

# SUPPLEMENTAL GENERATION INTERCONNECTION REQUIREMENTS

(Applicable to Generation Interconnection  
Facilities 1 MW and Greater)

November 16, 2023

# 1. INTRODUCTION

## 1.1 Introduction - Supplemental

- These requirements supplement SaskPower's Generation Interconnection Requirements.
- They provide supplemental requirements for Facilities owners (SaskPower and non-SaskPower) of non-synchronous wind or solar-PV generation (inverter-based resources) interconnecting to the SaskPower Transmission System.
- These requirements are subject to revision.

## 1.4. Compliance Requirements

### 1.4. Compliance Requirements – Supplemental

- Facilities must follow adopted NERC standards whether registered with SERA, MRO, or NERC or not.

# 3. GENERATION INTERCONNECTION FACILITY REQUIREMENTS

## 3.15. Control, Operating and Monitoring Requirements

### 3.15.4 Control, Operating and Monitoring – Performance Requirements

- Calculated power capability: Continuously calculated power capability, based on environmental measurements, provided to SaskPower's SCADA system in near real time (every 4 seconds).
  - Shall be tested during commissioning to demonstrate 95% average hourly accuracy.
- Pro-rated curtailable to any level via SCADA, due to dispatch limitations.
- Fully curtailable to any level via SCADA, due to local transmission constraints.
- Controlled power ramp rate limits (up and down), SCADA (remote) settable from 1% to 30% of rated MW per minute.

# 4. INVERTER BASED RESOURCE (IBR) REQUIREMENTS

## 4.16.3 Fast Frequency Response (FFR)

### 4.16.3.1 Fast Frequency Response (FFR) – Supplemental

- FFR is required to be provided from wind and solar-PV generation facilities from capacity or headroom that is required or requested by SaskPower for regulation.
- If the generation facility is curtailed for dispatch reasons, the curtailed capacity will also be added to the capacity available for FFR.

#### 4.16.3.1.1 FFR Performance Requirements - Supplemental

- Refer to IEEE 2800 Figure 5a for definitions of dynamic performance metrics and IEEE 2800 Section 6.2 for dynamic performance requirements.

- Additional requirements:
  - Frequency droop control mode: settable from 0 to 10% with 30 – 200 mhz adjustable deadband.
  - Reaction time  $\leq$  5ms.
  - Step response time  $\leq$  100ms (applied response time may be longer, depending on system studies).
  - Step response damping coefficient  $\geq$  0.3.

#### 4.16.4 Primary Frequency Response (PFR)

##### 4.16.4.1 Primary Frequency Response (PFR) – Supplemental

- PFR is required to be provided from wind and solar-PV generation facilities.
- PFR (down) is required to be provided from wind and solar-PV generation facilities independent of active power setpoint or dispatch.
- PFR (up) is required to be provided from wind and solar-PV generation facilities from available headroom that is required or requested by SaskPower for regulation.
- If the generation facility is curtailed for dispatch reasons, the curtailed capacity will also be added to the capacity available for "PFR-up".

##### 4.16.4.1.1 PFR Performance Requirements – Supplemental

- Refer to IEEE 2800 Figure 5a for definition of dynamic performance metrics for a control reference step and IEEE 2800 Table 8 for dynamic performance requirements.
- Additional requirements:
  - Frequency droop control mode: settable from 0 to 10% with 30 – 200 mhz adjustable deadband.
    - Droop and deadband to be provided by SaskPower.
  - Reaction time  $\leq$  5ms.
  - Step response time  $\leq$  100ms.
    - Applied response time may be longer, to be supplied by SaskPower.
  - Step response damping coefficient  $\geq$  0.3.

