LIMITED OPERATION IMPACT STUDY REPORT

GEN-2016-043

Published April 2020

By SPP Generator Interconnections Dept.

REVISION HISTORY

Date	Author	Change Description
3/4/2019	SPP	Impact Study of Limited Operation for Generator Interconnection GEN-2016-043 Report Issued
4/8/2020	SPP	Inclusion of stability analysis results prior to completion of the r-plan, Gentleman – Thedford (Cherry Co) - Holt Co. 345 kV circuits (NTC 200220)

EXECUTIVE SUMMARY

Interconnection Customer GEN-2016-043 has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 230 MW of wind generation to be interconnected with Energy Resource Interconnection Service (ERIS) into the Transmission System of Nebraska Public Power District (NPPD) in Wayne County, Nebraska. GEN-2016-043, 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-2016-001-1 (or most recent iteration) Impact Re-study can be placed into service.

This LOIS addresses the effects of interconnecting the generator to the rest of the transmission system for the system topology and conditions as identified under the following assumptions:

1. Gentleman – Thedford – Holt 345 kV project is assumed to be out of service in all models.
2. Atwood capacitive reactive power support (10 Mvar capacitor bank) is assumed to be out of service in all models.
3. SPP GIR's GEN-2016-021, GEN-2016-023, and GEN-2016-029 are assumed to be out of service in all models.
4. All other transmission system upgrades identified in the DISIS-2016-001-1 and higher queued studies are included in the models.

For this LOIS, a power flow analysis was conducted that considers only the equal and higher queued projects listed within **Table 1A** and **Table 1B** 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 3**, 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.

For this LOIS, a transient stability analysis was conducted that considers the lower, equal, and higher queued projects listed within the MEPPI report 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 the MEPPI report, 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 and Stability analysis from this LOIS has determined that the GEN-2016-043 request can interconnect **230 MW** of generation with Energy Resource Interconnection Service on an interim basis 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 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 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.

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

GEN-2016-043 has requested 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 NPPD.

The purpose of this study is to reevaluate the impacts of interconnecting GEN-2016-043 request of 230 MW comprised of one hundred (100) GE 2.3 MW wind turbines generators and associated facilities at NPPD's Hoskins 345 kV substation. The Customer has requested this amount to be studied with ERIS.

Only power flow analysis was conducted for this Limited Operation Interconnection Service. Limited Operation Studies are conducted under GIA Section 5.9.

In addition to the study assumptions outlined in the Executive Summary, this LOIS considers the Base Case as well as all Generating Facilities (and with respect to 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 or projects to interconnect to the Transmission System listed in **Table 1A** and **Table 1B**; 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 and projects. Those listed within **Table 1A** are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the time GEN-2016-043 is in service. Also listed in **Table 1A** are the amount of MWs of interconnection service expected at the effective time of this study, the fuel type, the group number, the service type, and the current status of each particular prior queued request. **Table 1B** lists the projects included within the study.

Table 1A: Generation Requests Included within LOIS

Project	MW	Service	Fuel Type	Group Number	Status
NPPD Distributed (Broken Bow)	7.3	ER	Heat	09 NEB	
NPPD Distributed (Burwell)	3	ER	Heat	09 NEB	
NPPD Distributed (Ord)	10.8	ER	Heat	09 NEB	
NPPD Distributed (Stuart)	1.8	ER	Heat	09 NEB	
NPPD Distributed (Columbus Hydro)	45	ER	Hydro	09 NEB	
WAPA SEAMS (Gavins Pt Hydro)	102	ER	Hydro	09 NEB	
WAPA SEAMS (Ft Randle Hydro)	352	ER	Hydro	09 NEB	
WAPA SEAMS (Spirit Mound Heat)	120	ER	Heat	09 NEB	
NPPD Distributed (Burt County Wind)	12	ER	Wind	09 NEB	
NPPD Distributed (Buffalo County Solar)	10	ER	Solar	09 NEB	
NPPD Distributed (North Platte - Lexington)	54	ER	Hydro	09 NEB	
GEN-2003-021N	75	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2004-023N	75	ER	Coal	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-020N	42	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-038N005	80	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-038N019	80	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2007-011N08	81	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-119O	60	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-037N1	74.8	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-044N	40.5	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION

Table 1A: Generation Requests Included within LOIS

Project	MW	Service	Fuel Type	Group Number	Status
GEN-2008-086N02	201	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-123N	89.7	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2009-040	73.8	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2010-041	10.5	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2010-051	200	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-018	73.6	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-027	120	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-056	3.6	ER	Hydro	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-056A	3.6	ER	Hydro	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-056B	4.5	ER	Hydro	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2012-021	4.8	ER	Gas	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-002	50.6	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/ON SUSPENSION
GEN-2013-008	1.2	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-019	73.6	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/ON SUSPENSION
GEN-2013-032	204	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2014-004	3.96	ER	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION

Table 1A: Generation Requests Included within LOIS

Project	MW	Service	Fuel Type	Group Number	Status
GEN-2014-013	73.5	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-031	35.8	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-032	10.22	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-039	73.39	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2007-017IS	200	ER/NR	Wind	09 NEB	ON SCHEDULE
GEN-2007-018IS	200	ER/NR	Wind	09 NEB	ON SCHEDULE
GEN-2015-007	160	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-023	300.72	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-076	158.4	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SUSPENSION
GEN-2015-087	66	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/ON SUSPENSION
GEN-2015-088	300	ER/NR	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2016-050	250.7	ER	Wind	09 NEB	FACILITY STUDY STAGE
GEN-2015-089	200	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE
GEN-2016-075	50	ER	Wind	09 NEB	FACILITY STUDY STAGE
GEN-2016-043	230	ER	Wind	09 NEB	IA FULLY EXECUTED/ON SCHEDULE

Table 1B: Upgrade Projects included within LOIS

Upgrade Project	Type	Description	Status	Study Assignment
Keystone – Gentleman 345kV CKT 2	New Line	Build approximately 30 miles of new 345kV transmission from Keystone to Gentleman	Facility Study Stage	DISIS-2016-001-1
Banner County – Keystone 345kV CKT 1	New Line	Build approximately 140 miles of new 345kV transmission from Banner County to Keystone	Facility Study Stage	DISIS-2016-001-1

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 2: Upgrade Projects not included but Required for Full Interconnection Service

Upgrade Project	Type	Description	Status	Study Assignment
Atwood Capacitive Reactive Power Support	Reactive Power Support	Install 10 Mvars of Capacitor bank(s) at Atwood 115kV	Facility Study Stage	DISIS-2016-001-1
Gentleman – Thedford – Holt County 345kV	New Line, Transformer, and Substation	Build approximately 227 miles of new 345kV transmission from Gentleman to Thedford to Holt County. Install Thedford 345/115/13kV transformer and build Holt County substation	Delayed ISD 1/1/2021	2012 SPP Integrated Transmission Plan (ITP10)

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 3**. 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 3: Higher or Equally Queued GI Requests not included within LOIS

Project	MW	Service	Fuel Type	Group Number	Status
GEN-2016-021	300	ER	Wind	09 NEB	FACILITY STUDY STAGE
GEN-2016-023	150.5	ER	Wind	09 NEB	FACILITY STUDY STAGE
GEN-2016-029	150	ER	Wind	09 NEB	FACILITY STUDY STAGE

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

FACILITIES

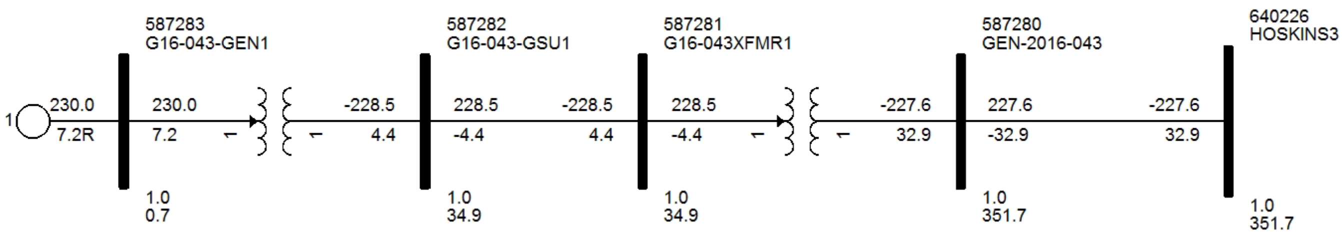
GENERATING FACILITY

Interconnection Customer's request, GEN-2016-043, totals 230 MW; it consists of one hundred (100) GE 2.3 MW wind turbines generators and associated facilities at Nebraska Public Power District's (NPPD) Hoskins 345kV substation.

INTERCONNECTION FACILITIES

Figure 1 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the requests.

Figure 1: 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 GEN-2016-043 LOIS requested in-service date of December 2021. 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.

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 2016 series of 2017 ITP Near-Term study models including these seasonal models:

- Year 1 (2017) Winter Peak (17WP)
- Year 2 (2018) Spring (18G)
- Year 2 (2018) Summer Peak (18SP)
- Year 5 (2021) Light (21L)
- Year 5 (2021) Summer (21SP)
- Year 5 (2021) Winter (21WP) peak
- Year 10 (2026) Summer (26SP) peak

To incorporate the Interconnection Customers' request, a re-dispatch of existing generation within SPP was performed with respect to the amount of the Customers' injection.

For Variable Energy Resources (VER) (solar/wind) in each power flow case, ERIS, is evaluated for the generating plants within a geographical area of the interconnection request(s) for the VERs dispatched at 100% nameplate of maximum generation. The VERs in the remote areas is dispatched at 20% nameplate of maximum generation. SPP projects are dispatched across the SPP footprint using load factor ratios.

Peaking units are not dispatched in the Year 2 spring and Year 5 light, or in the "High VER" summer and winter peaks. To study peaking units' impacts, the Year 1 winter peak, Year 2 summer peak, and Year 5 summer and winter peaks, and Year 10 summer peak models are developed with peaking units dispatched at 100% of the nameplate rating and VERs dispatched at 20% of the nameplate rating. Each interconnection request is also modeled separately at 100% nameplate for certain analyses.

All generators (VER and peaking) that requested NRIS are dispatched in an additional analysis into the interconnecting Transmission Owner's (T.O.) area at 100% nameplate with ERIS only requests at 80% nameplate. This method allows for identification of network constraints that are common between regional groupings to have affecting requests share the mitigating upgrade costs throughout the cluster.

For this LOIS, only the previous queued requests listed in **Table 1** were assumed to be in-service at 100% dispatch.

STUDY METHODOLOGY AND CRITERIA

THERMAL OVERLOADS

Network constraints are found by using PSS/E AC Contingency Calculation (ACCC) analysis with PSS/E MUST First Contingency Incremental Transfer Capability (FCITC) analysis on the entire cluster grouping dispatched at the various levels previously mentioned.

