# Impact Study of Limited Operation for Generator Interconnection

# GEN-2011-016
# GEN-2011-017

**June 2014**
**Generator Interconnection**

SPP Southwest Power Pool

# Executive Summary

This study report addresses the request of two separate Interconnection Customers (GEN-2011-016 and GEN-2011-017) to interconnect their requested generators before the completion of all network upgrades identified in their interconnection studies. The two Interconnection Customer's generation totals 499.1 MW of nameplate generation. The following Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) addresses the interconnection of 499.1 MW of generation to be interconnected as an Energy Resource (ER) into the Transmission System of Sunflower Electric Power Corporation (SUNC). GEN-2011-016 is located in Ford County, Kansas. GEN-2011-017 is located in Hodgeman County, Kansas. Under the GIA Section 5.9, these Customers have requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-001 (or most recent iteration) Impact Study can be placed into service.

This LOIS addresses the effects of interconnecting the generators to the rest of the transmission system for the system topology and conditions as expected on December 31, 2015. GEN-2011-016 is requesting the interconnection of eighty seven (87) Siemens SWT 2.3 MW wind turbine generators and associated facilities into the Spearville 345kV substation. GEN-2011-017 is requesting the interconnection of one-hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated facilities through a tap on Spearville – Post Rock 345kV transmission line. For the typical LOIS, both a power flow and transient stability analysis are conducted. The LOIS 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 LOIS may need to be restudied to ensure that interconnection service remains for the customer's request.

Power flow analysis from this LOIS has determined that the customer's request will be able to interconnect as an Energy Resource prior to the completion of the required Network Upgrades, listed within Table 3 of this report. Refer to Table 5 and 6 for the power flow results. 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 LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator(s) 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 Customers 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. Transient stability analysis from this LOIS has determined that the transmission system will remain stable for the one-hundred five (105) selected faults for the limited operation interconnection of GEN-2011-016 and GEN-2011-017.

Nothing in this study should be construed as a guarantee of delivery or 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.

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# Purpose

<OMITTED TEXT> (Interconnection Customers) have requested a restudy of a Limited Operation System Impact Study (LOIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for interconnection requests into the Transmission System of Sunflower Electric Power Corporation (SUNC).

The purpose of this study is to evaluate the impacts of interconnecting GEN-2011-016, a request of 200.1 MW comprised of eighty seven (87) Siemens SWT 2.3 MW wind turbine generators and associated facilities interconnecting into the Spearville 345kV substation to be located in Ford County, Kansas, and GEN-2011-017, a request of 299.0 MW comprised of one-hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated facilities through a tap on Spearville – Post Rock 345kV transmission line to be located in Hodgeman County, Kansas. The Customers have requested this amount to be studied as an Energy Resource (ER) with a Limited Operation Interconnection Service to commence on or around 12/31/2015.

Both power flow and transient stability analysis were conducted for this Limited Operation Interconnection Service. Limited Operation Studies are conducted under GIA Section 5.9.

The LOIS 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 LOIS 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 LOIS 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 LOIS 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 12/31/2015 in-service of the customers for this LOIS. 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 LOIS*

| Project | MW | Total MW | Fuel Source | POI | Status |
|---|---|---|---|---|---|
| Gray County Wind (Montezuma) | 110.0 | 110.0 | Wind | Gray County Tap 115kV | Commercial Operation |
| GEN-2001-039A (Shooting Star) | 105.0 | 105.0 | Wind | Shooting Star Tap 115kV | Commercial Operation |
| GEN-2001-039M (Central Plains) | 99.0 | 99.0 | Wind | Central Plains Tap 115kV | Commercial Operation |
| GEN-2002-025A (KCPL) | 148.5 | 148.5 | Wind | Spearville 230kV | Commercial Operation |
| GEN-2003-006A (Merridian Way) | 200.0 | 200.0 | Wind | Elm Creek 230kV | Commercial Operation |
| GEN-2003-019 (Smoky Hills) | 249.3 | 249.3 | Wind | Smoky Hills Tap 230kV | Commercial Operation |
| GEN-2004-014 (KCPL) | 154.5 | 154.5 | Wind | Spearville 230kV | Commercial Operation |
| GEN-2005-012 (Westar) | 248.4 | 248.4 | Wind | Spearville 345kV | Commercial Operation |
| GEN-2006-006 | 205.5 | 205.5 | Wind | Spearville 345kV | IA Executed/On Suspension |
| GEN-2006-021 (Flat Ridge I) | 101.0 | 101.0 | Wind | Flat Ridge Tap 138kV | Commercial Operation |
| GEN-2007-040 (Cimarron II) | 200.1 | 200.1 | Wind | Buckner 345kV | Commercial Operation |
| GEN-2008-018 | 250.0 | 250.0 | Wind | Finney 345kV | Commercial Operation |
| GEN-2008-079 (Ensign) | 98.9 | 98.9 | Wind | Tap Cudahy – Ft Dodge 115kV | Commercial Operation |
| GEN-2008-124 | 200.1 | 200.1 | Wind | Ironwood 345kV | IA Executed/On Schedule for 1/2016 |
| GEN-2010-009 (Cimarron I) | 165.6 | 165.6 | Wind | Buckner 345kV | Commercial Operation |
| GEN-2010-045 | 197.8 | 197.8 | Wind | Buckner 345kV | IA Executed/On Schedule for 2017 |
| GEN-2010-057 | 201.0 | 201.0 | Wind | Rice County 230kV | Commercial Operation |
| GEN-2011-008 | 600.0 | 600.0 | Wind | Clark County 345kV | IA Executed/ On Schedule for 2019 |
| GEN-2011-014 | 201.0 | 201.0 | Wind | Beaver County 345kV | IA Pending |
| GEN-2011-019 | 299.0 | 299.0 | Wind | Woodward 345kV | IA Executed/On Schedule for 2017 |
| GEN-2011-020 | 299.0 | 299.0 | Wind | Woodward 345kV | IA Executed/On Schedule for 2017 |
| GEN-2011-016 | 200.1 | 200.1 | Wind | Spearville 345kV | IA Pending |
| GEN-2011-017 | 299.0 | 299.0 | Wind | Tap Spearville – Post Rock 345kV | IA Executed/On Schedule for 2017 |

This LOIS was required because the Customers are requesting interconnection prior to the completion of all of their required upgrades listed within the latest iteration of their Definitive Interconnection System Impact Study (DISIS). Table 2 below lists the required upgrade projects for which these requests have cost responsibility. Table 3 below lists the projects that are not in-service at the time of the Customers in-service date and are not included in this LOIS study. The customers were included within the DISIS-2011-001 that was posted July 29, 2011. The cluster has been restudied since the original posting. This report can be located here at the following GI Study URL: http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2011_Impact_Studies.

*Table 2: Upgrade Projects Required for Full Interconnection Service*

| Upgrade Project | Type | Description | Status |
|---|---|---|---|
| Beaver County – Buckner 345kV | Assumed out of service for the study | Contingent on DISIS-2011-001 Customers | Current Estimated In-Service date unknown |
| Spearville – Post Rock – Axtell 345kV | Assumed to be in service for the study | Build Priority Project | In Service |
| Woodward – Border – TUCO 345kV and associated equipment | Assumed to be in service for the study | Build Priority Project | Current Estimated In-Service date of 5/19/2014 |
| Hitchland – Woodward 345kV double circuit and associated equipment | Assumed to be in service for the study | Build Priority Project | Current Estimated in service date of 6/30/2014 |
| Spearville – Clark County – Thistle – Wichita 345kV double circuit and associated equipment | Assumed to be in service for the study | Build Priority Project | Current Estimated In-Service date of 12/31/2014 |
| Woodward – Thistle 345kV double circuit and associated equipment | Assumed to be in service for the study | Build Priority Project | Current Estimated In-Service date of 12/31/2014 |

*Table 3: Upgrade Projects Not Included in this Study*

| Upgrade Project | Type | Description | Status |
|---|---|---|---|
| Beaver County – Buckner 345kV | Assumed out of service for the study | Contingent on DISIS-2011-001 Customers | Current Estimated In-Service date unknown |

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 LOIS 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 LOIS, either because no request for an LOIS has been made or the request is on suspension, etc.

*Table 4: Higher or Equally Queued GI Requests not included within this LOIS*

| Project | Remainder MW | Total MW | Fuel | POI | Status |
|---|---|---|---|---|---|
| GEN-2007-038 | 200.0 | 200.0 | Wind | Spearville 345kV | IA Executed/On Schedule for 8/2015 |
| GEN-2010-015 | 200.1 | 200.1 | Wind | Spearville 345kV | IA Executed/On Schedule for 1/2015 |

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-2011-016 Interconnection Customer's request to interconnect a total of 200.1 MW is comprised of eighty seven (87) Siemens SWT 2.3 MW wind turbine generators and associated facilities. GEN-2011-017 Interconnection Customer's request to interconnect a total of 299.0 MW is comprised of one-hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated facilities.

