# Interim Availability Interconnection System Impact Study for Generator Interconnection

# GEN-2014-025

**December 2014**
**Generator Interconnection**

Southwest Power Pool

# Executive Summary

<OMITTED TEXT> (Customer; GEN-2014-025) has requested an Interim Availability Interconnection System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 2.415 MW of wind generation to be interconnected as an Energy Resource (ER) into the Transmission System of Midwest Energy, Inc (MIDW) in Rush County, Kansas. GEN-2014-025, under GIP Section 11A, has requested Interim Interconnection Service for this 2.415 MW of generation. Pursuant to GIP 11A.2.4, SPP is performing this Interim Availability Interconnection System Impact Study (IAISIS) to determine the impacts of interconnecting to the transmission system before the completion of the studies normally required under the GIP.

This IAISIS addresses the effects of interconnecting the generation to the rest of the transmission system for the system topology and conditions as expected in October 2015. GEN-2014-025 is requesting the interconnection of a 2.415 MW uprate of twenty-one (21) Siemens SWT-2.3 MW wind turbine generators and associated facilities at the GEN-2009-020 tap on the Nekoma – Bazine 69 kV line. The original Interconnection Request, GEN 2009-020, was studied for twenty-one (21) Siemens turbines that have a normal rating of 2.3 MW. The new rating of the generators will be 2.415 MW each for a total of 50.715 MW. The IAISIS assumes that only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within Table 2 of this report. If additional generation projects, listed within Table 4, with queue priority equal to or higher than the study project request rights to go into commercial operation before all Network Upgrades identified within Table 2 of this report are completed, this IAISIS will need to be restudied to ensure that interconnection service remains for the GEN-2014-025 request.

Power flow analysis from this IAISIS has determined that the GEN-2014-025 request can interconnect 2.415 MW of generation as an Energy Resource prior to the completion of the studies normally required under the GIP, and any required Network Upgrades (if any), listed within Table 2 of this report. Should any other projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available. It should be noted that although this IAISIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, it is likely that the Customer may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

SPP will coordinate with the Transmission Owner (MIDW) to determine if any additional facilities are required solely for the uprate of the generators. It is not anticipated that any additional facilities beyond what are already required for GEN-2009-020 will be required for Interim Interconnection Service. SPP will then tender the Interconnection Customer an Interim Generator Interconnection Agreement for the additional generation.

Nothing in this study should be construed as a guarantee of transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

# Table of Contents

# Purpose

<OMITTED TEXT> (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for an interconnection request into the Transmission System of Midwest Energy, Inc (MIDW).

GEN-2014-025 is requesting the interconnection of a 2.415 MW uprate of twenty-one (21) Siemens SWT-2.3 MW wind turbine generators and associated facilities at the GEN-2009-020 tap on the Nekoma – Bazine 69 kV line. The new rating of the generators will be 2.415 MW each for a total of 50.715 MW of generation.

The purpose of this study is to evaluate the impacts of interconnecting GEN-2014-025, a 2.415 MW uprate of twenty-one (21) Siemens SWT-2.3 MW wind turbine generators and associated facilities at the GEN-2009-020 tap on the Nekoma – Bazine 69 kV line in Rush County, Kansas. The Customer has requested this amount to be studied as an Energy Resource (ER) with Interim Interconnection Service to commence on or around December of 2014. The uprate of the generators will bring the total nameplate generation of the facility to 50.715 MW.

Power flow and Transient stability analysis were conducted for this IAISIS.

The IAISIS considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the IAISIS is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have a pending higher queued Interconnection Request to interconnect to the Transmission System listed in Table 1; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS at the expense of the Customer.

Nothing within this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service rights. Should the Customer require transmission service, those rights should be requested through SPP's Open Access Same-Time Information System (OASIS).

This IAISIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested 10/2015 in-service of GEN 2009-020 and GEN-2014-025 for this IAISIS. Also listed in Table 1 are both the amount of MWs of interconnection service expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

*Table 1: Generation Requests Included within IAISIS*

| Project | MW | Total MW | Fuel Source | POI | Status |
|---|---|---|---|---|---|
| GEN-2001-039M | 100.0 | 100.0 | Wind | Central Plains Tap 115kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2003-006A | 200.0 | 200.0 | Wind | Elm Creek 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2003-019 | 250.0 | 250.0 | Wind | Smoky Hills Tap 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2008-092 | 201.0 | 201.0 | Wind | Post Rock 230kV | IA FULLY EXECUTED/ON SCHEDULE |
| GEN-2009-020 | 48.3 | 48.3 | Wind | Tap Nekoma – Bazine 69kV | IA FULLY EXECUTED/ON SCHEDULE |
| GEN-2010-057 | 201.0 | 201.0 | Wind | Rice County 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2014-025 | 2.4 | 2.4 | Wind | Tap Nekoma – Bazine 69kV | DISIS STAGE |

This IAISIS was required because the Customer is requesting interconnection prior to the completion of all Interconnection Studies required under the GIP. Table 2 below lists the required upgrade projects for which this request currently has cost responsibility (if any). Table 3 below lists the projects that were included with this study. GEN-2014-025 is included within the DISIS-2014-002 to be posted January 31, 2014. This request may have additional cost responsibility for upgrades that will be assigned in DISIS-2014-002.

*Table 2: Required Network Upgrades*

| Upgrade Project | Type | Description | Status |
|---|---|---|---|
| To be determined in DISIS 2014-002 | | | |

*Table 2: Upgrade Projects included*

| Upgrade Project | Type | Description | Status |
|---|---|---|---|
| To be determined in DISIS 2014-002 | | | |

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS at the expense of the Customer. The higher or equally queued projects that were not included in this study are listed in Table 4. While this list is not all inclusive it is a list of the most probable and affecting prior queued requests that were not included within this IAISIS, either because no request for an IAISIS has been made or the request is on suspension, etc.

*Table 3: Higher or Equally Queued GI Requests not included within IAISIS*

| Project | Remainder MW | Total MW | Fuel | POI | Status |
|---|---|---|---|---|---|
| GEN-2006-040 | 108 | 108 | Wind | Mingo 115kV | IA FULLY EXECUTED/ON SUSPENSION |
| GEN-2007-011 | 135.0 | 135.0 | Wind | Syracuse 115kV | IA FULLY EXECUTED/ON SUSPENSION |
| GEN-2008-017 | 300.0 | 300.0 | Wind | Setab 345kV | IA FULLY EXECUTED/ON SCHEDULE |
| GEN-2009-008 | 199.5 | 199.5 | Wind | South Hays 230kV | IA FULLY EXECUTED/ON SUSPENSION |
| GEN-2010-048 | 70.0 | 70.0 | Wind | Tap Beach Station - Redline 115kV | DISIS STAGE |
| GEN-2013-033 | 28.0 | 28.0 | Gas | Goodman Energy Center 115kV | TRANSITIONED TO IFS QUEUE |
| GEN-2014-041 | 120.75 | 120.75 | Wind | Arnold 115kV | DISIS STAGE |
| ASGI-2013-004 | 29.6 | 29.6 | Gas | Morris 115kV | |

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

# Facilities

## Generating Facility

GEN-2014-025 Interconnection Customer's request to interconnect a 2.415 MW uprate of twenty-one (21) Siemens SWT-2.3 MW wind turbine generators wind turbine generators and associated interconnection facilities. The generators will have a 2.415 MW rating after the uprate.

## Interconnection Facilities

The POI for GEN-2014-025 Interconnection Customer is through the Nekoma – Bazine 69 kV line in Rush County, Kansas. Figure 1 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.