For Energy Resource Interconnection Service (ERIS), thermal overloads are determined for system intact (n-0) (greater than or equal to 100% of Rate A - normal) and for contingency (n-1) (greater than or equal to 100% of Rate B – emergency) conditions.

The overloads are then screened to determine which of generator interconnection requests have at least

- 3% Distribution Factor (DF) for system intact conditions (n-0),
- 20% DF upon outage based conditions (n-1),
- or 3% DF on contingent elements that resulted in a non-converged solution.

Interconnection Requests that requested Network Resource Interconnection Service (NRIS) are also studied in a separate NRIS analysis to determine if any constraint measured greater than or equal to a 3% DF. If so, these constraints are also considered for transmission reinforcement under NRIS.

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 monitored 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 areas 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.

VOLTAGE

For non-converged power flow solutions that are determined to be caused by lack of voltage support, appropriate transmission support will be determined to mitigate the constraint.

After all thermal overload and voltage support mitigations are determined; a full ACCC analysis is then performed to determine voltage constraints. The following voltage performance guidelines are used in accordance with the Transmission Owner local planning criteria.

SPP Areas (69kV+):

Transmission Owner	Voltage Criteria (System Intact)	Voltage Criteria (Contingency)
AEPW	0.95 – 1.05 pu	0.92 – 1.05 pu
GRDA	0.95 – 1.05 pu	0.90 – 1.05 pu
SWPA	0.95 – 1.05 pu	0.90 – 1.05 pu
OKGE	0.95 – 1.05 pu	0.90 – 1.05 pu
OMPA	0.95 – 1.05 pu	0.90 – 1.05 pu
WFEC	0.95 – 1.05 pu	0.90 – 1.05 pu

SWPS	0.95 – 1.05 pu	0.90 – 1.05 pu
MIDW	0.95 – 1.05 pu	0.90 – 1.05 pu
SUNC	0.95 – 1.05 pu	0.90 – 1.05 pu
KCPL	0.95 – 1.05 pu	0.90 – 1.05 pu
INDN	0.95 – 1.05 pu	0.90 – 1.05 pu
SPRM	0.95 – 1.05 pu	0.90 – 1.05 pu
NPPD	0.95 – 1.05 pu	0.90 – 1.05 pu
WAPA	0.95 – 1.05 pu	0.90 – 1.05 pu
WERE L-V	0.95 – 1.05 pu	0.93 – 1.05 pu
WERE H-V	0.95 – 1.05 pu	0.95 – 1.05 pu
EMDE L-V	0.95 – 1.05 pu	0.90 – 1.05 pu
EMDE H-V	0.95 – 1.05 pu	0.92 – 1.05 pu
LES	0.95 – 1.05 pu	0.90 – 1.05 pu
OPPD	0.95 – 1.05 pu	0.90 – 1.05 pu

<u>SPP Buses with more stringent voltage criteria:</u>

Bus Name/Number	**Voltage Criteria (System Intact)**	**Voltage Criteria (Contingency)**
TUCO 230kV 525830	0.925 – 1.05 pu	0.925 – 1.05 pu
Wolf Creek 345kV 532797	0.985 – 1.03 pu	0.985 – 1.03 pu
FCS 646251	1.001 – 1.047 pu	1.001 – 1.047 pu

<u>Affected System Areas (115kV+):</u>

Transmission Owner	**Voltage Criteria (System Intact)**	**Voltage Criteria (Contingency)**
AECI	0.95 – 1.05 pu	0.90 – 1.05 pu
EES-EAI	0.95 – 1.05 pu	0.90 – 1.05 pu
LAGN	0.95 – 1.05 pu	0.90 – 1.05 pu
EES	0.95 – 1.05 pu	0.90 – 1.05 pu
AMMO	0.95 – 1.05 pu	0.90 – 1.05 pu
CLEC	0.95 – 1.05 pu	0.90 – 1.05 pu
LAFA	0.95 – 1.05 pu	0.90 – 1.05 pu
LEPA	0.95 – 1.05 pu	0.90 – 1.05 pu
XEL	0.95 – 1.05 pu	0.90 – 1.05 pu
MP	0.95 – 1.05 pu	0.90 – 1.05 pu
SMMPA	0.95 – 1.05 pu	0.90 – 1.05 pu
GRE	0.95 – 1.05 pu	0.90 – 1.10 pu
OTP	0.95 – 1.05 pu	0.90 – 1.05 pu
OTP-H (115kV+)	0.97 – 1.05 pu	0.92 – 1.10 pu
ALTW	0.95 – 1.05 pu	0.90 – 1.05 pu
MEC	0.95 – 1.05 pu	0.90 – 1.05 pu
MDU	0.95 – 1.05 pu	0.90 – 1.05 pu
SPC	0.95 – 1.05 pu	0.95 – 1.05 pu
DPC	0.95 – 1.05 pu	0.90 – 1.05 pu
ALTE	0.95 – 1.05 pu	0.90 – 1.05 pu

The constraints identified through the voltage scan are then screened for the following for each interconnection request. 1) 3% DF on the contingent element and 2) 2% change in pu voltage. In certain conditions, engineering judgement was used to determine whether or not a generator had impacts to voltage constraints.

RESULTS

The LOIS ACCC analysis indicates that the Interconnection Customer(s) can interconnect their generation into the SPP transmission system at the requested 230 MW before all required upgrades listed within the DISIS-2016-001-1 or latest iteration can be placed into service. ACCC results for the LOIS can be found in **Table 4**, **Table 5 ,** and **Table 6**.

Constraints listed in **Table 6** do not require additional transmission reinforcement for Interconnection Service, but could require Interconnection Customer to reduce generation in operational conditions. These transmission constraints occur when this study's generation is dispatched into the SPP footprint for ERIS and SPS footprint for NRIS.

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(s) may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Table 4: Thermal Constraints for Transmission Reinforcement Mitigation

[redacted]										
			N/A						N/A	

Table 5: Voltage Constraints for Transmission Reinforcement Mitigation

[redacted]										
			N/A						N/A	

Table 6: Thermal Constraints Not Requiring Additional Transmission Reinforcement Mitigation

[redacted]										
			N/A							N/A

STABILITY ANALYSIS

The previous revision of this LOIS report referenced the transient stability analysis from DISIS-2016-001-1 that included the r-plan, Gentleman to Thedford to Holt County 345kV circuits, which is not scheduled to be in-service prior to the requested Commercial Operation Date (COD) of the GEN-2016-043 request. Transient stability analysis was performed, without these facilities in-service, for this LOIS by Mitsubishi Electric Power Products (MEPPI).

With all previously-assigned and currently-assigned Network Upgrades scheduled to be placed in service by the COD of the GEN-2016-043 request, no violations were observed, including violations of low-voltage ride-through requirements, for the probable P1, P4, & P6 Planning Events studied using the normal group dispatch

A prior analysis for evaluating Limited Operation for the GEN-2015-023 request[1], which included an additional dispatch scenario to evaluate the Gerald Gentleman Station registered NERC flowgate #6006, identified that for P6, prior outage, Planning Events involving Laramie River Station to Sidney and Stegall to Sidney 345 kV circuits, determined that a system adjustment involving curtailment of generation from generating facilities may be required following a prior outage to achieve acceptable system response for a subsequent fault event.

It should be noted that for certain system conditions curtailment may be necessary to maintain system stability for potential circuit outages including P6 and P7 Planning Events.

With all previously-assigned and currently-assigned Network Upgrades placed in service and identified system adjustments applied, no violations were observed, including violations of low-voltage ride-through requirements, for the probable Planning Events studied.

[1] http://opsportal.spp.org/documents/studies/files/2015_Generation_Studies/20190208_GEN-2015-023_LOIS_FINAL_w_Stability.pdf

CONCLUSION

GEN-2016-043 has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 230 MW of wind generation to be interconnected with Energy Resource Interconnection Service (ERIS) into the Transmission System of Nebraska Public Power District in Wayne County, Nebraska. GEN-2016-043 , 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-2016-001-1 (or most recent iteration) Impact Re-study can be placed into service.

Power flow and Stability analysis from this LOIS has determined that GEN-2016-043 request can interconnect their full generation amount 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.

Any changes to these assumptions may require a re-study of this LOIS at the expense of the Customer. (For example, one or more of the previously queued requests not included within this study executes an interconnection agreement and commences commercial operation.)

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

APPENDIX A: STABILITY ANALYSIS

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Southwest Power Pool, Inc. (SPP)

Limited Operation and Interim Stability Analysis for Group 09 Q1 2020

Final Report

REP-0814
Revision #02

April 2020

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Report Revision Table

Revision	Report Revision Table	Date	Author/ Approved
0	Issue Draft Report for review	03/19/2020	JTF/ NWT
1	Re-performed analysis taking into account the recent withdrawals of GEN-2015-053, GEN-2015-087, and GEN-2010-041. A revised set of faults focused on the East Nebraska area was used for the re-analysis.	04/03/2020	JTF/ NWT
2	Addressed SPP comments, Issued Final Report	04/08/2020	JTF/NWT

Title:	**Limited Operation and Interim Stability Analysis for Group 09 Q1 2020: Final Report REP-0814**
Date:	April 2020
Author:	Jacob T. Fritz; Engineer, Power Systems Engineering Dept. *Jacob T. Fritz*
Reviewed:	Nicholas W. Tenza; Senior Engineer, Power Systems Engineering Dept. *Nicholas W. Tenza*

EXECUTIVE SUMMARY

SPP was requested by Interconnection Customers to perform a Limited Operation study for requests GEN-2015-023, GEN-2015-089, GEN-2016-021, and GEN-2016-043 and Interim Availability Interconnection System Impact Study for study request GEN-2018-070. The DISIS-2015-001-1 Group 09 Impact Study identified the R-Plan upgrade (Gerald Gentleman Station to Thedford to Holt 345 kV circuits) as a requirement prior to the interconnection of GEN-2015-023 and had been included as a Base Case upgrade in each subsequent study. Since that study and more recent model developments, it has been determined that no steady-state thermal or voltage constraints exist for specific study requests prior to the completion of the R-Plan upgrade.

The Limited Operation and Interim studies required a Stability Analysis to determine the interconnection service available for GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and GEN-2018-070 without the R-Plan upgrade and other upgrades assigned through DISIS-2016-001 and without observing system instability or other response violations. Refer to Table ES-1 for the interconnection data for GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and GEN-2018-070.

