# DISIS-2015-002-7

## Definitive Interconnection System Impact Study Report

## Groups 6 & 7 Restudy

Published on February 22, 2019

By Generator Interconnections Dept.

# REVISION HISTORY

| DATE OR VERSION NUMBER | AUTHOR | CHANGE DESCRIPTION |
|---|---|---|
| 2/5/2016 | SPP | Draft issued to Transmission Owners for review |
| 2/12/2016 | SPP | Report Issued (DISIS-2015-002). Some stability analysis still pending. Group 2, 6, 7, 15 and 16 Interconnection Request Results not included in this issue. |
| 2/22/2016 | SPP | Draft issued to Transmission Owners for Group 2, 6, and 7 review |
| 2/29/2016 | SPP | Report Issued (DISIS-2015-002) to include Group 2, 6, and 7 Results. Some stability analysis still pending. 15 and 16 Interconnection Request Results not included in this issue. |
| 3/17/2016 | SPP | Draft issued to Transmission Owners for Group 15, and 16 review |
| 3/29/2016 | SPP | Report Issued (DISIS-2015-002) to include Group 15 and 16 Results. Group 16 stability analysis still pending. |
| 4/28/2016 | SPP | Report Issued to include Group 16 stability analysis |
| 8/01/2016 | SPP | ReStudy to account for withdrawn projects. |
| 8/04/2016 | SPP | DISIS-2015-002-1 reposted for AECI Affected System Cost Allocation correction and update to Introduction Section Stand-Alone Language |
| 11/29/2016 | SPP | Restudy Power Flow Analysis for Group 1 only. Cost Allocation for all projects. To account for withdrawn Projects, Report Reposted (DISIS-2015-002-2) |
| 7/10/2017 | SPP | Restudy Power Flow Analysis for Group 1 only to account for withdrawn projects GEN-2011-051, GEN-2015-060, and GEN-2015-081. Report Reposted (DISIS-2015-002-3) |

| DATE OR VERSION NUMBER | AUTHOR | CHANGE DESCRIPTION |
|---|---|---|
| 9/22/2017 | SPP | Restudy Analysis for Group 8 only to account for withdrawn projects GEN-2015-067. Report Reposted (DISIS-2015-002-4).<br><br>Groups 2, 6, and 16 results to be posted once at a later date. |
| 11/2/2017 | SPP | Report Issued to include Groups 2, 6, and 16 restudy analysis. Additionally latest cost estimate for GEN-2015-063 Tap – Mathewson 345kV upgrade are included for the allocated Group 8 request. |
| 02/16/2018 | SPP | Restudy Analysis for Group 7 to reflect upgrade changes from the prior re-study. |
| 12/21/2018 | SPP | Restudy Analysis for Group 6 to account for withdrawn requests. |
| 01/9/2019 | SPP | Cluster total estimates in Section 5 and Conclusion, Revised costs in Appendix E and F. |
| 2/22/2019 | SPP | Report Issued for DISIS-2015-002-7, Group 6 and 7. |

# CONTENTS

# SECTION 1: INTRODUCTION

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT), SPP has conducted this Definitive Interconnection System Impact Study (DISIS) for generation interconnection requests received during the DISIS Queue Cluster Window which closed on September 30, 2015. The customers will be referred to in this study as the DISIS Interconnection Customers. This DISIS analyzes the impact of interconnecting new generation totaling 441.20 MW to the SPP Transmission System. The interconnecting SPP Transmission Owners include:

- American Electric Power West (AEPW)
- Basin Electric Power Cooperative (BEPC)
- Grand River Dam Authority (GRDA)
- Kansas City Power and Light\KCP&L Greater Missouri Operations (KCPL)
- Midwest Energy (MIDW)
- Nebraska Public Power District (NPPD)
- Oklahoma Gas and Electric (OKGE)
- Omaha Public Power District (OPPD)
- Southwestern Public Service (SPS)
- Southwestern Power Administration (SWPA)*
- Western Area Power Administration (WAPA)
- Westar Energy, Inc. (WERE)
- Western Farmers Electric Cooperative (WFEC)

*SWPA is a SPP Contract Participant

The generation interconnection requests included in this System Impact Study are listed in Appendix A by queue number, amount, requested interconnection service type, area, requested interconnection point, proposed interconnection point, and the requested in-service date[1].

The primary objective of this DISIS is to identify the system constraints, transient instabilities, and over-dutied equipment associated with connecting the generation to the area transmission system. The Impact Study and other subsequent Interconnection Studies are designed to identify required Transmission Owner Interconnection Facilities, Network Upgrades and other Direct Assignment Facilities needed to inject power into the grid at each specific point of interconnection.

[1] The generation interconnection requests in-service dates may need to be deferred based on the required lead time for the Network Upgrades necessary. The Interconnection Customers that proceed to the Facility Study will be provided a new in-service date based on the completion of the Facility Study or as otherwise provided for in the GIP.

# SECTION 2: MODEL DEVELOPMENT (STUDY ASSUMPTIONS)

## *SUBSECTION A: INTERCONNECTION REQUESTS INCLUDED IN THE CLUSTER*

This DISIS includes all interconnection requests that were submitted during the DISIS Queue Cluster Window that met all of the requirements of the Generator Interconnection Procedures (GIP) that were in effect at the time this study commenced. Appendix A lists the interconnection requests that are included in this study.

## *SUBSECTION B: AFFECTED SYSTEM INTERCONNECTION REQUEST*

Affected System Interconnection Requests included in this study are listed in Appendix A with the "ASGI" prefix. Affected System Interconnection Requests were only studied in "cluster" scenarios.

## *SUBSECTION C: PREVIOUSLY QUEUED INTERCONNECTION REQUESTS*

The previous-queued requests included in this study are listed in Appendix B. In addition to the Base Case Upgrades, the previous-queued requests and associated upgrades were assumed to be in-service and added to the Base Case models. These requests were dispatched as Energy Resource Interconnection Service (ERIS) resources with equal distribution across the SPP footprint. Prior-queued requests that requested Network Resource Interconnection Service (NRIS) were also dispatched in separate NRIS scenarios sinking into the area of the interconnecting transmission owner.

## *SUBSECTION D: DEVELOPMENT OF BASE CASES*

### POWER FLOW

The power flow models used for this study are based on the 2016-series Integrated Transmission Planning models used for the 2017 ITP-Near Term analysis. These models include:

- 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 peak (21WP)
- Year 10 2026 summer peak (26SP)

### DYNAMIC STABILITY

The dynamic stability models used for this study are based on the 2016-series SPP Model Development Working Group (MDWG) Models. These models include:

- Year 1 2017 winter peak (17WP)
- Year 2 2018 summer peak (18SP)
- Year 10 2026 summer peak (26SP)

## SHORT CIRCUIT

The Year 2 and Year 10 dynamic stability summer peak models were used for short-circuit analysis.

## BASE CASE UPGRADES

The facilities listed in the table below are part of the current SPP Transmission Expansion Plan, the Balanced Portfolio, or recently approved Priority Projects. These facilities have an approved Notification to Construct (NTC) or are in construction stages and were assumed to be in-service at the time of dispatch and added to the base case models. The DISIS Interconnection Customers have not been assigned advancement costs for the projects listed below.

The DISIS Interconnection Customers' Generation Facilities in-service dates may need to be delayed until the completion of the following upgrades. In some cases, the in-service date is beyond the allowable time a customer can delay. In this case, the Interconnection Customer may move forward with Limited Operation or remain in the DISIS Queue for additional study cycles. If, for some reason, construction on these projects is discontinued, additional restudies will be needed to determine the interconnection needs of the DISIS Interconnection Customers.

| NTC | UID | TO | Upgrade | Estimated Date of Upgrade Completion (EOC) |
|---|---|---|---|---|
| 200360 | 50957 | SPS | Intrepid West - Potash Junction 115 kV Ckt 1 Rebuild | 4/15/2019 |
| 200360 | 51250 | SPS | National Enrichment Plant - Targa 115 kV Ckt 1 | 4/5/2019 |
| 200391 | 51528 | OGE | DeGrasse 345 kV Substation | 6/1/2019 |
| 200391 | 51529 | OGE | DeGrasse 345/138 kV Transformer | 6/1/2019 |
| 200391 | 51530 | OGE | DeGrasse - Knob Hill 138 kV New Line | 6/1/2019 |
| 200391 | 51569 | OGE | DeGrasse 138 kV Substation (OGE) | 6/1/2019 |
| 200220 | 50442 | NPPD | Cherry Co. (Thedford) - Gentleman 345 kV Ckt 1 | 1/1/2021 |
| 200220 | 50444 | NPPD | Cherry Co. (Thedford) Substation 345 kV | 1/1/2021 |
| 200220 | 50445 | NPPD | Cherry Co. (Thedford) - Holt Co. 345 kV Ckt 1 | 1/1/2021 |
| 200220 | 50446 | NPPD | Holt Co. Substation 345 kV | 1/1/2021 |
| 200309 | 50457 | SPS | Hobbs - Yoakum 345 kV Ckt 1 | 6/1/2020 |
| 200395 | 50447 | SPS | Tuco - Yoakum 345 kV Ckt 1 | 6/1/2020 |
| 200395 | 50451 | SPS | Yoakum 345/230 kV Ckt 1 Transformer | 6/1/2019 |
| 200282 | 50869 | SPS | China Draw - Yeso Hills 115 kV Ckt 1 | 12/30/2023 |
| 200369 | 51481 | SPS | Canyon East Tap - Randall 115 kV Ckt 1 Rebuild | 5/15/2020 |
| 200309 | 50447 | SPS | Tuco - Yoakum 345 kV Ckt 1 | 6/1/2020 |
| 200396 | 51531 | WFEC | DeGrasse 138 kV Substation (WFEC) | 12/31/2019 |
| 200395 | 50920 | SPS | Seminole 230/115 kV #1 Transformer | 11/14/2019 |
| 200262 | 51039 | SPS | Yoakum County Interchange 230/115 kV Ckt 1 Transformer | 3/15/2019 |
| 200395 | 50921 | SPS | Seminole 230/115 kV #2 Transformer | 5/14/2019 |
| 200262 | 51050 | SPS | Yoakum County Interchange 230/115 kV Ckt 2 Transformer | 5/31/2019 |

### CONTINGENT UPGRADES

The following facilities do not yet have approval. These facilities have been assigned to higher-queued interconnection customers. These facilities have been included in the models for this study and are assumed to be in service. This list may not be all-inclusive. The DISIS Interconnection Customers, at this time, do not have cost responsibility for these facilities but may later be assigned cost if higher-queued customers terminate their Generation Interconnection Agreement or withdraw from the interconnection queue. The DISIS Interconnection Customer Generation Facilities in-service dates may need to be delayed until the completion of the following upgrades.

All previously allocated projects have been completed.

### POTENTIAL UPGRADES NOT IN THE BASE CASE

Any potential upgrades that do not have a Notification to Construct (NTC) and are not explicitly listed within this report have not been included in the base case. These upgrades include any identified in the SPP Extra-High Voltage (EHV) overlay plan, or any other SPP planning study other than the upgrades listed above in the previous section.

### REGIONAL GROUPINGS

The interconnection requests listed in Appendix A are grouped into sixteen (16) active regional groups based on geographical and electrical impacts. These groupings are shown in Appendix C. This restudy is a study of regional grouping 6 (South Texas Panhandle/New Mexico Area) and 7 (Southwest Oklahoma Area) only.

## *SUBSECTION E: DEVELOPMENT OF ANALYSIS CASES*

### POWER FLOW

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 are dispatched at 20% nameplate of maximum generation in the models.  These projects are dispatched across the SPP footprint using load factor ratios.

Peaking units are not dispatched in the spring case, or in the "High VER" summer and winter peak cases. To study peaking units' impacts, the Year 1 winter peak and Year 2 summer peak, 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.

Each interconnection request is included in the power flow analysis models as an equivalent generator(s) dispatched at the applicable percentage of the requested service amount with 0.95 power factor capability. The facility modeling includes explicit representation of equivalent Generator Step-Up (GSU) and main project transformer(s) with impedance data provided in the interconnection request. Equivalent collector system(s) as well as transmission lead line(s) shorter than 20 miles are added to the power flow analysis models with zero impedance branches.

### DYNAMIC STABILITY

For each group, all interconnection requests are dispatched at 100% nameplate output while the other groups are dispatched at 20% output for VERs and 100% output for thermal requests.

- Each study group includes system adjustments of dispatching, to maximum output, generation interconnected at the same or adjacent substations to a current study request within that group.
- Study Group 9 included an additional dispatch scenario to evaluate the Gerald Gentleman Station registered NERC flowgate #6006.
- Study Group 16 included system adjustments for the Miles City DC Tie, North Dakota – Canadian border – The phase shifting transformer to Saskatchewan Power (also known as B-10T), and reduction of WAPA (area 652) load and generation:
    - 2017 Winter Peak –
        - Miles City DC Tie– 200MW East to West transfer
        - B-10T – 65MW South to North transfer
    - 2018 Summer Peak –
        - Miles City DC Tie – 200MW East to West transfer
        - B-10T – 200MW North to South transfer
        - 1,100 MW reduction to load and generation (proxy for summer shoulder)
    - 2026 Summer Peak –
        - Miles City DC Tie – 200MW East to West transfer

Each interconnection request is included in the dynamic stability analysis models as an equivalent generator(s) dispatched at the applicable percentage of the aggregate generator nameplate capabilities provided in the interconnection request. The facility modeling includes explicit representation of equivalent Generator Step-up (GSU) transformer(s), equivalent collector system(s), main project transformer(s), and transmission lead line(s) with impedance data provided in the interconnection request.