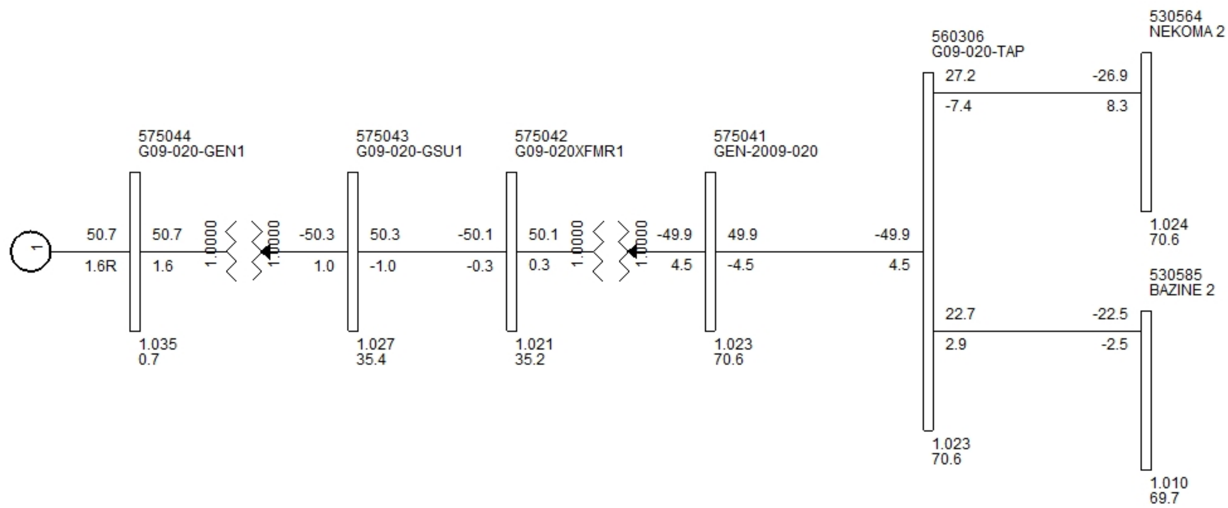


*Figure 1: Proposed POI Configuration and Request Power Flow Model*

## Base Case Network Upgrades

The Network Upgrades included within the cases used for this IAISIS study are those facilities that are a part of the SPP Transmission Expansion Plan or the Balanced Portfolio projects that have in-service dates prior to the GEN-2014-025 IAISIS requested in-service date of December 2014. These facilities have an approved Notice to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other upgrades were included for this IAISIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer.

# Power Flow Analysis

Power flow analysis is used to determine if the transmission system can accommodate the injection from the request without violating thermal or voltage transmission planning criteria.

## Model Preparation

Power flow analysis was performed using modified versions of the 2014 series of transmission service request study models including the 2015 (spring, summer, and winter) seasonal models. To incorporate the Interconnection Customer's request, a re-dispatch of existing generation within SPP was performed with respect to the amount of the Customer's injection and the interconnecting Balancing Authority. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. For this IAISIS, only the previous queued requests listed in Table 1 were assumed to be in-service.

## Study Methodology and Criteria

The ACCC function of PSS/E is used to simulate contingencies, including single and multiple facility (i.e. breaker-to-breaker, etc.) outages, within all of the control areas of SPP and other control areas external to SPP and the resulting data analyzed. This satisfies the "more probable" contingency testing criteria mandated by NERC and the SPP criteria.

The contingency set includes all SPP control area branches and ties 69 kV and above, first tier Non-SPP control area branches and ties 115 kV and above, any defined contingencies for these control areas, and generation unit outages for the SPP control areas with SPP reserve share program redispatch.

The monitor elements include all SPP control area branches, ties, and buses 69 kV and above, and all first tier Non-SPP control area branches and ties 69 kV and above. NERC Power Transfer Distribution Flowgates for SPP and first tier Non-SPP control area are monitored. Additional NERC Flowgates are monitored in second tier or greater Non-SPP control areas. Voltage monitoring was performed for SPP control area buses 69 kV and above.