Table ES-1
Study Request Interconnection Data

Request	Size (MW)	Generator Model (Generator Bus Number)	Point of Interconnection
GEN-2015-023	300.72	GE 1.79 MW Wind (584653) GE 1.79 MW Wind (584656)	Grand Prairie-Grand Island (Holt County NE) 345 kV (640510)
GEN-2015-089	200	GE 2.0 MW Wind (563232)	Utica 230 kV (652526)
GEN-2016-021	300	Vestas V110 VCSS 2.0MW Wind (587153)	Hoskins 345kV (640226)
GEN-2016-043	230	Vestas V136 3.6MW/Vestas V136 3.45MW Wind (587283, 587286)	Hoskins 345kV (640226)

GEN-2018-070*	18.31	GE 2.0 MW Wind (563232)	Utica 230 kV (652526)

*note GEN-2018-070 is an uprate for GEN-2015-089

SUMMARY OF LIMITED OPERATION STUDY AND INTERIM STABILITY ANALYSIS

The Limited Operation study and Interim Stability Analysis determined there were no contingencies that resulted in system/voltage instability, generation tripping offline, or poor post-fault voltage recovery when all generation interconnection requests were connected at 100% output. It was determined all five study requests may connect at 100% output without causing any voltage or rotor angle stability concerns.

Note prior studies, including DISIS-2015-001 and DISIS-2016-001, modeled the generating facilities interconnecting at Grand Prairie 345 kV substation with the user-written PSS/E Model for Vestas OptiSpeed™ Wind Turbines Version 7.6. This study used the updated user-written Vestas Generic Model Structure V7 to represent these generating facilities.

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SECTION 1: OBJECTIVES

The objective of this report is to provide Southwest Power Pool, Inc. (SPP) with the deliverables for the "Limited Operation and Interim Stability Analysis for Group 9 Q1 2020". SPP was requested by Interconnection Customers to perform a Limited Operation study for requests GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and Interim Availability Interconnection System Impact Study for request GEN-2018-070. These studies require a stability analysis which has been conducted for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions and included in this report.

SECTION 2: BACKGROUND

The Siemens Power Technologies International PSS/E power system simulation program Version 33.10.0 was used for this stability analysis. The stability cases for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak cases under normal dispatch conditions and studied contingencies, excluding contingencies West of the Gerald Gentleman Station, were utilized from the DISIS-2016-001-4 Group 09 study. The previously studied Gerald Generation Station dispatch scenario cases were not evaluated for this analysis due to the exclusion of the R-Plan upgrade and POI locations of each study request. The models include the DISIS-2016-001 study projects as well as Interim request GEN-2018-070 shown in Table 2-1 and the previously queued projects listed in Table 2-2. The DISIS-2016-001 study projects shown in Table 2-3 were removed from the study models to reflect current system configurations. Refer to Section 3.1 for the changes made to the base cases to reflect the removal of the upgrades and study projects associated with DISIS-2016-001. Power flow one-line diagrams for the GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and GEN-2018-070 generation interconnection projects are shown in Figures 2-1 through 2-4. Note that the one-line diagrams represent 2017 Winter Peak conditions.

Prior studies, including DISIS-2015-001 and DISIS-2016-001, modeled the Grand Prairie generating facility with the user-written PSS/E Model for Vestas OptiSpeed™ Wind Turbines Version 7.6. This study used the updated user-written Vestas Generic Model Structure V7 to represent these generating facilities in the study models. In discussions with the Grand Prairie generating facility turbine vendor regarding the previously observed instability, SPP was advised to replace the PSS/E Vestas WTG user-written model with the newer version of the Vestas WTG user-written model. This newer user-written model version incorporates the dynamic adjustment of the reactive power set point value during simulation to more accurately reproduce the WTG capabilities with voltage regulation as a standard feature in all Vestas wind turbine projects. The dynamic data file (dyre) parameters, appropriate to represent the Grand Prairie project specific design, were provided by the vendor.

The Limited Operation study and Interim Stability Analysis determined the amount of interconnection service available for GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and GEN-2018-070 without violations on the stability and voltage recovery of the nearby system. If problems with stability or voltage recovery are identified, the identification of available interconnection capacity was investigated. Three-phase faults and single line-to-ground faults were examined as listed in Table 2-4.

Table 2-1: Interconnection Projects Included in the Model

Request	Size (MW)	Generator Model (Gen Bus Number)	Point of Interconnection
GEN-2015-007	160.0	GE 116m 2.0MW (wind; 584513)	Hoskins 345kV (640226)
GEN-2015-023	300.72	GE 1.79 MW Wind (584653) GE 1.79 MW Wind (584656)	Grand Prairie-Grand Island (Holt County NE) 345 kV (640510)
GEN-2015-076	158.4	Vestas 3.3-117 3.3 MW (wind; 585133, 585136)	Belden 115kV (640080)
GEN-2015-088	300	Vestas V100 2.0 MW (wind; 585243)	Tap on Moore (640277) to Pauline (640312) 345kV
GEN-2015-089	200	GE 2.0 MW Wind (563232)	Utica 230 kV (652526)
GEN-2016-021	300	Vestas V110 VCSS 2.0MW Wind (587153)	Hoskins 345kV (640226)
GEN-2016-043	230	Vestas V136 3.6MW/Vestas V136 3.45MW Wind (587283, 587286)	Hoskins 345kV (640226)
GEN-2016-050	250.7	GE 2.3MW Wind (587353)	Axtell (640065)-Post Rock (530583) 345 kV (560082)
GEN-2018-070	18.31	GE 2.0 MW Wind (563232)	Utica 230 kV (652526)

Table 2-2: Previously Queued Nearby Interconnection Projects Included

Request	Size (MW)	Generator Model (Gen Bus Number)	Point of Interconnection
Beatrice Power Station	250	Thermal 80/90MW	Beatrice 115kV (640088)
Broken Arrow	7.3		Broken Bow 115kV (640089)
Buffalo County Solar	10		Kearney Northeast (640249)
Burt County Wind	12		Tekamah & Oakland 115kV (640300)
Burwell	3.3		Ord 115kV (640308)
Columbus Hydro	45	Hydro 15MW	Columbus 115kV (640136)
North Platte - Lexington	66.7	Hydro 21.6/23.5MW	Multiple: Jeffrey 115kV, John_1 115kV, John_2 115kV (640238, 640240, 640242)
Ord	10.8		Ord 115kV (640308)
Stuart	1.8		Ainsworth 115kV (640051)
Ft Randle Hydro	356	Hydro 44/45MW	Ft Randle (WAPA) 230kV & 115kV (652510)
Gavins Pt Hydro	102	Hydro 34MW	Gavins Point (WAPA) 115kV (652511)
Spirit Mound Heat	120	Thermal 60MW	Spirit Mound (WAPA) 115kV (659121)
GEN-2003-021N	75	WT12A1,WT12T1,WT1G1 (640026)	Tap on the Ainsworth – Calamus 115kV line (640050)
GEN-2004-023N	75	EXAC2,GENROU,IEEEG1 (640028)	Columbus 115kV (640119)
GEN-2006-020N	42	Vestas V90 VCUS 1.8 & 3.0 MW (640421,579441)	Bloomfield 115kV (640084)

Request	Size (MW)	Generator Model (Gen Bus Number)	Point of Interconnection
GEN-2006-037N1	73.1	GE 1.7MW (640449)	Broken Bow 115kV (640089)
GEN-2006-038N005	80	GE 1.6MW (640428)	Broken Bow 115kV (640089)
GEN-2006-038N019	81	GE 1.5MW (640431)	Petersburg 115kV (640444)
GEN-2006-044N	40.5	GE 1.5MW (645062)	Petersburg 115kV (640444)
GEN-2007-011N08	81	Vestas V90 VCRS 3.0MW (640418)	Bloomfield 115kV (640084)
GEN-2008-086N02/GEN-2014-032	211.22	GE 100m 1.79MW (645063 and 645064)	Meadow Grove 230kV (GEN-2008-086N02 POI) (640540)
GEN-2008-119O	60	GE 1.5MW (645061)	S1399 161kV (646399)
GEN-2008-123N	89.66	GE 2.3MW (572054), GE 2.0MW (572055), GE 1.79MW (572056)	Tap Pauline (640313) – Guide (640206) POI (Rosemont 115 kV, 560134)
WAPA queue: GI0717/ GI0718	400	Vestas V110 VCSS 2.0MW (652353, 579456)	Tap Ft. Thompson-Hope County 345 kV (Grand Prairie, 652532)
GEN-2009-040	72	Vestas V100 VCSS 2.0MW (532904)	Marshall 115kV (533303)
GEN-2010-051	200	GE 100m 1.7MW (580014, 580017, 580020)	Tap on the Twin Church – Hoskins 230kV line (560347)
GEN-2011-018/GEN-2013-008/GEN-2014-004	78.76	GE 1.79MW (640555)	Steele County 115kV (640426)

Request	Size (MW)	Generator Model (Gen Bus Number)	Point of Interconnection
GEN-2011-027	120	GE 1.85MW (580022, 580021, 580023)	Tap Twin Church-Hoskins 230kV (560347)
GEN-2011-056	3.6 MW increase (Pgen=21.6MW)	ESAC8B,GENESAL,PIDGOV (640013)	Jeffrey 115kV (640238)
GEN-2011-056A	3.6 MW increase (Pgen=21.6MW)	ESAC8B,GENESAL,PIDGOV (640014)	Johnson 1 115kV (640240)
GEN-2011-056B	4.5 MW increase (Pgen=23.5MW)	ESAC8B,GENESAL,PIDGOV (640015)	Johnson 2 115kV (640242)
GEN-2012-021	4.8 MW	GENSAE,AC8B,GGOV1 IEEEVC (650010)	84th & Bluff 115kV (650275)
GEN-2013-002	50.6	Siemens 2.3MW VS (583703)	Tap Sheldon - SW7&Bennet - Folsom/Pleasant Hill 115kV (560746)
GEN-2013-019	73.6	Siemens 2.3MW VS (583703)	Tap Sheldon - SW7&Bennet - Folsom/Pleasant Hill 115kV (560746)
GEN-2013-032	202.5	GE 2..5MW (583783 & 583786)	Neligh 115kV (640293)
GEN-2014-013	73.5	GE 1.79MW (583833)	Meadow Grove 230kV (GEN-2008-086N02 POI) (640540)
GEN-2014-031	35.8	GE 1.79MW (583836)	Meadow Grove 230kV (GEN-2008-086N02 POI) (640540)
GEN-2014-039	73.39	Vestas V110 VCSS 2.0MW Vestas V110 VCSS 1.905MW (584093)	Friend 115kV (640174)