### SHORT CIRCUIT

The Year 2 and Year 10 dynamic stability Summer Peak models were used for this analysis.

# SECTION 3: IDENTIFICATION OF NETWORK CONSTRAINTS (SYSTEM PERFORMANCE)

## *SUBSECTION A: 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 described.

For ERIS, thermal overloads are determined for system intact (n-0) greater than 100% of Rate A - normal and for contingency (n-n) greater than 100% of Rate B – emergency conditions.

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

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

Appropriate transmission reinforcements are identified to mitigate the constraints.

Interconnection Requests that requested 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 assigned transmission reinforcements to mitigate the impacts.

## *SUBSECTION B: VOLTAGE*

For non-converged power flow solutions that are determined to be caused by lack of voltage support, appropriate transmission support will be identified 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 voltage criteria is applicable to all SPP facilities 69 kV and greater in the absence of more stringent criteria:

| System Intact | Contingency |
|---|---|
| 0.95 – 1.05 per unit | 0.90 – 1.05 per unit |

Areas and specific buses having more-stringent voltage criteria:

| Areas/Facilities | System Intact | Contingency |
|---|---|---|
| AEPW – all buses<br>EMDE High Voltage | 0.95 – 1.05 per unit | 0.92 – 1.05 per unit |
| WERE Low Voltage | 0.95 – 1.05 per unit | 0.93 – 1.05 per unit |
| WERE High Voltage | 0.95 – 1.05 per unit | 0.95 – 1.05 per unit |
| TUCO 230 kV<br>Bus #525830 | 0.925 – 1.05 per unit | 0.925 – 1.05 per unit |
| Wolf Creek 345 kV<br>Bus #532797 | 0.985 – 1.03 per unit | 0.985 – 1.03 per unit |
| FCS Bus #646251 | 1.001 – 1.047 per unit | 1.001 – 1.047 per unit |

First-Tier External Areas facilities 115 kV and greater.

| Area | System Intact | Contingency |
|---|---|---|
| EES-EAI<br>LAGN<br>EES<br>AMMO<br>CLEC<br>LAFA<br>LEPA<br>XEL<br>MP<br>SMMPA<br>GRE<br>OTP<br>ALTW<br>MEC<br>MDU<br>DPC<br>ALTE | 0.95 – 1.05 per unit | 0.90 – 1.05 per unit |
| OTP-H (115kV+) | 0.97 – 1.05 per unit | 0.92 – 1.10 per unit |
| SPC | 0.95 – 1.05 per unit | 0.95 – 1.05 per unit |

The constraints identified through the voltage scan are 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.

## *SUBSECTION C: DYNAMIC STABILITY*

Stability issues are considered for transmission reinforcement under ERIS. Generators that fail to meet low voltage ride-through requirements (FERC Order #661-A) or SPP's stability requirements for damping or dynamic voltage recovery are assigned upgrades such that these requirements can be met.

## SUBSECTION D: UPGRADES ASSIGNED

Thermal overloads that require transmission support to mitigate are discussed in Section 8 and listed in Appendix G-T (Cluster Analysis). Voltage constraints that may require transmission support are discussed in Section 8 and listed in Appendix G-V (Cluster Analysis). Constraints that are identified solely through the stability analysis are discussed in Section 9 and the appropriate appendix for the detailed stability study of that Interconnection Request. All of these upgrades are cost assigned in Appendix E and Appendix F.

Other network constraints not requiring transmission reinforcements are shown in Appendix H-T (Cluster Analysis). With a defined source and sink in a Transmission Service Request, this list of network constraints can be refined and expanded to account for all Network Upgrade requirements for firm transmission service. Additional constraints identified by multi-element contingencies are listed in Appendix I.

In no way does the list of constraints in Appendix G-T (Cluster Analysis) identify all potential constraints that 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, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

# SECTION 4: DETERMINATION OF COST ALLOCATED NETWORK UPGRADES

Cost Allocated Network Upgrades of Variable Energy Resources (VER) (solar/wind) generation interconnection requests are determined using the Year 2 spring model. Cost Allocated Network Upgrades of peaking units are determined using the Year 5 summer peak model. A PSS/E and MUST sensitivity analysis is performed to determine the DF with no contingency that each generation interconnection request has on each new upgrade. The impact each generation interconnection request has on each upgrade project is weighted by the size of each request. Finally, the costs due by each request for a particular project are then determined by allocating the portion of each request's impact over the impact of all affecting requests.

For example, assume that there are three Generation Interconnection requests, X, Y, and Z that are responsible for the costs of Upgrade Project '1'. Given that their respective PTDF for the project have been determined, the cost allocation for Generation Interconnection request 'X' for Upgrade Project 1 is found by the following set of steps and formulas:

Determine an impact factor for a given project for all responsible GI requests:

$$Request\ X\ Impact\ Factor\ on\ Upgrade\ Project\ 1 = PTDF(\%)(X) \times MW(X) = X1$$

$$Request\ Y\ Impact\ Factor\ on\ Upgrade\ Project\ 1 = PTDF(\%)(Y) \times MW(Y) = Y1$$

$$Request\ Z\ Impact\ Factor\ on\ Upgrade\ Project\ 1 = PTDF(\%)(Z) \times MW(Z) = Z1$$

Determine each request's Allocation of Cost for that particular project:

$$Request\ X's\ Project\ 1\ Cost\ Allocation\ (\$) = \frac{Network\ Upgrade\ Project\ 1\ Cost\ (\$) \times X1}{X1 + Y1 + Z1}$$

Repeat previous for each responsible GI request for each Project.

The cost allocation of each needed Network Upgrade is determined by the size of each request and its impact on the given project. This allows for the most efficient and reasonable mechanism for sharing the costs of upgrades.

## SUBSECTION A: CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADES

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

# SECTION 5: REQUIRED INTERCONNECTION FACILITIES

The requirement to interconnect the requested generation into the existing and proposed transmission systems in the affected areas of the SPP transmission footprint consist of the necessary cost allocated shared facilities listed in Appendix F by upgrade. The interconnection requirements for Groups 6 and 7 total an estimated **$52.3 million**

Interconnection Facilities specific to each interconnection request are listed in Appendix E. A preliminary one-line diagram for each request is listed in Appendix D.

For an explanation of how required Network Upgrades and Interconnection Facilities were determined, refer to the section on "Identification of Network Constraints."

## *SUBSECTION A: FACILITIES ANALYSIS*

The interconnecting Transmission Owner for each Interconnection Request has provided its preliminary analysis of required Transmission Owner Interconnection Facilities and the associated Network Upgrades, shown in Appendix D. This analysis was limited only to the expected facilities to be constructed by the Transmission Owner at the Point of Interconnection. These costs are included in the one-line diagrams in Appendix D and also listed in Appendix E and F as combined "Interconnection Costs". If the one-lines and costs in Appendix D have been updated by the Transmission Owner's Interconnection Facilities Study, those costs will be noted in the appendix. These costs will be further refined by the Transmission Owner as part of the Interconnection Facilities Study. Any additional Network Upgrades identified by this DISIS beyond the Point of Interconnection are defined and estimated by either the Transmission Owner or by SPP. These additional Network Upgrade costs will also be refined further by the Transmission Owner within the Interconnection Facilities Study.

## *SUBSECTION B: ENVIRONMENTAL REVIEW*

For Interconnection Requests that result in an interconnection to, or modification to, the transmission facilities of the Western-UGP, a National Environmental Policy Act (NEPA) Environmental Review will be required. The Interconnection Customer will be required to execute an Environmental Review Agreement per Section 8.6.1 of the GIP.

# SECTION 6: AFFECTED SYSTEMS COORDINATION

The following procedures are in place to coordinate with Affected Systems.

- Impacts on Associated Electric Cooperative Inc. (AECI) – For any observed violations of thermal overloads on AECI facilities, AECI has been notified by SPP to evaluate the violations for impacts on its transmission system.
- Impacts on Midcontinent Independent System Operator (MISO) – Per SPP's agreement with MISO, MISO will be contacted and provided a list of interconnection requests that proceed to move forward into the Interconnection Facilities Study Queue. MISO will then evaluate the Interconnection Requests for impacts and will be in contact with affected Interconnection Customers. For potential impacts see Appendix H-T – Affected System and Appendix H-V – Affected System.
- Impacts on Minnkota Power Cooperative, Inc (MPC) – MPC will be contacted and provided a list of interconnection requests that proceed to move forward into the Interconnection Facilities Study Queue. MPC will then evaluate the Interconnection Requests for impacts. For potential impacts see Appendix H-T – Affected System and Appendix H-V – Affected System.
- Impacts to other affected systems – For any observed violations of thermal overloads or voltage constraints, SPP will contact the owner of the facility for further information.

# SECTION 7: POWER FLOW ANALYSIS

## *SUBSECTION A: POWER FLOW ANALYSIS METHODOLOGY*

The ACCC function of PSS/E is used to simulate single element and special (i.e., breaker-to-breaker, multi-element, etc.) contingencies in portions or all of the modeled control areas of SPP as well as control areas external to SPP.

## *SUBSECTION B: POWER FLOW ANALYSIS*

A power flow analysis is conducted for each Interconnection Customer's facility using modified versions of the year 1 winter peak season, the year 2 spring, year 2 summer peak season, year 5 summer and winter peak seasons, year 5 light load season, and year 10 summer peak seasonal models. The output of the Interconnection Customer's facility is offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an ERIS request. Requests that are pursuing NRIS have an additional analysis conducted for displacing resources in the interconnecting Transmission Owner's balancing area.

# SECTION 8: POWER FLOW RESULTS

## *SUBSECTION A: CLUSTER SCENARIO*

The Cluster Scenario considers the Base Case as well as all Interconnection Requests in the DISIS Study Queue and all generating facilities (and with respect to (3) below, any identified Network Upgrades associated with such higher-queued interconnection) that, on the date the DISIS is commenced:

1. are directly connected to the Transmission System;
2. are interconnection to Affected Systems and may have an impact on the Interconnection Request;
3. have a pending higher-queued Interconnection Request to interconnect to the Transmission System; and
4. have no Interconnection Queue Position but have executed a GIA or requested that an unexecuted GIA be filed with FERC.

Constraints and associated mitigations for each Interconnection Request are summarized below. Details are contained in Appendix G-T and Appendix G-V. Cost allocation for the Cluster Scenario is found in Appendix E.

## CLUSTER GROUP 6 (SOUTH TEXAS PANHANDLE/NEW MEXICO AREA)

Requests for this study group as well as prior-queued requests are listed in Appendix C.

The following table outlines the incremental mitigation scenarios for Group 6.

*Table 8-1 Group 6 Cluster Upgrade Scenarios*

| Scenario | Incremental Mitigation |
|---|---|
| 0 | None |
| 2 | Border Capactive Reactive Power Support |
| | Deaf Smith Capactive Reactive Power Support |
| | Oklaunion Capactive Reactive Power Support |
| 3 | Deaf Smith - Plant X 230kV CKT 1 |
| | Newhart - Plant X 230kV CKT 1 |

The following ERIS thermal constraints were observed for single contingency (N-1), and multicontingency (P1, P2, etc.) conditions for Group 6. The table below summarizes constraints and associated mitigations.

*Table 8-2 Group 6 Cluster ERIS Thermal Constraints*

| Monitored Element | Limiting Rate A/B (MVA) | TC %Loading (%MVA) | Contingency | Mitigation |
|---|---|---|---|---|
| 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 121.496 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' | Fix ~70 structures and two wavetraps at Plant X and Deaf Smith to achieve rating of 977 amps (389 MVA) |
| 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 131.1164 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | Fix ~14 structures to achieve rating of 1134 amps (451 MVA) |

The following ERIS voltage constraints were observed for single contingency (N-1), and multicontingency (P1, P2, etc.) conditions for Group 6. The table below summarizes constraints and associated mitigations.

*Table 8-3 Group 6 Cluster ERIS Voltage Constraints*

| Monitored Element | TC Voltage (PU) | VMIN (PU) | VMAX (PU) | Contingency | Mitigation |
|---|---|---|---|---|---|
| 'BORDER 7345.00 345KV' | 0.838006 | 0.9 | 1.05 | OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' | Install +100Mvar Capacitor Bank(s) at Oklaunion 345kV<br><br>and<br><br>Install +100Mvar Capacitor Bank(s) at Border 345kV<br><br>and<br><br>Install +60Mvar Capacitor Bank(s) at Deaf Smith 230kV |
| 'BUSHLAND INTERCHANGE 230KV' | 0.897887 | 0.9 | 1.05 | | |
| 'CHAN+TASCOS6230.00 230KV' | 0.884732 | 0.9 | 1.05 | | |
| 'DEAF SMITH COUNTY INTERCHANGE 230KV' | 0.864164 | 0.9 | 1.05 | | |
| 'G1149G1504 345.00 345KV' | 0.838006 | 0.9 | 1.05 | | |
| 'NEWHART 230 230KV' | 0.890638 | 0.9 | 1.05 | | |
| 'SHAMROCK 115KV' | 0.908806 | 0.92 | 1.05 | | |
| 'SHAMROCK 69KV' | 0.891455 | 0.9 | 1.05 | | |
| 'SWISHER COUNTY INTERCHANGE 230KV' | 0.899093 | 0.9 | 1.05 | | |
| 'XIT_INTG 6230.00 230KV' | 0.870756 | 0.9 | 1.05 | | |
| 'OKLAUN HVDC7345.00 345KV' | 0.857986 | 0.9 | 1.05 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' | |
| 'OKLAUNION 345KV' | 0.857916 | 0.9 | 1.05 | | |

### CLUSTER GROUP 7 (SOUTHWEST OKLAHOMA AREA)

Requests for this study group as well as prior-queued requests are listed in Appendix C.

