, the controller/IED or similar equipment shall continue to monitor the individual turbine or met tower, store data for up to one week and be capable of supplying the recorded data for retrieval. Uninterruptible Power Supply systems (UPS) shall be provided to ensure data collection is not interrupted by power disturbances.

2.1.5. If requested, view-only remote monitoring capability that replicates the on-site Facilities' SCADA screen(s) shall be provided to SaskPower.

2.1.6. The design and operation of the Facilities' SCADA system shall collect and refresh data as required by SaskPower and supply it to the SaskPower RTU with an update frequency of no less than 0.2 Hz. Refer to Appendix 1. SaskPower will poll its local RTU for related data with a frequency of up to 0.1 Hz.

2.1.7. The design and operation of the Facilities aggregate SCADA system shall be capable of two-step update of SaskPower controlled values, if required (step 1: set via set point, step 2: execute).

### 2.2 Operating Requirements

2.2.1. The design and operation of the Facilities' SCADA system/controller shall accept a curtailment signal from SaskPower's Control Center via the local SaskPower RTU representing the generated power to which the Facilities shall be curtailed. The Facilities' SCADA system/controller shall be capable of providing 0 MW to the Facilities full rating curtailment range (equivalent to curtailment function off). The curtailment shall be possible within the time frame determined by the ramp-rate control values entered into the SCADA system/controller.

2.2.2. The design and operation of the Facilities' SCADA system/controller shall provide positive ramp rate control of the Facilities output. The Facilities' SCADA system/controller shall accept a control value set by SaskPower's Contol Center via the local SaskPower RTU to enable/disable the ramp rate control function. The current ramp rate control status (on or off) shall be fed back

10 This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 3.13 Interconnection Facility Requirements – Monitoring of Interconnection Facilities.

into the local RTU for confirmation to SaskPower's Control Center. Ramp rate control is to be used during controlled (planned) start-up or other operation of the Facilities. Under normal operating conditions following start-up, ramp rate control will be disabled by SaskPower's Control Center via the local RTU, unless the SaskPower Transmission System conditions require it. The Facilities' SCADA system/controller shall accept a ramp rate value set by SaskPower's Control Center via the local SaskPower RTU for the positive ramp rate of the Facilities. The current ramp rate in the Facilities control system shall be fed back into the local RTU for confirmation to SaskPower's Control Center. The Facilities' SCADA system/controller shall be capable of positive ramp rate control of 0 to 100 MW/minute (weather conditions permitting). If the ramp rate control function is enabled by SaskPower's Control Center via the local RTU, the maximum positive ramp rate shall not be exceeded during any controlled start-up or other operation of the Facilities.

2.2.3. The design and operation of the Facilities' SCADA system/controller shall provide negative ramp rate control of the Facilities output. The Facilities' SCADA system/controller shall accept a control value set by SaskPower's Control Center via the local SaskPower RTU to enable/disable the ramp rate control function. The current ramp rate control status (on or off) shall be fed back into the local RTU for confirmation to SaskPower's Control Center. Negative ramp rate control will be used during controlled (planned) shut-down or other operation of the Facilities (for example during the curtailment process). The Facilities' SCADA system/controller shall accept a ramp rate value set by SaskPower's Control Center via the local SaskPower RTU for the negative ramp rate of the Facilities. The current ramp rate in the Facilities' control system is to be fed back into the local RTU for confirmation to SaskPower's Control Center. The Facilities' control system shall be capable of negative ramp control rates of 0 to 100 MW/minute (weather conditions permitting). If the ramp rate control function is enabled by SaskPower's Control Center via the local RTU, the maximum negative ramp rate shall not be exceeded during any controlled shutdown or other operation of the Facilities. Emergency shutdown of the Facilities shall not be subject to the negative ramp control. Emergency shutdown shall be used only during emergencies, otherwise shutdowns are controlled via the ramp rate.

2.2.4. The design and operation of the Facilities' control systems shall be capable of regulating the interconnection voltage based on information received via the SaskPower RTU.

2.2.5. The following metering, status and indication values shall be supplied to the SaskPower RTU from equipment in the Facilities' main substation: status and indication of all motorized switches and breakers, all power flow information at the interconnection (MW, MVAr, MVA, and power factor), all available voltages, etc. Appendix 1 includes information that shall be made available to SaskPower's Control Center through the SaskPower RTU as per requirements listed in these Interconnection Requirements. Appendix 1 is subject to revision by SaskPower at its sole discretion.

## 2.3 Communications Systems

2.3.1. The design and operation of the Facilities shall include any applicable Facilities' dedicated communications links. Details on the Facilities' communications network (fibre optic, point-to-point wireless, etc.) shall be provided to SaskPower.