#### 4.16.5 Automatic Generation Control (AGC)

##### 4.16.5.1 Regulation

- Wind and solar-PV generation facilities (IBR) must follow AGC signals sent to it from SaskPower.
- Wind and solar-PV generation facilities (IBR) must provide additional capacity for regulation to offset their generation variability or make arrangements to take regulation service under SaskPower's OATT or an equivalent agreement.
  - A minimum of 5% of the nameplate capacity must be added to wind generation facilities for the purposes of regulation.
  - A minimum of 5% of the nameplate capacity must be added to solar-PV generation facilities for the purposes of regulation.
  - For hybrid wind and solar-PV generation facilities, a minimum of 5% of the total nameplate capacity must be added to hybrid generation facilities for the purpose of regulation.
  - The added capacity shall create a minimum capacity reservation (headroom for regulation-up) for regulation purposes.
  - For regulation-down an equivalent capacity reservation shall be reserved (headroom for regulation-down) for regulation purposes.

- Reservation shall be in physical units and maintained across the operating range of the generation facility.
- Regulation-up or regulation-down signals shall be sent to the generation facilities by SaskPower's AGC.
- If the generation facility is curtailed for dispatch reasons, the curtailed capacity will also be added to the capacity available for "regulation-up".

#### **4.16.5.1.1 Regulation Performance Requirements**

- AGC: Pro-rated, full AGC participation with ramp rate SCADA (remote) settable from 10 to 60 MW/min.

### **4.16.6 Negative Sequence Current Injection**

#### **4.16.6.1. Negative Sequence Current Injection – Supplemental**

- Facility shall inject negative sequence current during faults.

### **4.16.7 Design and Operation of the Facilities' Continuous and Dynamic Reactive Power Capability**

#### **4.16.7.1 Voltage Regulation – Supplemental**

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

#### **4.16.7.1.1 Voltage Regulation Performance Requirements – Supplemental**

- Refer to IEEE 2800 Figure 5b for definition of dynamic performance metrics for a system quantity step and IEEE 2800 Table 5 for dynamic performance requirements.
- Additional requirements:
  - Voltage droop AVR control mode: settable from 0 to 10%.
    - Droop to be provided by SaskPower.
  - Reaction time  $\leq 5\text{ms}$ .
  - Step response time  $\leq 100\text{ms}$ .
    - Applied response time may be longer, to be supplied by SaskPower.
  - Step response damping coefficient  $\geq 0.3$ .

### **4.16.8 Required Data for Inverter Based Resources**

#### **4.16.8.1 Required Data for Inverter Based Resources – Supplemental**

- In addition to Appendix D and E the facilities must also meet Appendices D-1 and E-1.

### **4.16.9 Power System Stabilizer (PSS) or Equivalent**

- PSS (Power System Stabilizer) or equivalent function shall be provided to damp any potential power oscillations.

### **4.16.10 IBR short-term rating**

- Facilities shall have a temporary power output capability:  $\geq 150\%$  for  $\geq 1$  second.

## APPENDIX D-1: SCADA Technical and Operating Requirements for Wind Aggregated Generating Facilities

Signal Type	Description	Unit
<b>Facility owner data acquisition requirements</b> for each wind aggregated facility directly connected to transmission system		
Analog	<b>Net real power</b> at point of connection	MW
	<b>Net reactive power</b> at point of connection	MVAr
	<b>Frequency</b> at the point of connection	Hz
	<b>Voltage</b> at the point of connection	kV
	<b>Voltage regulation</b> setpoint	kV
	<b>Potential real power capability</b> , which would have been produced at the point of connection without aggregated generation facilities curtailment and based on real time metrological conditions, update value every 4 seconds.	MW
	<b>Real power limit</b> used in the power curtailment limiting control system at the aggregated generating facility	MW
	<b>Up ramp power rate</b> of change setpoint	MW/min
	<b>Down ramp power rate</b> of change setpoint	MW/min
	<b>Real power</b> of each collector system feeder	MW
	<b>Reactive power</b> of each collector system feeder	MVAr
	<b>Voltage</b> for each collector bus	kV
	<b>Real power</b> of station service transformer greater than 0.5 MW	MW
	<b>Reactive power</b> of station service transformer greater than 0.5 MW	MVAr
	<b>Reactive power</b> of each reactive power resource (other than generating units)	MVAr
	<b>Real power</b> at low side of transmission system step up transformer	MW
	<b>Reactive power</b> at low side of transmission system step up transformer	MVAr
	Transmission system step up <b>transformer tap position</b> if load tap changer exists	Tap position
	<b>Wind Speed</b> at hub height as collected at the meteorological tower	m/s
	<b>Wind direction</b> from the true north as collected at the meteorological tower	Degrees
	<b>Wind Speed</b> at 50% hub height as collected at the meteorological tower	m/s
	<b>Ambient temperature</b> at hub height as collected at the meteorological tower	Degrees Celsius
	<b>Barometric pressure</b> at hub height as collected at the meteorological tower	Mbar
	<b>Relative humidity</b> at 2 to 10 m above ground at the meteorological tower	%
<b>Air density</b> at hub height	kg/m <sup>3</sup>	
<b>Precipitation</b> at the meteorological tower	mm	

