Interconnection Facilities Study

GEN-2015-005 (IFS-2015-001-04)

June 2016

Generator Interconnection

SPP Southwest Power Pool

Revision History

Date	Author	Change Description
2/22/2016	SPP	Draft Interconnection Facilities Study Report Revision 0 Issued
2/25/2016	SPP	Final Interconnection Facilities Study Report Revision 0 Issued
6/09/2016	SPP	Final Interconnection Facilities Study Report Revision 1 Issued to account for Affected System Impact Report and Costs

Table of Contents

Interconnection Facilities Study Summary

Interconnection Facilities Study Introduction

GEN-2015-005/IFS-2015-001-04 will be referred to in this study as the Interconnection Request. Interconnection Customer is the entity or entities making the request for interconnection. The Interconnection Request is a 200.11 MW wind farm facility located in DeKalb County, Missouri. The Interconnection Request was studied in the DISIS-2015-001 Impact Study as an Energy Resource Interconnection Service (ERIS) only request. Since the posting of the DISIS-2015-001 Impact Study the Interconnection Customer has executed the Interconnection Facilities Study Agreement per Appendix 4 or Appendix 4A and provided deposit securities as required by the Section 8.9 of the Generator Interconnection Produce (GIP) to proceed to the Interconnection Facilities Study. The GIP is covered under Attachment V of the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT). The request for interconnection was placed with SPP in accordance with OATT, which covers new generation interconnections on SPP's transmission system.

Kansas City Power and Light (KCPL) on the behalf of Transource Missouri (TMO) and Omaha Public Power District (OPPD) performed a detailed Interconnection Facilities Study at the request of SPP for the Interconnection Request. Originally, during the Interconnection Customer execution of Appendix 1 the Interconnection Customer proposed in-service date for the Interconnection Request is December 31, 2017. During the Interconnection Customer execution of Appendix 4, the Interconnection Customer proposed in-service date for the Interconnection Request is December 31, 2016. SPP has proposed the full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s) are completed. Full interconnection service will require Network Upgrade(s) listed in the "Other Network Upgrade(s)" section.

The primary objective of the Interconnection Facilities Study (IFS) is to identify necessary Transmission Owner Interconnection Facilities, network upgrade(s), other direct assigned upgrade(s), and associated upgrade lead times needed for the additional of the requested Interconnection Service into the SPP Transmission System at the specific Point of Interconnection (POI).

Phase(s) of Interconnection Service

It is not expected that Interconnection Service will occur in phases. However, Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

Credits/Compensation for Amounts Advanced for Network Upgrade(s)

Interconnection Customer shall be entitled to either credits or potentially Long Term Congestion Rights (LTCR), otherwise known as compensation, in accordance with Attachment Z2 of the SPP Tariff for any Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, and not refunded to the Interconnection Customer.

Interconnection Customer Interconnection Facilities

The Interconnection Request's Generation Facility currently consists of ninety-two (92) 2.0 MW General Electric (G.E.) and nine (9) 1.79 MW General Electric (G.E.) wind turbines for a total generating nameplate of 200.11 MW. The 34.5kV collector system for this wind farm is planned to be connect to one (1) 345/34.5kV Interconnection Customer owned and maintained transformer at the Interconnection Customer owned substation. A six (6) mile overhead 345kV transmission circuit will connect the Generating Facility from the Interconnection Customer owned substation to the new TMO owned and maintained Substation tapping the planned TMO Nebraska City – Mullins Creek – Sibley 345kV transmission circuit. The location of the new proposed substation in DeKalb County is approximately forty-seven (47) miles from Sibley 345kV on the Mullins Creek – Sibley transmission circuit in DeKalb County, Missouri. The Interconnection Customer will be responsible for all of the transmission facilities connecting the Interconnection Customer owned substation to the Point of Interconnection (POI) at the new Substation 345kV tapping the planned TMO Nebraska City – Mullins Creek – Sibley 345kV transmission circuit.

The Interconnection Customer will be responsible for any equipment located at the Customer substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI, including approximately 8.5 Mvar[1] of reactors to compensate for injection of reactive power into the transmission system under no/light wind conditions. Also, the Interconnection Customer will need to coordinate with the Transmission Owner for relay, protection, control, and communication system configurations.

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s)

To facilitate interconnection, the interconnecting Transmission Owner, TMO, will need to construct a new substation including a 345kV ring bus, three (3) 3000A continuous ampacity rated 345kV circuit breakers, disconnect switches, structures, and any associated terminal equipment for the acceptance of the Interconnection Customer's Interconnection Facilities. Also, for the addition of the Interconnection Request TMO will also require one (1) 25Mvar switchable reactor and one (1) 3000A continuous ampacity breaker at the new DeKalb County 345kV Substation. Currently, TMO estimates an Engineering and Construction (E&C) lead time of approximately eighteen (18) months after a fully executed Generator Interconnection Agreement (GIA) for the completion of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. Since this schedule may not meet the Interconnection Customer's most recent proposed commercial operation date, TMO will be open to negotiating the "Option to Build" choice during the negotiation period of the GIA for the Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s). Design expectations and standards for the "Option to Build" will be discussed during the GIA.

[1] This approximate minimum reactor amount is needed for the current configuration of the wind farm as studied in the DISIS-2015-001 Impact Study.

At this time, Interconnection Customer is responsible for $18,262,000 of TMO Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s). **Table 1** displays the estimated costs for TOIF and Non-Shared Network Upgrade(s).

Table 1: Interconnection Customer TOIF and Non-Shared Network Upgrade(s)

TOIF and Non-Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
TMO Interconnection Substation: Transmission Owner Interconnection Facilities 345kV Substation work for line terminal, line switch, dead end structure, line relaying, and revenue metering	$600,000	100%	$600,000
TMO Interconnection Substation - Non-Shared Network Upgrades 345kV Substation work for new ring bus, three (3)345kV 3000A circuit breakers, 25Mvar reactor, line relaying, disconnect switches, and associated equipment. Also includes all associated equipment and work to cut-in the new substation into the Mullin Creek - Sibley 345 kV.	$17,662,000	100%	$17,662,000
OPPD Affected Substations – Non-Shared Network Upgrades Substation relay work at Nebraska City	$0	100%	$0
Total	$18,262,000	100%	$18,262,000

If higher queued Interconnection Request, GEN-2014-021/IFS-2014-002-04 withdraws or terminates it's Generator Interconnection Request (GIR), Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s) for reactor power upgrade requirements could change for the Interconnection Request.

Shared Network Upgrade(s)

The Interconnection Request was studied in the DISIS-2015-001 Impact Study as an Energy Resource Interconnection Service (ERIS) only request. At this time, the Interconnection Customer is allocated $0 for Shared Network Upgrades. If higher queued Interconnection Request(s) withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued Interconnection Request(s) and the Network Upgrade(s) associated with those higher queued Interconnection Requests being placed in service. At this time, the Interconnection Customer is allocated the following cost listed in **Table 2** for Shared Network Upgrade.

Table 2: Interconnection Customer Shared Network Upgrades

Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
Currently not allocated Shared Network Upgrades	$0	n/a	$0
Total	$0	n/a	$0

Other Network Upgrade(s)

Certain Other Network Upgrades are currently not the cost responsibility of the Interconnection Customer but will be required for full Interconnection Service.

1) Nebraska City – Mullin Creek – Sibley 345kV circuit #1[2] assigned as SPP Priority Projects per SPP-NTC-20097 and 20098. This project is currently on schedule for 12/31/2016 in-service.

Depending upon the status of higher or equally queued customers, the Interconnection Request's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

Affected Systems Analysis

Per agreement between SPP and the Mid-Continent Independent System Operator (MISO), SPP has notified MISO of the GEN-2015-005 Interconnection Request as having possible impacts to the MISO Transmission System. Since the posting of original revision of the GEN-2015-005 Interconnection Facilities Studies report, MISO performed an Affected System Study for the Interconnection Requests. That study is attached. MISO identified constraints at the Raun 345kV substation owned by Mid-American Energy (MEC). The constraints were estimated at $50,000 to mitigate. These upgrades are assignable to GEN-2015-007 as the Interconnection Request that impacts the constraint. Currenlty, GEN-2015-005 is not assigned Affected System Indentified Network Upgrade(s).

Table 3: MISO Affected System Upgrades

MISO Affected System Upgrade Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
Currently no upgrades allocated to GEN-2015-005			$0
Total			$0

Conclusion

Interconnection Service for the Interconnection Request will be delayed until the Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades are constructed. The Interconnection Customer is responsible for $18,262,000 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated $0 for Shared Network Upgrades. After all Interconnection Facilities and Network

[2] SPP-NTC-20097 Link:
http://www.spp.org/documents/12572/ntc%2020097_kansas%20city%20power%20&%20light%20greater%20missouri%20operations%20company%20-%20harold%20wyble.pdf

SPP-NTC-20098 Link:
http://www.spp.org/documents/12571/ntc%2020098_omaha%20public%20power%20district%20-%20mohamad%20doghman%20.pdf

Upgrades have been placed into service, Interconnection Service for 200.11 MW, as requested by Interconnection Request can be allowed.

At this time the total allocation of costs assigned to Interconnection Customer for interconnection Service are estimated at $18,262,000.