The following table outlines the incremental mitigation scenarios for Group 7.

*Table 8-4 Group 7 Cluster Upgrade Scenarios*

| Scenario | Incremental Mitigation |
|---|---|
| 0 | None |
| 2 | Grapevine - Wheeler - Sweetwater 230kV CKT 1 |

The following ERIS thermal constraints were observed for single contingency (N-1), and multicontingency (P1, P2, etc.) conditions for Group 7. The table below summarizes constraints and associated mitigations.

*Table 8-5 Group 7 Cluster ERIS Thermal Constraints*

| Monitored Element | Limiting Rate A/B (MVA) | TC %Loading (%MVA) | Contingency | Mitigation |
|---|---|---|---|---|
| 'GRAPEVINE INTERCHANGE - STATELINE INTERCHANGE 230KV CKT 1' | 318.69 | 101.6636 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' | Replace wavetrap at Grapevine to achieve 814 amps (324 MVA), rebuild ~5 miles of 230kV and replace terminal equipment to achieve 1150 amps (458 MVA) minimum |
| 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 120.0909 | | |
| 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 115.9076 | | |

## *SUBSECTION B: LIMITED OPERATION*

Limited Operation results are listed below. While these results are based on the criteria listed in GIP 8.4.3, the Interconnection Customer may request additional scenarios for Limited Operation based on higher queued Interconnection Requests not being placed in service. Please refer to section 8 Subsection A for power flow constraint mitigation.

*Table 8-6: Limited Operation Results*

| Interconnection Request | MW Requested | LOIS Available (MW) |
|---|---|---|
| GEN-2015-020 | 100.00 | 0 |
| GEN-2015-055 | 40.00 | 4 |
| GEN-2015-056 | 101.20 | 0 |
| GEN-2015-071 | 200.00 | 9 |

## *SUBSECTION C: 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, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

# SECTION 9: STABILITY & SHORT CIRCUIT ANALYSIS

A stability and short-circuit analysis was conducted for each Interconnection Request using modified versions of the MDWG Models dynamic cases. The stability analysis assumes that all upgrades identified in the power flow analysis are in-service unless otherwise noted in the individual group stability study.

For each group, the interconnection requests are studied at 100% nameplate output while the other groups are dispatched at 20% output for Variable Energy Resource (VER) requests and 100% output for other requests. The output of the Interconnection Customer's facility is offset in each model by a reduction in output of existing online SPP generation.

A synopsis is included for each group. The detailed stability study for each group can be found in the Appendices.

A preliminary short-circuit analysis was performed for this study and will be refined in the Interconnection Facilities Study with any additional required upgrades and cost assignment identified at that time.

## *9.1 POWER FACTOR REQUIREMENTS SUMMARY*

Power Factor Requirements:

| **Request** | **Size (MW)** | **Point of Interconnection** | **Power Factor Requirement at POI*** | |
|---|---|---|---|---|
| | | | **Lagging (supplying)** | **Leading (absorbing)** |
| GEN-2015-020 | 100 | Oasis 115kV | 0.95 | 0.95 |
| GEN-2015-055 | 40 | Erick 138kV | 0.95 | 0.95 |
| GEN-2015-056 | 101.2 | Crossroads 345kV | 0.95 | 0.95 |
| GEN-2015-071 | 200 | Chisholm 345kV | 0.95 | 0.95 |

*As the facility study agreement for each project was executed prior to the effective date in the compliance filing for FERC Order No. 827, reactive power is required for all projects, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

## *9.2 CLUSTER STABILITY AND SHORT-CIRCUIT SUMMARY*

### CLUSTER GROUP 6 (SOUTH TEXAS PANHANDLE/NEW MEXICO AREA)

New requests for this study group as well as prior-queued requests are listed in Appendix C.

The Group 6 cases included the following system adjustments of dispatching, to maximum output, generation interconnected at the same or adjacent substations to a current study request:

- Tolk units: GEN-2015-056

Additionally, to evaluate the planned conversion of the Tolk units to operate normally as synchronous condensers except during Summer Peaks, the 2017 Winter Peak case included a reduction to the Tolk unit 1 maximum output to 175 MW and switched off Tolk unit 2.

The Group 6 stability analysis for this area was performed by Aneden Consulting (Aneden). With the new requests modeled, violations of stability damping criteria and voltage recovery criteria were not observed. Upgrades identified in the power flow analysis were also tested in the stability analysis.

For certain contingencies at and near the POI of the higher queued GEN-2014-033 request, the PV solar generators (inverters) tripped offline due to frequency relays. The frequency protection relays set points were adjusted to prevent the unit from tripping on a known issue with PSS/E frequency calculations during low voltages associated with a nearby fault.

With all previously-assigned and currently-assigned Network Upgrades placed in service and identified system adjustments applied, no violations were observed (except as noted earlier), including violations of low-voltage ride-through requirements, for the probable contingencies studied.

The Group 6 power factor and short circuit analysis were not performed again for this restudy, the previous study results remain valid.

## CLUSTER GROUP 7 (SOUTHWESTERN OKLAHOMA AREA)

New requests for this study group as well as prior-queued requests are listed in Appendix C.

The Group 7 stability analysis for this area was performed by Aneden Consulting (Aneden). With the new requests modeled, violations of stability damping criteria and voltage recovery criteria were not observed for fault events under system intact conditions.

System instability was observed for fault events with prior outage of the Chisolm to Gracemont 345 kV line, Chisolm to Elk City 230 kV line, or the Sweetwater to Wheeler 230 kV line. As a result, GEN-2015-071 may have to be curtailed following the outage of these lines to maintain system reliability.

The results for the prior outage fault analysis identifying the curtailment amount required for each fault event will be included in a reposting of this report. The updated consultant report may note that for certain prior outage conditions curtailment (system adjustment) will be needed to maintain system stability for subsequent circuit outages.

With all previously-assigned and currently-assigned Network Upgrades placed in service and identified system adjustments applied, no violations were observed (except as noted earlier), including violations of low-voltage ride-through requirements, for the probable contingencies studied.

The Group 7 power factor and short circuit analysis were not performed again for this restudy, the previous study results remain valid.

# SECTION 10: CONCLUSION

The minimum cost of interconnecting all Group 6 and Group 7 generation interconnection requests included in this Definitive Interconnection System Impact Restudy is estimated at **$52.3 million**, not including the exceptions noted in Section 5.

Allocated costs for Network Upgrades and Transmission Owner Interconnection Facilities are listed in Appendix E and F. For Interconnection Requests that result in an interconnection to, or modification of, the transmission facilities of the Western-UGP (WAPA), a National Environmental Policy Act (NEPA) Environmental Review will be required. The Interconnection Customer will be required to execute an Environmental Review Agreement per Section 8.6.1 of the GIP.

These costs do not include the cost of upgrades of other transmission facilities listed in Appendix H which are Network Constraints. These interconnection costs do not include any cost of any Network Upgrades that are identified as required through the short circuit analysis. Potential over-duty circuit breakers capability will be identified by the Transmission Owner in the Interconnection Facilities Study.

The Interconnection Facilities Study will be revised, if needed, following the posting of this DISIS. The Interconnection Facilities Study may include additional study analysis, additional facility upgrades not yet identified by this DISIS, such as circuit breaker replacements and affected system facilities, and further refinement of existing cost estimates.

The required interconnection costs listed in Appendices E, and F, and other upgrades associated with Network Constraints do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer submits a Transmission Service Request (TSR) through SPP's Open Access Same Time Information System (OASIS) as required by Attachment Z1 of the SPP Open Access Transmission Tariff (OATT).

# APPENDICES

## *A: GENERATION INTERCONNECTION REQUESTS CONSIDERED FOR IMPACT STUDY*

# A: Generation Interconnection Requests Considered for Study

| Request | Amount | Service | Area | Requested Point of Interconnection | Proposed Point of Interconnection | Requested In-Service Date |
|---|---|---|---|---|---|---|
| ASGI-2015-006 | 9 | ER | SWPA | Tupelo 138kV | Tupelo 138kV | |
| GEN-2015-020 | 100 | ER | SPS | Oasis 115kV | Oasis 115kV | 12/1/2016 |
| GEN-2015-034 | 200 | ER | OKGE | Ranch Road 345kV | Ranch Road 345kV | 10/31/2017 |
| GEN-2015-045 | 20 | ER | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV | Tap Lawton - Sunnyside (Terry Road) 345kV | 12/1/2017 |
| GEN-2015-046 | 300 | ER | WAPA | Tande 345kV | Tande 345kV | 12/1/2017 |
| GEN-2015-047 | 297.8 | ER | OKGE | Sooner 345kV | Sooner 345kV | 12/1/2017 |
| GEN-2015-048 | 200 | ER | OKGE | Cleo Corner 138kV | Cleo Corner 138kV | 12/1/2017 |
| GEN-2015-052 | 300 | ER | WERE | Tap Open Sky - Rose Hill 345kV | Tap Open Sky - Rose Hill 345kV | 12/1/2017 |
| GEN-2015-055 | 40 | ER | WFEC | Erick 138kV | Erick 138kV | 10/30/2016 |
| GEN-2015-056 | 101.2 | ER | SPS | Crossroads 345kV | Crossroads 345kV | 12/1/2017 |
| GEN-2015-057 | 100 | ER | OKGE | Minco 345kV | Minco 345kV | 12/1/2016 |
| GEN-2015-062 | 4.5 | ER | OKGE | Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV | Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV | 3/1/2016 |
| GEN-2015-063 | 300 | ER | OKGE | Tap Woodring - Mathewson 345kV | Tap Woodring - Mathewson 345kV | 12/1/2017 |
| GEN-2015-064 | 197.8 | ER | SUNCMKEC | Mingo 115kV | Mingo 115kV | 11/1/2017 |
| GEN-2015-065 | 202.4 | ER | SUNCMKEC | Mingo 345kV | Mingo 345kV | 11/1/2017 |
| GEN-2015-066 | 248.4 | ER | OKGE | Tap Cleveland - Sooner 345kV | Tap Cleveland - Sooner 345kV | 12/1/2017 |
| GEN-2015-069 | 300 | ER | WERE | Union Ridge 230kV | Union Ridge 230kV | 12/1/2017 |
| GEN-2015-071 | 200 | ER | AEPW | Chisholm 345kV | Chisholm 345kV | 9/30/2017 |
| GEN-2015-073 | 200.1 | ER/NR | WERE | Emporia Energy Center 345kV | Emporia Energy Center 345kV | 12/31/2018 |
| GEN-2015-076 | 158.4 | ER | NPPD | Belden 115kV | Belden 115kV | 7/31/2017 |
| GEN-2015-087 | 66 | ER/NR | NPPD | Tap Fairbury - Hebron 115kV | Tap Fairbury - Hebron 115kV | 1/1/2019 |
| GEN-2015-088 | 300 | ER/NR | NPPD | Tap Moore - Pauline 345kV | Tap Moore - Pauline 345kV | 1/1/2019 |
| GEN-2015-090 | 220 | ER | WERE | Tap Thistle - Wichita 345kV Dbl CKT | Tap Thistle - Wichita 345kV Dbl CKT | 12/1/2017 |
| GEN-2015-092 | 250 | ER | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV | Tap Lawton - Sunnyside (Terry Road) 345kV | 12/1/2017 |
| GEN-2015-093 | 250 | ER | OKGE | Gracemont 345kV | Gracemont 345kV | 12/1/2017 |
| GEN-2015-096 | 149 | ER | WAPA | Tap Belfied - Rhame 230kV | Tap Belfied - Rhame 230kV | 12/31/2017 |
| GEN-2015-098 | 100 | ER | WAPA | Mingusville 230kV | Mingusville 230kV | 12/15/2017 |
| **Total:** | **4,814.60** | | | | | |

*In-Service Date for each request is to be determined after the Interconnection Facility Study is completed.