2.3.2. The design and operation of the Facilities shall provide certification of network integrity and maximum attenuations for the communications systems to individual turbines and met towers.

2.3.3. All wireless communications, if used, shall be encrypted using applicable industry best-practice solutions, and updated as required. The type of wireless installation shall be identified, together with the encryption technology that will be used.

2.3.4. SaskPower will design and install the communications systems required between the local SaskPower RTU and SaskPower's Control Center.

2.3.5. The design and operation of the Facilities shall account for the operational cyber security needs and applications to protect the Facilities' SCADA systems, including from SaskPower networks. The implemented operational cyber security systems shall be designed and operated as per industry best practices relating to the protection of SCADA and industrial control systems. The cyber security installations may also be subject to applicable NERC Critical Infrastructure Protection cyber security standards.

### 2.4 Generation Forecast Data Requirements

2.4.1. The design and operation of the Facilities shall provide SaskPower with the data necessary to prepare electrical generation forecast for the Facilities. The Facilities owner is responsible for any costs related to the collection and delivery of the data to SaskPower.

2.4.2. The design and operation of the Facilities shall collect weather and other substation data as required and supply them to the SaskPower RTU on a near real-time basis, or with an update frequency of no less than 0.2 Hz. SaskPower will poll its local RTU for related data with a frequency of up to 0.1 Hz.

2.4.3. The design and operation of the Facilities shall install and maintain permanent met-towers around the site to provide the capability of measuring and recording representative wind data for all hours in the year. The number of permanent met-towers required is either: (i) one (1) for wind farms with a nameplate capacity less than or equal to 90 MW; or (ii) two (2) for wind farms with a nameplate capacity greater than 90 MW. The location of the required met-towers shall be determined by SaskPower's generation forecasting service provider at SaskPower's cost, once the final locations of the turbines has been determined. The Facilities owner is responsible for any costs related to moving the met-towers, if required. The Facilities owner is responsible for the ongoing maintenance of the met-towers and related costs such as, but not limited to, communication costs and land costs. SaskPower shall be provided access to the met-towers for the purposes of inspection and verification as SaskPower may reasonably request from time to time.

2.4.4. The design and operation of the Facilities shall account for installing and maintaining sufficient measuring equipment to collect the necessary data to reasonably determine the turbines' availability and the amount of any derate.

2.4.5. By noon Saskatchewan time on each Friday, SaskPower's Control Center shall be provided the Facilities' expected derate, if any, by hour for the following two weeks. SaskPower's Control Center shall be provided an update if the expected derate, if any, by hour changes by more than 5 MW for any given hour.

## 3. TESTING AND COMMISSIONING[11]

The Facilities owner should propose a plan for equipment acceptance testing and commissioning that will confirm:

- the safe, reliable operation of individual turbines and the Facilities as a unit, including the SCADA system;
- the Facilities' compliance with the requirements of the Governmental Authorities, applicable Reliability Standards, SaskPower Non-Utility Generation Interconnection Requirements, and these Interconnection Requirements.

The tests should be carried out on the Facilities' individual wind turbines, or other parts of the Facilities constituent components as appropriate. For some tests, type tests with supporting documentation, on identical systems would be considered in place of an actual site test.

The Facilities owner shall conduct whatever tests are required to ensure the safe, reliable operation of the Facilities and its constituent components as well as compliance with the interconnection requirements of SaskPower and in compliance with any requirements of the authorities having jurisdiction. The Facilities owner will be required to submit an electrical commissioning report prior to commercial operation.

The electrical commissioning report should include, but not be limited to:

a) Generator – all documentation regarding specifics of factory testing, model #s, etc; insulation resistance; DC winding resistance; high potential.

b) Transformer – all documentation regarding specifics of factory testing, model #s, etc; insulation resistance; DC winding resistance; turns ratio; CT Saturation.

c) Power cables – insulation resistance, high potential (or agreed-to equivalent).

d) Circuit Breaker – insulation resistance; contact resistance; functional checks.

e) Electrical Protection System – functional checks of the protective relaying system.

f) SCADA system and turbine control systems – functionality checks.

g) Voltage and power factor regulation systems – functionality checks.

h) Frequency control system – functionality checks.

i) All other Interconnection Customer commissioning and functionality checks.

Equipment acceptance tests should include, but are not limited to:

- HV cable insulation testing, transformer, switch gear, and generator;
- testing of the protective relaying system;
- SCADA system;
- Turbine control systems;

[11] This section supplements SaskPower's Non-Utility Generation Interconnection Requirements Section 4.13. Performance Testing and Machine Parameter Validation

- voltage and power factor regulation systems;
- frequency control system.