Table 2-3: DISIS-2016-001 Interconnection Projects Removed from the Model

Request	Size (MW)	Generator Model (Gen Bus Number)	Point of Interconnection
GEN-2010-041	10.5	GE 1.5MW (580071)	S1399 161kV (646399)
GEN-2015-053	50	GE 2.5MW (wind; 583783 & 583786)	Antelope 115kV (640521)
GEN-2015-087	66	Vestas V100 2.0 MW (wind; 585233)	Tap on Fairbury (640169) to Hebron (640218) 115kV
GEN-2016-075	50	Vestas V110 VCSS 2.0MW Wind (579459)	Tap Ft. Thompson-Grand Island 345 kV (Grand Prairie, 652532)
GEN-2016-023	150.5	GE 2.0MW and 1.79MW Wind (587093, 587095)	Tap Sidney (659426) - Laramie River (659131) 345kV (560075)
GEN-2016-029	150.5	GE 2.0MW and 1.79MW Wind (587193,587195)	Tap Sidney (659426) - Laramie River (659131) 345kV (560075)

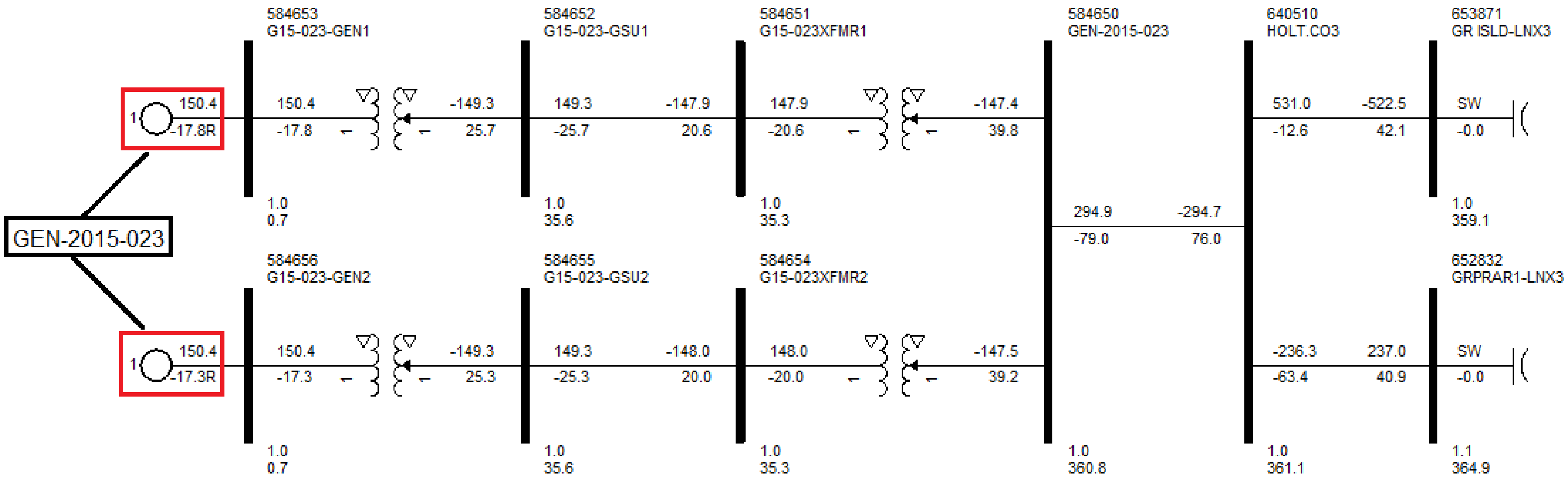

Figure 2-1. Power flow one-line diagram for interconnection project at the Grand Prairie-Grand Island (Holt County NE) 345kV POI (GEN-2015-023).

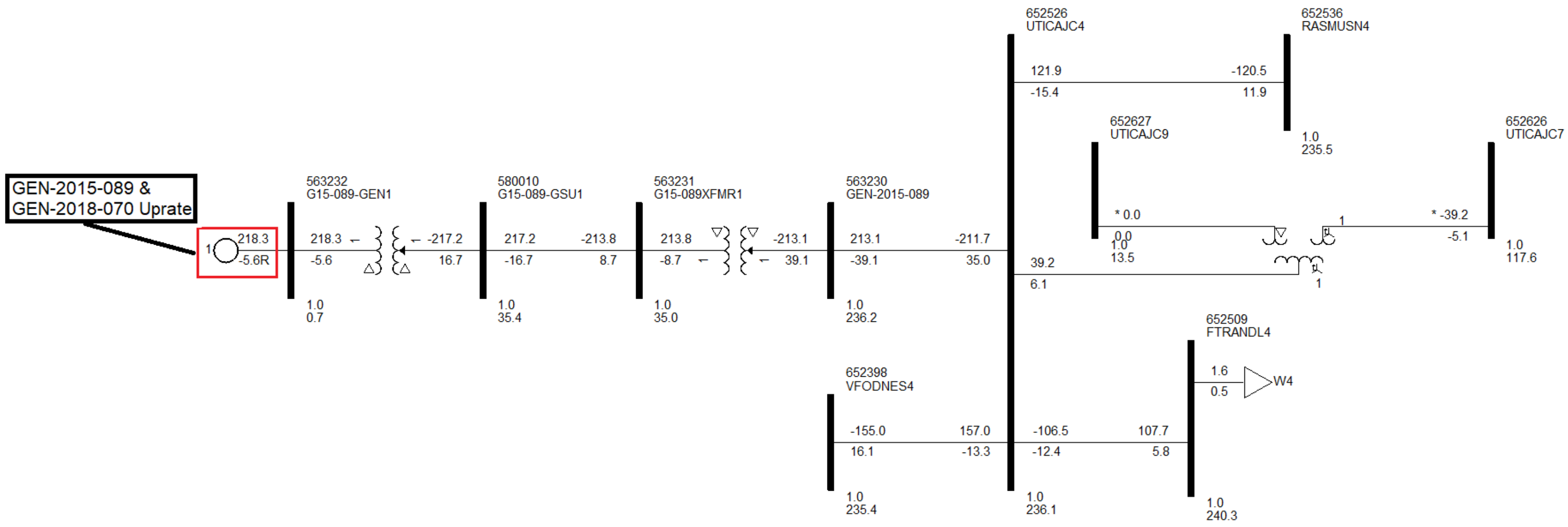

Figure 2-2. Power flow one-line diagram for interconnection project at the Utica 230kV POI (GEN-2015-089 and GEN-2018-070 (Uprate).

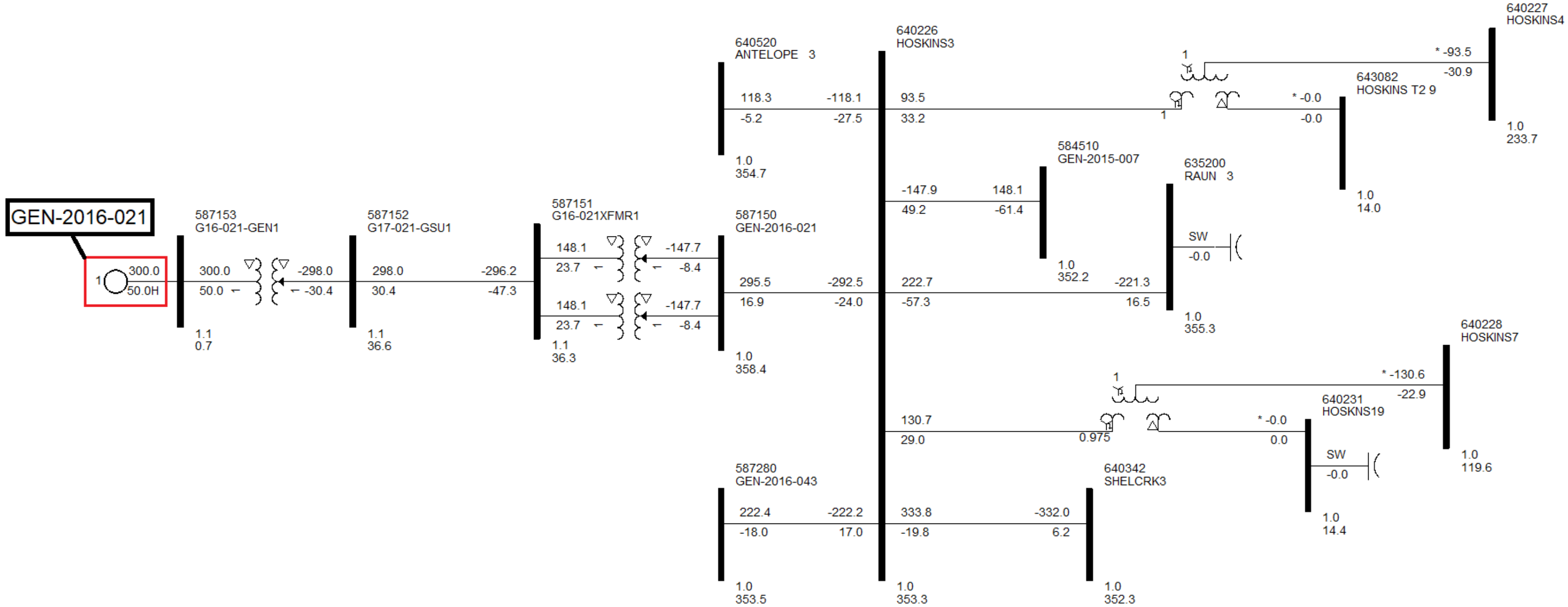

Figure 2-3. Power flow one-line diagram for interconnection project at the Hoskins 345kV POI (GEN-2016-021).