## Results

The IAISIS ACCC analysis indicates that the Customer can interconnect generation into the MIDW transmission system as requested before all required upgrades (if any) listed within the DISIS-2014-002 study can be placed into service. Should any other GI requests, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available.

ACCC results for the IAISIS can be found in Table 5 and 6 below. Generator Interconnection Energy Resource analysis doesn't mitigate for those issues in which the affecting GI request has less than a 20% OTDF, Table 6 is provided for informational purposes only so that the Customer understands there may be operational conditions when they may be required to reduce their output to maintain system reliability.

## Limited Operation and System Reliability

In no way does this study guarantee limited operation for all periods of time. It should be noted that although this IAISIS analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, it is likely that the Customer may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

*Table 4: Interconnection Constraints for Mitigation of GEN-2014-025 IAISIS @ 2.415MW*

| Season | Dispatch Group | Flow | Monitored Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Max MW Available | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| All | | | N/A | | | | | 2.415 | N/A |

*Table 5: Additional Constraints of GEN-2014-025 IAISIS @ 2.415MW*

| Season | Dispatch Group | Flow | Monitored Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Max Available | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| All | | | N/A | | | | | 2.415 | N/A |

# Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

## Model Preparation

Transient stability analysis was performed using modified versions of the 2014 series of Model Development Working Group (MDWG) dynamic study models including the 2015 winter and 2015 summer seasonal models. The cases are then adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally the prior queued and study generation dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

## Disturbances

Twelve contingencies were identified for the Interim scenario for use in this study. These faults are listed within Table 7. These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

With exception to transformers, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically only performed for three-phase faults, unless otherwise noted. Additionally the sequence of events for a transformer is to 1) apply a three-phase fault for five (5) cycles and 2) clear the fault by tripping the affected transformer facility. Unless otherwise noted there will be no re-closing into a transformer fault.

*Table 7: Contingencies Evaluated for Limited Operation*

| | Contingency Number and Name | Description |
|---|---|---|
| 1 | FLT_01_G0920tap_Nekoma_69kV_3PH | *3-Phase fault on the GEN-2009-020 tap –Nekoma 69kV CKT 1 near the GEN-2009-020 tap 69kV bus.* |
| 2 | FLT_02_G0920tap_Bazine_69kV_3PH | *3-Phase fault on the GEN-2009-020 tap –Bazine 69kV CKT 1 near the GEN-2009-020 tap 69kV bus.* |
| 3 | FLT_03_Bazine_Pawnee_69kV_3PH | *3-Phase fault on the Bazine –Pawnee 69kV CKT 1 near the Bazine 69kV bus.* |
| 4 | FLT_04_Pawnee_Hanstn_69kV_3PH | *3-Phase fault on the Pawnee –Hanstn 69kV CKT 1 near the Pawnee 69kV bus.* |
| 5 | FLT_05_Hanstn_Kinsly_69kV_3PH | *3-Phase fault on the Hanstn –Kinsly 69kV CKT 1 near the Hanstn 69kV bus.* |
| 6 | FLT_06_Kinsly_Zook_69kV_3PH | *3-Phase fault on the Kinsly –Zook 69kV CKT 1 near the Kinsly 69kV bus.* |
| 7 | FLT_07_Zook_Seward_69kV_3PH | *3-Phase fault on the Zook –Seward 69kV CKT 1 near the Zook 69kV bus.* |
| 8 | FLT_08_Seward_GBSouth_69kV_3PH | *3-Phase fault on the Seward – GBSouth 69kV CKT 1 near the Seward 69kV bus.* |
| 9 | FLT_09_Seward_Hudson_69kV_3PH | *3-Phase fault on the Seward – Hudson 69kV CKT 1 near the Seward 69kV bus.* |
| 10 | FLT_10_Seward_SEWRDMW3_69_115kV_3PH | *3-Phase fault on the Seward 115/69/12.5kV transformer CKT 1 near the Seward 69kV bus.* |
| 11 | FLT_11_Nekoma_Albert_69kV_3PH | *3-Phase fault on the Nekoma – Albert 69kV CKT 1 near the Nekoma 69kV bus.* |
| 12 | FLT_12_Nekoma_Nekoma_69_115kV_3PH | *3-Phase fault on the Nekoma 115/69/12.5kV transformer CKT 1 near the Nekoma 115kV bus.* |

