

SUPPLEMENTAL GENERATION INTERCONNECTION REQUIREMENTS

**(Applicable to Generation Interconnection Facilities
1 MW and Greater)**

July 13, 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 dynamic performance metrics
 - Frequency droop control mode: settable from 0 to 10% with 30 – 200 mhz adjustable deadband.

- Reaction time ≤ 5 ms.
- Step response time ≤ 100 ms (applied response time may be longer, depending on system studies).
- Step response damping coefficient ≥ 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 dynamic performance metrics for a control reference step
 - 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 ≤ 5 ms.
 - Step response time ≤ 100 ms
 - Applied response time may be longer, to be supplied by SaskPower.
 - Step response damping coefficient ≥ 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 9% 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 combined ratio may be considered for the purposes 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 dynamic performance metrics for a system quantity step
 - 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 ≥ 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 ≥ 1 second

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

Signal Type	Description	Unit
Facility owner data acquisition requirements for each wind aggregated facility directly connected to transmission system		
Analog	Net real power at point of connection	MW
	Net reactive power at point of connection	MVAr
	Frequency at the point of connection	Hz
	Voltage at the point of connection	kV
	Voltage regulation setpoint	kV
	Potential real power capability , 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
	Real power limit used in the power curtailment limiting control system at the aggregated generating facility	MW
	Up ramp power rate of change setpoint	MW/min
	Down ramp power rate of change setpoint	MW/min
	Real power of each collector system feeder	MW
	Reactive power of each collector system feeder	MVAr
	Voltage for each collector bus	kV
	Real power of station service transformer greater than 0.5 MW	MW
	Reactive power of station service transformer greater than 0.5 MW	MVAr
	Reactive power of each reactive power resource (other than generating units)	MVAr
	Real power at low side of transmission system step up transformer	MW
	Reactive power at low side of transmission system step up transformer	MVAr
	Transmission system step up transformer tap position if load tap changer exists	Tap position
	Wind Speed at hub height as collected at the meteorological tower	m/s
	Wind direction from the true north as collected at the meteorological tower	Degrees
	Wind Speed at 50% hub height as collected at the meteorological tower	m/s
	Ambient temperature at hub height as collected at the meteorological tower	Degrees Celsius
	Barometric pressure at hub height as collected at the meteorological tower	Mbar
	Relative humidity at 2 to 10 m above ground at the meteorological tower	%
Air density at hub height	kg/m ³	
Precipitation at the meteorological tower	mm	

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

Signal Type	Description	Unit	
Facility owner data acquisition requirements for each wind aggregated facility directly connected to transmission system			
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 centre 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	
Energy Management System supervisory control data requirements for each wind aggregated generating facility connected to the transmission system			
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

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

Signal Type	Description	Unit
Facility owner data acquisition requirements for each solar aggregated facility directly connected to transmission system		
Analog	Net real power at point of connection	MW
	Net reactive power at point of connection	MVAr
	Frequency at the point of connection	Hz
	Voltage at the point of connection	kV
	Voltage regulation setpoint	kV
	Potential real power capability , 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
	Real power limit used in the power curtailment limiting control system at the aggregated generating facility	MW
	Up ramp power rate of change setpoint	MW/min
	Down ramp power rate of change setpoint	MW/min
	Real power of each collector system feeder	MW
	Reactive power of each collector system feeder	MVAr
	Voltage for each collector bus	kV
	Real power of station service transformer greater than 0.5 MW	MW
	Reactive power of station service transformer greater than 0.5 MW	MVAr
	Reactive power of each reactive power resource (other than generating units)	MVAr
	Real power at low side of transmission system step up transformer	MW
	Reactive power at low side of transmission system step up transformer	MVAr
	Transmission system step up transformer tap position if load tap changer exists	Tap position
	Wind Speed at between 2 to 10 m above ground at meteorological tower	m/s
	Wind direction from the true north at between 2 to 10 m above ground at meteorological tower	Degrees
	Barometric pressure at 2 to 10 m above ground as collected at the meteorological tower	Mbar
	Relative humidity at 2 to 10 m above ground at meteorological tower	%
	Precipitation at meteorological tower	mm
	Battery bank charge level at each PV bank	MW (DC)
	Battery bank charge/discharge rate at each PV bank	+/- MW/s
	Ambient temperature at each PV bank	Degrees Celsius
	Solar tracking at each PV bank	Degrees/s
	Solar array plane angle off horizontal at each PV bank	Degrees
	Solar altitude angle at each PV bank	Degrees
	Solar azimuth angle at each PV bank	Degrees
Solar incidence angle at each PV bank	Degrees	
Back of solar panel temperature at each PV bank	Degrees Celsius	
Global horizontal irradiance at each PV bank	W/m ²	

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

Signal Type	Description	Unit	
Facility owner data acquisition requirements for each solar aggregated facility directly connected to transmission system			
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 centre 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	
Energy Management System supervisory control data requirements for each solar aggregated generating facility connected to the transmission system			
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