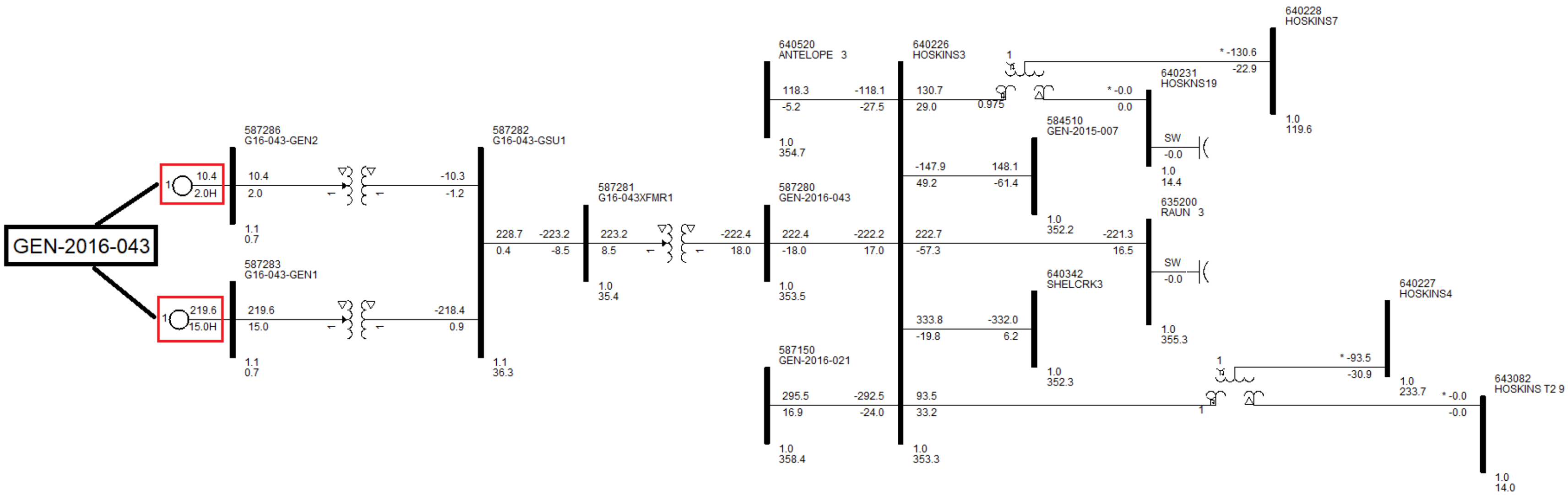

Figure 2-4. Power flow one-line diagram for interconnection project at the Hoskins 345kV POI (GEN-2016-043).

Table 2-4: Case List with Contingency Description

Ref. No.	Cont. Name	Description
1	FLT18-3PH	3 phase fault on the Sweetwater (640374) to Axtell (640065) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
2	FLT19-3PH	3 phase fault on the Sweetwater (640374) to Grand Island (653571) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
3	FLT20-3PH	3 phase fault on the Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
4	FLT23-3PH	3 phase fault on the Grand Island (653571) to McCool (640271) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
5	FLT28-SB	**Sweetwater 345 kV Stuck Breaker Scenario 1** a. Apply single phase fault at the Sweetwater (640374) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1. d. Trip Sweetwater (640374) to Axtell (640065) 345kV line circuit 1.
6	FLT29-SB	**Sweetwater 345 kV Stuck Breaker Scenario 2** a. Apply single phase fault at the Sweetwater (640374) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1. d. Trip Sweetwater (640374) to Grand Island (653571) 345kV line circuit 1.
7	FLT30-SB	**Sweetwater 345 kV Stuck Breaker Scenario 3** a. Apply single phase fault at the Sweetwater (640374) 345kV bus. b. Wait 16 cycles and remove fault. c. Trip Sweetwater (640374) to Axtell (640065) 345kV line circuit 1. d. Trip Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1.
8	FLT33-PO	**Prior outage on the Sweetwater (640374) – Axtell (640065) 345 kV line circuit 1** 3 phase fault on the Sweetwater (640374) to Grand Island (653571) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
9	FLT34-PO	**Prior outage on the Sweetwater (640374) – Gentleman (640183) 345 kV line circuit 1** 3 phase fault on the Sweetwater (640374) to Grand Island (653571) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
10	FLT35-PO	**Prior outage on the Sweetwater (640374) – Axtell (640065) 345 kV line circuit 1** 3 phase fault on the Sweetwater (640374) to Gentleman (640183) 345kV line circuit 1, near Sweetwater. a. Apply fault at the Sweetwater 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
11	FLT89-3PH	3 phase fault on the Hoskins (640226) to Antelope (640520) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
12	FLT90-3PH	3 phase fault on the Hoskins (640226) to Shell Creek (640342) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
13	FLT91-3PH	3 phase fault on the Hoskins (640226) to Raun (635200) 345kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
14	FLT92-3PH	3 phase fault on the Hoskins 345/230/13.8kV (640226/640227/643082) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
15	FLT93-3PH	3 phase fault on the Hoskins 345/115/13.8kV (640226/640228/640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
16	FLT94-3PH	3 phase fault on the Raun (635200) to Sioux City (652564) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
17	FLT96-3PH	3 phase fault on the Raun (635200) to S3451 (645451) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
18	FLT98-3PH	3 phase fault on the Raun 345/161kV (635200/635201) transformer, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
19	FLT99-3PH	3 phase fault on the Raun (635200) to Highland (635400) 345kV line circuit 1, near Raun. a. Apply fault at the Raun 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
20	FLT100-3PH	3 phase fault on the Shell Creek (640342) to Columbus (640125) 345kV line circuit 1, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
21	FLT101-3PH	3 phase fault on the Shell Creek 345/230/13.8kV (640342/640343/643136) transformer, near Shell Creek. a. Apply fault at the Shell Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
22	FLT102-3PH	3 phase fault on the Antelope 345/115/13.8kV (640520/640521/640524) transformer, near Antelope. a. Apply fault at the Antelope 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
23	FLT103-3PH	3 phase fault on the Hoskins 230/115/13.8kV (640227/640228/643083) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
24	FLT104-3PH	3 phase fault on the Hoskins (640227) to G10-051-Tap (560347) 230kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
25	FLT105-3PH	3 phase fault on the Hoskins (640228) to Norfolk (640298) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
26	FLT106-3PH	3 phase fault on the Hoskins (640228) to Belden (640080) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
27	FLT107-3PH	3 phase fault on the Hoskins (640228) to Norfolk North (640296) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
28	FLT108-3PH	3 phase fault on the Hoskins (640228) to Stanton West (640363) 115kV line circuit 1, near Hoskins. a. Apply fault at the Hoskins 115kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
29	FLT109-SB	Hoskins 345 kV Stuck Breaker Scenario 1 a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins 345/230/13.8kV (640226/640227/643082) transformer
30	FLT110-SB	Hoskins 345 kV Stuck Breaker Scenario 2 a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins (640226) – Shell Creek (640342) 345kV d. Hoskins (640226) – Antelope (640520) 345kV
31	FLT111-SB	Hoskins 345 kV Stuck Breaker Scenario 3 a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Hoskins 345/230/13.8kV (640226/640227/643082) transformer d. Hoskins 345/115/13.8kV (640226/640228/640231) transformer
32	FLT112-PO	Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1; 3 phase fault on Hoskins 345kV (640226) to Antelope 345kV (640520), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
33	FLT113-PO	Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1; 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
34	FLT114-PO	Prior Outage of Hoskins 345 kV (640226) to Raun 345 kV (635200) CKT 1; 3 phase fault on Hoskins 345/115/13.8kV (640226/640228/640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
35	FLT115-PO	Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1; 3 phase fault on Hoskins 345kV (640226) to Raun 345kV (635200), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
36	FLT116-PO	Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1; 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
37	FLT117-PO	Prior Outage of Hoskins 345 kV (640226) to Antelope 345 kV (640520) CKT 1; 3 phase fault on Hoskins 345/115/13.8kV (640226/640228/640231) transformer, near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
38	FLT118-PO	Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer; 3 phase fault on Hoskins 345kV (640226) to Antelope 345kV (640520), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
39	FLT119-PO	Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer; 3 phase fault on Hoskins 345kV (640226) to Shell Creek 345kV (640342), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
40	FLT120-PO	Prior Outage of Hoskins 345/230/13.8 kV (640226/640227/643082) Transformer; 3 phase fault on Hoskins 345kV (640226) to Raun 345kV (635200), near Hoskins. a. Apply fault at the Hoskins 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
41	FLT122-3PH	3 phase fault on the Holt County (640510) to Grand Island-LNX (653871) to Grand Island (653571) 345kV line circuit 1, near Holt County. a. Apply fault at the Holt County 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
42	FLT123-3PH	3 phase fault on the Grand Prairie (652532) to Grand Prairie-LNX3 (652832) to Holt County (640510) 345kV line circuit 1, near Grand Prairie. a. Apply fault at the Grand Prairie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
43	FLT124-3PH	3 phase fault on the Grand Prairie (652532) to Grand Prairie (648513) 345kV line circuit 1, near Grand Prairie. a. Apply fault at the Grand Prairie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
44	FLT125-3PH	3 phase fault on the Grand Prairie (652532) to Grand Prairie-LNX2 (652833) to Fort Thompson (652807) 345kV line circuit 1, near Grand Prairie. a. Apply fault at the Grand Prairie 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
45	FLT128-SB	**Grand Island 345 kV Stuck Breaker Scenario** a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 16 cycles and trip the following elements c. Holt County (640510) to Grand Island-LNX3 (653871) to Grand Island (653571) 345kV d. Sweetwater (640374) to Grand Island (653571) 345kV
46	FLT129-PO	**Prior Outage of Grand Prairie 345 kV (652532) to Grand Prairie-LNX3 (652832) to Holt County (640510) 345 kV CKT 1;** 3 phase fault on the Grand Prairie 345 kV (652532) to Grand Prairie-LNX3 (652833) to Ft Thompson-LNX3 (652807) to Ft Thompson (652506) 345kV line circuit 1, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
47	FLT130-PO	**Prior Outage of Grand Prairie 345 kV (652532) to Grand Prairie-LNX3 (652832) to Holt County (640510) 345 kV CKT 1;** 3 phase fault on the Ft Thompson 345/230/14.8kV (652506/652507/652273) transformer, near Ft Thompson. a. Apply fault at the Ft Thompson 345kV bus. b. Clear fault after 6.5 cycles by tripping the faulted line.
48	FLT140-3PH	3 phase fault on the Grand Island (653571) to Sweetwater (640374) 345kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
49	FLT141-3PH	3 phase fault on the Grand Island (640200) to Columbus West (640131) 230kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
50	FLT142-3PH	3 phase fault on the Grand Island (640200) to Hastings (640214) 230kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
51	FLT143-3PH	3 phase fault on the Grand Island (640200) to Riverdale (640330) 230kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
52	FLT144-3PH	3 phase fault on the Grand Island (640201) to Aurora (640063) 115kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 115kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
53	FLT145-3PH	3 phase fault on the Grand Island (640201) to CENCITY7 (640107) 115kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 115kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
54	FLT146-3PH	3 phase fault on the Grand Island (640201) to ST. LIB 7 (640353) 115kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 115kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
55	FLT147-3PH	3 phase fault on the Grand Island (640201) to SUB-D 7 (642071) 115kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 115kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
56	FLT148-3PH	3 phase fault on the Grand Island (640201) to SUB-E 7 (642072) 115kV line circuit 1, near Grand Island. a. Apply fault at the Grand Island 115kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
57	FLT150-3PH	3 phase fault on the Ft. Thompson (652507) to Ft Randall (652509) 230kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
58	FLT151-3PH	3 phase fault on the Ft. Thompson (652507) to Huron (652514) 230kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
59	FLT152-3PH	3 phase fault on the Ft. Thompson (652507) to LAKPLAT4 (652516) 230kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
60	FLT153-3PH	3 phase fault on the Ft. Thompson (652507) to Oahe (652519) 230kV line circuit 3, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
61	FLT154-3PH	3 phase fault on the Ft. Thompson (652507) to Big Bend (652540) 230kV line circuit 3, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
62	FLT155-3PH	3 phase fault on the Ft. Thompson (652507) to Big Bend (652541) 230kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
63	FLT156-3PH	3 phase fault on the Ft. Thompson (652507) to Letcher (652606) 230kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
64	FLT157-3PH	3 phase fault on the Ft. Thompson (652506) to Ft Thompson-LNX3 (652806) to G16-017-TAP (560074) 345kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
65	FLT158-3PH	3 phase fault on the Ft. Thompson (652506) to Ft Thompson-LNX3 (652807) to Grand Prairie-LNX3 (652833) to Grand Prairie (652532) 345kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
66	FLT159-3PH	3 phase fault on the Ft. Thompson (652276) to MOS-AMES-ER8 (655153) 69kV line circuit 1, near Ft. Thompson. a. Apply fault at the Ft. Thompson 69kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
67	FLT160-3PH	3 phase fault on the Holt (640510) to Grand Prairie-LNX3 (652832) to Grand Prairie (652532) 345kV line circuit 1, near Holt. a. Apply fault at the Holt 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
68	FLT161-3PH	3 phase fault on the Grand Island 345/230/13.8kV (653571/640200/643071) transformer, near Grand Island. a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
69	FLT162-3PH	3 phase fault on the Grand Island 345/230/13.8kV (653571/640200/653316) transformer, near Grand Island. a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
70	FLT163-3PH	3 phase fault on the Grand Island 345/230/13.8kV (653571/640200/653314) transformer, near Grand Island. a. Apply fault at the Grand Island 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
71	FLT164-3PH	3 phase fault on the Grand Island 230/115/13.8kV (640200/640201/640203) transformer, near Grand Island. a. Apply fault at the Grand Island 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
72	FLT165-3PH	3 phase fault on the Grand Island 230/115/13.8kV (640200/640201/643070) transformer, near Grand Island. a. Apply fault at the Grand Island 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
73	FLT168-3PH	3 phase fault on the Ft. Thompson 345/230/13.8kV (652506/652507/652274) transformer, near Ft. Thompson. a. Apply fault at the Ft. Thompson 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
74	FLT169-3PH	3 phase fault on the Ft. Thompson 345/230/13.8kV (652506/652507/652273) transformer, near Ft. Thompson. a. Apply fault at the Ft. Thompson 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
75	FLT170-3PH	3 phase fault on the Ft. Thompson 230/69kV (652507/652276) transformer, near Ft. Thompson. a. Apply fault at the Ft. Thompson 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
76	FLT7160-EE	Extreme Event outage that results in the loss of the Grand Prairie (652833) to Ft Thompson (652807) 345kV line and the Meadow Grove (640540) to Ft Randall (652509) 345kV line, near Grand Prairie.
77	FLT94-PO	Prior outage of the Gentleman (640183) to Red Willow (640325) 345kV line followed by 3 phase fault on the Ft. Thompson (652506) to Grand Prairie (652532) 345kV line, near Ft. Thompson.