Appendices

A: KCPL/TMO Transmission Owner Interconnection Facilities Study Report

See next page for KCPL/TMO Interconnection Facilities Study Report.

Transource Missouri

Facility Study for Southwest Power Pool

Generation Interconnection Request

GEN-2015-005

Studies prepared by Kansas City Power & Light Transmission Planning on behalf of Transource Missouri
October 28, 2015

Executive Summary

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (Tariff) and at the request of SPP, KCP&L Transmission Planning performed the following Facility Study on behalf of Transource Missouri (TMO) to satisfy the Facility Study Agreement executed by the requesting Interconnection Customer (Customer) for SPP Generation Interconnection request Gen-2015-005. The request for interconnection was placed with SPP in accordance the Tariff, which covers new generation interconnections on SPP member's transmission system. The Customer requests interconnection service for a 200-MW wind farm to connect into the Sibley– Mullin Creek 345 kV transmission line (Midwest Transmission Project; MTP) currently under development and construction by TMO. The Customer has proposed a commercial operation date for the wind farm of December 31, 2016. The requirements for interconnection consist of construction a new 345kV substation on the Sibley– Mullin Creek 345kV transmission line in De Kalb County, near Stewartsville, Missouri.

The total cost for TMO to construct the new 345kV substation, the interconnection facility, is estimated at $18,262,000. This estimate is accurate to +/- twenty (20) percent, based on current prices, in accordance with Attachment A of Appendix 4 of the Interconnection Facilities Study Agreement. However, recent cost fluctuations in materials are very significant and the accuracy of this estimate at the time of actual procurement and construction cannot be assured.

The current expected in-service date for the MTP line is December 31, 2016. The estimated construction schedule for completing the 345 kV interconnection substation is 18 months after execution of Generator Interconnection Agreement (GIA). Since this schedule cannot meet the Customer's requested commercial operation date, TMO is agreeable to the Customer selecting "Option to Build" choice in the GIA for constructing the interconnection substation.

This Facility Study does not guarantee the availability of transmission service necessary to deliver the additional generation to any specific point inside or outside the SPP transmission system. The transmission network facilities may not be adequate to deliver the additional generation output to the transmission system. If the Customer requests firm transmission service under the SPP Tariff at a future date, Network Upgrades or other new construction may be required to provide the service requested under the SPP Tariff.

Interconnection Facilities

The primary objective of this study is to identify the transmission owner network upgrades for interconnection facilities. The Customer desires to interconnect a 200-MW wind farm using VESTA 2 Mw wind turbines at a location near Stewartsville, Missouri to the Sibley– Mullin Creek 345 kV transmission line, currently under construction. The proposed commercial operation date for the wind farm is December 31, 2016. The Sibley – Mullin Creek 345 kV line will be constructed, owned, operated and maintained by Transource Missouri and is scheduled for an in-service date of December 31, 2016. In accordance with KCP&L Facility Connection Standards, the requirements for interconnection consist of constructing a new 345kV substation on the Sibley– Mullin Creek transmission line in De Kalb County Missouri. This 345kV substation shall be constructed, owned, operated and maintained by TMO. A one-line diagram of the proposed substation is shown in Figure 1 on page 6. The Customer will be responsible to construct, own and maintain all facilities on the Customer's side of the point of interconnection. The major components of the transmission owner network upgrades and their estimated costs are shown below.

TMO substation land	$ 200,000
TMO substation	$13,372,000
TMO transmission line cut-in	$ 850,000
TMO AFUDC & contingency	$ 3,840,000
Total	$18,262,000

Description of transmission owner network upgrades

TMO substation land: TMO will require seven (7) acres for suitable substation site at a location in close proximity to the Sibley– Mullin Creek 345 kV transmission line. The Customer may opt to convey necessary land rights for substation site to TMO. The Customer is responsible for acquiring the right of way required for the customer's transmission line connection from the wind farm to the TMO substation.

TMO substation: TMO will grade site to level and construct 345kV ring bus substation with three (3) 345kV breakers and three (3) 345 kV line terminal positions. Includes all bus work, line and disconnect switches, grounding grid, security fence, control house, system protection relaying, communications equipment, and station power equipment. The substation shall have a 3000 amp continuous rating and have the capability of interrupting 50,000 amps of fault current. The substation will include 345 kV revenue metering on Customer's transmission line from the generating facility. A disturbance monitoring device shall be installed that is capable of recording faults, frequency swings and other system disturbances. This device shall be equipped with a GPS time clock and shall be capable of using existing telephone systems.

TMO transmission line cut-in: TMO will install three (3) new 345 kV transmission dead-end towers and conductor spans to substation bus work. Customer is responsible for all facilities, including 345kV transmission elements, on the customer's side of the interconnection point.

Engineering, Procurement, and Construction Schedule: The schedule for TMO to design, procure equipment and construct a 345 kV substation of this type is approximately 18 months. Since this schedule may not meet the Customer's requested commercial operation date, TMO is agreeable to the Customer selecting the "Option to Build" choice in the GIA for constructing the interconnection substation. According to good business practice, the TMO engineering and procurement process cannot begin until the parties have executed a mutually agreeable Generation Interconnection Agreement.

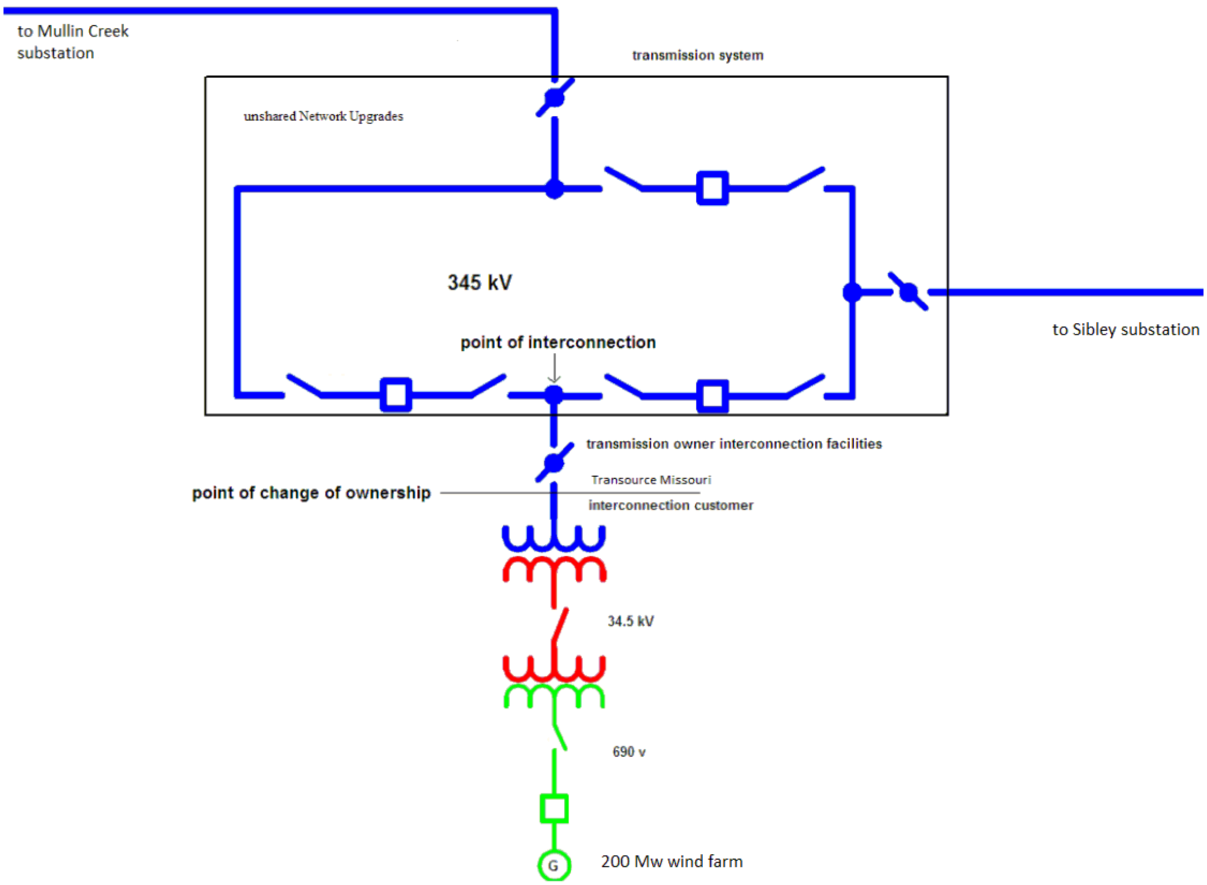
Short Circuit Fault Duty Evaluation

KCP&L engineering staff reviewed short circuit analysis performed by SPP for the proposed De Kalb County 345 kV substation to determine if the added generation would cause the available fault currents to exceed the interrupting capability of any existing KCP&L circuit breakers. The fault currents are within KCP&L's circuit breaker interrupting capability with the addition of the Gen-2015-005 wind farm.

Other Required Interconnection Facilities

The cost estimate includes one 25 Mvar 345kV shunt reactor as a place holder. Additional detailed study analysis is required to confirm the need for shunt reactive capability at the point of interconnection.

Figure 1: Preliminary One-Line Diagram De Kalb County 345kV Substation



B: OPPD Transmission Owner Interconnection Facilities Study Report

See next page for OPPD Interconnection Facilities Study Report.