## Interconnection Facilities

GEN-2011-016

The POI for GEN-2011-016 Interconnection Customer is the Spearville 345kV substation in Ford 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.

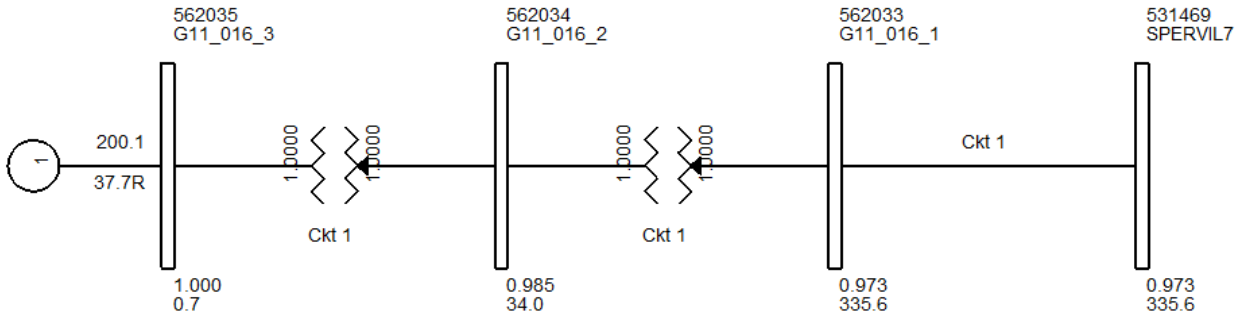


*Figure 1: Proposed POI Configuration and Request Power Flow Model*

GEN-2011-017

The POI for GEN-2011-017 Interconnection Customer is through a tap on the Spearville – Post Rock 345kV transmission line in Hodgeman County, Kansas. Figure 2 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.

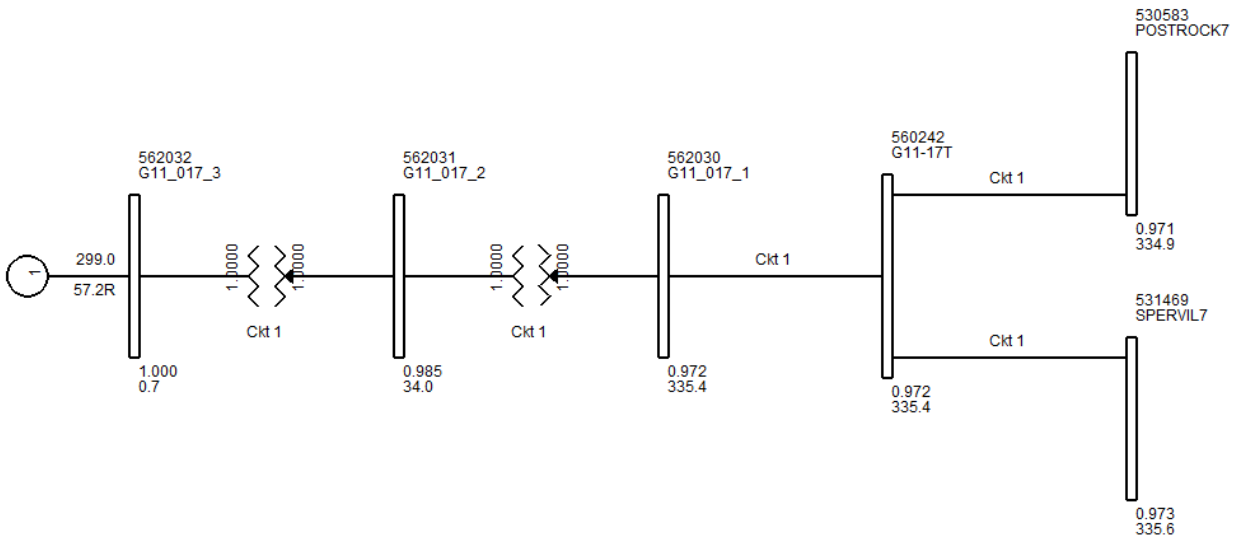


*Figure 2: Proposed POI Configuration and Request Power Flow Model*

## Base Case Network Upgrades

The Network Upgrades included within the cases used for this LOIS 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 Customers requested in-service date of December 31, 2015. These facilities have an approved Notification 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 LOIS. 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(s).

# 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 2013 series of transmission service request study models including the 2014 and 2019 (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 LOIS, 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 69kV 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 LOIS ACCC analysis indicates that the Customers can interconnect their generation into the SUNC transmission system as requested before all required upgrades listed within the DISIS-2011-001 study can be placed into service. Should any other GI 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.

ACCC results for the LOIS can be found in Table 5, 6 and 7 below. Table 7 has the overloads that are less than 20% TDF and are not for mitigation. Generator Interconnection Energy Resource analysis doesn't mitigate for those issues in which the affecting GI request has less than a 20% OTDF.

## Curtailment and System Reliability

In no way does this study guarantee operation for all periods of time. It should be noted that although this study 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.

Power Flow Analysis

*Table 5: Interconnection Constraints for Reinforcement of GEN-2011-016 LOIS @ 200.1MW*

| Season | Dispatch Group | Flow | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Max MW Available | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| ALL | | | N/A | | | | | 200.1 | N/A |

*Table 6: Interconnection Constraints for Reinforcement of GEN-2011-017 LOIS @ 299.0MW*

| Season | Dispatch Group | Flow | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Max MW Available | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| ALL | | | N/A | | | | | 299.0 | N/A |

*Table 7: Interconnection Constraints that do not require reinforcement*

| Season | Dispatch Group | Flow | Source | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| 14G | 03ALL | - | G11_016 | Non-converged Contingency | - | - | 0.44933 | - | DBL-THIS-CLR |
| 14G | 03ALL | - | G11_017 | Non-converged Contingency | - | - | 0.41101 | - | DBL-THIS-CLR |
| 14G | 03ALL | - | G11_016 | Non-converged Contingency | - | - | 0.44933 | - | DBL-IRON-CLR |
| 14G | 03ALL | - | G11_017 | Non-converged Contingency | - | - | 0.41101 | - | DBL-IRON-CLR |
| 14G | 03G11_016 | - | G11_016 | Non-converged Contingency | - | - | 0.45043 | - | DBL-THIS-CLR |
| 14G | 03G11_017 | - | G11_017 | Non-converged Contingency | - | - | 0.41213 | - | DBL-THIS-CLR |
| 14G | 3 | - | G11_016 | Non-converged Contingency | - | - | 0.45047 | - | DBL-THIS-CLR |
| 14G | 3 | - | G11_017 | Non-converged Contingency | - | - | 0.41215 | - | DBL-THIS-CLR |
| 14G | 03ALL | FROM->TO | G11_016 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05349 | 242.3275 | DBL-WICH-THI |
| 14G | 03ALL | FROM->TO | G11_017 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04821 | 242.3275 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05349 | 231.9561 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_017 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04821 | 231.9561 | DBL-WICH-THI |
| 14G | 03G11_016 | FROM->TO | G11_016 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05379 | 207.1276 | DBL-WICH-THI |
| 14G | 03G11_017 | FROM->TO | G11_017 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04851 | 205.8021 | DBL-WICH-THI |
| 14G | 3 | FROM->TO | G11_016 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05381 | 202.7553 | DBL-WICH-THI |
| 14G | 3 | FROM->TO | G11_017 | HARPER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04852 | 202.7553 | DBL-WICH-THI |
| 14G | 03G11_016 | TO->FROM | G11_016 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05379 | 196.6507 | DBL-WICH-THI |
| 14G | 03G11_017 | TO->FROM | G11_017 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04851 | 195.3139 | DBL-WICH-THI |
| 14G | 3 | TO->FROM | G11_016 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.05381 | 192.2473 | DBL-WICH-THI |
| 14G | 3 | TO->FROM | G11_017 | CLEARWATER - MILAN TAP 138KV CKT 1 | 110 | 110 | 0.04852 | 192.2473 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.05374 | 159.2001 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04956 | 159.2001 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04473 | 143.1289 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |

## Power Flow Analysis

| Season | Dispatch Group | Flow | Source | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04214 | 143.1289 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 138.2562 | DBL-IRON-CLR |
| 14G | 03ALL | TO->FROM | G11_016 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04872 | 137.6726 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_017 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04415 | 137.6726 | DBL-SPRVL-CL |
| 14G | 03G11_017 | TO->FROM | G11_017 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04443 | 137.0446 | DBL-IRON-CLR |
| 14G | 3 | TO->FROM | G11_016 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04901 | 134.4715 | DBL-IRON-CLR |
| 14G | 3 | TO->FROM | G11_017 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04444 | 134.4715 | DBL-IRON-CLR |
| 14G | 03G11_016 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.054 | 130.9307 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04473 | 130.1034 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04214 | 130.1034 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04983 | 130.0066 | DBL-WICH-THI |
| 14G | 3 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.05401 | 127.6158 | DBL-WICH-THI |
| 14G | 3 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04984 | 127.6158 | DBL-WICH-THI |
| 14G | 03G11_016 | FROM->TO | G11_016 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 127.3446 | DBL-IRON-CLR |
| 14G | 03ALL | FROM->TO | G11_016 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04872 | 126.7428 | DBL-SPRVL-CL |
| 14G | 03ALL | FROM->TO | G11_017 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04415 | 126.7428 | DBL-SPRVL-CL |
| 14G | 03ALL | FROM->TO | G11_016 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.05349 | 126.4919 | DBL-WICH-THI |
| 14G | 03ALL | FROM->TO | G11_017 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.04821 | 126.4919 | DBL-WICH-THI |
| 14G | 03G11_017 | FROM->TO | G11_017 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04443 | 126.1517 | DBL-IRON-CLR |
| 14G | 03ALL | TO->FROM | G11_016 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.03348 | 125.596 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.04423 | 125.596 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.09442 | 125.5295 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.0946 | 125.5295 | DBL-WICH-THI |
| 14G | 3 | FROM->TO | G11_016 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04901 | 123.5959 | DBL-IRON-CLR |
| 14G | 3 | FROM->TO | G11_017 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04444 | 123.5959 | DBL-IRON-CLR |
| 14G | 03G11_016 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04495 | 123.446 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04236 | 122.7301 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.13615 | 122.39 | G11-17T 345.00 - POST ROCK 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.13615 | 122.39 | G11-17T 345.00 - POST ROCK 345KV CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 122.3869 | DBL-IRON-CLR |
| 14G | 03ALL | TO->FROM | G11_016 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04872 | 121.6688 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_017 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04415 | 121.6688 | DBL-SPRVL-CL |
| 14G | 03G11_017 | TO->FROM | G11_017 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04443 | 121.1911 | DBL-IRON-CLR |
| 14G | 3 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04496 | 120.867 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |
| 14G | 3 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04237 | 120.867 | NORTHWEST - TATONGA7 345.00 345KV CKT 1 |
| 14G | 3 | TO->FROM | G11_016 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04901 | 118.6288 | DBL-IRON-CLR |
| 14G | 3 | TO->FROM | G11_017 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04444 | 118.6288 | DBL-IRON-CLR |

Power Flow Analysis

| Season | Dispatch Group | Flow | Source | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| 14G | 03ALL | FROM->TO | G11_016 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.03348 | 118.2057 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_017 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.04423 | 118.2057 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.08033 | 116.9323 | DBL-WICH-THI |
| 14G | 03ALL | FROM->TO | G11_017 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.09474 | 116.9323 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03521 | 116.6253 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03321 | 116.6253 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 115.8444 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03134 | 115.6664 | GEN520997 1-MORLND2 |
| 14G | 03G11_017 | TO->FROM | G11_017 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04443 | 114.6522 | DBL-SPRVL-CL |
| 14G | 03G11_016 | TO->FROM | G11_016 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.03356 | 113.6311 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.04431 | 113.4488 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03689 | 112.8634 | IODINE - WOODWARD EHV 138KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03481 | 112.8634 | IODINE - WOODWARD EHV 138KV CKT 1 |
| 14G | 3 | TO->FROM | G11_016 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.03355 | 112.5403 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 3 | TO->FROM | G11_017 | HAYS PLANT - SOUTH HAYS 115KV CKT 1 | 83 | 99 | 0.0443 | 112.5403 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 3 | TO->FROM | G11_016 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04901 | 112.0108 | DBL-SPRVL-CL |
| 14G | 3 | TO->FROM | G11_017 | GREENSBURG - SSTARTP3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.04444 | 112.0108 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03689 | 111.0928 | DEWEY - IODINE 138KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03481 | 111.0928 | DEWEY - IODINE 138KV CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04495 | 110.7676 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04236 | 110.0534 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03134 | 109.3366 | GEN520998 1-MORLND3 |
| 14G | 3 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04496 | 108.2042 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 3 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.04237 | 108.2042 | TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.10944 | 107.6955 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_017 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.08246 | 107.6955 | DBL-WICH-THI |
| 14G | 03G11_016 | FROM->TO | G11_016 | SEWARD - ST JOHN 115KV CKT 1 | 80.3 | 87.6 | 0.03733 | 106.834 | DBL-IRON-CLR |
| 14G | 03G11_016 | FROM->TO | G11_016 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.05379 | 106.2679 | DBL-WICH-THI |
| 14G | 03G11_017 | FROM->TO | G11_017 | SEWARD - ST JOHN 115KV CKT 1 | 80.3 | 87.6 | 0.03777 | 106.0142 | DBL-IRON-CLR |
| 14G | 03G11_017 | FROM->TO | G11_017 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.04851 | 105.505 | DBL-WICH-THI |
| 14G | 03G11_016 | FROM->TO | G11_016 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 105.1089 | DBL-SPRVL-CL |
| 14G | 03G11_016 | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.09491 | 104.9406 | DBL-WICH-THI |
| 14G | 03ALL | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.07805 | 104.8508 | AXTELL - POST ROCK 345KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_017 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.10102 | 104.8508 | AXTELL - POST ROCK 345KV CKT 1 |

## Power Flow Analysis

| Season | Dispatch Group | Flow | Source | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03664 | 104.7913 | THISTLE7 345.00 - WICHITA 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03431 | 104.7913 | THISTLE7 345.00 - WICHITA 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03664 | 104.7913 | THISTLE7 345.00 - WICHITA 345KV CKT 2 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03431 | 104.7913 | THISTLE7 345.00 - WICHITA 345KV CKT 2 |
| 14G | 03ALL | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.07863 | 104.7636 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.08573 | 104.7636 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | KNOLL - N HAYS3 115.00 115KV CKT 1 | 80 | 88 | 0.03348 | 104.7327 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | KNOLL - N HAYS3 115.00 115KV CKT 1 | 80 | 88 | 0.04423 | 104.7327 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03G11_016 | FROM->TO | G11_016 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.03356 | 104.6776 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03G11_017 | FROM->TO | G11_017 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.04431 | 104.4762 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.13015 | 104.4351 | DBL-IRON-CLR |
| 14G | 03G11_017 | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.09509 | 104.2587 | DBL-WICH-THI |
| 14G | 03G11_017 | FROM->TO | G11_017 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04443 | 103.9231 | DBL-SPRVL-CL |
| 14G | 3 | FROM->TO | G11_016 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.05381 | 103.7559 | DBL-WICH-THI |
| 14G | 3 | FROM->TO | G11_017 | CLEARWATER - GILL ENERGY CENTER WEST 138KV CKT 1 | 191 | 191 | 0.04852 | 103.7559 | DBL-WICH-THI |
| 14G | 3 | FROM->TO | G11_016 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.03355 | 103.4823 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 3 | FROM->TO | G11_017 | HAYS PLANT - VINE STREET 115KV CKT 1 | 80 | 88 | 0.0443 | 103.4823 | KNOLL 230 - POSTROCK6 230.00 230KV CKT 1 |
| 14G | 3 | FROM->TO | G11_016 | SEWARD - ST JOHN 115KV CKT 1 | 80.3 | 87.6 | 0.03734 | 103.4133 | DBL-IRON-CLR |
| 14G | 3 | FROM->TO | G11_017 | SEWARD - ST JOHN 115KV CKT 1 | 80.3 | 87.6 | 0.03778 | 103.4133 | DBL-IRON-CLR |
| 14G | 03G11_016 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03149 | 103.1973 | GEN520997 1-MORLND2 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03138 | 103.1926 | LAWTON EASTSIDE - OKLAUNION 345KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_016 | CUDAHY - KISMET 3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.03129 | 103.1689 | BUCKNER7 345.00 - HOLCOMB 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03755 | 103.0171 | RENFROW7 345.00 - VIOLA 7 345.00 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03577 | 103.0171 | RENFROW7 345.00 - VIOLA 7 345.00 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03521 | 102.9374 | WOODWARD - WOODWARD 69KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03321 | 102.9374 | WOODWARD - WOODWARD 69KV CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.12797 | 102.9354 | DBL-IRON-CLR |
| 14G | 03ALL | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.12967 | 102.4658 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.12748 | 102.4658 | DBL-SPRVL-CL |
| 14G | 3 | TO->FROM | G11_016 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.09494 | 102.1993 | DBL-WICH-THI |
| 14G | 3 | TO->FROM | G11_017 | CIRCLE - MULLERGREN 230KV CKT 1 | 318.7 | 318.7 | 0.09511 | 102.1993 | DBL-WICH-THI |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03134 | 102.0201 | BASE CASE |
| 14G | 03G11_016 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03537 | 101.6442 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.13615 | 101.6296 | G11-17T 345.00 - SPEARVILLE 345KV CKT 1 |
| 14G | 3 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03149 | 101.579 | GEN520997 1-MORLND2 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03219 | 101.3967 | RENFROW7 345.00 (BANK 1) 345/138/13.8KV TRANSFORMER CKT 1 |