Ref. No.	Cont. Name	Description
78	FLT1107-3PH	3 phase fault on the UticaJ4 (652526) 230 kV to Rasmussen (652536) 230kV circuit 1 line a. Apply fault at the UticaJ4 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
79	FLT1108-3PH	3 phase fault on the Utica Junction (652526) 230kV to VFODNES4 (652398) 230kV circuit 1 line a. Apply fault at the UticaJ4 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
80	FLT1109-3PH	3 phase fault on the Utica Junction (652526) 230 kV to Ft Randall (652509) 230 kV circuit 1 line a. Apply fault at the UticaJ4 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
81	FLT1110-3PH	3 phase fault on the Utica Junction 230/115/13.2kV (652526/652626/652627) Transformer. a. Apply fault at the Utica Junction 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line Utica Junction 230/115/13.2kV (652526/652626/652627) Transformer
82	FLT1111-SB	Rasmussen 230 kV Stuck Breaker Scenario 1 a. Apply fault at the Rasmussen 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rasmussen (652536) to Utica Junction (652526) 230 kV d. Rasmussen (652536) to Sioux City (652565) 230 kV
83	FLT1113-SB	Ft Randall 230 kV Stuck Breaker Scenario 1 a. Apply fault at the VFODNES4 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Ft Randall (652509) to Utica Junction (652526) 230 kV d. Ft Randall (652509) to Meadow Grove (640540) 230 kV
84	FLT9001-3PH	3 phase fault on the VFODNES 230/69 kV (652398/652399) Transformer. a. Apply fault at the VFODNES (652398) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted VFODNES 230/69 kV (652398/652399) Transformer.
85	FLT9002-3PH	3 phase fault on the VFODNES 230/115/12.5 kV (652398/652397/652396) Transformer. a. Apply fault at the VFODNES (652398) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted VFODNES 230/115/12.5 kV (652398/652397/652396) Transformer.

Ref. No.	Cont. Name	Description
86	FLT9003-3PH	3 phase fault on the VFODNES (652398) 230 kV to Sioux Falls (652523) 230 kV circuit 1 line a. Apply fault at the VFODNES 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
87	FLT9004-3PH	3 phase fault on the Sioux Falls (652523) 230 kV to Letcher (652606) 230 kV circuit 1 line a. Apply fault at the Sioux Falls 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
88	FLT9005-3PH	3 phase fault on the Sioux Falls (652523) 230 kV to PAHOJA4 (652578) 230 kV circuit 1 line a. Apply fault at the Sioux Falls 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
89	FLT9006-3PH	3 phase fault on the Sioux Falls (652523) 230 kV to Split Rock (602004) 230 kV circuit 1 line a. Apply fault at the Sioux Falls 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
90	FLT9007-3PH	3 phase fault on the Sioux Falls (652523) 230 kV to Hanlon (652513) 230 kV circuit 1 line a. Apply fault at the Sioux Falls 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
91	FLT9008-3PH	3 phase fault on the Sioux Falls 230/115/13.2 kV (652523/652524/652233) Transformer a. Apply fault at the Sioux Falls (652523) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Sioux Falls 230/115/13.2 kV (652523/652524/652233) Transformer.
92	FLT9009-3PH	3 phase fault on the VFODNES7 (652397) 115 kV to HANLON (652591) 115 kV circuit 1 line a. Apply fault at the VFODNES7 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
93	FLT9010-3PH	3 phase fault on the Ft Randall (652509) 230 kV to Meadow Grove (640540) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
94	FLT9011-3PH	3 phase fault on the Ft Randall (652509) 230 kV to Sioux City (652565) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
95	FLT9012-3PH	3 phase fault on the Ft Randall (652509) 230 kV to Ft Thompson (652507) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
96	FLT9013-3PH	3 phase fault on the Ft Randall (652509) 230 kV to Lakplat (652516) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
97	FLT9014-3PH	3 phase fault on the Lakplat 230/69 kV (652516/652277) Transformer. a. Apply fault at the Lakplat (652516) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Lakplat 230/69 kV (652516/652277) Transformer.
98	FLT9015-3PH	3 phase fault on the Lakplat (652516) 230 kV to Ft Thompson (652507) 230 kV circuit 1 line a. Apply fault at the Lakplat 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
99	FLT9016-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to Big Bend (652540) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
100	FLT9017-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to Wessington (652607) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
101	FLT9018-3PH	3 phase fault on the FTTHOMP4 (652507) 230 kV to Big Bend (652541) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
102	FLT9019-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to Huron (652514) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
103	FLT9020-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to G16-094-TAP (587764) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
104	FLT9021-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to Oahe (652519) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
105	FLT9022-3PH	3 phase fault on the Ft Thompson 345/230/13.8 kV (652506/652507/652273) Transformer. a. Apply fault at the Ft Thompson (652507) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Ft Thompson 345/230/13.8 kV (652506/652507/652273) Transformer.
106	FLT9023-3PH	3 phase fault on the Ft Thompson 230/69 kV (652507/652276) Transformer. a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Ft Thompson 230/69 kV (652507/652276) Transformer.
107	FLT9024-3PH	3 phase fault on the 345 kV Ft Thompson (652506) to Ft Thompson -LNX3 (652806) circuit Z to GEN-2016-017 Tap (560074) circuit 1 line a. Apply fault at the Ft Thompson 345 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
108	FLT9025B-3PH	3 phase fault on the 345 kV Ft Thompson (652506) to Ft Thompson -LNX3 (652807) circuit Z to Grand Prairie-LNX3 (652833) circuit 1 to Grand Prairie (652532) circuit Z line a. Apply fault at the Ft Thompson 345 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
109	FLT9026-3PH	3 phase fault on the G16-094-TAP (587764) 230 kV to Oahe (652519) 230 kV circuit 1 line a. Apply fault at the G16-094-TAP 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
110	FLT9027-3PH	3 phase fault on the Rasmussen (652536) 230 kV to Sioux City (652565) 230 kV circuit 1 line a. Apply fault at the Rasmussen 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
111	FLT9028-3PH	3 phase fault on the Rasmussen 230/69 kV (652536/652287) Transformer. a. Apply fault at the Rasmussen (652536) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Rasmussen 230/69 kV (652536/652287) Transformer.