December 2015

Omaha Public Power District

Facility Study for Southwest Power Pool Generation Interconnection Request

GEN-2015-005

Prepared By: OPPD Transmission Planning

Executive Summary

A generation interconnection customer has requested Energy Recourse Interconnection Service (ERIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for the purpose adding a 200.11 MW wind generating facility in De Kalb County, Missouri. The proposed in-service date for this request is 12/31/16. A Definitive Interconnection System Impact Study (DISIS-2015-001) was performed by SPP and completed in July 2015 to study this generation interconnection (GI) request. The GI request is identified in SPP's generation interconnection queue as GEN-2015-005.

The point of interconnection (POI) for this 200.11 MW GI request is on the KCPL-GMO system approximately 47 miles from Sibley on the planned Sibley-Mullins Creek 345 kV transmission line. The Sibley-Mullins Creek section is part of a new 345 kV interconnection between OPPD and KCPL-GMO. The Nebraska section of the interconnection line will be owned and operated by OPPD and the Missouri section will be owned by Transource and operated by KCPL-GMO.

OPPD has conducted a facility study for the GEN-2015-005. The results of OPPD's facility study are summarized below:

Detailed Costs and Project Schedule for Required Interconnection

Study results did not identify any OPPD network upgrades or interconnection costs required for GEN-2015-005.

Upgrades	Initiating Study	Costs
NONE		

Steady State Powerflow Study Results:

- No thermal constraints with an impact greater than or equal to 20% or voltage constraints with an impact greater than or equal to 0.01 pu were identified for TPL-001-4 (system intact, single contingency & multiple contingency) conditions for the addition of GEN-2015-005.

Short Circuit Study Results:

- The results from this short circuit assessment showed GEN-2015-005 had a small effect on both three-phase and line-to-ground fault currents near the OPPD area. After adding the GEN-2015-005 all impacted buses in the OPPD area were effected by less than 1 kA. The symmetrical fault current increased at the nearest OPPD facility (S3458) by approximately 83 amps (0.25%). The fault current increase from the GEN-2015-005 wind farm did not cause any OPPD equipment ratings to be exceeded.

Steady State Analysis

Computer Programs

Steady-state analysis was performed using PSS®E version 33.

Methodology

Base cases representing system conditions in 2015 spring, summer, and winter peak seasons, the 2020 summer and winter peak seasons, and the 2025 summer peak season were created without the GEN-2015-005 project. Study cases were then created by adding the GEN-2015-005 project and dispatching the generating facility at 200.11 MW. Nonlinear (AC) contingency analysis was performed on both the base and study cases and the incremental impact of the GEN-2015-005 project was evaluated by comparing flows and voltages with and without the proposed interconnection.

The steady state contingency analysis performed covered all contingencies (P1 through P7) represented in NERC standard TPL-001-4.

Steady State Model

The following SPP DIS 2015 models series were used in this analysis.

- DIS1501TC13ALL-15G0
- DIS1501TC13ALL-15SP0
- DIS1501TC13ALL-15WP0
- DIS1501TC13ALL-20SP0
- DIS1501TC13ALL-20WP0
- DIS1501TC13ALL-25SP0

These models had wind generation in cluster group 9 (Nebraska Area) and 13 (Northwest Missouri Area) set to 20% of nameplate capacity and projects GEN-2014-021 and GEN-2015-005 set to 100% by default. In addition to the default dispatch these models were modified to include other relevant prior queued generating facilities from cluster group 9 (Nebraska) and Iowa. All wind generation that was added to the model or in the area of the studied project GEN-2015-005 was set to 100% of nameplate capacity and sunk to generation outside the study area in four directions. The location of the generation in the area of GEN-2015-005 is shown in Figure 1. The following generating facilities were either added or dispatched to their maximum nameplate capacity in the models:

- GEN-2008-119O (Nebraska) 60 MW
- GEN-2008-123N (Nebraska) 89.7 MW
- GEN-2009-040 (Nebraska) 74.0 MW
- GEN-2010-041 (Nebraska) 10.5 MW
- GEN-2011-018 (Nebraska) 73.6 MW
- GEN-2013-002 (Nebraska) 50.6 MW
- GEN-2013-008 (Nebraska) 1.2 MW
- GEN-2013-014 (Nebraska) 25.5 MW
- GEN-2013-019 (Nebraska) 73.6 MW
- R26 - (Iowa) 400 MW
- GEN-2014-004 (Nebraska) 3.96 MW
- GEN-2014-039(Nebraska) 73.39 MW

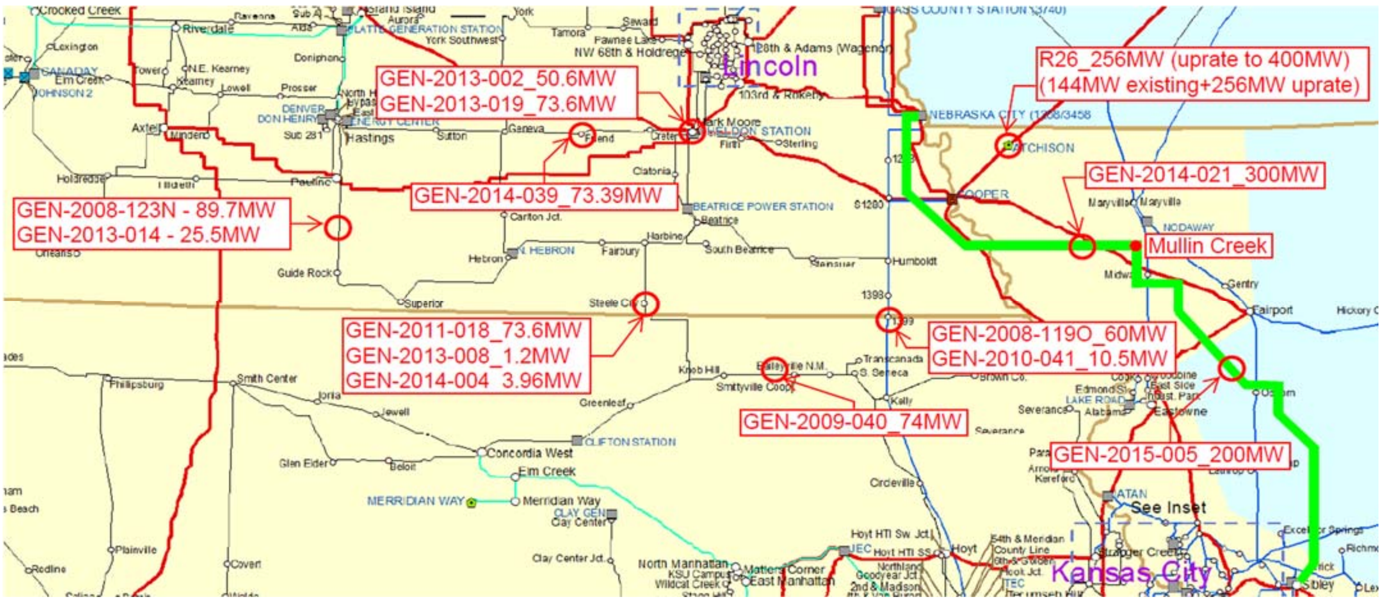


Figure 1: Location of generation modified from SPP DIS models.

Cases were solved with transformer tap adjustment enabled, area interchange enabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

The model parameters used in this study for GEN-2015-005 are documented in Section A.1 of Appendix A.

Contingency Criteria

Contingencies considered for steady-state analysis includes:

- System intact (no contingencies)
- Single Contingency analysis
  - All transmission facilities 69 kV and above in OPPD’s control area (area 645) and select neighboring transmission facilities 345kV and above near the POI.
- Multiple Contingency analysis
  - All transmission facilities 100 kV and above in OPPD’s control area (area 645) and select neighboring transmission facilities 345kV and above near the POI.

As part of the multiple contingency analysis, an N-1-1 analysis was performed to evaluate the impacts of planned prior outages. Planned prior outages that may be problematic are typically scheduled during light load conditions.

For all contingency and post-disturbance analyses, cases were solved with transformer tap adjustment enabled, area interchange adjustment enabled, phase shifter adjustment enabled and switched shunt adjustment enabled.

Monitored Elements

All transmission facilities 100 kV and above in OPPD’s control system were monitored.

Thermal loadings were monitored for 90% and above for the system intact and single event contingency analysis and 95% and above for the N-1-1 analysis.

Voltages were monitored outside the range of 0.95 to 1.05 pu for both the base case and change case.

Reliability Margins

All system elements were monitored using the applicable facility ratings.

Performance Criteria

A branch is considered a significantly affected facility (SAF) if both of the following conditions are met:

1) The branch is loaded above its applicable normal or emergency rating for the post-change case.
2) The distribution factor is greater than 20% for ERIS.

For non-linear contingency analysis, distribution factors are calculated as follows:
Project MW

$$DF = 100 \times \frac{MVA\ flow\ (with\ Project) - MVA\ flow\ (w/o\ Project)}{Project\ MW}$$

A voltage impact is considered significant if both of the following conditions are met; all significant voltage impacts must be resolved before a project can receive interconnection service.

1) The bus voltage is outside of applicable normal or emergency limits for the post-change case.
2) The change in bus voltage between the change case and base case is greater than 0.01 per unit (pu).