**APPENDIX D-1: SCADA Technical and Operating Requirements for Wind Aggregated Generating Facilities**

Signal Type	Description	Unit	
<b>Facility owner data acquisition requirements for each wind aggregated facility directly connected to transmission system</b>			
Status	<b>Breaker</b> , circuit switchers, motor operated switches	0 = Open	1 = Closed
	<b>Communication failure alarm</b> from RTU acting as data concentrator of one or more generating units to the control center of transmission facility, if applicable	0 = Normal	1 = Alarm
	<b>Communication failure indication</b> between an intelligent electronic device and any remote RTU acting as a data concentrator	0 = Normal	1 = Alarm
	Each <b>collector system feeder breaker</b>	0 = Open	1 = Closed
	Each <b>reactive power resource feeder breaker</b>	0 = Open	1 = Closed
	<b>Power curtailment limiting control</b> system status	0 = Off	1 = On
	<b>Up ramp power rate of change control</b> status	0 = Off	1 = On
	<b>Down ramp power rate of change control</b> status	0 = Off	1 = On
	<b>Voltage regulation system</b> status	0 = Manual	1 = Automatic
	<b>Power system stabilizer</b> (or equivalent) status, if applicable	0 = Manual	1 = Automatic
	Generating unit <b>step up transformer voltage regulator</b> of transmission system if step up transformer has a load tap changer	0 = Manual	1 = Automatic
	<b>Remedial action scheme armed status</b> , if applicable	0 = Disarmed	1 = Armed
	<b>Remedial action scheme operated status on communication failure</b> , if applicable	0 = Normal	1 = Alarm
	<b>Remedial action scheme operated status on runback</b> , if applicable	0 = Normal	1 = Alarm
<b>Remedial action scheme operated status on trip</b> , if applicable	0 = Normal	1 = Alarm	
<b>Energy Management System supervisory control data requirements for each wind aggregated generating facility connected to the transmission system</b>			
Analog	<b>Facility curtailment power limit</b> setpoint	MW	
	<b>Up ramp power rate of change</b> setpoint	MW/min	
	<b>Down ramp power rate of change</b> setpoint	MW/min	
	<b>Voltage regulation</b> setpoint	kV	
Status	<b>Up ramp power rate of change</b> control	0 = Disable	1 = Enable
	<b>Down ramp power rate of change</b> control	0 = Disable	1 = Enable
	<b>Facility curtailment power limit</b> control	0 = Disable	1 = Enable