## *B: PRIOR-QUEUED INTERCONNECTION REQUESTS*

# B: Prior Queued Interconnection Requests

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| ASGI-2010-006 | 150 | AECI | Remington 138kV | |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV | |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV | |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV | |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV | |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV | |
| ASGI-2010-020 | 30 | SPS | Tap LE-Tatum - LE-Crossroads 69kV | |
| ASGI-2010-021 | 15 | SPS | Tap LE-Saunders Tap - LE-Anderson 69kV | |
| ASGI-2011-001 | 27.3 | SPS | Lovington 115kV | Commerical Operation |
| ASGI-2011-002 | 20 | SPS | Herring 115kV | 12/1/2010 |
| ASGI-2011-002 | 20 | SPS | Herring 115kV | 12/1/2010 |
| ASGI-2011-003 | 10 | SPS | Hendricks 69kV | |
| ASGI-2011-004 | 20 | SPS | Pleasant Hill 69kV | |
| ASGI-2012-002 | 18.15 | SPS | FE-Clovis Interchange 115kV | |
| ASGI-2012-006 | 22.5 | SUNCMKEC | Tap Hugoton - Rolla 69kV | |
| ASGI-2013-001 | 11.5 | SPS | PanTex South 115kV | |
| ASGI-2013-002 | 18.4 | SPS | FE Tucumcari 115kV | |
| ASGI-2013-003 | 18.4 | SPS | FE Clovis 115kV | |
| ASGI-2013-004 | 36.6 | SUNCMKEC | Morris 115kV | |
| ASGI-2013-004 | 36.6 | SUNCMKEC | Morris 115kV | |
| ASGI-2013-004 | 36.6 | SUNCMKEC | Morris 115kV | |
| ASGI-2013-005 | 1.65 | SPS | FE Clovis 115kV | |
| ASGI-2014-014 | 56.4 | GRDA | Ferguson 69kV | |
| ASGI-2014-014 | 56.4 | GRDA | Ferguson 69kV | |
| ASGI-2014-014 | 56.4 | GRDA | Ferguson 69kV | |
| ASGI-2015-001 | 6.132 | SUNCMKEC | Ninnescah 115kV | |
| ASGI-2015-002 | 2 | SPS | SP-Yuma 69kV | |
| ASGI-2015-004 | 56.364 | GRDA | Coffeyville City 69kV | |
| ASGI-2015-004 | 56.364 | GRDA | Coffeyville City 69kV | |
| ASGI-2015-004 | 56.364 | GRDA | Coffeyville City 69kV | |
| GEN-2001-014 | 94.5 | WFEC | Ft Supply 138kV | 6/30/2007 |
| GEN-2001-026 | 74.25 | WFEC | Washita 138kV | 10/1/2003 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV | 10/1/2002 |
| GEN-2001-036 | 80 | SPS | Norton 115kV | 10/1/2002 |
| GEN-2001-037 | 102 | OKGE | FPL Moreland Tap 138kV | 10/1/2002 |
| GEN-2001-039A | 104 | SUNCMKEC | Shooting Star Tap 115kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2001-039M | 100 | SUNCMKEC | Central Plains Tap 115kV | 12/1/2008 |
| GEN-2002-004 | 200 | WERE | Latham 345kV | 9/30/2003 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2002-004 | 200 | WERE | Latham 345kV | 9/30/2003 |
| GEN-2002-005 | 123 | WFEC | Red Hills Tap 138kV | 12/31/2006 |
| GEN-2002-008 | 240 | SPS | Hitchland 345kV | 11/1/2007 |
| GEN-2002-008 | 240 | SPS | Hitchland 345kV | 11/1/2007 |
| GEN-2002-008 | 240 | SPS | Hitchland 345kV | 11/1/2007 |
| GEN-2002-008IS | 40.5 | WAPA | Edgeley 115kV [Pomona 115kV] | Commercial Operation |
| GEN-2002-009 | 79.8 | SPS | Hansford 115kV | 9/30/2006 |
| GEN-2002-009IS | 40 | WAPA | Ft Thompson 69kV [Hyde 69kV] | Commercial Operation |
| GEN-2002-022 | 239.2 | SPS | Bushland 230kV | 12/15/2006 |
| GEN-2002-022 | 239.2 | SPS | Bushland 230kV | 12/15/2006 |
| GEN-2002-023N | 0.8 | NPPD | Harmony 115kV | On-Line |
| GEN-2002-025A | 150 | SUNCMKEC | Spearville 230kV | 6/1/2006 |
| GEN-2003-004 | 100 | WFEC | Washita 138kV | 12/1/2005 |
| GEN-2003-005 | 100 | WFEC | Anadarko - Paradise (Blue Canyon) 138kV | 12/1/2006 |
| GEN-2003-005 | 100 | WFEC | Anadarko - Paradise (Blue Canyon) 138kV | 12/1/2006 |
| GEN-2003-006A | 201.6 | SUNCMKEC | Elm Creek 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2003-006A | 201.6 | SUNCMKEC | Elm Creek 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2003-019 | 250 | MIDW | Smoky Hills Tap 230kV | 11/1/2006 |
| GEN-2003-019 | 250 | MIDW | Smoky Hills Tap 230kV | 11/1/2006 |
| GEN-2003-020 | 159.1 | SPS | Martin 115kV | 6/1/2007 |
| GEN-2003-020 | 159.1 | SPS | Martin 115kV | 6/1/2007 |
| GEN-2003-021N | 75 | NPPD | Ainsworth Wind Tap 115kV | 10/1/2005 |
| GEN-2003-021N | 75 | NPPD | Ainsworth Wind Tap 115kV | 10/1/2005 |
| GEN-2003-022 | 120 | AEPW | Weatherford 138kV | 12/31/2004 |
| GEN-2004-014 | 154.5 | SUNCMKEC | Spearville 230kV | 11/15/2005 |
| GEN-2004-020 | 27 | AEPW | Weatherford 138kV | 12/31/2005 |
| GEN-2004-023 | 20.6 | WFEC | Washita 138kV | 12/1/2005 |
| GEN-2004-023N | 75 | NPPD | Columbus Co 115kV | 1/1/2009 |
| GEN-2005-003 | 30.6 | WFEC | Washita 138kV | 12/1/2005 |
| GEN-2005-003IS | 100 | WAPA | Nelson 115kV | Commercial Operation |
| GEN-2005-008 | 120 | OKGE | Woodward 138kV | 7/31/2007 |
| GEN-2005-008IS | 50 | WAPA | Hilken 230kV [Ecklund 230kV] | Commercial Operation |
| GEN-2005-012 | 248.4 | SUNCMKEC | Ironwood 345kV | 12/31/2015 |
| GEN-2005-012 | 248.4 | SUNCMKEC | Ironwood 345kV | 12/31/2015 |
| GEN-2005-013 | 199.8 | WERE | Caney River 345kV | 11/1/2007 |
| GEN-2006-002 | 100.8 | AEPW | Sweetwater 230kV | 12/31/2006 |
| GEN-2006-002 | 100.8 | AEPW | Sweetwater 230kV | 12/31/2006 |
| GEN-2006-002IS | 51 | WAPA | Wessington Springs 230kV | Commercial Operation |
| GEN-2006-006IS | 10 | XEL | Marshall 115kV | Commercial Operation |
| GEN-2006-015IS | 50 | WAPA | Hilken 230kV [Ecklund 230kV] | Commercial Operation |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV | 6/1/2007 |
| GEN-2006-020N | 42 | NPPD | Bloomfield 115kV | 1/1/2009 |
| GEN-2006-020S | 20 | SPS | DWS Frisco 115kV | 9/1/2007 |
| GEN-2006-021 | 94 | SUNCMKEC | Flat Ridge Tap 138kV | 5/31/2008 |
| GEN-2006-024S | 18.9 | WFEC | Buffalo Bear Tap 69kV | 12/31/2007 |
| GEN-2006-026 | 604 | SPS | Hobbs 230kV & Hobbs 115kV | 6/1/2008 |
| GEN-2006-026 | 604 | SPS | Hobbs 230kV & Hobbs 115kV | 6/1/2008 |
| GEN-2006-026 | 604 | SPS | Hobbs 230kV & Hobbs 115kV | 6/1/2008 |
| GEN-2006-031 | 75 | MIDW | Knoll 115kV | On-Line |
| GEN-2006-035 | 224 | AEPW | Sweetwater 230kV | 12/1/2008 |
| GEN-2006-035 | 224 | AEPW | Sweetwater 230kV | 12/1/2008 |
| GEN-2006-037N1 | 73.1 | NPPD | Broken Bow 115kV | 1/1/2010 |
| GEN-2006-038N005 | 79.9 | NPPD | Broken Bow 115kV | 12/1/2010 |
| GEN-2006-038N019 | 79.9 | NPPD | Petersburg North 115kV | 5/1/2011 |
| GEN-2006-043 | 98.9 | AEPW | Sweetwater 230kV | 8/1/2008 |
| GEN-2006-044 | 370 | SPS | Hitchland 345kV | 10/1/2010 |
| GEN-2006-044 | 370 | SPS | Hitchland 345kV | 10/1/2010 |
| GEN-2006-044 | 370 | SPS | Hitchland 345kV | 10/1/2010 |
| GEN-2006-044 | 370 | SPS | Hitchland 345kV | 10/1/2010 |
| GEN-2006-044N | 40.5 | NPPD | North Petersburg 115kV | 1/1/2010 |
| GEN-2006-046 | 129.6 | OKGE | Dewey 138kV | 12/31/2009 |
| GEN-2007-011N08 | 81 | NPPD | Bloomfield 115kV | 1/1/2009 |
| GEN-2007-013IS | 50 | WAPA | Wessington Springs 230kV | Commercial Operation |
| GEN-2007-014IS | 100 | WAPA | Wessington Springs 230kV | Commercial Operation |
| GEN-2007-015IS | 100 | WAPA | Hilken 230kV [Ecklund 230kV] | Commercial Operation |
| GEN-2007-017IS | 166 | WAPA | Ft Thompson-Grand Island 345kV | On Schedule |
| GEN-2007-018IS | 234 | WAPA | Ft Thompson-Grand Island 345kV | On Schedule |
| GEN-2007-020IS | 16 | WAPA | Nelson 115kV | Commercial Operation |
| GEN-2007-021 | 201 | OKGE | Tatonga 345kV | 8/1/2009 |
| GEN-2007-021 | 201 | OKGE | Tatonga 345kV | 8/1/2009 |
| GEN-2007-025 | 299.2 | WERE | Viola 345kV | 12/31/2009 |
| GEN-2007-025 | 299.2 | WERE | Viola 345kV | 12/31/2009 |
| GEN-2007-040 | 200.1 | SUNCMKEC | Buckner 345kV | 12/15/2010 |
| GEN-2007-043 | 200 | OKGE | Minco 345kV | 12/1/2009 |
| GEN-2007-044 | 300 | OKGE | Tatonga 345kV | 12/1/2009 |
| GEN-2007-044 | 300 | OKGE | Tatonga 345kV | 12/1/2009 |
| GEN-2007-044 | 300 | OKGE | Tatonga 345kV | 12/1/2009 |
| GEN-2007-046 | 200 | SPS | Hitchland 115kV | 12/31/2011 |
| GEN-2007-046 | 200 | SPS | Hitchland 115kV | 12/31/2011 |
| GEN-2007-050 | 170.2 | OKGE | Woodward EHV 138kV | 10/1/2009 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2007-050 | 170.2 | OKGE | Woodward EHV 138kV | 10/1/2009 |
| GEN-2007-052 | 135 | WFEC | Anadarko 138kV | 5/1/2009 |
| GEN-2007-052 | 135 | WFEC | Anadarko 138kV | 5/1/2009 |
| GEN-2007-052 | 135 | WFEC | Anadarko 138kV | 5/1/2009 |
| GEN-2007-062 | 423.6 | OKGE | Woodward EHV 345kV | 12/31/2011 |
| GEN-2007-062 | 423.6 | OKGE | Woodward EHV 345kV | 12/31/2011 |
| GEN-2008-003 | 101.2 | OKGE | Woodward EHV 138kV | 8/31/2009 |
| GEN-2008-008IS | 5 | WAPA | Nelson 115kV | Commercial Operation |
| GEN-2008-013 | 300 | OKGE | Hunter 345kV | 10/1/2010 |
| GEN-2008-013 | 300 | OKGE | Hunter 345kV | 10/1/2010 |
| GEN-2008-018 | 249.75 | SPS | Finney 345kV | 12/31/2012 |
| GEN-2008-018 | 249.75 | SPS | Finney 345kV | 12/31/2012 |
| GEN-2008-021 | 42 | WERE | Wolf Creek 345kV | On-Line |
| GEN-2008-022 | 299.7 | SPS | Crossroads 345kV | 9/1/2011 |
| GEN-2008-022 | 299.7 | SPS | Crossroads 345kV | 9/1/2011 |
| GEN-2008-022 | 299.7 | SPS | Crossroads 345kV | 9/1/2011 |
| GEN-2008-023 | 148.8 | AEPW | Hobart Junction 138kV | 12/1/2010 |
| GEN-2008-023 | 148.8 | AEPW | Hobart Junction 138kV | 12/1/2010 |
| GEN-2008-037 | 99 | WFEC | Slick Hills 138kV | 11/30/2011 |
| GEN-2008-044 | 197.8 | OKGE | Tatonga 345kV | 12/1/2011 |
| GEN-2008-044 | 197.8 | OKGE | Tatonga 345kV | 12/1/2011 |
| GEN-2008-047 | 298.9 | OKGE | Beaver County 345kV | 12/31/2012 |
| GEN-2008-047 | 298.9 | OKGE | Beaver County 345kV | 12/31/2012 |
| GEN-2008-051 | 322 | SPS | Potter County 345kV | 12/31/2010 |
| GEN-2008-079 | 98.9 | SUNCMKEC | Crooked Creek 115kV | 12/1/2010 |
| GEN-2008-086N02 | 201 | NPPD | Meadow Grove 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2008-086N02 | 201 | NPPD | Meadow Grove 230kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2008-092 | 200.5 | MIDW | Post Rock 230kV | 12/1/2011 |
| GEN-2008-092 | 200.5 | MIDW | Post Rock 230kV | 12/1/2011 |
| GEN-2008-098 | 100.8 | WERE | Waverly 345kV | 12/31/2011 |
| GEN-2008-119O | 60 | OPPD | S1399 161kV | 12/31/2009 |
| GEN-2008-123N | 89.66 | NPPD | Tap Pauline - Guide Rock (Rosemont) 115kV | 12/31/2016 |
| GEN-2008-124 | 200.1 | SUNCMKEC | Ironwood 345kV | 1/1/2016 |
| GEN-2008-129 | 80 | KCPL | Pleasant Hill 161kV | 5/1/2009 |
| GEN-2008-129 | 80 | KCPL | Pleasant Hill 161kV | 5/1/2009 |
| GEN-2009-001IS | 200 | WAPA | Groton-Watertown 345kV | On Schedule |
| GEN-2009-008 | 198.69 | MIDW | South Hays 230kV | 9/1/2011 |
| GEN-2009-018IS | 99.5 | WAPA | Groton 115kV | Commercial Operation |
| GEN-2009-020 | 48.3 | MIDW | Walnut Creek 69kV | 12/31/2011 |
| GEN-2009-020AIS | 130.5 | WAPA | Tripp Junction 115kV | Commercial Operation |
| GEN-2009-020AIS | 130.5 | WAPA | Tripp Junction 115kV | Commercial Operation |
| GEN-2009-025 | 59.8 | OKGE | Nardins 69kV | 12/31/2011 |
| GEN-2009-026IS | 110 | WAPA | Dickenson-Heskett 230kV | On Schedule |
| GEN-2009-040 | 72 | WERE | Marshall 115kV | 12/31/2012 |
| GEN-2010-001 | 299.7 | OKGE | Beaver County 345kV | 1/1/2012 |
| GEN-2010-001 | 299.7 | OKGE | Beaver County 345kV | 1/1/2012 |