Contingency Analysis Results

The incremental impact of the proposed interconnection on individual facilities was evaluated by comparing flows and voltages without and with the project. Analysis was performed using PSS®E activity ACCC. Although the analysis only required results to be screened to a distribution factor greater than 20% for ERIS they were screened to 3%.

System Intact Conditions

There were no facilities that met the SAF criteria for voltage or thermal conditions for NERC TPL-001-4 category P0 (pre-contingency) conditions.

Single & Multiple Event Contingencies

There were no facilities that met the SAF criteria for voltage or thermal conditions for NERC TPL-001-4 category P1, P2, P3, P4, P5, P6 and P7 conditions.

Short Circuit Study

Computer Programs

Short-Circuit analyses was performed using PSS®E version 32.

Methodology

Analysis was performed using PSS®E activity ANSI, which calculates fault currents according to the ANSI/IEEE Standard C37.5-1979. The following assumptions were made during execution of activity ANSI:

- Maximum operating voltage is 1.05 pu
- Transformer impedance correction was not applied to zero-sequence transformer impedances
- For branches and machines with a zero value of resistance in the positive or zero sequence network, the zero value was replaced with a non-zero resistance equal to the positive or zero sequence reactance divided by a scaling factor. A scaling factor of 83 for branches and a factor of 252 for machines were used.
- The fault-current multiplying factors include the effects of dc decrement only
- Reactance is used to determine short-circuit current magnitudes (E/X calculation)
- Contact parting times are the minimum parting times shown in Figure 10 of IEEE Standard C37.010-1999, i.e., three-cycle contact parting time for 5-cycle breaker, two-cycle contact parting time for 3-cycle breaker, and 1.5-cycle contact parting time for 2-cycle breaker.

For both three-phase and single-line-to-ground faults, activity ANSI calculates the symmetrical fault current, the X/R ratio as specified in ANSI/IEEE Standard C37.5-1979 and IEEE Standard C37.010-1999, and the fault-current multiplying factor from ANSI/IEEE Standard C37.5-1979 for determining the adequacy of the interrupting capability of breakers rated on a total current basis. Fault-current multiplying factors for determining the adequacy of the interrupting capability of breakers rated on a symmetrical current basis are not calculated by the activity and were determined external to PSS®E from IEEE Standard C37.010-1999 and C37.04-1999.

Results were produced for a transmission-system topology of all branches in service for all buses within the OPPD area and all buses seven or fewer buses away from the GEN-2015-005 POI. Results were analyzed for increases in fault current caused by the GEN-2015-005 between three-phase and single-line-to-ground faults of the product of the symmetrical fault current and the fault-current multiplying factor. An evaluation was done to determine if any of the circuit breakers in OPPD's system would have inadequate interrupting capability based on the results for a transmission-system topology of all branches in service. For any such breakers, more-detailed analysis would then be performed to determine the actual interrupting duty of those breakers based on the configuration of the substation in which they are located.

For the OPPD system, only circuit breakers at a nominal voltage level of 69 kV or higher were evaluated. Adequacy of the interrupting capability of each OPPD circuit breaker was determined by multiplying the symmetrical fault current (or total fault current as applicable to the rating) seen by the breaker by the appropriate fault-current multiplying factor and comparing the result with the breaker's interrupting rating reduced for reclosing service as appropriate.

Short-Circuit Model

The short circuit analysis was performed using the best available short circuit model to assess the fault duty of buses within the study area and to identify if any circuit breaker ratings were exceeded as a result of the GEN-2015-005 addition.

For the short circuit model OPPD developed two cases: a base case without GEN-2015-005 and a study case which included GEN-2015-005. The only difference between the base case and the study case was the inclusion of the GEN-2015-005 in the study case.

A one-line diagram showing how the GEN-2015-005 project was modeled is shown in Figure 3. The model parameters used in this study for GEN-2015-005 are documented in Section A.2 of Appendix A.

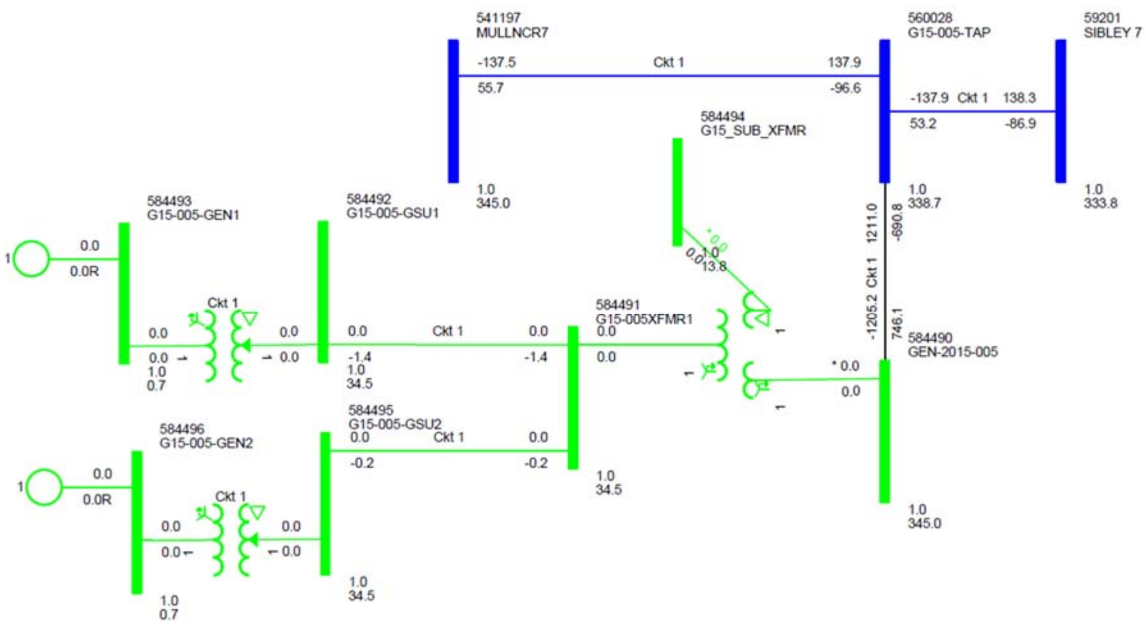


Figure 3: GEN-2015-005 Short Circuit One-Line Diagram

Results

Results, from the base case and the study case, for asymmetrical fault current and the product of symmetrical fault current and the appropriate multiplying factor from the ANSI/IEEE standards for a transmission-system topology of all branches in service were compared to study the impact of adding GEN-2015-005. Results were reviewed for busses with a fault current increase of greater than or equal to one amp for breakers with rated interrupting times of 2, 3 and 5 cycles for all buses seven or fewer buses away from the GEN-2015-005 POI and for all OPPD area busses. The higher of the currents for either three-phase or single-line-to-ground faults were used in the comparison to the breaker rating.

The results of the short circuit analysis show fault current increases at several substation in the study area. The largest increase at an OPPD facility was observed at S3458 to be 0.25% (83 amps) and outside the OPPD area at Mullin Creek at 4.1% (417 amps). After adding the GEN-2015-005 all impacted buses in the OPPD area were effected by less than 1 kA.

OPPD performed an evaluation to determine whether any of the circuit breakers would have inadequate interrupting capability as a result of the fault current from adding the GEN-2015-005 wind farm. The fault current increase from the GEN-2015-005 wind farm did not cause any OPPD equipment ratings to be exceeded.

Appendix A. Modeling Data for GEN-2015-005

A.1 Power Flow Model Data

PSS®E Activity EXAM

DATA FOR BUS 560028 [G15-005T   345.00] RESIDING IN AREA 540, ZONE 595, OWNER 540:

```
                                                                                  X--- NORMAL --X  X- EMERGENCY -X
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE   VMAX    VMIN     VMAX    VMIN
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.01842 -16.55 1.10000 0.90000  1.10000 0.90000

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
541197 MULLNCR7    345.00  1   0.00176  0.02673  0.48598  1  T  1792.0 1792.0 1792.0   55.0     540 1.000
541201 SIBLEY 7    345.00  1   0.00150  0.02285  0.41530  1  F  1792.0 1792.0 1792.0   47.0     540 1.000
562665 G15_005_1   345.00  1   0.00000  0.00010  0.00000  1  F     0.0    0.0    0.0    6.0  Z  540 1.000
```

DATA FOR BUS 562665 [G15_005_1   345.00] RESIDING IN AREA 540, ZONE 595, OWNER 540:

```
                                                                                  X--- NORMAL --X  X- EMERGENCY -X
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE   VMAX    VMIN     VMAX    VMIN
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.01842 -16.55 1.10000 0.90000  1.10000 0.90000

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
560028 G15-005T    345.00  1   0.00000  0.00010  0.00000  1  T     0.0    0.0    0.0    6.0  Z  540 1.000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED             MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
562666 G15_005_2   34.500  1  G1505SUB     1 T T 2 1  0.00213  0.08500  138.0  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 VECTOR GROUP
562666 G15_005_2   34.500  1  1 1.00000 0.0000    0.0 1.00000 0.0000    0.0    0.0    0.0  540 1.000

X------- TO BUS --------X     W C                                          X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
562666 G15_005_2   34.500  1  T 1  0 1.10000 0.90000 1.10000 0.90000   33                                0.000
```