Ref. No.	Cont. Name	Description
112	FLT9029-3PH	3 phase fault on the Sioux City 345/230/13.8 kV (652564/652565/652305) Transformer. a. Apply fault at the Sioux City (652565) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted Sioux City 345/230/13.8 kV (652564/652565/652305) Transformer.
113	FLT9030-3PH	3 phase fault on the Sioux City 230/161/13.8 kV (652565/652566/652308) Transformer. a. Apply fault at the Sioux City (652565) 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line Sioux City 230/161/13.8 kV (652565/652566/652308) Transformer.
114	FLT9031-3PH	3 phase fault on the Sioux City (652565) 230 kV to TWIN CH4 (640386) 230 kV circuit 1 line a. Apply fault at the Sioux City 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
115	FLT9032-3PH	3 phase fault on the Sioux City (652565) 230 kV to Denison (652567) 230 kV circuit 1 line a. Apply fault at the Sioux City 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
116	FLT9033-3PH	3 phase fault on the Sioux City (652565) 230 kV to Eagle (659900) 230 kV circuit 1 line a. Apply fault at the Sioux City 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
117	FLT9034-3PH	3 phase fault on the Sioux City (652564) 345 kV to Sioux City -LNX3 (652864) to Split Rock 345 kV line a. Apply fault at the Sioux City 345 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
118	FLT9035-3PH	3 phase fault on the Sioux City (652564) 345 kV to Raun (635200) 345 kV circuit 1 line a. Apply fault at the Sioux City 345 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
119	FLT9036-3PH	3 phase fault on the Ft Thompson (652507) 230 kV to Letcher (652606) 230 kV circuit 1 line a. Apply fault at the Ft Thompson 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
120	FLT9037-3PH	3 phase fault on the Utica Junction (652626) 115 kV to FREEMAN-ER7 (655418) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
121	FLT9038-3PH	3 phase fault on the Utica Junction (652626) 115 kV to Menno Junction (660007) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
122	FLT9039-3PH	3 phase fault on the Utica Junction (652626) 115 kV to Napa Junction (660026) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
123	FLT9040-3PH	3 phase fault on the Meadow Grove (640540) 230 kV to Columbus (640133) 230 kV circuit 1 line a. Apply fault at the Meadow Grove 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
124	FLT9041-3PH	3 phase fault on the Meadow Grove (640540) 230 kV to PR BRZ4 (648506) 230 kV circuit 1 line a. Apply fault at the Meadow Grove 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line, trip generators at PR BRZ
125	FLT9001-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the VFODNES 230/69 kV (652398/652399) Transformer. a. Apply fault at the VFODNES 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line VFODNES 230/69 kV (652398/652399) Transformer.
126	FLT9002-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the VFODNES 230/115/12.5 kV (652398/652397/652396) Transformer. a. Apply fault at the VFODNES 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line VFODNES 230/115/12.5 kV (652398/652397/652396) Transformer.
127	FLT9003-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the VFODNES (652398) 230 kV to Sioux Falls (652523) 230 kV circuit 1 line a. Apply fault at the VFODNES 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
128	FLT9010-PO1	3 phase fault on the Ft Randall (652509) 230 kV to Meadow Grove (640540) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
129	FLT9011-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Sioux City (652565) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
130	FLT9012-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Ft Thompson (652507) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
131	FLT9013-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Lakplat (652516) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
132	FLT9037-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to FREEMAN-ER7 (655418) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
133	FLT9038-PO1	Prior Outage of Utica Junction 230 kV (652526) to Rasmussen 230 kV (652536) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to Menno Junction (660007) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
134	FLT9039-PO3	Prior Outage of Utica Junction 230 kV (652526) to Ft Randall (652509) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to Napa Junction (660026) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
135	FLT9010_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Meadow Grove (640540) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
136	FLT9011_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Sioux City (652565) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
137	FLT9012_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Ft Thompson (652507) 230 kV circuit 1 line a. Apply fault at the Ft Randall 4 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
138	FLT9013_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Ft Randall (652509) 230 kV to Lakplat (652516) 230 kV circuit 1 line a. Apply fault at the Ft Randall 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
139	FLT9027-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Rasmussen (652536) 230 kV to Sioux City (652565) 230 kV circuit 1 line a. Apply fault at the Rasmussen 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line.

Ref. No.	Cont. Name	Description
140	FLT9028-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Rasmussen 230/69 kV (652536/652287) Transformer. a. Apply fault at the Rasmussen 230 kV bus b. Clear fault after 6 cycles by tripping the faulted line Rasmussen 230/69 kV (652536/652287) Transformer.
141	FLT9037_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to FREEMAN-ER7 (655418) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 6 cycles by tripping the faulted line.
142	FLT9038_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to Menno Junction (660007) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
143	FLT9039_3-PO4	Prior Outage of Utica Junction 230 kV (652526) to VFODNES4 230 kV (652398) circuit 1 line 3 phase fault on the Utica Junction (652626) 115 kV to Napa Junction (660026) 115 kV circuit 1 line a. Apply fault at the Utica Junction 115 kV bus b. Clear fault after 7 cycles by tripping the faulted line.
144	FLT1001-SB	Stuck Breaker at Utica Junction (652626) a. Apply single phase fault at Utica Junction (652626) 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Utica Junction (652526) 230 kV/ (652626)115 kV/ (652627) 13.2 kV transformer d. Utica Junction (652626) 115 kV to FREEMAN-ER7 (655418) 115 kV circuit 1 line
145	FLT1002-SB	VFODNES4 230 kV Stuck Breaker Scenario 1 a. Apply fault at the VFODNES4 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. VFODNES4 (652398) to UticaJ4 (652526) 230 kV d. VFODNES4 230kV (652398) to 69kV (652399) Transformer

Ref. No.	Cont. Name	Description
146	FLT1003-SB	VFODNES4 230 kV Stuck Breaker Scenario 2 a. Apply fault at the VFODNES4 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. VFODNES4 (652398) to UticaJ4 (652526) 230 kV d. VFODNES4 230kV (652398) to 115kV (652397) to 12.5kV (652396) Transformer
147	FLT1004-SB	VFODNES4 230 kV Stuck Breaker Scenario 3 a. Apply fault at the VFODNES4 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. VFODNES4 (652398) to Sioux City4 (652523) 230 kV d. VFODNES4 230kV (652398) to 69kV (652399) Transformer
148	FLT1005-SB	VFODNES4 230 kV Stuck Breaker Scenario 4 a. Apply fault at the VFODNES4 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. VFODNES4 (652398) to Sioux City4 (652523) 230 kV d. VFODNES4 230kV (652398) to 115kV (652397) to 12.5kV (652396) Transformer
149	FLT1006-SB	Utica Junction 230 kV Stuck Breaker Scenario 1 a. Apply fault at the Utica Junction (652526) 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rasmussen (652536) to UticaJ4 (652526) 230 kV d. VFODNES4 (652398) to UticaJ4 (652526) 230 kV
150	FLT1007-SB	Utica Junction 230 kV Stuck Breaker Scenario 2 a. Apply fault at the Utica Junction (652526) 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Rasmussen (652536) to Utica Junction (652526) 230 kV d. Ft Randall (652509) to Utica Junction (652526) 230 kV
151	FLT1008-SB	Utica Junction 230 kV Stuck Breaker Scenario 3 a. Apply fault at the Utica Junction (652526) 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Utica Junction (652526) 230 kV to (652626) 115kV to (652627) 13.2kV Transformer d. VFODNES4 (652398) to Utica Junction (652526) 230 kV

Ref. No.	Cont. Name	Description
152	FLT1009-SB	Utica Junction 230 kV Stuck Breaker Scenario 4 a. Apply fault at the Utica Junction (652526) 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Utica Junction (652526) 230 kV to (652626) 115kV to (652627) 13.2kV Transformer d. Ft Randall (652509) to Utica Junction (652526) 230 kV

SECTION 3: LIMITED OPERATION STUDY AND INTERIM STABILITY ANALYSIS

The objective of the Limited Operation study and Interim Stability Analysis was to determine the impacts of the generator interconnections on the stability and voltage recovery on the SPP transmission system. If problems with stability or voltage recovery were identified, the identification of available interconnection capacity was investigated.

3.1 Approach

MEPPI utilized the three (3) following DISIS-2016-001-4 power flow cases and dynamic databases:

- MDWG16-17WP_DIS16021_G09
- MDWG16-18SP_DIS16021_G09
- MDWG16-26SP_DIS16021_G09

The analysis was performed on three cases (17W, 18S, and 26S). Each case was examined prior to the Limited Operation study and Interim Stability Analysis to ensure the case contained the DISIS-2016-001 study projects and any previously queued projects listed in Tables 2-1 and 2-2. The DISIS-2016-001 study projects (GEN-2016-023, GEN-2016-029, and GEN-2016-075) shown in Table 2-3 were removed from the study models. All upgrades identified in the DISIS-2016-001-4 stability analysis with a scheduled completion date after 12/01/2020 were also removed from the cases. The following upgrades were removed/confirmed to be removed from each case to begin the study:

- Reroute Laramie River Station to Stegall 345kV circuit #1 through the GEN-2016-023-Tap substation
- SPP R Plan
    - Thedford 345/115/13.8 kV transformer
    - Gerald Gentleman Station to Thedford 345 kV circuit #1
    - Holt County to Thedford 345 kV circuit #1
- Gerald Gentleman Station to Keystone 345 kV circuit #2
- Keystone to Sidney 345 kV circuit #2

After updating the power flow cases with the above changes and dispatching units local to the study area according to SPP criteria, there was no suspect power flow data in the study area. The dynamic datasets were also verified and stable initial system conditions (i.e., "flat lines") were achieved. Three-phase and single phase-to-ground faults listed in Table 2-4 were examined. Single-phase fault impedances were calculated for each season to result in a voltage of approximately 60% of the pre-fault voltage. Refer to Table 3-1 for a list of the calculated single-phase fault impedances.

Table 3-1: Calculated Single-Phase Fault Impedances

[1]Ref. No.	Contingency Name	Faulted Bus	Single-Phase Fault Impedance (MVA)		
			2017 Winter	2018 Summer	2026 Summer
1	FLT28-SB	Sweetwater (640374) 345kV	-3828.1	-3828.1	-3828.1
2	FLT29-SB	Sweetwater (640374) 345kV	-3828.1	-3828.1	-3828.1
3	FLT30-SB	Sweetwater (640374) 345kV	-3828.1	-3828.1	-3828.1
4	FLT109-SB	Hoskins (640226) 345kV	-4640.6	-4640.6	-4640.6
5	FLT110-SB	Hoskins (640226) 345kV	-4640.6	-4640.6	-4640.6
6	FLT111-SB	Hoskins (640226) 345kV	-4640.6	-4640.6	-4640.6
7	FLT1001-SB	Utica Junction (652626) 115kV	-1187.5	-1187.5	-1187.5
8	FLT1002-SB	VFODNES (652398) 230kV	-1875.0	-1875.0	-1875.0
9	FLT1003-SB	VFODNES (652398) 230kV	-1875.0	-1875.0	-1875.0
10	FLT1004-SB	VFODNES (652398) 230kV	-1875.0	-1875.0	-1875.0
11	FLT1005-SB	VFODNES (652398) 230kV	-1875.0	-1875.0	-1875.0
12	FLT1006-SB	Utica Junction (652526) 230kV	-2203.1	-2203.1	-2203.1
13	FLT1007-SB	Utica Junction (652526) 230kV	-2203.1	-2203.1	-2203.1
14	FLT1008-SB	Utica Junction(652526) 230kV	-2203.1	-2203.1	-2203.1
15	FLT1111-SB	Rasmussen (652536) 230kV	-1875.0	-1875.0	-1875.0
16	FLT1113-SB	Ft Randall (652509) 230kV	-3015.6	-3015.6	-3015.6

(1) Refer to Table 2-4 for a description of the contingency scenario

Bus voltages, machine rotor angles, and previously queued generation in the study area were monitored in addition to bus voltages and machine rotor angles in the following areas:

- 640 NPPD
- 645 OPPD
- 650 LES
- 652 WAPA
- 600 XEL
- 608 MP
- 613 SMMPA
- 615 GRE
- 620 OTP
- 661 MDU

Requested and previously queued generation outside the above study area was also monitored.