| GEN-2010-001IS | 99 | WAPA | Bismarck-Glenham 230kV | On Schedule |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2010-003 | 100.8 | WERE | Waverly 345kV | 12/31/2011 |
| GEN-2010-003IS | 34 | WAPA | Wessington Springs 230kV | Commercial Operation |
| GEN-2010-005 | 299.2 | WERE | Viola 345kV | 12/1/2012 |
| GEN-2010-005 | 299.2 | WERE | Viola 345kV | 12/1/2012 |
| GEN-2010-006 | 205 | SPS | Jones 230kV | 6/1/2012 |
| GEN-2010-009 | 165.6 | SUNCMKEC | Buckner 345kV | 12/1/2011 |
| GEN-2010-011 | 29.7 | OKGE | Tatonga 345kV | 12/31/2011 |
| GEN-2010-014 | 358.8 | SPS | Hitchland 345kV | 12/31/2013 |
| GEN-2010-014 | 358.8 | SPS | Hitchland 345kV | 12/31/2013 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV | 8/1/2012 |
| GEN-2010-040 | 298.45 | OKGE | Cimarron 345kV | 11/30/2011 |
| GEN-2010-040 | 298.45 | OKGE | Cimarron 345kV | 11/30/2011 |
| GEN-2010-041 | 10.29 | OPPD | S1399 161kV | 12/31/2011 |
| GEN-2010-046 | 56 | SPS | TUCO Interchange 230kV | 5/1/2013 |
| GEN-2010-051 | 200 | NPPD | Tap Hoskins - Twin Church (Dixon County) 230kV | 12/15/2012 |
| GEN-2010-055 | 4.5 | AEPW | Wekiwa 138kV | 12/31/2011 |
| GEN-2010-057 | 201 | MIDW | Rice County 230kV | 8/1/2012 |
| GEN-2011-008 | 600 | SUNCMKEC | Clark County 345kV | 12/1/2015 |
| GEN-2011-008 | 600 | SUNCMKEC | Clark County 345kV | 12/1/2015 |
| GEN-2011-008 | 600 | SUNCMKEC | Clark County 345kV | 12/1/2015 |
| GEN-2011-010 | 100.8 | OKGE | Minco 345kV | 12/1/2012 |
| GEN-2011-011 | 50 | KCPL | Iatan 345kV | 12/31/2010 |
| GEN-2011-014 | 198 | OKGE | Tap Hitchland - Woodward Dbl Ckt (GEN-2011-014 Tap) 345kV | 12/31/2013 |
| GEN-2011-016 | 200.1 | SUNCMKEC | Ironwood 345kV | 12/1/2013 |
| GEN-2011-018 | 73.6 | NPPD | Steele City 115kV | 12/1/2013 |
| GEN-2011-019 | 175 | OKGE | Woodward 345kV | 12/31/2012 |
| GEN-2011-020 | 165.6 | OKGE | Woodward 345kV | 12/31/2012 |
| GEN-2011-022 | 299 | SPS | Hitchland 345kV | 12/31/2012 |
| GEN-2011-022 | 299 | SPS | Hitchland 345kV | 12/31/2012 |
| GEN-2011-025 | 78.76 | SPS | Tap Floyd County - Crosby County 115kV | 6/30/2012 |
| GEN-2011-027 | 120 | NPPD | Tap Hoskins - Twin Church (Dixon County) 230kV | 12/31/2012 |
| GEN-2011-037 | 7 | WFEC | Blue Canyon 5 138kV | 1/1/2012 |
| GEN-2011-040 | 111 | OKGE | Carter County 138kV | 12/31/2012 |
| GEN-2011-040 | 111 | OKGE | Carter County 138kV | 12/31/2012 |
| GEN-2011-045 | 205 | SPS | Jones 230kV | 6/1/2013 |
| GEN-2011-046 | 27 | SPS | Lopez 115kV | 6/1/2013 |
| GEN-2011-048 | 175 | SPS | Mustang 230kV | 3/1/2013 |
| GEN-2011-049 | 250.7 | OKGE | Border 345kV | 12/31/2013 |
| GEN-2011-050 | 108 | AEPW | Santa Fe Tap 138kV | 12/31/2013 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2011-054 | 300 | OKGE | Cimarron 345kV | 11/30/2013 |
| GEN-2011-054 | 300 | OKGE | Cimarron 345kV | 11/30/2013 |
| GEN-2011-056 | 3.6 | NPPD | Jeffrey 115kV | 6/30/2012 |
| GEN-2011-056A | 3.6 | NPPD | John 1 115kV | 6/30/2012 |
| GEN-2011-056B | 4.5 | NPPD | John 2 115kV | 6/30/2012 |
| GEN-2011-057 | 150 | WERE | Creswell 138kV | 12/31/2013 |
| GEN-2012-001 | 61.2 | SPS | Cirrus Tap 230kV | 11/30/2012 |
| GEN-2012-004 | 41.4 | OKGE | Carter County 138kV | 12/31/2013 |
| GEN-2012-004 | 41.4 | OKGE | Carter County 138kV | 12/31/2013 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV | 4/1/2014 |
| GEN-2012-012IS | 75 | WAPA | Wolf Point-Circle 115kV | On Suspension |
| GEN-2012-020 | 478 | SPS | TUCO 230kV | 9/30/2015 |
| GEN-2012-020 | 478 | SPS | TUCO 230kV | 9/30/2015 |
| GEN-2012-021 | 4.8 | LES | Terry Bundy Generating Station 115kV | 8/1/2013 |
| GEN-2012-024 | 178.2 | SUNCMKEC | Clark County 345kV | 12/31/2015 |
| GEN-2012-028 | 74 | WFEC | Gotebo 69kV | 12/1/2014 |
| GEN-2012-032 | 299 | OKGE | Open Sky 345kV | 11/30/2014 |
| GEN-2012-032 | 299 | OKGE | Open Sky 345kV | 11/30/2014 |
| GEN-2012-033 | 98.06 | OKGE | Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV | 12/1/2014 |
| GEN-2012-034 | 7 | SPS | Mustang 230kV | 6/1/2013 |
| GEN-2012-035 | 7 | SPS | Mustang 230kV | 6/1/2013 |
| GEN-2012-036 | 7 | SPS | Mustang 230kV | 6/1/2013 |
| GEN-2012-037 | 203 | SPS | TUCO 345kV | 3/1/2015 |
| GEN-2012-041 | 121.5 | OKGE | Ranch Road 345kV | 4/15/2015 |
| GEN-2013-002 | 50.6 | LES | Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2 | 12/31/2013 |
| GEN-2013-007 | 100 | OKGE | Tap Prices Falls - Carter 138kV | 12/31/2014 |
| GEN-2013-008 | 1.2 | NPPD | Steele City 115kV | 12/31/2013 |
| GEN-2013-009IS | 19.5 | WAPA | Redfield NW 115kV | Commercial Operation |
| GEN-2013-011 | 30 | AEPW | Turk 138kV | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2013-012 | 147 | OKGE | Redbud 345kV | 11/30/2014 |
| GEN-2013-012 | 147 | OKGE | Redbud 345kV | 11/30/2014 |
| GEN-2013-012 | 147 | OKGE | Redbud 345kV | 11/30/2014 |
| GEN-2013-012 | 147 | OKGE | Redbud 345kV | 11/30/2014 |
| GEN-2013-016 | 203 | SPS | TUCO 345kV | 12/1/2016 |
| GEN-2013-019 | 73.6 | LES | Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2 | 6/30/2014 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2013-022 | 25 | SPS | Norton 115kV | 5/1/2015 |
| GEN-2013-027 | 148.4 | SPS | Tap Tolk - Yoakum 230kV | 3/31/2016 |
| GEN-2013-028 | 559.5 | GRDA | Tap N Tulsa - GRDA 1 345kV | 4/16/2016 |
| GEN-2013-028 | 559.5 | GRDA | Tap N Tulsa - GRDA 1 345kV | 4/16/2016 |
| GEN-2013-029 | 299 | OKGE | Renfrow 345kV | 12/15/2015 |
| GEN-2013-029 | 299 | OKGE | Renfrow 345kV | 12/15/2015 |
| GEN-2013-030 | 300 | OKGE | Beaver County 345kV | 12/15/2015 |
| GEN-2013-032 | 202.5 | NPPD | Antelope 115kV | 12/31/2016 |
| GEN-2013-033 | 28 | MIDW | Knoll 115kV | 12/31/2015 |
| GEN-2013-033 | 28 | MIDW | Knoll 115kV | 12/31/2015 |
| GEN-2013-033 | 28 | MIDW | Knoll 115kV | 12/31/2015 |
| GEN-2014-001 | 200.6 | WERE | Tap Wichita - Emporia Energy Center (GEN-2014-001 Tap) 345kV | 7/15/2014 |
| GEN-2014-001IS | 103.7 | WAPA | Newell-Maurine 115kV | IA Pending |
| GEN-2014-002 | 10.5 | OKGE | Tatonga 345kV (GEN-2007-021 POI) | 12/31/2014 |
| GEN-2014-003 | 15.8 | OKGE | Tatonga 345kV (GEN-2007-044 POI) | 12/31/2014 |
| GEN-2014-004 | 4 | NPPD | Steele City 115kV (GEN-2011-018 POI) | IA FULLY EXECUTED/COMMERCIAL OPERATION |
| GEN-2014-005 | 5.7 | OKGE | Minco 345kV (GEN-2011-010 POI) | IA FULLY EXECUTED/ON SCHEDULE |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV | On Schedule |
| GEN-2014-010IS | 150 | WAPA | Neset 115kV | On Schedule |
| GEN-2014-013 | 73.4 | NPPD | Meadow Grove (GEN-2008-086N2 Sub) 230kV | 12/31/2014 |
| GEN-2014-014IS | 151.5 | WAPA | Belfield-Rhame 230kV | On Schedule |
| GEN-2014-020 | 99.1 | AEPW | Tuttle 138kV | 12/31/2014 |
| GEN-2014-021 | 300 | KCPL | Tap Nebraska City - Mullin Creek (Holt) 345kV | 12/1/2016 |
| GEN-2014-021 | 300 | KCPL | Tap Nebraska City - Mullin Creek (Holt) 345kV | 12/1/2016 |
| GEN-2014-025 | 2.4 | MIDW | Walnut Creek 69kV | 10/15/2015 |
| GEN-2014-028 | 35 | EMDE | Riverton 161kV | 1/1/2016 |
| GEN-2014-031 | 35.8 | NPPD | Meadow Grove 230kV | 10/1/2015 |
| GEN-2014-032 | 10.2 | NPPD | Meadow Grove 230kV | 10/1/2015 |
| GEN-2014-032 | 10.2 | NPPD | Meadow Grove 230kV | 10/1/2015 |
| GEN-2014-033 | 70 | SPS | Chaves County 115kV | 12/31/2016 |
| GEN-2014-034 | 70 | SPS | Chaves County 115kV | 12/31/2016 |
| GEN-2014-035 | 30 | SPS | Chaves County 115kV | 12/31/2016 |
| GEN-2014-039 | 73.4 | NPPD | Friend 115kV | 12/1/2016 |
| GEN-2014-040 | 319.7 | SPS | Castro 115kV | 9/1/2016 |
| GEN-2014-056 | 250 | OKGE | Minco 345kV | 12/31/2016 |
| GEN-2014-057 | 249.9 | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV | 12/31/2016 |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| GEN-2014-064 | 248.4 | OKGE | Otter 138kV | 12/1/2016 |
| GEN-2015-001 | 200 | OKGE | Ranch Road 345kV | 12/31/2016 |
| GEN-2015-004 | 52.9 | OKGE | Border 345kV | 5/15/2017 |
| GEN-2015-005 | 200.1 | KCPL | Tap Nebraska City - Sibley (Ketchem) 345kV | 12/31/2017 |
| GEN-2015-005 | 200.1 | KCPL | Tap Nebraska City - Sibley (Ketchem) 345kV | 12/31/2017 |
| GEN-2015-007 | 160 | NPPD | Hoskins 345kV | 12/31/2016 |
| GEN-2015-013 | 120 | WFEC | Synder 138kV | 12/1/2016 |
| GEN-2015-014 | 150 | SPS | Tap Cochran - Lehman 115kV | 12/1/2016 |
| GEN-2015-015 | 154.56 | OKGE | Road Runner 138kV | 7/31/2016 |
| GEN-2015-016 | 200 | KCPL | Tap Marmaton - Centerville 161kV | 12/31/2017 |
| GEN-2015-021 | 20 | SUNCMKEC | Johnson Corner 115kV | 12/31/2016 |
| GEN-2015-023 | 300.7 | NPPD | Holt County 345kV | 12/31/2019 |
| GEN-2015-023 | 300.7 | NPPD | Holt County 345kV | 12/31/2019 |
| GEN-2015-024 | 217.7 | WERE | Tap Thistle - Wichita 345kV Dbl CKT | 12/31/2016 |
| GEN-2015-025 | 215.9 | WERE | Tap Thistle - Wichita 345kV Dbl CKT | 12/31/2016 |
| GEN-2015-029 | 161 | OKGE | Tatonga 345kV | 12/1/2016 |
| Gray County Wind (Montezuma) | 110 | SUNCMKEC | Gray County Tap 115kV | |
| Llano Estacado (White Deer) | 80 | SPS | Llano Wind 115kV | |
| MPC00100 | 99 | OTP | Langdon 115 kV | In Service |
| MPC00200 | 60 | OTP | Langdon 115 kV | In Service |
| MPC00200 | 60 | OTP | Langdon 115 kV | In Service |
| MPC00300 | 40.5 | OTP | Langdon 115 kV | In Service |
| MPC00500 | 378.8 | OTP | Maple River 230 kV | In Service |
| MPC00500 | 378.8 | OTP | Maple River 230 kV | In Service |
| MPC00500 | 378.8 | OTP | Maple River 230 kV | In Service |
| MPC00500 | 378.8 | OTP | Maple River 230 kV | In Service |
| MPC00500 | 378.8 | OTP | Maple River 230 kV | In Service |
| MPC01200 | 49.6 | OTP | Maple River 230 kV | In Service |
| MPC01300 | 455 | OTP | Square Butte 230 kV | In Service |
| MPC02100 | 100 | OTP | Center - Mandan 230 kV | In Service |
| NPPD Distributed (Broken Bow) | 8.3 | NPPD | Broken Bow 115kV | |
| NPPD Distributed (Buffalo County Solar) | 10 | NPPD | Kearney Northeast | |
| NPPD Distributed (Burt County Wind) | 12 | NPPD | Tekamah & Oakland 115kV | |
| NPPD Distributed (Burt County Wind) | 12 | NPPD | Tekamah & Oakland 115kV | |
| NPPD Distributed (Burwell) | 3 | NPPD | Ord 115kV | |
| NPPD Distributed (Columbus Hydro) | 45 | NPPD | Columbus 115kV | |
| NPPD Distributed (Columbus Hydro) | 45 | NPPD | Columbus 115kV | |
| NPPD Distributed (Columbus Hydro) | 45 | NPPD | Columbus 115kV | |
| NPPD Distributed (North Platte Lexington) | 54 | NPPD | Multiple: Jeffrey 115kV, John_1 115kV, John_2 115kV | |
| NPPD Distributed (North Platte Lexington) | 54 | NPPD | Multiple: Jeffrey 115kV, John_1 115kV, John_2 115kV | |
| NPPD Distributed (North Platte Lexington) | 54 | NPPD | Multiple: Jeffrey 115kV, John_1 115kV, John_2 115kV | |
| NPPD Distributed (Ord) | 11.9 | NPPD | Ord 115kV | |
| NPPD Distributed (Stuart) | 2.1 | NPPD | Ainsworth 115kV | |
| SPS Distributed (Carson) | 10 | SPS | Martin 115kV | Commerical Operation |
| SPS Distributed (Dumas 19th St) | 20 | SPS | Dumas 19th Street 115kV | |
| SPS Distributed (Dumas 19th St) | 20 | SPS | Dumas 19th Street 115kV | |
| SPS Distributed (Etter) | 20 | SPS | Etter 115kV | |