DATA FOR BUS 562666 [G15_005_2   34.500] RESIDING IN AREA 540, ZONE 595, OWNER 540:

```
                                                                                  X--- NORMAL --X  X- EMERGENCY -X
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE   VMAX    VMIN     VMAX    VMIN
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.01271  -9.73 1.10000 0.90000  1.10000 0.90000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED             MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
```

```
562665 G15_005_1   345.00  1  G1505SUB     1 F F 2 1  0.00213  0.08500  138.0  0.00000  0.00000  0
562667 G15_005_3   0.6900  1  G1505GSU1    1 T T 2 1  0.00767  0.05750  225.0  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 VECTOR GROUP
562665 G15_005_1   345.00  1  1 1.00000 0.0000    0.0 1.00000 0.0000    0.0    0.0    0.0  540 1.000
562667 G15_005_3   0.6900  1  1 1.00000 0.0000    0.0 1.00000 0.0000    0.0    0.0    0.0  540 1.000

X------- TO BUS --------X     W C                                        X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
562665 G15_005_1   345.00  1  F 1  0 1.10000 0.90000 1.10000 0.90000   33                              0.000
562667 G15_005_3   0.6900  1  T 1  0 1.10000 0.90000 1.10000 0.90000    5                              0.000
```

DATA FOR BUS 562667 [G15_005_3   0.6900] RESIDING IN AREA 540, ZONE 595, OWNER 540:

```
                                                                                  X--- NORMAL --X  X- EMERGENCY -X
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE   VMAX    VMIN     VMAX    VMIN
 2     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.02000  -6.90 1.10000 0.90000  1.10000 0.90000

                                                 X--------- REMOTE BUS ----------X
PLNT PGEN    QGEN    QMAX    QMIN  VSCHED  PCT Q   BUS# X-- NAME --X BASKV VOLTAGE
    200.1     7.3    65.8   -65.8 1.02000 100.00

ID ST  PGEN   QGEN   QMAX   QMIN  MBASE  Z S O R C E    X T R A N   GENTAP   PMAX   PMIN OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 WMOD   WPF
1  1  184.0    6.7   60.5  -60.5  204.4 0.0000 0.8000 0.0000 0.0000 1.0000  184.0    0.0  540 1.000                                       2  0.9500
2  1   16.1    0.6    5.3   -5.3   17.9 0.0000 0.8000 0.0000 0.0000 1.0000   16.1    0.0  540 1.000                                       2  0.9500

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED              MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
562666 G15_005_2   34.500  1  G1505GSU1    1 F F 2 1  0.00767  0.05750  225.0  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 VECTOR GROUP
562666 G15_005_2   34.500  1  1 1.00000 0.0000    0.0 1.00000 0.0000    0.0    0.0    0.0  540 1.000

X------- TO BUS --------X     W C                                        X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
562666 G15_005_2   34.500  1  F 1  0 1.10000 0.90000 1.10000 0.90000    5                              0.000
```

A.2 Short Circuit Wind Farm Parameters

PSS®E Activity EXAM

DATA FOR BUS 560028 [G15-005-TAP 345.00] RESIDING IN AREA 540, ZONE 595, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 0.98186   2.23
```

```
X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
 59201 SIBLEY 7    345.00  1   0.00155  0.02285  0.41529  1  F  1792.0 1792.0 1792.0   47.0     540 1.000
541197 MULLNCR7    345.00  1   0.00181  0.02673  0.48599  1  T  1792.0 1792.0 1792.0   55.0     540 1.000
584490 GEN-2015-005345.00  1   0.00029  0.00299  0.05040  1  F     0.0    0.0    0.0    6.0     540 1.000
```

DATA FOR BUS 584490 [GEN-2015-005345.00] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
560028 G15-005-TAP 345.00  1   0.00029  0.00299  0.05040  1  T     0.0    0.0    0.0    6.0     540 1.000

X- XFRMER -X X---- WINDING 1 BUS ----X X---- WINDING 2 BUS ----X X---- WINDING 3 BUS ----X     S C C C
X-- NAME --X   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV CKT T W Z M OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
G15_SUB_XFMR 584490 GEN-2015-005345.00 584491 G15-005XFMR134.500 584494 G15_SUB_XFMR13.800  1  1 1 2 1  540 1.000

X- XFRMER -X S C X--------- SPECIFIED NOMINAL MEASURED IMPEDANCES AND MVA BASES ----------X X-ACTUAL IMPEDANCES FROM IMPEDANCE CORRECTION TABLE-X
X-- NAME --X T Z   R 1-2    X 1-2 SBAS1-2   R 2-3    X 2-3 SBAS2-3   R 3-1    X 3-1 SBAS3-1   R 1-2    X 1-2    R 2-3    X 2-3    R 3-1    X 3-1
G15_SUB_XFMR 1 2  0.00191  0.07648  300.0  0.00191  0.07648  300.0  0.00191  0.07648  300.0

X- XFRMER -X X----- WINDING BUS -----X  S C    MAGNETIZING Y   SYSTEM BASE NOM.                           TBL CORRECTED   STAR POINT BUS
X-- NAME --X   BUS# X-- NAME --X BASKV  T M    MAG1     MAG2   R WNDNG  X WNDNG  RATEA  RATEB  RATEC TBL R WNDNG  X WNDNG VOLTAGE  ANGLE
G15_SUB_XFMR 584490 GEN-2015-005345.00* 1 1  0.00000  0.00000  0.00032  0.01275  500.0  500.0  500.0  0                    1.00000    0.0
             584491 G15-005XFMR134.500  1                      0.00032  0.01275  500.0  500.0  500.0  0
             584494 G15_SUB_XFMR13.800* 1                      0.00032  0.01275  166.7  166.7  166.7  0

X- XFRMER -X X----- WINDING BUS -----X C                                                           X---- CONTROLLED BUS ----X CNXTN
X-- NAME --X   BUS# X-- NAME --X BASKV W CN  WIND V  NOM V  ANGLE   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV ANGLE    CR      CX
G15_SUB_XFMR 584490 GEN-2015-005345.00 1  0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584491 G15-005XFMR134.500    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584494 G15_SUB_XFMR13.800    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
```

DATA FOR BUS 584491 [G15-005XFMR134.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584492 G15-005-GSU134.500  1   0.00305  0.00278  0.02792  1  F     0.0    0.0    0.0    0.0     540 1.000
584495 G15-005-GSU234.500  1   0.04000  0.02814  0.00301  1  F     0.0    0.0    0.0    0.0     540 1.000

X- XFRMER -X X---- WINDING 1 BUS ----X X---- WINDING 2 BUS ----X X---- WINDING 3 BUS ----X     S C C C
X-- NAME --X   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV CKT T W Z M OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
G15_SUB_XFMR 584490 GEN-2015-005345.00 584491 G15-005XFMR134.500 584494 G15_SUB_XFMR13.800  1  1 1 2 1  540 1.000

X- XFRMER -X S C X--------- SPECIFIED NOMINAL MEASURED IMPEDANCES AND MVA BASES ----------X X-ACTUAL IMPEDANCES FROM IMPEDANCE CORRECTION TABLE-X
X-- NAME --X T Z   R 1-2    X 1-2 SBAS1-2   R 2-3    X 2-3 SBAS2-3   R 3-1    X 3-1 SBAS3-1   R 1-2    X 1-2    R 2-3    X 2-3    R 3-1    X 3-1
G15_SUB_XFMR 1 2  0.00191  0.07648  300.0  0.00191  0.07648  300.0  0.00191  0.07648  300.0
```

```
X- XFRMER -X X----- WINDING BUS -----X  S C    MAGNETIZING Y   SYSTEM BASE NOM.                           TBL CORRECTED   STAR POINT BUS
X-- NAME --X   BUS# X-- NAME --X BASKV  T M    MAG1     MAG2   R WNDNG  X WNDNG  RATEA  RATEB  RATEC TBL R WNDNG  X WNDNG VOLTAGE  ANGLE
G15_SUB_XFMR 584490 GEN-2015-005345.00* 1 1  0.00000  0.00000  0.00032  0.01275  500.0  500.0  500.0  0                    1.00000    0.0
             584491 G15-005XFMR134.500  1                      0.00032  0.01275  500.0  500.0  500.0  0
             584494 G15_SUB_XFMR13.800* 1                      0.00032  0.01275  166.7  166.7  166.7  0

X- XFRMER -X X----- WINDING BUS -----X C                                                        X---- CONTROLLED BUS ----X CNXTN
X-- NAME --X   BUS# X-- NAME --X BASKV W CN  WIND V  NOM V  ANGLE   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV ANGLE    CR       CX
G15_SUB_XFMR 584490 GEN-2015-005345.00 1  0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584491 G15-005XFMR134.500    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584494 G15_SUB_XFMR13.800    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
```

DATA FOR BUS 584492 [G15-005-GSU134.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584491 G15-005XFMR134.500  1   0.00305  0.00278  0.02792  1  T     0.0    0.0    0.0    0.0     540 1.000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED              MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
584493 G15-005-GEN10.6900  1  GEN_1_GSU    1 F F 2 1  0.00760  0.05700  207.0  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584493 G15-005-GEN10.6900  1  1 1.00000 0.0000    0.0 1.00000 0.0000  207.0  207.0    0.0  540 1.000

X------- TO BUS --------X     W C                                   X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV    ANGLE    CR       CX
584493 G15-005-GEN10.6900  1  F 1  0 1.10000 0.90000 1.10000 0.90000    5                              0.000
```