## Results

Results of the stability analysis are summarized in Table 8. These results are valid for the Customers interconnecting with a generation amount up to 2.415 MW given the study assumptions. The results indicate that the transmission system remains stable for all single contingencies studied. The plots will be available upon request.

*Table 8: Fault Analysis Results for Limited Operation*

| | Contingency Number and Name | 2014WP | 2015SP |
|---|---|---|---|
| 1 | FLT_01_G0920tap_Nekoma_69kV_3PH | Stable | Stable |
| 2 | FLT_02_G0920tap_Bazine_69kV_3PH | Stable | Stable |
| 3 | FLT_03_Bazine_Pawnee_69kV_3PH | Stable | Stable |
| 4 | FLT_04_Pawnee_Hanstn_69kV_3PH | Stable | Stable |
| 5 | FLT_05_Hanstn_Kinsly_69kV_3PH | Stable | Stable |
| 6 | FLT_06_Kinsly_Zook_69kV_3PH | Stable | Stable |
| 7 | FLT_07_Zook_Seward_69kV_3PH | Stable | Stable |
| 8 | FLT_08_Seward_GBSouth_69kV_3PH | Stable | Stable |
| 9 | FLT_09_Seward_Hudson_69kV_3PH | Stable | Stable |
| 10 | FLT_10_Seward_SEWRDMW3_69_115kV_3PH | Stable | Stable |
| 11 | FLT_11_Nekoma_Albert_69kV_3PH | Stable | Stable |
| 12 | FLT_12_Nekoma_Nekoma_69_115kV_3PH | Stable | Stable |

## FERC LVRT Compliance

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu.

Fault contingencies were developed to verify that wind farms remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table 9.

*Table 9: LVRT Contingencies*

| Contingency Name | Description |
|---|---|
| FLT_01_G0920tap_Nekoma_69kV_3PH | *3-Phase fault on the GEN-2009-020 tap –Nekoma 69kV CKT 1 near the GEN-2009-020 tap 69kV bus.* |
| FLT_02_G0920tap_Bazine_69kV_3PH | *3-Phase fault on the GEN-2009-020 tap –Bazine 69kV CKT 1 near the GEN-2009-020 tap 69kV bus.* |

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. Customers are found to be in compliance with FERC Order #661A.

# Conclusion

<OMITTED TEXT> (Interconnection Customer, GEN-2014-025) has requested an Interim Availability Interconnection System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 2.415 MW of wind generation to be interconnected as an Energy Resource (ER) into the transmission facility of Midwest Energy, Inc Services (MIDW) in Rush County, Kansas. The point of interconnection will be through a new tap on the Nekoma – Bazine 69 kV line. GEN-2014-025, under GIP Section 11A, has requested this Interim Availability System Impact Study (IAISIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2014-002 (or most recent iteration) Impact Study can be placed into service.

Power flow and Transient stability analysis from this IAISIS has determined that the GEN-2014-025 request can interconnect prior to the completion the DISIS-2014-002 study and of the required Network Upgrades (if any), listed within Table 2 of this report.

SPP will coordinate with the Transmission Owner (MIDW) to determine if any additional facilities are required solely for the uprate of the generators. It is not anticipated that any additional facilities beyond what are already required for GEN-2009-020 will be required for Interim Interconnection Service. SPP will then tender the Interconnection Customer an Interim Generator Interconnection Agreement for the additional generation.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, will require a re-study of this IAISIS at the expense of the Customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.