| Request | Amount | Area | Requested/Proposed Point of Interconnection | Status or In-Service Date |
|---|---|---|---|---|
| SPS Distributed (Etter) | 20 | SPS | Etter 115kV | |
| SPS Distributed (Hopi) | 10 | SPS | Hopi 115kV | |
| SPS Distributed (Jal) | 10 | SPS | S Jal 115kV | |
| SPS Distributed (Lea Road) | 10 | SPS | Lea Road 115kV | |
| SPS Distributed (Monument) | 10 | SPS | Monument 115kV | |
| SPS Distributed (Moore E) | 25 | SPS | Moore East 115kV | |
| SPS Distributed (Moore E) | 25 | SPS | Moore East 115kV | |
| SPS Distributed (Ocotillo) | 10 | SPS | S_Jal 115kV | |
| SPS Distributed (Sherman) | 20 | SPS | Sherman 115kV | |
| SPS Distributed (Sherman) | 20 | SPS | Sherman 115kV | |
| Sunray | 49.5 | SPS | Valero 115kV | Commerical Operation |
| **Total:** | **54,432.2** | | | |

## *C: STUDY GROUPINGS*

# C. Study Groups

| GROUP 1: WOODWARD AREA | | | |
|---|---|---|---|
| Request | Capacity | Area | Proposed Point of Interconnection |
| GEN-2001-014 | 94.5 | WFEC | Ft Supply 138kV |
| GEN-2001-037 | 102 | OKGE | FPL Moreland Tap 138kV |
| GEN-2005-008 | 120 | OKGE | Woodward 138kV |
| GEN-2006-024S | 18.9 | WFEC | Buffalo Bear Tap 69kV |
| GEN-2006-046 | 129.6 | OKGE | Dewey 138kV |
| GEN-2007-021 | 201 | OKGE | Tatonga 345kV |
| GEN-2007-043 | 200 | OKGE | Minco 345kV |
| GEN-2007-044 | 300 | OKGE | Tatonga 345kV |
| GEN-2007-050 | 170.2 | OKGE | Woodward EHV 138kV |
| GEN-2007-062 | 423.6 | OKGE | Woodward EHV 345kV |
| GEN-2008-003 | 101.2 | OKGE | Woodward EHV 138kV |
| GEN-2008-044 | 197.8 | OKGE | Tatonga 345kV |
| GEN-2010-011 | 29.7 | OKGE | Tatonga 345kV |
| GEN-2010-040 | 298.45 | OKGE | Cimarron 345kV |
| GEN-2011-010 | 100.8 | OKGE | Minco 345kV |
| GEN-2011-019 | 175 | OKGE | Woodward 345kV |
| GEN-2011-020 | 165.6 | OKGE | Woodward 345kV |
| GEN-2011-054 | 300 | OKGE | Cimarron 345kV |
| GEN-2014-002 | 10.5 | OKGE | Tatonga 345kV (GEN-2007-021 POI) |
| GEN-2014-003 | 15.8 | OKGE | Tatonga 345kV (GEN-2007-044 POI) |
| GEN-2014-005 | 5.7 | OKGE | Minco 345kV (GEN-2011-010 POI) |
| GEN-2014-020 | 99.1 | AEPW | Tuttle 138kV |
| GEN-2014-056 | 250 | OKGE | Minco 345kV |
| GEN-2015-029 | 161 | OKGE | Tatonga 345kV |
| PRIOR QUEUED SUBTOTAL | 3,670.45 | | |
| GEN-2015-048 | 200 | OKGE | Cleo Corner 138kV |
| GEN-2015-057 | 100 | OKGE | Minco 345kV |
| GEN-2015-093 | 250 | OKGE | Gracemont 345kV |
| CURRENT CLUSTER SUBTOTAL | 550.00 | | |
| AREA TOTAL | 4,220.45 | | |

## GROUP 2: HITCHLAND AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| ASGI-2011-002 | 20 | SPS | Herring 115kV |
| ASGI-2013-001 | 11.5 | SPS | PanTex South 115kV |
| ASGI-2016-010 | 90 | SPS | Powell Corner 115kV |
| GEN-2002-008 | 240 | SPS | Hitchland 345kV |
| GEN-2002-009 | 79.8 | SPS | Hansford 115kV |
| GEN-2002-022 | 239.2 | SPS | Bushland 230kV |
| GEN-2003-020 | 159.1 | SPS | Martin 115kV |
| GEN-2006-020S | 20 | SPS | DWS Frisco 115kV |
| GEN-2006-044 | 370 | SPS | Hitchland 345kV |
| GEN-2007-046 | 200 | SPS | Hitchland 115kV |
| GEN-2008-047 | 298.9 | OKGE | Beaver County 345kV |
| GEN-2008-051 | 322 | SPS | Potter County 345kV |
| GEN-2010-001 | 299.7 | OKGE | Beaver County 345kV |
| GEN-2010-014 | 358.8 | SPS | Hitchland 345kV |
| GEN-2011-014 | 198 | OKGE | Tap Hitchland - Woodward Dbl Ckt (GEN-2011-014 Tap) 345kV |
| GEN-2011-022 | 299 | SPS | Hitchland 345kV |
| GEN-2013-030 | 300 | OKGE | Beaver County 345kV |
| Llano Estacado (White Deer) | 80 | SPS | Llano Wind 115kV |
| SPS Distributed (Carson) | 10 | SPS | Martin 115kV |
| SPS Distributed (Dumas 19th St) | 20 | SPS | Dumas 19th Street 115kV |
| SPS Distributed (Etter) | 20 | SPS | Etter 115kV |
| SPS Distributed (Moore E) | 25 | SPS | Moore East 115kV |
| SPS Distributed (Sherman) | 20 | SPS | Sherman 115kV |
| PRIOR QUEUED SUBTOTAL | 3,681.00 | | |
| AREA TOTAL | 3,681.00 | | |

## GROUP 3: SPEARVILLE AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| ASGI-2012-006 | 22.5 | SUNCMKEC | Tap Hugoton - Rolla 69kV |
| ASGI-2015-001 | 6.132 | SUNCMKEC | Ninnescah 115kV |
| ASGI-2018-003 | | | Appleton 69 kV |
| GEN-2001-039A | 104 | SUNCMKEC | Shooting Star Tap 115kV |
| GEN-2002-025A | 150 | SUNCMKEC | Spearville 230kV |
| GEN-2004-014 | 154.5 | SUNCMKEC | Spearville 230kV |
| GEN-2005-012 | 248.4 | SUNCMKEC | Ironwood 345kV |
| GEN-2006-021 | 94 | SUNCMKEC | Flat Ridge Tap 138kV |
| GEN-2007-040 | 200.1 | SUNCMKEC | Buckner 345kV |
| GEN-2008-018 | 249.75 | SPS | Finney 345kV |
| GEN-2008-079 | 98.9 | SUNCMKEC | Crooked Creek 115kV |
| GEN-2008-124 | 200.1 | SUNCMKEC | Ironwood 345kV |
| GEN-2010-009 | 165.6 | SUNCMKEC | Buckner 345kV |
| GEN-2011-008 | 600 | SUNCMKEC | Clark County 345kV |
| GEN-2011-016 | 200.1 | SUNCMKEC | Ironwood 345kV |
| GEN-2012-007 | 120 | SUNCMKEC | Rubart 115kV |
| GEN-2012-024 | 178.2 | SUNCMKEC | Clark County 345kV |
| GEN-2015-021 | 20 | SUNCMKEC | Johnson Corner 115kV |
| Gray County Wind (Montezuma) | 110 | SUNCMKEC | Gray County Tap 115kV |
| PRIOR QUEUED SUBTOTAL | 2,922.28 | | |
| AREA TOTAL | 2,922.28 | | |

| GROUP 4: NORTHWEST KANSAS AREA | | | |
|---|---|---|---|
| **Request** | **Capacity** | **Area** | **Proposed Point of Interconnection** |
| ASGI-2013-004 | 36.6 | SUNCMKEC | Morris 115kV |
| GEN-2001-039M | 100 | SUNCMKEC | Central Plains Tap 115kV |
| GEN-2003-006A | 201.6 | SUNCMKEC | Elm Creek 230kV |
| GEN-2003-019 | 250 | MIDW | Smoky Hills Tap 230kV |
| GEN-2006-031 | 75 | MIDW | Knoll 115kV |
| GEN-2008-092 | 200.5 | MIDW | Post Rock 230kV |
| GEN-2009-008 | 198.69 | MIDW | South Hays 230kV |
| GEN-2009-020 | 48.3 | MIDW | Walnut Creek 69kV |
| GEN-2010-057 | 201 | MIDW | Rice County 230kV |
| GEN-2013-033 | 28 | MIDW | Knoll 115kV |
| GEN-2014-025 | 2.4 | MIDW | Walnut Creek 69kV |
| **PRIOR QUEUED SUBTOTAL** | **1,342.09** | | |
| GEN-2015-064 | 197.8 | SUNCMKEC | Mingo 115kV |
| GEN-2015-065 | 202.4 | SUNCMKEC | Mingo 345kV |
| **CURRENT CLUSTER SUBTOTAL** | **400.20** | | |
| **AREA TOTAL** | **1,742.29** | | |