DATA FOR BUS 584493 [G15-005-GEN10.6900] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 2     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

                                                     X--------- REMOTE BUS ----------X
PLNT PGEN    QGEN    QMAX    QMIN  VSCHED  PCT Q   BUS# X-- NAME --X BASKV VOLTAGE
      0.0     0.0    89.1   -89.1 1.03000 100.00

ID ST  PGEN   QGEN   QMAX   QMIN  MBASE  Z S O R C E    X T R A N   GENTAP   PMAX   PMIN OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 WMOD   WPF
1  1    0.0    0.0   89.1  -89.1  204.4 0.0000 0.8000 0.0000 0.0000 1.0000  184.0   17.2  540 1.000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED              MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
584492 G15-005-GSU134.500  1  GEN_1_GSU    1 T T 2 1  0.00760  0.05700  207.0  0.00000  0.00000  0

X------- TO BUS --------X     C
```

```
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584492 G15-005-GSU134.500  1  1 1.00000 0.0000    0.0 1.00000 0.0000  207.0  207.0    0.0  540 1.000

X------- TO BUS --------X     W C                                     X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
584492 G15-005-GSU134.500  1  T 1  0 1.10000 0.90000 1.10000 0.90000    5                               0.000
```

DATA FOR BUS 584494 [G15_SUB_XFMR13.800] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

X- XFRMER -X X---- WINDING 1 BUS ----X X---- WINDING 2 BUS ----X X---- WINDING 3 BUS ----X     S C C C
X-- NAME --X   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV CKT T W Z M OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
G15_SUB_XFMR 584490 GEN-2015-005345.00 584491 G15-005XFMR134.500 584494 G15_SUB_XFMR13.800  1  1 1 2 1  540 1.000

X- XFRMER -X S C X--------- SPECIFIED NOMINAL MEASURED IMPEDANCES AND MVA BASES ----------X X-ACTUAL IMPEDANCES FROM IMPEDANCE CORRECTION TABLE-X
X-- NAME --X T Z   R 1-2    X 1-2 SBAS1-2   R 2-3    X 2-3 SBAS2-3   R 3-1    X 3-1 SBAS3-1   R 1-2    X 1-2    R 2-3    X 2-3    R 3-1    X 3-1
G15_SUB_XFMR 1 2  0.00191  0.07648  300.0  0.00191  0.07648  300.0  0.00191  0.07648  300.0

X- XFRMER -X X----- WINDING BUS -----X  S C    MAGNETIZING Y   SYSTEM BASE NOM.                           TBL CORRECTED   STAR POINT BUS
X-- NAME --X   BUS# X-- NAME --X BASKV  T M    MAG1     MAG2   R WNDNG  X WNDNG  RATEA  RATEB  RATEC TBL R WNDNG  X WNDNG VOLTAGE  ANGLE
G15_SUB_XFMR 584490 GEN-2015-005345.00* 1 1  0.00000  0.00000  0.00032  0.01275  500.0  500.0  500.0  0                  1.00000    0.0
             584491 G15-005XFMR134.500  1                      0.00032  0.01275  500.0  500.0  500.0  0
             584494 G15_SUB_XFMR13.800* 1                      0.00032  0.01275  166.7  166.7  166.7  0

X- XFRMER -X X----- WINDING BUS -----X C                                                       X---- CONTROLLED BUS ----X CNXTN
X-- NAME --X   BUS# X-- NAME --X BASKV W CN  WIND V  NOM V  ANGLE   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV ANGLE    CR      CX
G15_SUB_XFMR 584490 GEN-2015-005345.00 1  0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584491 G15-005XFMR134.500    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
             584494 G15_SUB_XFMR13.800    0 1.00000 0.0000    0.0 1.10000 0.90000 1.10000 0.90000   33                               0.0
```

DATA FOR BUS 584495 [G15-005-GSU234.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 1     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

X------- TO BUS --------X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING ST MET RATE-A RATE-B RATE-C LENGTH ZI OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584491 G15-005XFMR134.500  1   0.04000  0.02814  0.00301  1  T     0.0    0.0    0.0    0.0     540 1.000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED              MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M   R 1-2    X 1-2  SBAS1-2   MAG1     MAG2  TBL  R 1-2    X 1-2
584496 G15-005-GEN20.6900  1  GEN_2_GSU    1 F F 2 1  0.00760  0.05700   20.2  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584496 G15-005-GEN20.6900  1  1 1.00000 0.0000    0.0 1.00000 0.0000   20.2   20.2    0.0  540 1.000

X------- TO BUS --------X     W C                                     X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
```

```
584496 G15-005-GEN20.6900  1  F 1  0 1.10000 0.90000 1.10000 0.90000    5                             0.000
```

```
DATA FOR BUS 584496 [G15-005-GEN20.6900] RESIDING IN AREA  540, ZONE  596, OWNER  540:

CODE P Q - L O A D     I - L O A D     Y - L O A D G-SHUNT B-SHUNT VOLTAGE  ANGLE
 2     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0 1.00000   0.00

                                                 X--------- REMOTE BUS ----------X
PLNT PGEN    QGEN    QMAX    QMIN  VSCHED  PCT Q   BUS# X-- NAME --X BASKV VOLTAGE
      0.0     0.0     7.8    -7.8 1.03000 100.00

ID ST  PGEN   QGEN   QMAX   QMIN  MBASE  Z S O R C E    X T R A N   GENTAP   PMAX   PMIN OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4 WMOD   WPF
1  1    0.0    0.0    7.8   -7.8   17.9 0.0000 0.8000 0.0000 0.0000 1.0000   16.1    1.4  540 1.000

X------- TO BUS --------X        XFRMER    S W M C C      SPECIFIED              MAGNETIZING Y        TBL CORRECTED
  BUS# X-- NAME --X BASKV CKT X-- NAME --X T 1 T Z M    R 1-2    X 1-2  SBAS1-2   MAG1      MAG2  TBL  R 1-2    X 1-2
584495 G15-005-GSU234.500  1  GEN_2_GSU    1 T T 2 1  0.00760  0.05700   20.2  0.00000  0.00000  0

X------- TO BUS --------X     C
  BUS# X-- NAME --X BASKV CKT W  WINDV1  NOMV1  ANGLE  WINDV2  NOMV2  RATEA  RATEB  RATEC OWN1 FRAC1 OWN2 FRAC2 OWN3 FRAC3 OWN4 FRAC4
584495 G15-005-GSU234.500  1  1 1.00000 0.0000    0.0 1.00000 0.0000   20.2   20.2    0.0  540 1.000

X------- TO BUS --------X     W C                                      X---- CONTROLLED BUS ----X CONECXN
  BUS# X-- NAME --X BASKV CKT 1 W CN   RMAX    RMIN    VMAX    VMIN  NTPS    BUS# X-- NAME --X BASKV   ANGLE    CR      CX
584495 G15-005-GSU234.500  1  T 1  0 1.10000 0.90000 1.10000 0.90000    5                             0.000
```

PSS®E Activity SQEX

```
DATA FOR BUS 560028 [G15-005-TAP 345.00] RESIDING IN AREA  540, ZONE  595, OWNER  540:

CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X------- TO BUS --------X     X- POS AND NEG SEQUENCE -X X---- ZERO SEQUENCE -----X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING   LINE R   LINE X CHARGING ST ZI
 59201 SIBLEY 7    345.00  1   0.00155  0.02285  0.41529  0.01594  0.06256  0.23385  1
541197 MULLNCR7    345.00  1   0.00181  0.02673  0.48599  0.01866  0.07322  0.27366  1
584490 GEN-2015-005345.00  1   0.00029  0.00299  0.05040  0.00174  0.00852  0.00000  1

X------ FROM BUS -------X X------- TO BUS --------X
  BUS# X-- NAME --X BASKV   BUS# X-- NAME --X BASKV CKT  MUTUAL IMPEDANCE    B1     B2
 59201 SIBLEY 7    345.00 560028 G15-005-TAP 345.00  1   -0.0023  -0.0024  0.9366 1.0000
300107 5OSBORN     161.00 301310 5REX        161.00  1                     0.3504 0.5850
```