Power Flow Analysis

| Season | Dispatch Group | Flow | Source | Overloaded Element | RATEA (MVA) | RATEB (MVA) | TDF | TC% LOADING | Contingency |
|---|---|---|---|---|---|---|---|---|---|
| 14G | 03ALL | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03052 | 101.3967 | RENFROW7 345.00 (BANK 1) 345/138/13.8KV TRANSFORMER CKT 1 |
| 14G | 3 | FROM->TO | G11_016 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04901 | 101.3023 | DBL-SPRVL-CL |
| 14G | 3 | FROM->TO | G11_017 | GREENSBURG - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.04444 | 101.3023 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_016 | CIMARRON RIVER TAP - KISMET 3 115.00 115KV CKT 1 | 115.1 | 115.1 | 0.03129 | 101.2887 | BUCKNER7 345.00 - HOLCOMB 345KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03157 | 101.1081 | SPP-SWPS-03 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03156 | 101.1058 | ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1 |
| 14G | 03G11_017 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03337 | 101.1025 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03156 | 101.0937 | ELK CITY 230KV - SWEETWATER 230KV CKT 1 |
| 14G | 03G11_016 | TO->FROM | G11_016 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.13663 | 101.0936 | G11-17T 345.00 - POST ROCK 345KV CKT 1 |
| 14G | 03G11_016 | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.11237 | 100.7785 | DBL-IRON-CLR |
| 14G | 03G11_017 | TO->FROM | G11_017 | MULLERGREN - SPEARVILLE 230KV CKT 1 | 398 | 398 | 0.13663 | 100.3235 | G11-17T 345.00 - POST ROCK 345KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.07055 | 100.2846 | CIRCLE - MULLERGREN 230KV CKT 1 |
| 14G | 03ALL | FROM->TO | G11_017 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.08806 | 100.2846 | CIRCLE - MULLERGREN 230KV CKT 1 |
| 14G | 03G11_017 | FROM->TO | G11_017 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.12459 | 100.2507 | DBL-IRON-CLR |
| 14G | 03G11_016 | TO->FROM | G11_016 | MEDICINE LODGE - SUN CITY 115KV CKT 1 | 115.1 | 115.1 | 0.049 | 100.1286 | DBL-SPRVL-CL |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.0314 | 100 | RENFROW4 138.00 - SAND RDG_138138.00 138KV CKT 1 |
| 14G | 03ALL | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03156 | 100 | GRAPEVINE INTERCHANGE - STATELINE INTERCHANGE 230KV CKT 1 |
| 14G | 3 | TO->FROM | G11_016 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03537 | 99.7 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 3 | TO->FROM | G11_017 | FPL SWITCH - WOODWARD 138KV CKT 1 | 133 | 153 | 0.03338 | 99.7 | WOODWARD (WOODWRD2) 138/69/13.2KV TRANSFORMER CKT 1 |
| 14G | 03ALL | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.11198 | 99.6 | DBL-SPRVL-CL |
| 14G | 03ALL | FROM->TO | G11_017 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.1242 | 99.6 | DBL-SPRVL-CL |
| 14G | 03G11_016 | FROM->TO | G11_016 | SMOKYHL6 230.00 - SUMMIT 230KV CKT 1 | 330 | 330 | 0.08071 | 99.6 | DBL-WICH-THI |

# 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 2013 series of Model Development Working Group (MDWG) dynamic study models including the 2014 winter, 2015 summer, and 2024 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

One-hundred five (105) contingencies were identified for the Limited Operation scenario for use in this study. These faults are listed within Table 8. 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 8: Contingencies Evaluated for Limited Operation*

| | Contingency Number and Name | Description |
|---|---|---|
| 1 | FLT_001_SPERVIL7_BUCKNER7_345kV_3PH | *3-Phase fault on the Buckner – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 2 | FLT_002_SPERVIL7_BUCKNER7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 3 | FLT_003_SPERVIL7_CLARKCOUNTY7_345kV_3PH | *3-Phase fault on the Clark County – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 4 | FLT_004_SPERVIL7_CLARKCOUNTY7_345kV_1PH | *Single-phase fault similar to previous fault.* |

| | Contingency Number and Name | Description |
|---|---|---|
| 5 | FLT_005_SPERVIL7_IRONWOOD7_345kV_3PH | *3-Phase fault on the Ironwood – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 6 | FLT_006_SPERVIL7_IRONWOOD7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 7 | FLT_007_SPERVIL7_G11017TAP_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 8 | FLT_008_SPERVIL7_G11017TAP_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 9 | FLT_009_SPERVIL7_SPEARVL6_345_230kV_3PH | *3-Phase fault on the Spearville 345/230/13.8kV transformer near the Spearville 345kV bus.* |
| 10 | FLT_010_SPERVIL7_LANCER3_345_115kV_3PH | *3-Phase fault on the Spearville 345/115/13.8kV (Lancer) transformer near the Spearville 345kV bus.* |
| 11 | FLT_011_BUCKNER7_HOLCOMB7_345kV_3PH | *3-Phase fault on the Buckner – Holcomb 345kV CKT near the Buckner 345kV bus.* |
| 12 | FLT_012_BUCKNER7_HOLCOMB7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 13 | FLT_013_HOLCOMB7_FINNEY7_345kV_3PH | *3-Phase fault on the Finney – Holcomb 345kV CKT near the Holcomb 345kV bus.* |
| 14 | FLT_014_HOLCOMB7_FINNEY7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 15 | FLT_015_HOLCOMB7_SETAB7_345kV_3PH | *3-Phase fault on the Holcomb – Setab 345kV CKT near the Holcomb 345kV bus.* |
| 16 | FLT_016_HOLCOMB7_SETAB7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 17 | FLT_017_HOLCOMB7_HOLCOMB3_345_115kV_3PH | *3-Phase fault on the Holcomb 345/115/13.8kV transformer near the Holcomb 345kV bus.* |
| 18 | FLT_018_FINNEY7_HITCHLAND7_345kV_3PH | *3-Phase fault on the Finney – Hitchland 345kV CKT near the Finney 345kV bus.* |
| 19 | FLT_019_FINNEY7_HITCHLAND7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 20 | FLT_020_IRONWOOD7_SPERVIL7_345kV_3PH | *3-Phase fault on the Ironwood – Spearville 345kV CKT near the Ironwood 345kV bus.* |
| 21 | FLT_021_IRONWOOD7_SPERVIL7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 22 | FLT_022_IRONWOOD7_CLARKCOUNTY7_345kV_3PH | *3-Phase fault on the Clark County – Ironwood 345kV CKT near the Ironwood 345kV bus.* |
| 23 | FLT_023_IRONWOOD7_CLARKCOUNTY7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 24 | FLT_024_CLARKCOUNTY7_THISTLE7_345kV_3PH | *3-Phase fault on the Clark County – Thistle 345kV CKT near the Clark County 345kV bus.* |
| 25 | FLT_025_CLARKCOUNTY7_THISTLE7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 26 | FLT_026_THISTLE7_WICHITA7_345kV_3PH | *3-Phase fault on the Thistle – Wichita 345kV CKT near the Thistle 345kV bus.* |
| 27 | FLT_027_THISTLE7_WICHITA7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 28 | FLT_028_THISTLE7_WWRDEHV7_345kV_3PH | *3-Phase fault on the Thistle – Woodward 345kV CKT near the Thistle 345kV bus.* |
| 29 | FLT_029_THISTLE7_WWRDEHV7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 30 | FLT_030_THISTLE7_THISTLE4_345_138kV_3PH | *3-Phase fault on the Thistle 345/138/13.8kV transformer near the Thistle 345kV bus.* |
| 31 | FLT_031_WWRDEHV7_TATONGA7_345kV_3PH | *3-Phase fault on the Tatonga – Woodward 345kV CKT near the Woodward 345kV bus.* |
| 32 | FLT_032_WWRDEHV7_TATONGA7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 33 | FLT_033_WWRDEHV7_BORDER7_345kV_3PH | *3-Phase fault on the Border – Woodward 345kV CKT near the Woodward 345kV bus.* |
| 34 | FLT_034_WWRDEHV7_BORDER7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 35 | FLT_035_WWRDEHV7_BEAVERCO_345kV_3PH | *3-Phase fault on the Beaver County – Woodward 345kV CKT near the Woodward 345kV bus.* |
| 36 | FLT_036_WWRDEHV7_BEAVERCO_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 37 | FLT_037_WWRDEHV7_WWRDEHV4_345_138kV_3PH | *3-Phase fault on the Woodward 345/138/13.8kV transformer near the Woodward 345kV bus.* |
| 38 | FLT_038_BEAVERCO_HITCHLAND7_345kV_3PH | *3-Phase fault on the Beaver County – Hitchland 345kV CKT near the Beaver County 345kV bus.* |
| 39 | FLT_039_BEAVERCO_HITCHLAND7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 40 | FLT_040_WICHITA7_EMPEC7_345kV_3PH | *3-Phase fault on the Emporia Energy Center – Wichita 345kV CKT near the Wichita 345kV bus.* |
| 41 | FLT_041_WICHITA7_EMPEC7_345kV_1PH | *Single-phase fault similar to previous fault.* |