| GROUP 6: SOUTH TEXAS PANHANDLE/NEW MEXICO AREA | | | |
|---|---|---|---|
| Request | Capacity | Area | Proposed Point of Interconnection |
| ASGI-2010-010 | 42.2 | SPS | Lovington 115kV |
| ASGI-2010-020 | 30 | SPS | Tap LE-Tatum - LE-Crossroads 69kV |
| ASGI-2010-021 | 15 | SPS | Tap LE-Saunders Tap - LE-Anderson 69kV |
| ASGI-2011-001 | 27.3 | SPS | Lovington 115kV |
| ASGI-2011-003 | 10 | SPS | Hendricks 69kV |
| ASGI-2011-004 | 20 | SPS | Pleasant Hill 69kV |
| ASGI-2012-002 | 18.15 | SPS | FE-Clovis Interchange 115kV |
| ASGI-2013-002 | 18.4 | SPS | FE Tucumcari 115kV |
| ASGI-2013-003 | 18.4 | SPS | FE Clovis 115kV |
| ASGI-2013-005 | 1.65 | SPS | FE Clovis 115kV |
| ASGI-2015-002 | 2 | SPS | SP-Yuma 69kV |
| ASGI-2016-001 | 2.5 | SPS | Wolfforth 115kV |
| ASGI-2016-002 | 0.35 | SPS | SP-Yuma 115kV |
| ASGI-2016-004 | 9.6 | SPS | Palo Duro 115kV |
| ASGI-2016-009 | 3 | SPS | Wolfforth 115kV |
| GEN-2001-033 | 180 | SPS | San Juan Tap 230kV |
| GEN-2001-036 | 80 | SPS | Norton 115kV |
| GEN-2006-018 | 168.1 | SPS | TUCO Interchange 230kV |
| GEN-2006-026 | 604 | SPS | Hobbs 230kV & Hobbs 115kV |
| GEN-2008-022 | 299.7 | SPS | Crossroads 345kV |
| GEN-2010-006 | 205 | SPS | Jones 230kV |
| GEN-2010-046 | 56 | SPS | TUCO Interchange 230kV |
| GEN-2011-025 | 78.76 | SPS | Tap Floyd County - Crosby County 115kV |
| GEN-2011-045 | 205 | SPS | Jones 230kV |
| GEN-2011-046 | 27 | SPS | Lopez 115kV |
| GEN-2011-048 | 175 | SPS | Mustang 230kV |
| GEN-2012-001 | 61.2 | SPS | Cirrus Tap 230kV |
| GEN-2012-020 | 478 | SPS | TUCO 230kV |
| GEN-2012-034 | 7 | SPS | Mustang 230kV |
| GEN-2012-035 | 7 | SPS | Mustang 230kV |
| GEN-2012-036 | 7 | SPS | Mustang 230kV |
| GEN-2012-037 | 203 | SPS | TUCO 345kV |
| GEN-2013-016 | 203 | SPS | TUCO 345kV |
| GEN-2013-022 | 25 | SPS | Norton 115kV |
| GEN-2013-027 | 148.4 | SPS | Tap Tolk - Yoakum 230kV |
| GEN-2014-033 | 70 | SPS | Chaves County 115kV |
| GEN-2014-034 | 70 | SPS | Chaves County 115kV |
| GEN-2014-035 | 30 | SPS | Chaves County 115kV |
| GEN-2014-040 | 319.7 | SPS | Castro 115kV |
| GEN-2015-014 | 150 | SPS | Tap Cochran - Lehman 115kV |
| SPS Distributed (Hopi) | 10 | SPS | Hopi 115kV |
| SPS Distributed (Jal) | 10 | SPS | S Jal 115kV |
| SPS Distributed (Lea Road) | 10 | SPS | Lea Road 115kV |
| SPS Distributed (Monument) | 10 | SPS | Monument 115kV |
| SPS Distributed (Ocotillo) | 10 | SPS | S_Jal 115kV |
| Sunray | 49.5 | SPS | Valero 115kV |
| PRIOR QUEUED SUBTOTAL | 4,175.91 | | |

| | | | |
|---|---|---|---|
| GEN-2015-020 | 100 | SPS | Oasis 115kV |
| GEN-2015-056 | 101.2 | SPS | Crossroads 345kV |
| **CURRENT CLUSTER SUBTOTAL** | **201.20** | | |
| **AREA TOTAL** | **4,377.11** | | |

## GROUP 7: SOUTHWEST OKLAHOMA AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| GEN-2001-026 | 74.25 | WFEC | Washita 138kV |
| GEN-2002-005 | 123 | WFEC | Red Hills Tap 138kV |
| GEN-2003-004 | 100 | WFEC | Washita 138kV |
| GEN-2003-005 | 100 | WFEC | Anadarko - Paradise (Blue Canyon) 138kV |
| GEN-2003-022 | 120 | AEPW | Weatherford 138kV |
| GEN-2004-020 | 27 | AEPW | Weatherford 138kV |
| GEN-2004-023 | 20.6 | WFEC | Washita 138kV |
| GEN-2005-003 | 30.6 | WFEC | Washita 138kV |
| GEN-2006-002 | 100.8 | AEPW | Sweetwater 230kV |
| GEN-2006-035 | 224 | AEPW | Sweetwater 230kV |
| GEN-2006-043 | 98.9 | AEPW | Sweetwater 230kV |
| GEN-2007-052 | 135 | WFEC | Anadarko 138kV |
| GEN-2008-023 | 148.8 | AEPW | Hobart Junction 138kV |
| GEN-2008-037 | 99 | WFEC | Slick Hills 138kV |
| GEN-2011-037 | 7 | WFEC | Blue Canyon 5 138kV |
| GEN-2011-049 | 250.7 | OKGE | Border 345kV |
| GEN-2012-028 | 74 | WFEC | Gotebo 69kV |
| GEN-2015-004 | 52.9 | OKGE | Border 345kV |
| GEN-2015-013 | 120 | WFEC | Synder 138kV |
| PRIOR QUEUED SUBTOTAL | 1,906.55 | | |
| GEN-2015-055 | 40 | WFEC | Erick 138kV |
| GEN-2015-071 | 200 | AEPW | Chisholm 345kV |
| CURRENT CLUSTER SUBTOTAL | 240.00 | | |
| AREA TOTAL | 2,146.55 | | |

## GROUP 8: NORTH OKLAHOMA/SOUTH CENTRAL KANSAS AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| ASGI-2010-006 | 150 | AECI | Remington 138kV |
| ASGI-2014-014 | 56.4 | GRDA | Ferguson 69kV |
| ASGI-2015-004 | 56.364 | GRDA | Coffeyville City 69kV |
| ASGI-2017-008 | 158.6 | AECI | Remington to Shidler 138 kV |
| ASGI-2018-006 | | | Metz 69 kV |
| ASGI-2018-013 | | AECI | Remington 138 kV |
| GEN-2002-004 | 200 | WERE | Latham 345kV |
| GEN-2005-013 | 199.8 | WERE | Caney River 345kV |
| GEN-2007-025 | 299.2 | WERE | Viola 345kV |
| GEN-2008-013 | 300 | OKGE | Hunter 345kV |
| GEN-2008-021 | 42 | WERE | Wolf Creek 345kV |
| GEN-2008-098 | 100.8 | WERE | Waverly 345kV |
| GEN-2009-025 | 59.8 | OKGE | Nardins 69kV |
| GEN-2010-003 | 100.8 | WERE | Waverly 345kV |
| GEN-2010-005 | 299.2 | WERE | Viola 345kV |
| GEN-2010-055 | 4.5 | AEPW | Wekiwa 138kV |
| GEN-2011-057 | 150 | WERE | Creswell 138kV |
| GEN-2012-032 | 299 | OKGE | Open Sky 345kV |
| GEN-2012-033 | 98.06 | OKGE | Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV |
| GEN-2012-041 | 121.5 | OKGE | Ranch Road 345kV |
| GEN-2013-012 | 147 | OKGE | Redbud 345kV |
| GEN-2013-028 | 559.5 | GRDA | Tap N Tulsa - GRDA 1 345kV |
| GEN-2013-029 | 299 | OKGE | Renfrow 345kV |

| | | | |
|---|---|---|---|
| GEN-2014-001 | 200.6 | WERE | Tap Wichita - Emporia Energy Center (GEN-2014-001 Tap) 345kV |
| GEN-2014-028 | 35 | EMDE | Riverton 161kV |
| GEN-2014-064 | 248.4 | OKGE | Otter 138kV |
| GEN-2015-001 | 200 | OKGE | Ranch Road 345kV |
| GEN-2015-015 | 154.56 | OKGE | Road Runner 138kV |
| GEN-2015-016 | 200 | KCPL | Tap Marmaton - Centerville 161kV |
| GEN-2015-024 | 217.7 | WERE | Tap Thistle - Wichita 345kV Dbl CKT |
| GEN-2015-025 | 215.9 | WERE | Tap Thistle - Wichita 345kV Dbl CKT |
| **PRIOR QUEUED SUBTOTAL** | **5,173.68** | | |
| GEN-2015-034 | 200 | OKGE | Ranch Road 345kV |
| GEN-2015-047 | 297.8 | OKGE | Sooner 345kV |
| GEN-2015-052 | 300 | WERE | Tap Open Sky - Rose Hill 345kV |
| GEN-2015-062 | 4.5 | OKGE | Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV |
| GEN-2015-063 | 300 | OKGE | Tap Woodring - Mathewson 345kV |
| GEN-2015-066 | 248.4 | OKGE | Tap Cleveland - Sooner 345kV |
| GEN-2015-069 | 300 | WERE | Union Ridge 230kV |
| GEN-2015-073 | 200.1 | WERE | Emporia Energy Center 345kV |
| GEN-2015-090 | 220 | WERE | Tap Thistle - Wichita 345kV Dbl CKT |
| **CURRENT CLUSTER SUBTOTAL** | **2,070.80** | | |
| **AREA TOTAL** | **7,244.48** | | |

## GROUP 9: NEBRASKA AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| GEN-2002-023N | 0.8 | NPPD | Harmony 115kV |
| GEN-2003-021N | 75 | NPPD | Ainsworth Wind Tap 115kV |
| GEN-2004-023N | 75 | NPPD | Columbus Co 115kV |
| GEN-2006-020N | 42 | NPPD | Bloomfield 115kV |
| GEN-2006-037N1 | 73.1 | NPPD | Broken Bow 115kV |
| GEN-2006-038N005 | 79.9 | NPPD | Broken Bow 115kV |
| GEN-2006-038N019 | 79.9 | NPPD | Petersburg North 115kV |
| GEN-2006-044N | 40.5 | NPPD | North Petersburg 115kV |
| GEN-2007-011N08 | 81 | NPPD | Bloomfield 115kV |
| GEN-2007-017IS | 166 | WAPA | Ft Thompson-Grand Island 345kV |
| GEN-2007-018IS | 234 | WAPA | Ft Thompson-Grand Island 345kV |
| GEN-2008-086N02 | 201 | NPPD | Meadow Grove 230kV |
| GEN-2008-119O | 60 | OPPD | S1399 161kV |
| GEN-2008-123N | 89.66 | NPPD | Tap Pauline - Guide Rock (Rosemont) 115kV |
| GEN-2009-040 | 72 | WERE | Marshall 115kV |
| GEN-2010-041 | 10.29 | OPPD | S1399 161kV |
| GEN-2010-051 | 200 | NPPD | Tap Hoskins - Twin Church (Dixon County) 230kV |
| GEN-2011-018 | 73.6 | NPPD | Steele City 115kV |
| GEN-2011-027 | 120 | NPPD | Tap Hoskins - Twin Church (Dixon County) 230kV |
| GEN-2011-056 | 3.6 | NPPD | Jeffrey 115kV |
| GEN-2011-056A | 3.6 | NPPD | John 1 115kV |
| GEN-2011-056B | 4.5 | NPPD | John 2 115kV |
| GEN-2012-021 | 4.8 | LES | Terry Bundy Generating Station 115kV |
| GEN-2013-002 | 50.6 | LES | Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2 |
| GEN-2013-008 | 1.2 | NPPD | Steele City 115kV |
| GEN-2013-019 | 73.6 | LES | Tap Sheldon - Folsom & Pleasant Hill (GEN-2013-002 Tap) 115kV CKT 2 |
| GEN-2013-032 | 202.5 | NPPD | Antelope 115kV |
| GEN-2014-004 | 4 | NPPD | Steele City 115kV (GEN-2011-018 POI) |
| GEN-2014-013 | 73.4 | NPPD | Meadow Grove (GEN-2008-086N2 Sub) 230kV |
| GEN-2014-031 | 35.8 | NPPD | Meadow Grove 230kV |

| | | | |
|---|---|---|---|
| GEN-2014-032 | 10.2 | NPPD | Meadow Grove 230kV |
| GEN-2014-039 | 73.4 | NPPD | Friend 115kV |
| GEN-2015-007 | 160 | NPPD | Hoskins 345kV |
| GEN-2015-023 | 300.7 | NPPD | Holt County 345kV |
| NPPD Distributed (Broken Bow) | 8.3 | NPPD | Broken Bow 115kV |
| NPPD Distributed (Buffalo County Solar) | 10 | NPPD | Kearney Northeast |
| NPPD Distributed (Burt County Wind) | 12 | NPPD | Tekamah & Oakland 115kV |
| NPPD Distributed (Burwell) | 3 | NPPD | Ord 115kV |
| NPPD Distributed (Columbus Hydro) | 45 | NPPD | Columbus 115kV |
| NPPD Distributed (North Platte Lexington) | 54 | NPPD | Multiple: Jeffrey 115kV, John_1 115kV, John_2 115kV |
| NPPD Distributed (Ord) | 11.9 | NPPD | Ord 115kV |
| NPPD Distributed (Stuart) | 2.1 | NPPD | Ainsworth 115kV |
| **PRIOR QUEUED SUBTOTAL** | **2,921.95** | | |
| GEN-2015-076 | 158.4 | NPPD | Belden 115kV |
| GEN-2015-087 | 66 | NPPD | Tap Fairbury - Hebron 115kV |
| GEN-2015-088 | 300 | NPPD | Tap Moore - Pauline 345kV |
| **CURRENT CLUSTER SUBTOTAL** | **524.40** | | |
| **AREA TOTAL** | **3,446.35** | | |