```
 59391 MARYV5      161.00  59392 MIDWY5TP    161.00  1    0.0008   0.0019  0.6941 0.8051
541197 MULLNCR7    345.00 560028 G15-005-TAP 345.00  1                     0.1656 0.2049
 59392 MIDWY5TP    161.00  59394 STJOE5      161.00  1    0.0024   0.0028  0.1567 0.2951
541197 MULLNCR7    345.00 560028 G15-005-TAP 345.00  1                     0.2049 0.2636
 64786 COOPER 3    345.00  96039 7FAIRPT     345.00  1    0.0004   0.0008  0.5899 0.6113
541197 MULLNCR7    345.00 560028 G15-005-TAP 345.00  1                     0.0758 0.1051
300107 5OSBORN     161.00 301310 5REX        161.00  1    0.0018   0.0019  0.1654 0.3504
541197 MULLNCR7    345.00 560028 G15-005-TAP 345.00  1                     0.9573 1.0000
```

DATA FOR BUS 584490 [GEN-2015-005345.00] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X------- TO BUS --------X     X- POS AND NEG SEQUENCE -X X---- ZERO SEQUENCE -----X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING   LINE R   LINE X CHARGING ST ZI
560028 G15-005-TAP 345.00  1   0.00029  0.00299  0.05040  0.00174  0.00852  0.00000  1

X- XFRMER -X     S     X----- WINDING BUS -----X S C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X                    X-- POS & NEG --X
X-- NAME --X CKT T  CC   BUS# X-- NAME --X BASKV T C     R        X     RGROUND  XGROUND     R        X     RATIO   ANGLE TAB     NOMINAL R,X
G15_SUB_XFMR  1  1   2 584490 GEN-2015-005345.00 1 1  0.00025  0.01807                    0.00032  0.01275 1.00000    0.0   0
                       584491 G15-005XFMR134.500 1 1  0.00033  0.00502                    0.00032  0.01275 1.00000    0.0   0
                       584494 G15_SUB_XFMR13.800 1 3  0.00004  0.01285  0.00000  0.00000  0.00032  0.01275 1.00000    0.0   0

X- XFRMER -X     S X---- WINDING 1 BUS ----X   MAGNETIZING Y
X-- NAME --X CKT T   BUS# X-- NAME --X BASKV     G        B
G15_SUB_XFMR  1  1 584490 GEN-2015-005345.00  0.00000  0.00000
```

DATA FOR BUS 584491 [G15-005XFMR134.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X------- TO BUS --------X     X- POS AND NEG SEQUENCE -X X---- ZERO SEQUENCE -----X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING   LINE R   LINE X CHARGING ST ZI
584492 G15-005-GSU134.500  1   0.00305  0.00278  0.02792  0.00000  0.00000  0.00000  1
584495 G15-005-GSU234.500  1   0.04000  0.02814  0.00301  0.00000  0.00000  0.00000  1

X- XFRMER -X     S     X----- WINDING BUS -----X S C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X                    X-- POS & NEG --X
X-- NAME --X CKT T  CC   BUS# X-- NAME --X BASKV T C     R        X     RGROUND  XGROUND     R        X     RATIO   ANGLE TAB     NOMINAL R,X
G15_SUB_XFMR  1  1   2 584490 GEN-2015-005345.00 1 1  0.00025  0.01807                    0.00032  0.01275 1.00000    0.0   0
                       584491 G15-005XFMR134.500 1 1  0.00033  0.00502                    0.00032  0.01275 1.00000    0.0   0
                       584494 G15_SUB_XFMR13.800 1 3  0.00004  0.01285  0.00000  0.00000  0.00032  0.01275 1.00000    0.0   0

X- XFRMER -X     S X---- WINDING 1 BUS ----X   MAGNETIZING Y
X-- NAME --X CKT T   BUS# X-- NAME --X BASKV     G        B
G15_SUB_XFMR  1  1 584490 GEN-2015-005345.00  0.00000  0.00000
```

DATA FOR BUS 584492 [G15-005-GSU134.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X------- TO BUS --------X     X- POS AND NEG SEQUENCE -X X---- ZERO SEQUENCE -----X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING   LINE R   LINE X CHARGING ST ZI
584491 G15-005XFMR134.500  1   0.00305  0.00278  0.02792  0.00000  0.00000  0.00000  1

X------- TO BUS --------X     S W C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X   MAGNETIZING Y   X--WINDING 1-X WINDNG2    X-- POS & NEG --X
  BUS# X-- NAME --X BASKV CKT T 1 C     R        X     RGROUND  XGROUND     R        X        G        B     RATIO   ANGLE  RATIO TAB     NOMINAL R,X
584493 G15-005-GEN10.6900  1  1 F 3  0.00367  0.02753  0.00000  0.00000  0.00367  0.02753  0.00000  0.00000 1.00000    0.0 1.00000  0
```

DATA FOR BUS 584493 [G15-005-GEN10.6900] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  2   0.0000   0.0000   0.0000   0.0000

ID ST MBASE   ZGEN (POS.)    ZGEN (NEG.)    ZGEN (ZERO)     X T R A N   GENTAP
1  1  204.4  0.0000 0.2000  0.0000 0.2000  0.0000 0.2000  0.0000 0.0000 1.0000

X------- TO BUS --------X     S W C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X   MAGNETIZING Y   X--WINDING 1-X WINDNG2    X-- POS & NEG --X
  BUS# X-- NAME --X BASKV CKT T 1 C     R        X     RGROUND  XGROUND     R        X        G        B     RATIO   ANGLE  RATIO TAB     NOMINAL R,X
584492 G15-005-GSU134.500  1  1 T 3  0.00367  0.02753  0.00000  0.00000  0.00367  0.02753  0.00000  0.00000 1.00000    0.0 1.00000  0
```

DATA FOR BUS 584494 [G15_SUB_XFMR13.800] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X- XFRMER -X     S     X----- WINDING BUS -----X S C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X                   X-- POS & NEG --X
X-- NAME --X CKT T  CC   BUS# X-- NAME --X BASKV T C     R        X     RGROUND  XGROUND     R        X     RATIO   ANGLE TAB     NOMINAL R,X
G15_SUB_XFMR  1  1   2 584490 GEN-2015-005345.00 1 1  0.00025  0.01807                    0.00032  0.01275 1.00000    0.0   0
                       584491 G15-005XFMR134.500 1 1  0.00033  0.00502                    0.00032  0.01275 1.00000    0.0   0
                       584494 G15_SUB_XFMR13.800 1 3  0.00004  0.01285  0.00000  0.00000  0.00032  0.01275 1.00000    0.0   0

X- XFRMER -X     S X---- WINDING 1 BUS ----X   MAGNETIZING Y
X-- NAME --X CKT T   BUS# X-- NAME --X BASKV     G        B
G15_SUB_XFMR  1  1 584490 GEN-2015-005345.00  0.00000  0.00000
```

DATA FOR BUS 584495 [G15-005-GSU234.500] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  1   0.0000   0.0000   0.0000   0.0000

X------- TO BUS --------X     X- POS AND NEG SEQUENCE -X X---- ZERO SEQUENCE -----X
  BUS# X-- NAME --X BASKV CKT   LINE R   LINE X CHARGING   LINE R   LINE X CHARGING ST ZI
584491 G15-005XFMR134.500  1   0.04000  0.02814  0.00301  0.00000  0.00000  0.00000  1

X------- TO BUS --------X     S W C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X   MAGNETIZING Y   X--WINDING 1-X WINDNG2    X-- POS & NEG --X
  BUS# X-- NAME --X BASKV CKT T 1 C     R        X     RGROUND  XGROUND     R        X        G        B     RATIO   ANGLE  RATIO TAB     NOMINAL R,X
584496 G15-005-GEN20.6900  1  1 F 3  0.03753  0.28146  0.00000  0.00000  0.03753  0.28146  0.00000  0.00000 1.00000    0.0 1.00000  0
```

DATA FOR BUS 584496 [G15-005-GEN20.6900] RESIDING IN AREA 540, ZONE 596, OWNER 540:

```
CODE   ZERO SEQ LOAD      NEG SEQ LOAD
  2   0.0000   0.0000   0.0000   0.0000

ID ST MBASE   ZGEN (POS.)    ZGEN (NEG.)    ZGEN (ZERO)     X T R A N   GENTAP
1  1   17.9  0.0000 0.2000  0.0000 0.2000  0.0000 0.2000  0.0000 0.0000 1.0000