| Contingency Number and Name | | Description |
|---|---|---|
| 42 | FLT_042_WICHITA7_RENO7_345kV_3PH | *3-Phase fault on the Reno – Wichita 345kV CKT near the Wichita 345kV bus.* |
| 43 | FLT_043_WICHITA7_RENO7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 44 | FLT_044_WICHITA7_BENTON7_345kV_3PH | *3-Phase fault on the Benton – Wichita 345kV CKT near the Wichita 345kV bus.* |
| 45 | FLT_045_WICHITA7_BENTON7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 46 | FLT_046_WICHITA7_VIOLA7_345kV_3PH | *3-Phase fault on the Viola – Wichita 345kV CKT near the Wichita 345kV bus.* |
| 47 | FLT_047_WICHITA7_VIOLA7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 48 | FLT_048_G11017TAP_SPERVIL7_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Spearville 345kV CKT near the GEN-2011-017-Tap 345kV bus.* |
| 49 | FLT_049_G11017TAP_SPERVIL7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 50 | FLT_050_G11017TAP_POSTROCK7_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Post Rock 345kV CKT near the GEN-2011-017-Tap 345kV bus.* |
| 51 | FLT_051_G11017TAP_POSTROCK7_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 52 | FLT_052_POSTROCK7_AXTELL3_345kV_3PH | *3-Phase fault on the Axtell – Post Rock 345kV CKT near the Post Rock 345kV bus.* |
| 53 | FLT_053_POSTROCK7_AXTELL3_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 54 | FLT_054_POSTROCK7_POSTROCK6_345_230kV_3PH | *3-Phase fault on the Post Rock 345/230/13.8kV transformer near the Post Rock 345kV bus.* |
| 55 | FLT_055_AXTELL3_PAULINE3_345kV_3PH | *3-Phase fault on the Axtell – Pauline 345kV CKT near the Axtell 345kV bus.* |
| 56 | FLT_056_AXTELL3_PAULINE3_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 57 | FLT_057_AXTELL3_SWEETW3_345kV_3PH | *3-Phase fault on the Axtell – Sweetwater 345kV CKT near the Axtell 345kV bus.* |
| 58 | FLT_058_AXTELL3_SWEETW3_345kV_1PH | *Single-phase fault similar to previous fault.* |
| 59 | FLT_059_AXTELL3_AXTELL7_345_115kV_3PH | *3-Phase fault on the Axtell 345/115/13.8kV transformer near the Axtell 345kV bus.* |
| 60 | FLT_060_SPEARVL6_GRTBEND6_230kV_3PH | *3-Phase fault on the Great Bend – Spearville 230kV CKT near the Spearville 230kV bus.* |
| 61 | FLT_061_SPEARVL6_GRTBEND6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 62 | FLT_062_SPEARVL6_SPEARVL3_230_115kV_3PH | *3-Phase fault on the Spearville 230/115/13.8kV transformer near the Spearville 230kV bus.* |
| 63 | FLT_063_GRTBEND6_CIRCLE6_230kV_3PH | *3-Phase fault on the Circle – Great Bend 230kV CKT near the Great Bend 230kV bus.* |
| 64 | FLT_064_GRTBEND6_CIRCLE6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 65 | FLT_065_GRTBEND6_HEIZER6_230kV_3PH | *3-Phase fault on the Great Bend – Heizer 230kV CKT near the Great Bend 230kV bus.* |
| 66 | FLT_066_GRTBEND6_HEIZER6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 67 | FLT_067_SHAYS6_GRTBEND6_230kV_3PH | *3-Phase fault on the Great Bend – South Hays 230kV CKT near the South Hays 230kV bus.* |
| 68 | FLT_068_SHAYS6_GRTBEND6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 69 | FLT_069_POSTROCK6_SHAYS6_230kV_3PH | *3-Phase fault on the Post Rock – South Hays 230kV CKT near the Post Rock 230kV bus.* |
| 70 | FLT_070_POSTROCK6_SHAYS6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 71 | FLT_071_POSTROCK6_KNOLL6_230kV_3PH | *3-Phase fault on the Knoll – Post Rock 230kV CKT near the Post Rock 230kV bus.* |
| 72 | FLT_072_POSTROCK6_KNOLL6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 73 | FLT_073_KNOLL6_SMOKYHL6_230kV_3PH | *3-Phase fault on the Knoll – Smoky Hills 230kV CKT near the Knoll 230kV bus.* |
| 74 | FLT_074_KNOLL6_SMOKYHL6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 75 | FLT_075_SMOKYHL6_SUMMIT6_230kV_3PH | *3-Phase fault on the Smoky Hills – Summit 230kV CKT near the Smoky Hills 230kV bus.* |
| 76 | FLT_076_SMOKYHL6_SUMMIT6_230kV_1PH | *Single-phase fault similar to previous fault.* |
| 77 | FLT_077_NFTDODG3_FTDODGE3_115kV_3PH | *3-Phase fault on the Fort Dodge– North Fort Dodge 115kV CKT near the North Fort Dodge 115kV bus.* |
| 78 | FLT_078_NFTDODG3_FTDODGE3_115kV_1PH | *Single-phase fault similar to previous fault.* |

| | Contingency Number and Name | Description |
|---|---|---|
| 79 | FLT_079_NFTDODG3_SSTATTP3_115kV_3PH | *3-Phase fault on the North Fort Dodge– Shooting Star Tap 115kV CKT near the North Fort Dodge 115kV bus.* |
| 80 | FLT_080_NFTDODG3_SSTATTP3_115kV_1PH | *Single-phase fault similar to previous fault.* |
| 81 | FLT_081_FTDODGE3_CRKCK3_115kV_3PH | *3-Phase fault on the Crooked Creek Tap –Fort Dodge 115kV CKT near the Fort Dodge 115kV bus.* |
| 82 | FLT_082_FTDODGE3_CRKCK3_115kV_1PH | *Single-phase fault similar to previous fault.* |
| 83 | FLT_083_P4SPERBUCKSPER_SPEARVL6_345_230kV_1PH | *Loss of Buckner – Spearville 345kV CKT and Spearville 345/230/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Spearville 345kV bus.* |
| 84 | FLT_084_P4SPERCLARSPER_SPEARVL6_345_230kV_1PH | *Loss of Clark County – Spearville 345kV CKT and Spearville 345/230/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Spearville 345kV bus.* |
| 85 | FLT_085_P4SPERIRONSPER_SPEARVL6_345_230kV_1PH | *Loss of Ironwood – Spearville 345kV CKT and Spearville 345/230/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Spearville 345kV bus.* |
| 86 | FLT_086_P4SPER1117SPER_SPEARVL6_345_230kV_1PH | *Loss of GEN-2011-017-Tap – Spearville 345kV CKT and Spearville 345/230/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Spearville 345kV bus.* |
| 87 | FLT_087_P4AXTEPAULAXTE_AXTELL7_345_115kV_1PH | *Loss of Axtell – Pauline 345kV CKT and Axtell 345/115/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Axtell 345kV bus.* |
| 88 | FLT_088_P4AXTESWEEAXTE_AXTELL7_345_115kV_1PH | *Loss of Axtell – Sweetwater 345kV CKT and Axtell 345/115/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Axtell 345kV bus.* |
| 89 | FLT_089_P4THISWWRDTHIS_THISTLE4_345_138kV_1PH | *Loss of Thistle – Woodward 345kV CKT and Thistle 345/138/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Thistle 345kV bus.* |
| 90 | FLT_090_P4THISCLARTHIS_THISTLE4_345_138kV_1PH | *Loss of Clark County – Thistle 345kV CKT and Thistle 345/138/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Thistle 345kV bus.* |
| 91 | FLT_091_P4THISWICHTHIS_THISTLE4_345_138kV_1PH | *Loss of Thistle – Wichita 345kV CKT and Thistle 345/138/13.8kV transformer caused by a stuck breaker (16 cycle without reclose) attempting to clear a Single-Phase fault near the Thistle 345kV bus.* |
| 92 | FLT_092_P6SPVLCLRKSPVL_IRONWOOD7_345kV_3PH | *Prior outage of Clark County – Spearville 345kV CKT followed by system adjustments. Then 3-Phase fault on the Ironwood – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 93 | FLT_093_P7SPVLCLRKSPVL_IRONWOOD7_345kV_1PH | *Single-Phase fault on the Ironwood – Spearville 345kV CKT and Clark County – Spearville 345kV CKT near the Spearville 345kV bus.* |
| 94 | FLT_094_P6CLRKSPVLCLRK_IRONWOOD7_345kV_3PH | *Prior outage of Clark County – Spearville 345kV CKT followed by system adjustments. Then 3-Phase fault on the Ironwood – Spearville 345kV CKT near the Clark County 345kV bus.* |
| 95 | FLT_095_P7CLRKSPVLCLRK_IRONWOOD7_345kV_1PH | *Single-Phase fault on the Ironwood – Spearville 345kV CKT and Clark County – Spearville 345kV CKT near the Clark County 345kV bus.* |