The results of the analysis determined if reactive compensation or system upgrades were required to obtain acceptable system performance. If additional reactive compensation was required, the size, type, and location were determined. The proposed reactive reinforcements would ensure the wind or solar farm meets FERC Order 661A low voltage requirements and return the wind or solar farm to its pre-disturbance operating voltage. If the results indicated the need for fast responding reactive support, dynamic support such as an SVC or STATCOM was investigated. If tripping of the prior queued projects was observed during the stability analysis (for under/over voltage or under/over frequency) the simulations were re-ran with the prior queued project's voltage and frequency tripping disabled.

3.2 Limited Operation Study and Interim Stability Analysis Results

The Limited Operation study and Interim Stability Analysis determined there were no contingencies that resulted in system/voltage instability, generation tripping offline, or poor post-fault voltage recovery with GEN-2015-023, GEN-2015-089, GEN-2016-021, GEN-2016-043, and GEN-2018-070 connected at 100% output.

Refer to Table 3-2 for a summary of the Limited Operation study and Interim Stability Analysis results for the contingencies listed in Table 2-4. Table 3-2 is a summary of the stability results for the 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions and states whether the system remained stable or generation tripped offline, if acceptable voltage recovery was observed after the fault was cleared, and if the voltage recovered to above 0.9 p.u. and below 1.1 p.u. post fault steady-state conditions. Voltage recovery criteria includes ensuring that the transient voltage recovery is between 0.7 p.u. within 2.5 seconds after the fault is cleared and 1.2 p.u. at any point after the fault is cleared and ending in a steady-state voltage (for N-1 contingencies) at the pre-contingent level or at least above 0.9 p.u. and below 1.1. p.u.

Refer to Appendix A, Appendix B, and Appendix C for a complete set of plots for all contingencies for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions, respectively.

Table 3-2: Stability Analysis Summary of Results for 17WP, 18SP, and 26SP Conditions

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.		
1	FLT18-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT19-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT20-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT23-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT28-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT29-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT30-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT33-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT34-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT35-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT89-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT90-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT91-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT92-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT93-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT94-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT96-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT98-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
19	FLT99-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT100-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT101-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT102-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT103-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT104-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT105-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT106-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT109-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT110-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT112-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT113-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
34	FLT114-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT115-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT116-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT117-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT118-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT119-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT120-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT122-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT123-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT124-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT125-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT128-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT129-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT130-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT140-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT141-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT142-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT143-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT144-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT145-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT146-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT147-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT148-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT150-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT151-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT152-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT153-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT154-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT155-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT156-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
64	FLT157-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT158-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued): Stability Analysis Summary of Results for 17WP, 18SP, and 26SP Conditions

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.		
66	FLT159-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
67	FLT160-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
68	FLT161-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
69	FLT162-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
70	FLT163-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
71	FLT164-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
72	FLT165-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
73	FLT168-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
74	FLT169-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
75	FLT170-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
76	FLT7160-EE	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
77	FLT94-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
78	FLT1107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
79	FLT1108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
80	FLT1109-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
81	FLT1110-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
82	FLT1111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
83	FLT1113-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
84	FLT9001-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
85	FLT9002-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
86	FLT9003-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
87	FLT9004-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
88	FLT9005-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
89	FLT9006-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
90	FLT9007-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
91	FLT9008-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
92	FLT9009-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
93	FLT9010-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
94	FLT9011-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
95	FLT9012-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
96	FLT9013-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
97	FLT9014-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
98	FLT9015-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
99	FLT9016-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
100	FLT9017-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
101	FLT9018-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
102	FLT9019-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
103	FLT9020-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
104	FLT9021-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
105	FLT9022-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
106	FLT9023-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
107	FLT9024-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
108	FLT9025B-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
109	FLT9026-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
110	FLT9027-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
111	FLT9028-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
112	FLT9029-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
113	FLT9030-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
114	FLT9031-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
115	FLT9032-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
116	FLT9033-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
117	FLT9034-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
118	FLT9035-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
119	FLT9036-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
120	FLT9037-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
121	FLT9038-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
122	FLT9039-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
123	FLT9040-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
124	FLT9041-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
125	FLT9001-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
126	FLT9002-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
127	FLT9003-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
128	FLT9010-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
129	FLT9011-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
130	FLT9012-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued): Stability Analysis Summary of Results for 17WP, 18SP, and 26SP Conditions

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than 0.70 p.u.	Greater than 1.20 p.u.		
131	FLT9013-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
132	FLT9037-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
133	FLT9038-PO1	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
134	FLT9039-PO3	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
135	FLT9010_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
136	FLT9011_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
137	FLT9012_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
138	FLT9013_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
139	FLT9027-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
140	FLT9028-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
141	FLT9037_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
142	FLT9038_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
143	FLT9039_3-PO4	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
144	FLT1001-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
145	FLT1002-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
146	FLT1003-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
147	FLT1004-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
148	FLT1005-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
149	FLT1006-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
150	FLT1007-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
151	FLT1008-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
152	FLT1009-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

It was observed that FLT128-SB, which is a stuck breaker fault that results in the loss of the Grand Island to Sweetwater 345 kV line as well as the Grand Island to Holt County 345 kV line, resulted in slow but acceptable voltage recovery at buses nearby the fault for all seasonal peak conditions. The voltage response is within the SPP Performance Criteria so no action is required, however, this fault was investigated to see if improved voltage response could be achieved. It was determined that the system response could be improved by switching out the shunt reactors at Grand Prairie and Fort Thompson. Refer to Figure 3-1 for a representative plot of the bus voltage at Holt County 345 kV for FLT128-SB for the 2017 Summer Peak case with and without the shunt reactors nearby to the fault. It was determined that FLT128-SB resulted in acceptable voltage and system recovery with the shunt reactors online, however, it was determined that voltages near the fault recovered closer to their pre-fault voltages with the shunt reactors switched offline.

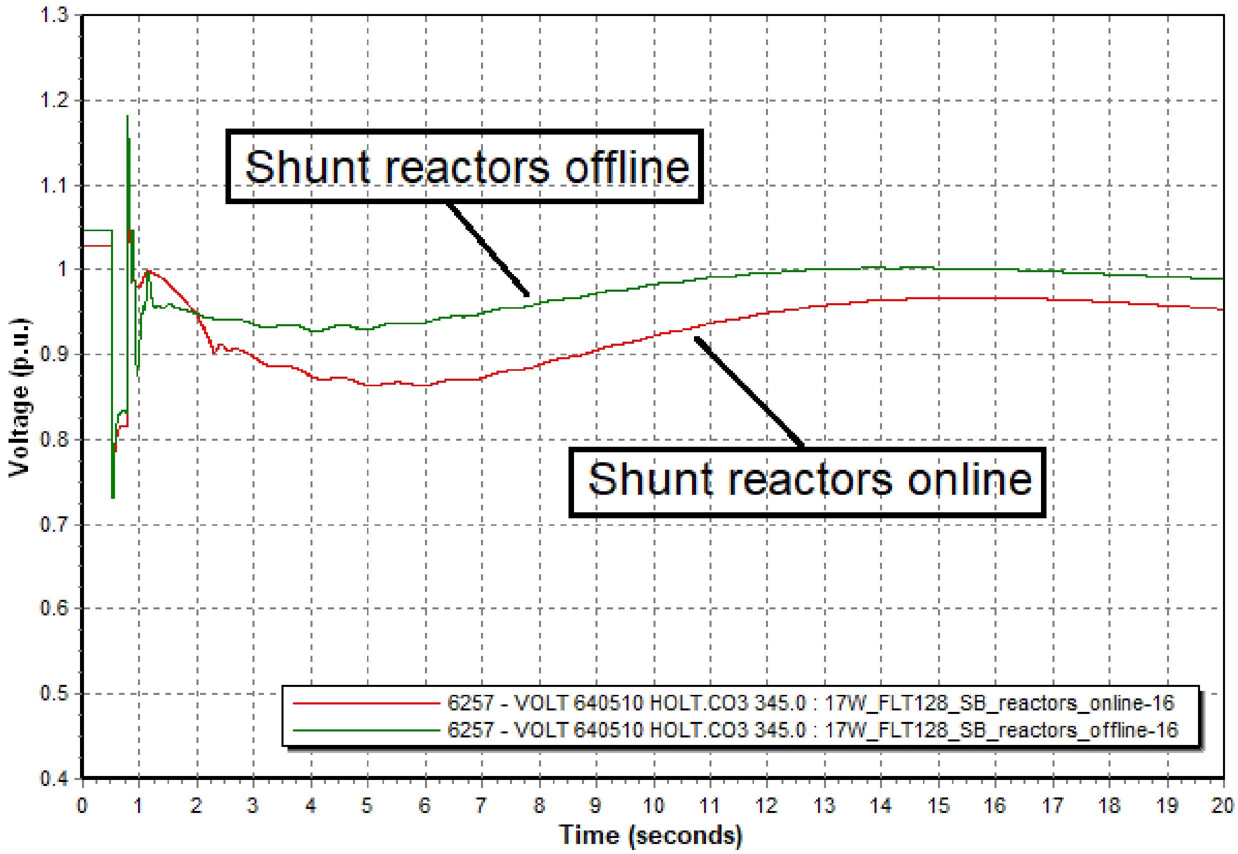

Figure 3-1. Plot of the voltage at Holt County 345 kV for FLT128-SB for 2017 Summer Peak case with and without the nearby shunt reactors.

SECTION 4: CONCLUSIONS

Summary of the Limited Operation Study and Interim Stability Analysis

The Limited Operation study and Interim Stability Analysis determined there were no contingencies that resulted in system/voltage instability, generation tripping offline, or poor post-fault voltage recovery when all generation interconnection requests were connected at 100% output. It was determined all five study requests may connect at 100% output without causing any voltage or rotor angle stability concerns prior to the completion of the R-Plan upgrade.

Prior studies, including DISIS-2015-001 and DISIS-2016-001, modeled the generating facilities interconnecting at Grand Prairie 345 kV substation with the user-written PSS/E Model for Vestas OptiSpeed™ Wind Turbines Version 7.6. This study used the updated user-written Vestas Generic Model Structure V7 to represent these generating facilities in the study models.

APPENDIX A: PLOTS FOR 2017 WINTER PEAK CONDITIONS

Plots available upon request

APPENDIX B: PLOTS FOR 2018 SUMMER PEAK CONDITIONS

Plots available upon request

APPENDIX C: PLOTS FOR 2026 SUMMER PEAK CONDITIONS

Plots available upon request