X------- TO BUS --------X     S W C X--------- ZERO SEQUENCE ---------X X-- POS & NEG --X   MAGNETIZING Y   X--WINDING 1-X WINDNG2    X-- POS & NEG --X
  BUS# X-- NAME --X BASKV CKT T 1 C     R        X     RGROUND  XGROUND     R        X        G        B     RATIO   ANGLE  RATIO TAB     NOMINAL R,X
584495 G15-005-GSU234.500  1  1 T 3  0.03753  0.28146  0.00000  0.00000  0.03753  0.28146  0.00000  0.00000 1.00000    0.0 1.00000  0
```

C: MISO Affected System Impact Study Report

See next page for MISO Affected System Impact Study Report.

MISO SPP DISIS-2015-001

Affected System Impact Study

May 2, 2016

MISO
720 City Center Drive
Carmel
Indiana - 46032
http://www.misoenergy.org

TABLE OF CONTENTS

TABLE OF TABLES

1. Executive Summary

This report documents the Affected System Impacts of three projects in the SPP generator interconnection queue on the Midcontinent Independent System Operator ("MISO") transmission system. The projects are listed in Table 1-1.

Table 1-1 List of SPP Group Generation Interconnection Projects

GI_Number	Capacity	Type	Service	POI_Bus
GEN-2015-005	200.1	Wind	ER	Tap Nebraska City - Sibley 345kV
GEN-2015-007	160	Wind	ER	Hoskins 345kV
GEN-2015-023	300.7	Wind	ER/NR	Holt County 345kV

The total cost of network upgrades is listed in Table 1-2 as shown below. The costs for Network Upgrades are planning level estimates and subject to be revised in the facility studies.

Table 1-2 Constrained Facility and Mitigation Costs

Project	Facility Owner	Constraint	Mitigation Required	Cost Estimate
G007	MEC	635200 RAUN 3 345 - 645451 S3451 3 345 1	Replace the wave trap at Raun and adjust relay settings. This will increase MidAmerican's rating of its section of the Raun-Ft. Calhoun line to above 1107 MVA for a new MidAmerican rating of 1195 MVA	$50,000

2. Study Methodology & Assumptions

2.1. Study Criteria

All interconnection requirements are based on the applicable MISO Interconnection Planning Criteria and in accordance with the NERC Reliability Standards. Steady state violations of applicable planning criteria were attributed to the SPP group generation requests by the usage of MISO injection criteria, and applicable local planning criteria.

2.2. Contingency Criteria

A comprehensive list of contingencies was considered for steady-state analysis:

- NERC Category A with system intact (no contingencies)
- NERC Category B contingencies
  - Single element outages, at buses with a nominal voltage of 69 kV and above in the following areas: CWLD (area 333), AMMO (area 356), AMIL (area357), WEC (area 295), WEC MI (area 296), XCEL (area 600), MP (area 608),SMMPA (area 613), GRE (area 615), OTP (area 620), ITCM (area 627),MPW (area 633), MEC (area 635), MDU (area 661), MHEB (area 667), DPC(area 680), ALTE (area 694), WPS (area 696), MGE (area 697), UPPC (area 698), CE(area 222), NPPD (area 640), OPPD (area 645), LES (area 650),WAPA (area 652), AECI (area 330), MIPU(area 540), KCPL (area 541),KACY (area 542), INDN (area 545).
  - Multiple-element outages initiated by a fault with normal clearing such as multi-terminal lines, in the Dakotas, Illinois, Iowa, Manitoba, Minnesota, Missouri, and Wisconsin.
- NERC Category C
  - Selected NERC Category C events in the study region of the Dakotas, Illinois, Iowa, Manitoba, Minnesota, Missouri, and Wisconsin.

2.3. Monitored Elements

Table 2-1 Monitored Area

Area #	Voltage	Area ID	Area Name
295	69kV and above	WEC	Wisconsin Electric Power Company (ATC)
296	69kV and above	MIUP	Michigan Upper Peninsula (ATC)
333	69kV and above	CWLD	Columbia, MO Water and Light
356	100kV and above	AMMO	Ameren Missouri
357	100kV and above	AMIL	Ameren Illinois
600	69kV and above	XEL	Xcel Energy North
608	69kV and above	MP	Minnesota Power & Light
613	69kV and above	SMMPA	Southern Minnesota Municipal Power Association
615	69kV and above	GRE	Great River Energy

620	69kV and above	OTP	Otter Tail Power Company
627	69kV and above	ALTW	Alliant Energy West
633	69kV and above	MPW	Muscatine Power & Water
635	69kV and above	MEC	MidAmerican Energy
661	69kV and above	MDU	Montana-Dakota Utilities Co.
680	69kV and above	DPC	Dairyland Power Cooperative
694	69kV and above	ALTE	Alliant Energy East (ATC)
696	69kV and above	WPS	Wisconsin Public Service Corporation (ATC)
697	69kV and above	MGE	Madison Gas and Electric Company (ATC)
698	69kV and above	UPPC	Upper Peninsula Power Company (ATC)

2.4. Model Development

The following MTEP base case load profiles were used for the study:

- 2017 Shoulder
- 2017 Summer Peak
- 2024 Shoulder
- 2024 Summer Peak

The study cases were built by adding and dispatching the appropriate queue projects to the base cases. The detail of each SPP interconnection request is listed in Table 1-1. The study projects were dispatched per MISO criteria to the entire SPP footprint, where generators were scaled in proportion to the available reserve.

2.5. Study Assumptions

This affected system impact study was conducted with all the participating generators operating together as a group. Analysis was not performed on individual generating units or subsets of the generating units unless specifically noted otherwise. Higher queued SPP projects were modeled as outlined in Appendix A of the report. The results obtained in this analysis may change if any of the data or assumptions made during the development of the study models is revised.

3. Steady State Analysis

3.1. Near Term (2017) Analysis

The following constraints were identified in the near term analysis for the off peak scenario. No violations were identified in the summer peak scenario. The following table lists the constraints identified.

Table 3-1 Near-Term Constraint

Scenario	Constraint	Contflow MVA	Rating MVA	Loading%	Contingency	G005 DF	G007 DF	G023 DF
2017SH	635200 RAUN 3 345 645451 S3451 3 345 1	1106.7	956	115.8	640226 HOSKINS3 345 640342 SHELCRK3 345 1	-4.0%	24.0%	-2.8%
2017SH	635200 RAUN 3 345 645451 S3451 3 345 1	961.5	956	100.6	** BASE CASE **	-3.7%	14.0%	-1.0%

3.2. Out Year(2024) Analysis

The following constraints were identified in the out year analysis for the off peak scenario. No violations were identified in the summer peak scenario. The following table lists the constraints identified.

Table 3-2 Out-Year Constraint

Scenario	Constraint	Contflow MVA	Rating MVA	Loading%	Contingency	G005 DF	G007 DF	G023 DF
2024SH	635200 RAUN 3 345 645451 S3451 3 345 1	1103.8	956	115.5	640226 HOSKINS3 345 640342 SHELCRK3 345 1	-3.9%	23.6%	-2.9%
2024SH	635200 RAUN 3 345 645451 S3451 3 345 1	964.6	956	100.9	** BASE CASE **	-3.7%	13.8%	-1.0%

4. Conclusion

The Affected system study identified Steady State thermal violations associated with the interconnection of the three SPP projects. These included injection constraints in the off peak scenario under both the Near-term (2017) and the Out-year (2024) analysis for SPP project number G007.

5. Appendix A

Table 5-1 SPP High Queued Projects

SPP Queue	Capacity MW	Area	Proposed Point of Interconnection	Fuel Type	SP output	SH output
GEN-2003-021N	75	NPPD	Ainsworth Wind Tap 115kV	Wind	20%	100%
GEN-2004-023N	75	NPPD	Columbus Co 115kV	Coal	100%	100%
GEN-2006-020N	42	NPPD	Bloomfield 115kV	Wind	20%	100%
GEN-2006-037N1	75	NPPD	Broken Bow 115kV	Wind	20%	100%
GEN-2006-038N005	80	NPPD	Broken Bow 115kV	Wind	20%	100%
GEN-2006-038N019	80	NPPD	Petersburg North 115kV	Wind	20%	100%
GEN-2006-044N	40.5	NPPD	North Petersburg 115kV	Wind	20%	100%
GEN-2007-011N08	81	NPPD	Bloomfield 115kV	Wind	20%	100%
GEN-2008-086N02	201	NPPD	Meadow Grove 230kV	Wind	20%	100%
GEN-2008-119O	60	OPPD	S1399 161kV	Wind	20%	100%
GEN-2008-123N	89.7	NPPD	Tap Pauline - Hildreth (Rosemont) 115kV	Wind	20%	100%
GEN-2008-129	80	GMO	Pleasant Hill 161kV	CT	100%	0%
GEN-2009-040	73.8	WERE	Marshall 115kV	Wind	20%	100%
GEN-2010-036	4.6	WERE	6th Street 115kV	Hydro	100%	100%
GEN-2010-041	10.5	OPPD	S1399 161kV	Wind	20%	100%
GEN-2010-051	200	NPPD	Tap Twin Church - Hoskins 230kV	Wind	20%	100%
GEN-2011-011	50	KCPL	Iatan 345kV	Coal	100%	100%
GEN-2011-018	73.6	NPPD	Steele City 115kV	Wind	20%	100%

SPP Queue	Capacity MW	Area	Proposed Point of Interconnection	Fuel Type	SP output	SH output
GEN-2011-027	120	NPPD	Tap Hoskins - Twin Church 230kV	Wind	20%	100%
GEN-2011-056	3.6	NPPD	Jeffrey 115kV	Hydro	100%	100%
GEN-2011-056A	3.6	NPPD	John 1 115kV	Hydro	100%	100%
GEN-2011-056B	4.5	NPPD	John 2 115kV	Hydro	100%	100%
GEN-2012-021	4.8	LES	Terry Bundy Generating Station 115kV	Gas	100%	100%
GEN-2013-002	50.6	LES	Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2	Wind	20%	100%
GEN-2013-008	1.2	NPPD	Steele City 115kV	Wind	20%	100%
GEN-2013-014	25.5	NPPD	Tap Guide Rock - Pauline (Rosemont) 115kV	Wind	20%	100%
GEN-2013-019	73.6	LES	Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2	Wind	20%	100%
GEN-2013-032	204	NPPD	Antelope 115kV	Wind	20%	100%
GEN-2014-004	4	NPPD	Steele City 115kV (GEN-2011-018 POI)	Wind	20%	100%
GEN-2014-013	73.5	NPPD	Meadow Grove (GEN-2008-086N2 Sub) 230kV	Wind	20%	100%
GEN-2014-021	300	GMO	Tap Nebraska City - MullinCreek 345kV	Wind	20%	100%
GEN-2014-031	35.8	NPPD	Meadow Grove 230kV	Wind	20%	100%
GEN-2014-032	10.2	NPPD	Meadow Grove 230kV	Wind	20%	100%
GEN-2014-039	73.4	NPPD	Friend 115kV	Wind	20%	100%