| | Contingency Number and Name | Description |
|---|---|---|
| 96 | FLT_096_P6DBLCLARKCOUNTY7_THISTLE7_345kV_3PH | *Prior outage of Clark County – Thistle 345kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Clark County – Thistle 345kV CKT 2 near the Clark County 345kV bus.* |
| 96_R1 | FLT_096_P6DBLCLARKCOUNTY7_THISTLE7_345kV_3PH_R1 | *Curtail 420MW of Generation near Spearville 345kV. Prior outage of Clark County – Thistle 345kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Clark County – Thistle 345kV CKT 2 near the Clark County 345kV bus.* |
| 97 | FLT_097_P7DBLCLARKCOUNTY7_THISTLE7_345kV_1PH | *Single-Phase fault on the Clark County – Thistle 345kV CKT 1 and Clark County – Thistle 345kV CKT 2 near the Clark County 345kV bus.* |
| 97_R1 | FLT_097_P7DBLCLARKCOUNTY7_THISTLE7_345kV_1PH_R1 | *Curtail 420MW of Generation near Spearville 345kV. Single-Phase fault on the Clark County – Thistle 345kV CKT 1 and Clark County – Thistle 345kV CKT 2 near the Clark County 345kV bus.* |
| 98 | FLT_098_P6DBLTHISTLE7_WWRDEHV7_345kV_3PH | *Prior outage of Thistle – Woodward 345kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Thistle – Woodward 345kV CKT 2 near the Thistle 345kV bus.* |
| 99 | FLT_099_P7DBLTHISTLE7_WWRDEHV7_345kV_1PH | *Single-Phase fault on the Thistle – Woodward 345kV CKT 1 and Thistle – Woodward 345kV CKT 2 near the Thistle 345kV bus.* |
| 100 | FLT_100_P6DBLTHISTLE7_WICHITA7_345kV_3PH | *Prior outage of Thistle – Wichita 345kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Thistle – Wichita 345kV CKT 2 near the Thistle 345kV bus.* |
| 101 | FLT_101_P7DBLTHISTLE7_WICHITA7_345kV_1PH | *Single-Phase fault on the Thistle – Wichita 345kV CKT 1 and Thistle – Wichita 345kV CKT 2 near the Thistle 345kV bus.* |
| 102 | FLT_102_P6DBLFTDODGE3_NFTDODG3_115kV_3PH | *Prior outage of Fort Dodge – North Fort Dodge 115kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Fort Dodge – North Fort Dodge 115kV CKT 2 near the Fort Dodge 115kV bus.* |
| 103 | FLT_103_P7DBLFTDODGE3_NFTDODG3_115kV_1PH | *Single-Phase fault on the Fort Dodge – North Fort Dodge 115kV CKT 1 and Fort Dodge – North Fort Dodge 115kV CKT 2 near the Fort Dodge 115kV bus.* |
| 104 | FLT_104_P6NFTDSPVLNFTD_LANCER3_115kV_3PH | *Prior outage of North Fort Dodge – Spearville 115kV CKT 1 followed by system adjustments. Then 3-Phase fault on the Lancer – North Fort Dodge 115kV CKT 1 near the North Fort Dodge 115kV bus.* |
| 105 | FLT_105_P7NFTDSPVLNFTD_LANCER3_115kV_1PH | *Single-Phase fault on the North Fort Dodge – Spearville 115kV CKT 1 and Lancer – North Fort Dodge 115kV CKT 1 near the North Fort Dodge 115kV bus.* |

## Power Factor Analysis and Reactor Requirements

Power factor analysis was performed for this study and is designed to demonstrate the reactive power requirements at the point of interconnection during the period of limited operation prior to the in service date of all required upgrades. Power factor analysis was performed both while the generator is dispatched at this study's determined limited output and off-line. In order to perform the analysis the request and equivalent transmission lines and collectors systems were modeled using specifications provided by the Customer.

*Table 9 - Power Factor Analysis and Reactor Requirements During LOIS Period*

| Request | Capacity | POI | Fuel | Generator | Power Factor Requirements at POI | Reactor Requirements at POI for 0.0 MW |
|---|---|---|---|---|---|---|
| GEN-2011-016 | 200.1 MW | Spearville 345kV | Wind | Siemens 2.3MW | 0.81pf lagging to 1.0pf | 16.0 MVAR |
| GEN-2011-017 | 299.0 MW | Tap on Spearville to Post Rock 345kV | Wind | Siemens 2.3MW | 0.81pf lagging to 0.977pf leading | 14.0 MVAR |

*NOTE: As reactive power is required for all projects, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.*

Analysis shows that while generating at 200.1MW & 299.0 MW the voltages at the GEN-2011-016 POI & GEN-2011-017 POI are low for most system conditions requiring an injection of reactive power from GEN-2011-016 & GEN-2011-017 to the system. While the GIA will require the requests to maintain a 0.95pf lagging to 0.95pf leading at the POI, this analysis shows that during the limited operation period the voltage could be extremely deficient during high west to east transfers requiring some type of mitigation, increasing the chances of curtailment.

During periods where the requests are off-line or not generating, the approximate amount of charging current provided by the GEN-2011-016 subsystem is 17.7MVAR & GEN-2011-017 subsystem is 15.7 MVAR. To perform this analysis, the study projects generation was reduced to 0MW and 0MVAR with the collector systems remaining connected to the system. Should the configuration of the request collector systems change from what was submitted, a restudy of the reactor requirements may be required. All other non-dispatchable projects with adjacent POI's were disconnected from the system. It is recommended that the Customer install at least 17.7MVAR of reactors at GEN-2011-016 and 15.7MVAR of reactors at GEN-2011-017 to compensate for the injection of charging current into the transmission system. It is also recommended that all of this reactive support be installed at the POI to counter the injection of capacitance from the 345kV Customer substation lead. Should the Customer choose to not install all of the reactors at the POI, additional reactors may be required.

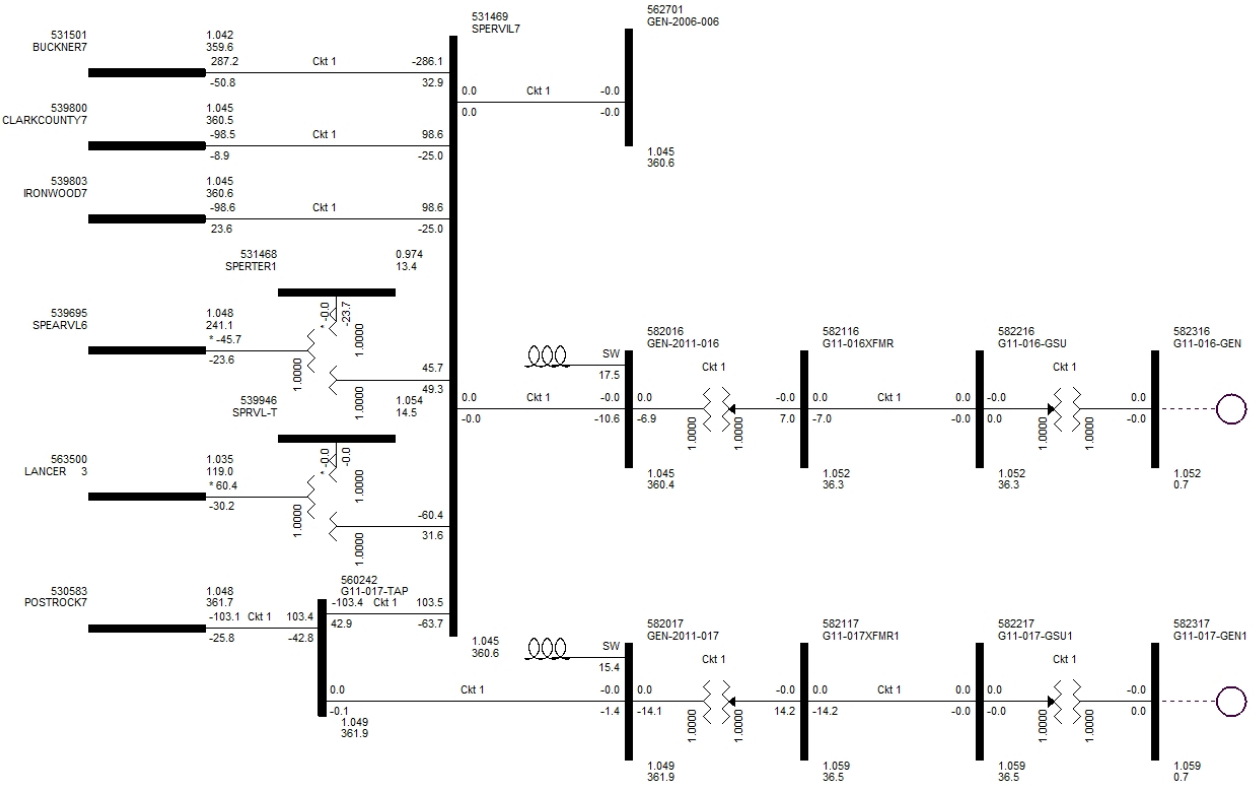


*Figure 3: GEN-2011-016 & GEN-2011-017 with generators turned off and shunt reactors added to the high side of the substation 345/34.5kV transformers*