The Facilities owner shall propose which tests will be required prior to energization of individual turbine or groups of turbines and which tests will be required prior to energization of the Facilities or its constituent components.

In addition to the above requirements, it is anticipated that the proposed test plan will include the following or similar tests:

| Test | Description |
|---|---|
| 1. Startup Test | Run though startup sequence.<br>▪ Demonstrate that the power gradient is within the maximum allowable power ramp rate.<br>▪ Monitor voltages on collector system and at the low and high voltage terminals of the Facilities' main substation step up transformer connected to the SaskPower Transmission System to confirm compliance with the specification. |
| 2. Full Output Reduction Test | Simulate shutdown of the Facilities at full output.<br>▪ Demonstrate power gradient during shutdown does not exceed the maximum allowable power ramp rate, notwithstanding emergency or protection limits. |
| 3. Voltage Regulation Test | Demonstrate the ability to regulate voltage at the machine terminals and at the low and high voltage terminals of the Facilities' main substation step up transformer connected to the SaskPower Transmission System as required by the specification. |
| 4. Power Factor Regulation Test | Demonstrate the ability to regulate power factor at the machine terminals and at the low and high voltage terminals of the Facilities' main substation step up transformer connected to the SaskPower Transmission System as required by the specification. |
| 5. Frequency Control Test | Demonstrate the ability to control the output of the Facilities' in response to an over or under frequency condition (droop). Type tests, with supporting documentation, on identical systems would be considered in place of an actual site test. |
| 6. Low Voltage Ride-Through Test | Demonstrate the ability of the Facilities' turbines to stay connected through low voltage conditions as required by the specification. Type tests, with supporting documentation, on identical systems would be considered in place of an actual site test. |
| 7. Frequency Ride-through Test | Demonstrate the off-frequency operation of the Facilities' as required by the specification. Type tests, with supporting documentation, on identical systems would be considered in place of an actual site test. |
| 8. Power Oscillation Test | Monitor Facilities' output during normal operation to confirm the absence of oscillations in the 1 Hz to 2 Hz range. |
| 9. Flicker/Harmonics Test | Record Facilities' output during normal operation and analyze for flicker and for harmonic content. |

# APPENDIX 1 –REQUIRED DATA

| | | | |
|---|---|---|---|
| Wind site | | | |
| Turbines in Pause | | Per wind site | Read |
| Turbines in Stop | | Per wind site | Read |
| Turbines in Emergency stop | | Per wind site | Read |
| Turbines without communication | | Per wind site | Read |
| Current Set point Ramp rate (feedback) | [MW/sec] | Per wind site | Read |
| Current Set point Power curtailment (feedback) | [MW] | Per wind site | Read |
| Current ramp rate control mode on/off (feedback) | On/off | Per wind site | Read |
| Set Ramp rate | [MW/sec] | Per wind site | Write |
| Set Power curtailment | [MW] | Per wind site | Write |
| Set Ramp rate control mode on/off | On/off | Per wind site | Write |
| Max MW Available (sum of total possible output from all available generators) | [MW] | Per wind site | Read |
| Turbines | | | |
| Power | [kW] | Per turbine | Read |
| Reactive power | [kVAr] | Per turbine | Read |
| Wind speed | [m/s] | Per turbine | Read |
| Wind direction | [degrees] | Per turbine | Read |
| Temperature (within any 5 Km radius) | [C] | Per applicable turbine | Read |
| Turbine Availability (which turbines are available to generate, even if they are not currently generating) | | Per turbine | Read |
| Met mast | | | |
| Wind speed hub height | [m/s] | Per met tower | Read |
| Wind direction hub height | [degree] | Per met tower | Read |
| Air pressure (at 2 to 3m elevation) | [Mbar] | Per met tower | Read |
| Temperature (at 2 to 3m elevation) | [C] | Per met tower | Read |
| Wind Speed at hub height - 30m | [m/s] | Per met tower | Read |
| Wind direction at hub height - 30m | [degree] | Per met tower | Read |
| Relative Humidity at 2 to 3m | % | Per met tower | Read |
| Precipitation | [mm] | Per met tower | Read |
| Facilities' Main Substation | | | |
| Active production | [MW] | | Read |
| Reactive production | [MVAr] | | Read |
| Switches, breakers | status | Per device | Read |
| Total MVAr support provided | [MVAr] | | Read |
| Dynamic MVAr support provided | [MVAr] | | Read |
| Total MVAr support available | [MVAr] | | Read |