**APPENDIX E-1: SCADA Technical and Operating Requirements for Solar Aggregated Generating Facilities**

Signal Type	Description	Unit
<b>Facility owner data acquisition requirements</b> for each solar aggregated facility directly connected to transmission system		
Analog	<b>Net real power</b> at point of connection	MW
	<b>Net reactive power</b> at point of connection	MVAr
	<b>Frequency</b> at the point of connection	Hz
	<b>Voltage</b> at the point of connection	kV
	<b>Voltage regulation</b> setpoint	kV
	<b>Potential real power capability</b> , which would have been produced at the point of connection without aggregated generation facilities curtailment and based on real time metrological conditions, update value every 4 seconds.	MW
	<b>Real power limit</b> used in the power curtailment limiting control system at the aggregated generating facility	MW
	<b>Up ramp power rate</b> of change setpoint	MW/min
	<b>Down ramp power rate</b> of change setpoint	MW/min
	<b>Real power</b> of each collector system feeder	MW
	<b>Reactive power</b> of each collector system feeder	MVAr
	<b>Voltage</b> for each collector bus	kV
	<b>Real power</b> of station service transformer greater than 0.5 MW	MW
	<b>Reactive power</b> of station service transformer greater than 0.5 MW	MVAr
	<b>Reactive power</b> of each reactive power resource (other than generating units)	MVAr
	<b>Real power</b> at low side of transmission system step up transformer	MW
	<b>Reactive power</b> at low side of transmission system step up transformer	MVAr
	Transmission system step up <b>transformer tap position</b> if load tap changer exists	Tap position
	<b>Wind Speed</b> at between 2 to 10 m above ground at meteorological tower	m/s
	<b>Wind direction</b> from the true north at between 2 to 10 m above ground at meteorological tower	Degrees
	<b>Barometric pressure</b> at 2 to 10 m above ground as collected at the meteorological tower	Mbar
	<b>Relative humidity</b> at 2 to 10 m above ground at meteorological tower	%
	<b>Precipitation</b> at meteorological tower	mm
	<b>Battery bank charge level</b> at each PV bank	MW (DC)
	<b>Battery bank charge/discharge rate</b> at each PV bank	+/- MW/s
	<b>Ambient temperature</b> at each PV bank	Degrees Celsius
	<b>Solar tracking</b> at each PV bank	Degrees/s
	<b>Solar array plane</b> angle off horizontal at each PV bank	Degrees
	<b>Solar altitude</b> angle at each PV bank	Degrees
	<b>Solar azimuth</b> angle at each PV bank	Degrees
	<b>Solar incidence</b> angle at each PV bank	Degrees
	<b>Back of solar panel temperature</b> at each PV bank	Degrees Celsius
<b>Global horizontal irradiance</b> at each PV bank	W/m <sup>2</sup>	

**APPENDIX E-1: SCADA Technical and Operating Requirements for Solar Aggregated Generating Facilities**

Signal Type	Description	Unit	
<b>Facility owner data acquisition requirements for each solar aggregated facility directly connected to transmission system</b>			
Status	Breaker, circuit switchers, motor operated switches	0 = Open	1 = Closed
	Communication failure alarm from RTU acting as data concentrator of one or more generating units to the control center of transmission facility, if applicable	0 = Normal	1 = Alarm
	Communication failure indication between an intelligent electronic device and any remote RTU acting as a data concentrator	0 = Normal	1 = Alarm
	Each collector system feeder breaker	0 = Open	1 = Closed
	Each reactive power resource feeder breaker	0 = Open	1 = Closed
	Power curtailment limiting control system status	0 = Off	1 = On
	Up ramp power rate of change control status	0 = Off	1 = On
	Down ramp power rate of change control status	0 = Off	1 = On
	Voltage regulation system status	0 = Manual	1 = Automatic
	Power system stabilizer (or equivalent) status, if applicable	0 = Manual	1 = Automatic
	Generating unit step up transformer voltage regulator of transmission system if step up transformer has a load tap changer	0 = Manual	1 = Automatic
	Remedial action scheme armed status, if applicable	0 = Disarmed	1 = Armed
	Remedial action scheme operated status on communication failure, if applicable	0 = Normal	1 = Alarm
	Remedial action scheme operated status on runback, if applicable	0 = Normal	1 = Alarm
Remedial action scheme operated status on trip, if applicable	0 = Normal	1 = Alarm	
<b>Energy Management System supervisory control data requirements for each solar aggregated generating facility connected to the transmission system</b>			
Analog	Facility curtailment power limit setpoint	MW	
	Up ramp power rate of change setpoint	MW/min	
	Down ramp power rate of change setpoint	MW/min	
	Voltage regulation setpoint	kV	
Status	Up ramp power rate of change control	0 = Disable	1 = Enable
	Down ramp power rate of change control	0 = Disable	1 = Enable
	Facility curtailment power limit control	0 = Disable	1 = Enable