## Results

Results of the stability analysis are summarized in Table 10. These results are valid for the Customers interconnecting with a generation amount up to 499.1 MW given the study assumptions. The results indicate that the transmission system remains stable for all single contingencies studied. A NERC Category "P7" event resulted in potential voltage instability. This instability can be mitigated with generation curtailments that limit the flows on the double circuit line from Clark County – Thistle 345kV. The plots will be available upon request.

*Table 10: Fault Analysis Results for Limited Operation*

| | Contingency Number and Name | 2014WP | 2015SP | 2024SP |
|---|---|---|---|---|
| 1 | FLT_001_SPERVIL7_BUCKNER7_345kV_3PH | Stable | Stable | Stable |
| 2 | FLT_002_SPERVIL7_BUCKNER7_345kV_1PH | Stable | Stable | Stable |
| 3 | FLT_003_SPERVIL7_CLARKCOUNTY7_345kV_3PH | Stable | Stable | Stable |
| 4 | FLT_004_SPERVIL7_CLARKCOUNTY7_345kV_1PH | Stable | Stable | Stable |
| 5 | FLT_005_SPERVIL7_IRONWOOD7_345kV_3PH | Stable | Stable | Stable |
| 6 | FLT_006_SPERVIL7_IRONWOOD7_345kV_1PH | Stable | Stable | Stable |
| 7 | FLT_007_SPERVIL7_G11017TAP_345kV_3PH | Stable | Stable | Stable |
| 8 | FLT_008_SPERVIL7_G11017TAP_345kV_1PH | Stable | Stable | Stable |
| 9 | FLT_009_SPERVIL7_SPEARVL6_345_230kV_3PH | Stable | Stable | Stable |
| 10 | FLT_010_SPERVIL7_LANCER3_345_115kV_3PH | Stable | Stable | Stable |
| 11 | FLT_011_BUCKNER7_HOLCOMB7_345kV_3PH | Stable | Stable | Stable |

| | Contingency Number and Name | 2014WP | 2015SP | 2024SP |
|---|---|---|---|---|
| 12 | FLT_012_BUCKNER7_HOLCOMB7_345kV_1PH | Stable | Stable | Stable |
| 13 | FLT_013_HOLCOMB7_FINNEY7_345kV_3PH | Stable | Stable | Stable |
| 14 | FLT_014_HOLCOMB7_FINNEY7_345kV_1PH | Stable | Stable | Stable |
| 15 | FLT_015_HOLCOMB7_SETAB7_345kV_3PH | Stable | Stable | Stable |
| 16 | FLT_016_HOLCOMB7_SETAB7_345kV_1PH | Stable | Stable | Stable |
| 17 | FLT_017_HOLCOMB7_HOLCOMB3_345_115kV_3PH | Stable | Stable | Stable |
| 18 | FLT_018_FINNEY7_HITCHLAND7_345kV_3PH | Stable | Stable | Stable |
| 19 | FLT_019_FINNEY7_HITCHLAND7_345kV_1PH | Stable | Stable | Stable |
| 20 | FLT_020_IRONWOOD7_SPERVIL7_345kV_3PH | Stable | Stable | Stable |
| 21 | FLT_021_IRONWOOD7_SPERVIL7_345kV_1PH | Stable | Stable | Stable |
| 22 | FLT_022_IRONWOOD7_CLARKCOUNTY7_345kV_3PH | Stable | Stable | Stable |
| 23 | FLT_023_IRONWOOD7_CLARKCOUNTY7_345kV_1PH | Stable | Stable | Stable |
| 24 | FLT_024_CLARKCOUNTY7_THISTLE7_345kV_3PH | Stable | Stable | Stable |
| 25 | FLT_025_CLARKCOUNTY7_THISTLE7_345kV_1PH | Stable | Stable | Stable |
| 26 | FLT_026_THISTLE7_WICHITA7_345kV_3PH | Stable | Stable | Stable |
| 27 | FLT_027_THISTLE7_WICHITA7_345kV_1PH | Stable | Stable | Stable |
| 28 | FLT_028_THISTLE7_WWRDEHV7_345kV_3PH | Stable | Stable | Stable |
| 29 | FLT_029_THISTLE7_WWRDEHV7_345kV_1PH | Stable | Stable | Stable |
| 30 | FLT_030_THISTLE7_THISTLE4_345_138kV_3PH | Stable | Stable | Stable |
| 31 | FLT_031_WWRDEHV7_TATONGA7_345kV_3PH | Stable | Stable | Stable |
| 32 | FLT_032_WWRDEHV7_TATONGA7_345kV_1PH | Stable | Stable | Stable |
| 33 | FLT_033_WWRDEHV7_BORDER7_345kV_3PH | Stable | Stable | Stable |
| 34 | FLT_034_WWRDEHV7_BORDER7_345kV_1PH | Stable | Stable | Stable |
| 35 | FLT_035_WWRDEHV7_BEAVERCO_345kV_3PH | Stable | Stable | Stable |
| 36 | FLT_036_WWRDEHV7_BEAVERCO_345kV_1PH | Stable | Stable | Stable |
| 37 | FLT_037_WWRDEHV7_WWRDEHV4_345_138kV_3PH | Stable | Stable | Stable |
| 38 | FLT_038_BEAVERCO_HITCHLAND7_345kV_3PH | Stable | Stable | Stable |
| 39 | FLT_039_BEAVERCO_HITCHLAND7_345kV_1PH | Stable | Stable | Stable |
| 40 | FLT_040_WICHITA7_EMPEC7_345kV_3PH | Stable | Stable | Stable |
| 41 | FLT_041_WICHITA7_EMPEC7_345kV_1PH | Stable | Stable | Stable |
| 42 | FLT_042_WICHITA7_RENO7_345kV_3PH | Stable | Stable | Stable |
| 43 | FLT_043_WICHITA7_RENO7_345kV_1PH | Stable | Stable | Stable |
| 44 | FLT_044_WICHITA7_BENTON7_345kV_3PH | Stable | Stable | Stable |
| 45 | FLT_045_WICHITA7_BENTON7_345kV_1PH | Stable | Stable | Stable |
| 46 | FLT_046_WICHITA7_VIOLA7_345kV_3PH | Stable | Stable | Stable |
| 47 | FLT_047_WICHITA7_VIOLA7_345kV_1PH | Stable | Stable | Stable |
| 48 | FLT_048_G11017TAP_SPERVIL7_345kV_3PH | Stable | Stable | Stable |
| 49 | FLT_049_G11017TAP_SPERVIL7_345kV_1PH | Stable | Stable | Stable |
| 50 | FLT_050_G11017TAP_POSTROCK7_345kV_3PH | Stable | Stable | Stable |
| 51 | FLT_051_G11017TAP_POSTROCK7_345kV_1PH | Stable | Stable | Stable |
| 52 | FLT_052_POSTROCK7_AXTELL3_345kV_3PH | Stable | Stable | Stable |
| 53 | FLT_053_POSTROCK7_AXTELL3_345kV_1PH | Stable | Stable | Stable |
| 54 | FLT_054_POSTROCK7_POSTROCK6_345_230kV_3PH | Stable | Stable | Stable |
| 55 | FLT_055_AXTELL3_PAULINE3_345kV_3PH | Stable | Stable | Stable |
| 56 | FLT_056_AXTELL3_PAULINE3_345kV_1PH | Stable | Stable | Stable |
| 57 | FLT_057_AXTELL3_SWEETW3_345kV_3PH | Stable | Stable | Stable |
| 58 | FLT_058_AXTELL3_SWEETW3_345kV_1PH | Stable | Stable | Stable |
| 59 | FLT_059_AXTELL3_AXTELL7_345_115kV_3PH | Stable | Stable | Stable |
| 60 | FLT_060_SPEARVL6_GRTBEND6_230kV_3PH | Stable | Stable | Stable |
| 61 | FLT_061_SPEARVL6_GRTBEND6_230kV_1PH | Stable | Stable | Stable |
| 62 | FLT_062_SPEARVL6_SPEARVL3_230_115kV_3PH | Stable | Stable | Stable |
| 63 | FLT_063_GRTBEND6_CIRCLE6_230kV_3PH | Stable | Stable | Stable |
| 64 | FLT_064_GRTBEND6_CIRCLE6_230kV_1PH | Stable | Stable | Stable |
| 65 | FLT_065_GRTBEND6_HEIZER6_230kV_3PH | Stable | Stable | Stable |
| 66 | FLT_066_GRTBEND6_HEIZER6_230kV_1PH | Stable | Stable | Stable |
| 67 | FLT_067_SHAYS6_GRTBEND6_230kV_3PH | Stable | Stable | Stable |
| 68 | FLT_068_SHAYS6_GRTBEND6_230kV_1PH | Stable | Stable | Stable |

| Contingency Number and Name | | 2014WP | 2015SP | 2024SP |
|---|---|---|---|---|
| 69 | FLT_069_POSTROCK6_SHAYS6_230kV_3PH | Stable | Stable | Stable |
| 70 | FLT_070_POSTROCK6_SHAYS6_230kV_1PH | Stable | Stable | Stable |
| 71 | FLT_071_POSTROCK6_KNOLL6_230kV_3PH | Stable | Stable | Stable |
| 72 | FLT_072_POSTROCK6_KNOLL6_230kV_1PH | Stable | Stable | Stable |
| 73 | FLT_073_KNOLL6_SMOKYHL6_230kV_3PH | Stable | Stable | Stable |
| 74 | FLT_074_KNOLL6_SMOKYHL6_230kV_1PH | Stable | Stable | Stable |
| 75 | FLT_075_SMOKYHL6_SUMMIT6_230kV_3PH | Stable | Stable | Stable |
| 76 | FLT_076_SMOKYHL6_SUMMIT6_230kV_1PH | Stable | Stable | Stable |
| 77 | FLT_077_NFTDODG3_FTDODGE3_115kV_3PH | Stable | Stable | Stable |
| 78 | FLT_078_NFTDODG3_FTDODGE3_115kV_1PH | Stable | Stable | Stable |
| 79 | FLT_079_NFTDODG3_SSTATTP3_115kV_3PH | Stable | Stable | Stable |
| 80 | FLT_080_NFTDODG3_SSTATTP3_115kV_1PH | Stable | Stable | Stable |
| 81 | FLT_081_FTDODGE3_CRKCK3_115kV_3PH | Stable | Stable | Stable |
| 82 | FLT_082_FTDODGE3_CRKCK3_115kV_1PH | Stable | Stable | Stable |
| 83 | FLT_083_P4SPERBUCKSPER_SPEARVL6_345_230kV_1PH | Stable | Stable | Stable |
| 84 | FLT_084_P4SPERCLARSPER_SPEARVL6_345_230kV_1PH | Stable | Stable | Stable |
| 85 | FLT_085_P4SPERIRONSPER_SPEARVL6_345_230kV_1PH | Stable | Stable | Stable |
| 86 | FLT_086_P4SPER1117SPER_SPEARVL6_345_230kV_1PH | Stable | Stable | Stable |
| 87 | FLT_087_P4AXTEPAULAXTE_AXTELL7_345_115kV_1PH | Stable | Stable | Stable |
| 88 | FLT_088_P4AXTESWEEAXTE_AXTELL7_345_115kV_1PH | Stable | Stable | Stable |
| 89 | FLT_089_P4THISWWRDTHIS_THISTLE4_345_138kV_1PH | Stable | Stable | Stable |
| 90 | FLT_090_P4THISCLARTHIS_THISTLE4_345_138kV_1PH | Stable | Stable | Stable |
| 91 | FLT_091_P4THISWICHTHIS_THISTLE4_345_138kV_1PH | Stable | Stable | Stable |
| 92 | FLT_092_P6SPVLCLRKSPVL_IRONWOOD7_345kV_3PH | Stable | Stable | Stable |
| 93 | FLT_093_P7SPVLCLRKSPVL_IRONWOOD7_345kV_1PH | Stable | Stable | Stable |
| 94 | FLT_094_P6CLRKSPVLCLRK_IRONWOOD7_345kV_3PH | Stable | Stable | Stable |
| 95 | FLT_095_P7CLRKSPVLCLRK_IRONWOOD7_345kV_1PH | Stable | Stable | Stable |
| 96 | FLT_096_P6DBLCLARKCOUNTY7_THISTLE7_345kV_3PH | Unstable | Unstable | Unstable |
| 96_R1 | FLT_096_P6DBLCLARKCOUNTY7_THISTLE7_345kV_3PH_R1 | Stable | Stable | Stable |
| 97 | FLT_097_P7DBLCLARKCOUNTY7_THISTLE7_345kV_1PH | Unstable | Unstable | Unstable |
| 97_R1 | FLT_097_P7DBLCLARKCOUNTY7_THISTLE7_345kV_1PH_R1 | Stable | Stable | Stable |
| 98 | FLT_098_P6DBLTHISTLE7_WWRDEHV7_345kV_3PH | Stable | Stable | Stable |
| 99 | FLT_099_P7DBLTHISTLE7_WWRDEHV7_345kV_1PH | Stable | Stable | Stable |
| 100 | FLT_100_P6DBLTHISTLE7_WICHITA7_345kV_3PH | Stable | Stable | Stable |
| 101 | FLT_101_P7DBLTHISTLE7_WICHITA7_345kV_1PH | Stable | Stable | Stable |
| 102 | FLT_102_P6DBLFTDODGE3_NFTDODG3_115kV_3PH | Stable | Stable | Stable |
| 103 | FLT_103_P7DBLFTDODGE3_NFTDODG3_115kV_1PH | Stable | Stable | Stable |
| 104 | FLT_104_P6NFTDSPVLNFTD_LANCER3_115kV_3PH | Stable | Stable | Stable |
| 105 | FLT_105_P7NFTDSPVLNFTD_LANCER3_115kV_1PH | Stable | 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 11.

*Table 11: LVRT Contingencies*

| Contingency Name | Description |
|---|---|
| FLT_001_SPERVIL7_BUCKNER7_345kV_3PH | *3-Phase fault on the Buckner – Spearville 345kV CKT near the Spearville 345kV bus.* |

| Contingency Name | Description |
|---|---|
| FLT_003_SPERVIL7_CLARKCOUNTY7_345kV_3PH | *3-Phase fault on the Clark County – Spearville 345kV CKT near the Spearville 345kV bus.* |
| FLT_005_SPERVIL7_IRONWOOD7_345kV_3PH | *3-Phase fault on the Ironwood – Spearville 345kV CKT near the Spearville 345kV bus.* |
| FLT_007_SPERVIL7_G11017TAP_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Spearville 345kV CKT near the Spearville 345kV bus.* |
| FLT_009_SPERVIL7_SPEARVL6_345_230kV_3PH | *3-Phase fault on the Spearville 345/230/13.8kV transformer near the Spearville 345kV bus.* |
| FLT_010_SPERVIL7_LANCER3_345_115kV_3PH | *3-Phase fault on the Spearville 345/115/13.8kV (Lancer) transformer near the Spearville 345kV bus.* |
| FLT_048_G11017TAP_SPERVIL7_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Spearville 345kV CKT near the GEN-2011-017-Tap 345kV bus.* |
| FLT_050_G11017TAP_POSTROCK7_345kV_3PH | *3-Phase fault on the GEN-2011-017-Tap – Post Rock 345kV CKT near the GEN-2011-017-Tap 345kV 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 Customers GEN-2011-016 and GEN-2011-017) have requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for a total of 499.1 MW of wind generation to be interconnected as an Energy Resource (ER) into the Transmission System of Sunflower Electric Power Corporation (SUNC) in Ford and Hodgeman County, Kansas. The point of interconnection for GEN-2011-016 will be the Spearville 345kV substation. The point of interconnection for GEN-2011-017 will be through a tap on Spearville – Post Rock 345kV transmission line. The Customers, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-001 (or most recent iteration) Impact Study can be placed into service.

Power flow analysis from this LOIS has determined that the Customers request can interconnect their generation as an Energy Resource prior to the completion of the required Network Upgrades, 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. Refer to Table 4 and 5 for the Limited Operation Interconnection Service available due to interconnection constraints.

Transient stability analysis indicates that the transmission system will remain stable for the contingencies listed within Table 8 with the addition of the Customers generation. Additionally, the Customers were found to be in compliance with FERC Order #661A when studied as listed within this report.

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 LOIS 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.