## GROUP 10: SOUTHEAST OKLAHOMA/NORTHEAST TEXAS AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| AREA TOTAL | 0.00 | | |

## GROUP 12: NORTHWEST ARKANSAS AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| GEN-2013-011 | 30 | AEPW | Turk 138kV |
| PRIOR QUEUED SUBTOTAL | 30.00 | | |
| AREA TOTAL | 30.00 | | |

## GROUP 13: NORTHWEST MISSOURI AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| ASGI-2016-003 | 6 | KCPL | Paola 161kV |
| ASGI-2017-006 | 238 | AECI | Maryville 161 kV |
| ASGI-2018-001 | 230 | AECI | Maryville 161 kV |
| ASGI-2018-007 | | | Salisbury 161 kV |
| ASGI-2018-008 | | | Centerville 161 kV |
| ASGI-2018-009 | | | Paola 161kV |
| ASGI-2018-010 | | | Pleasant Valley 161kV |
| ASGI-2018-011 | | | South Ottawa 161kV |
| ASGI-2018-012 | | | South Ottawa 161kV |
| GEN-2008-129 | 80 | KCPL | Pleasant Hill 161kV |
| GEN-2010-036 | 4.6 | WERE | 6th Street 115kV |
| GEN-2011-011 | 50 | KCPL | Iatan 345kV |
| GEN-2014-021 | 300 | KCPL | Tap Nebraska City - Mullin Creek (Holt) 345kV |
| GEN-2015-005 | 200.1 | KCPL | Tap Nebraska City - Sibley (Ketchem) 345kV |
| PRIOR QUEUED SUBTOTAL | 1,108.70 | | |
| AREA TOTAL | 1,108.70 | | |

## GROUP 14: SOUTH CENTRAL OKLAHOMA AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| ASGI-2016-011 | 7.407 | SWPA | Allen 138 kV |
| ASGI-2016-012 | 61.725 | SWPA | Tupelo 138 kV |
| ASGI-2016-013 | 4.938 | WFEC | Ashland 138 kV |
| GEN-2011-040 | 111 | OKGE | Carter County 138kV |
| GEN-2011-050 | 108 | AEPW | Santa Fe Tap 138kV |
| GEN-2012-004 | 41.4 | OKGE | Carter County 138kV |
| GEN-2013-007 | 100 | OKGE | Tap Prices Falls - Carter 138kV |
| GEN-2014-057 | 249.9 | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV |
| PRIOR QUEUED SUBTOTAL | 684.37 | | |
| ASGI-2015-006 | 9 | SWPA | Tupelo 138kV |
| GEN-2015-045 | 20 | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV |
| GEN-2015-092 | 250 | AEPW | Tap Lawton - Sunnyside (Terry Road) 345kV |
| CURRENT CLUSTER SUBTOTAL | 279.00 | | |
| AREA TOTAL | 963.37 | | |

| GROUP 15: E-SOUTH DAKOTA AREA | | | |
|---|---|---|---|
| Request | Capacity | Area | Proposed Point of Interconnection |
| ASGI-2016-005 | 20 | WAPA | Tap White Lake - Stickeny 69kV |
| ASGI-2016-006 | 20 | WAPA | Mitchall |
| ASGI-2016-007 | 20 | WAPA | Kimball 69kV |
| GEN-2002-009IS | 40 | WAPA | Ft Thompson 69kV [Hyde 69kV] |
| GEN-2007-013IS | 50 | WAPA | Wessington Springs 230kV |
| GEN-2007-014IS | 100 | WAPA | Wessington Springs 230kV |
| GEN-2009-001IS | 200 | WAPA | Groton-Watertown 345kV |
| GEN-2009-018IS | 99.5 | WAPA | Groton 115kV |
| GEN-2010-001IS | 99 | WAPA | Bismarck-Glenham 230kV |
| GEN-2010-003IS | 34 | WAPA | Wessington Springs 230kV |
| GEN-2013-009IS | 19.5 | WAPA | Redfield NW 115kV |
| GEN-2014-001IS | 103.7 | WAPA | Newell-Maurine 115kV |
| PRIOR QUEUED SUBTOTAL | 805.70 | | |
| AREA TOTAL | 805.70 | | |

| GROUP 16: W-NORTH DAKOTA AREA | | | |
|---|---|---|---|
| Request | Capacity | Area | Proposed Point of Interconnection |
| GEN-2005-008IS | 50 | WAPA | Hilken 230kV [Ecklund 230kV] |
| GEN-2006-015IS | 50 | WAPA | Hilken 230kV [Ecklund 230kV] |
| GEN-2007-015IS | 100 | WAPA | Hilken 230kV [Ecklund 230kV] |
| GEN-2009-026IS | 110 | WAPA | Dickenson-Heskett 230kV |
| GEN-2012-012IS | 75 | WAPA | Wolf Point-Circle 115kV |
| GEN-2014-006IS | 125 | WAPA | Williston 115kV |
| GEN-2014-010IS | 150 | WAPA | Neset 115kV |
| GEN-2014-014IS | 151.5 | WAPA | Belfield-Rhame 230kV |
| MPC01300 | 455 | OTP | Square Butte 230 kV |
| MPC02100 | 100 | OTP | Center - Mandan 230 kV |
| PRIOR QUEUED SUBTOTAL | 1,366.50 | | |
| GEN-2015-046 | 300 | WAPA | Tande 345kV |
| GEN-2015-096 | 149 | WAPA | Tap Belfied - Rhame 230kV |
| GEN-2015-098 | 100 | WAPA | Mingusville 230kV |
| CURRENT CLUSTER SUBTOTAL | 549.00 | | |
| AREA TOTAL | 0.00 | | |

## GROUP 17: W-SOUTH DAKOTA AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| GEN-2006-002IS | 51 | WAPA | Wessington Springs 230kV |
| GEN-2009-020AIS | 130.5 | WAPA | Tripp Junction 115kV |
| PRIOR QUEUED SUBTOTAL | 181.50 | | |
| AREA TOTAL | 0.00 | | |

## GROUP 18: E-NORTH DAKOTA AREA

| Request | Capacity | Area | Proposed Point of Interconnection |
|---|---|---|---|
| GEN-2002-008IS | 40.5 | WAPA | Edgeley 115kV [Pomona 115kV] |
| GEN-2005-003IS | 100 | WAPA | Nelson 115kV |
| GEN-2006-006IS | 10 | XEL | Marshall 115kV |
| GEN-2007-020IS | 16 | WAPA | Nelson 115kV |
| GEN-2008-008IS | 5 | WAPA | Nelson 115kV |
| MPC00100 | 99 | OTP | Langdon 115 kV |
| MPC00200 | 60 | OTP | Langdon 115 kV |
| MPC00300 | 40.5 | OTP | Langdon 115 kV |
| MPC00500 | 378.8 | OTP | Maple River 230 kV |
| MPC01200 | 49.6 | OTP | Maple River 230 kV |
| PRIOR QUEUED SUBTOTAL | 799.40 | | |
| AREA TOTAL | 0.00 | | |

| | | |
|---|---|---|
| CLUSTER TOTAL (CURRENT STUDY) | 4,814.6 | MW |
| PQ TOTAL (PRIOR QUEUED) | 30,770.1 | MW |
| CLUSTER TOTAL (INCLUDING PRIOR QUEUED) | 35,584.7 | MW |

## *D: PROPOSED POINT OF INTERCONNECTION ONE-LINE DIAGRAMS*

Link to 2015 Facility Study Reports: http://opsportal.spp.org/Studies/GenList?yearTypeId=135

| **GEN-2015-020** |
|---|

See Posted Interconnection Facilties Study for GEN-2015-020

| **GEN-2015-055** |
|---|

See Posted Interconnection Facilties Study for GEN-2015-055

| **GEN-2015-056** |
|---|

See Posted Interconnection Facilties Study for GEN-2015-056

| **GEN-2015-071** |
|---|

See Posted Interconnection Facilites Study for GEN-2015-071

## *E: COST ALLOCATION PER REQUEST*

# Appendix E. Cost Allocation Per Request

**(Including Previously Allocated Network Upgrades*)**

| Interconnection Request and Upgrades | Upgrade Type | Allocated Cost | Upgrade Cost |
|---|---|---|---|
| **GEN-2015-020** | | | |
| Border Capacitive Reactive Power Support (OKGE)<br>Install +100Mvar Capacitor Bank(s) at Border 345kV | Current Study | $1,158,326 | $2,369,160 |
| Deaf Smith - Plant X 230kV CKT 1 (SPS)<br>Fix ~70 structures and two wavetraps at Plant X and Deaf Smith to achieve 953 amps (380 MVA) minimum | Current Study | $1,973,148 | $4,500,000 |
| Deaf Smith Capacitive Reactive Power Support (SPS)<br>Install +60Mvar Capacitor Bank(s) at Deaf Smith 230kV | Current Study | $736,620 | $1,679,950 |
| GEN-2015-020 Interconnection Costs<br>See One-Line Diagram. | Current Study | $9,288,597 | $9,288,597 |
| Newhart - Plant X 230kV CKT 1 (SPS)<br>Fix ~14 structures to achieve 1035 amps (413 MVA) minimum | Current Study | $336,240 | $700,000 |
| Oklaunion Capacitive Reactive Power Support (AEPW)<br>Install +100Mvar Capacitor Bank(s) at Oklaunion 345kV | Current Study | $1,162,480 | $2,369,160 |
| | **Current Study Total** | $14,655,412 | |
| **GEN-2015-055** | | | |
| GEN-2015-055 Interconnection Costs<br>See One-Line Diagram. | Current Study | $2,300,000 | $2,300,000 |
| Grapevine - Wheeler (SPS) - Sweetwater (AEPW) 230kV CKT 1<br>Replace wavetrap at Grapevine to achieve 814 amps (324 MVA), rebuild ~5 miles of 230kV and replace terminal equipment to achieve 1150 amps (458 MVA) minimum | Current Study | $1,101,392 | $8,800,000 |
| | **Current Study Total** | $3,401,392 | |
| **GEN-2015-056** | | | |
| Border Capacitive Reactive Power Support (OKGE)<br>Install +100Mvar Capacitor Bank(s) at Border 345kV | Current Study | $1,210,834 | $2,369,160 |
| Deaf Smith - Plant X 230kV CKT 1 (SPS)<br>Fix ~70 structures and two wavetraps at Plant X and Deaf Smith to achieve 953 amps (380 MVA) minimum | Current Study | $2,526,852 | $4,500,000 |
| Deaf Smith Capacitive Reactive Power Support (SPS)<br>Install +60Mvar Capacitor Bank(s) at Deaf Smith 230kV | Current Study | $943,330 | $1,679,950 |
| GEN-2015-056 Interconnection Costs<br>See One-Line Diagram. | Current Study | $5,636,099 | $5,636,099 |

* Withdrawal of higher queued projects will cause a restudy and may result in higher costs

| Interconnection Request and Upgrades | Upgrade Type | Allocated Cost | Upgrade Cost |
|---|---|---|---|
| Newhart - Plant X 230kV CKT 1 (SPS)<br>Fix ~14 structures to achieve 1035 amps (413 MVA) minimum | Current Study | $363,760 | $700,000 |
| Oklaunion Capacitive Reactive Power Support (AEPW)<br>Install +100Mvar Capacitor Bank(s) at Oklaunion 345kV | Current Study | $1,206,680 | $2,369,160 |
| | **Current Study Total** | $11,887,554 | |
| **GEN-2015-071** | | | |
| GEN-2015-071 Interconnection Costs<br>See One-Line Diagram. | Current Study | $14,623,541 | $14,623,541 |
| Grapevine - Wheeler (SPS) - Sweetwater (AEPW) 230kV CKT 1<br>Replace wavetrap at Grapevine to achieve 814 amps (324 MVA), rebuild ~5 miles of 230kV and replace terminal equipment to achieve 1150 amps (458 MVA) minimum | Current Study | $7,698,608 | $8,800,000 |
| | **Current Study Total** | $22,322,149 | |
| | **TOTAL CURRENT STUDY COSTS:** | **$52,266,507** | |

* Withdrawal of higher queued projects will cause a restudy and may result in higher costs

## *F: COST ALLOCATION PER PROPOSED STUDY NETWORK UPGRADE*

# Appendix F. Cost Allocation by Upgrade

**Border Capacitive Reactive Power Support (OKGE)** **$2,369,160**

Install +100Mvar Capacitor Bank(s) at Border 345kV

| | | |
|---|---|---|
| GEN-2015-020 | | $1,158,326 |
| GEN-2015-056 | | $1,210,834 |
| **Total Allocated Costs** | **$2,369,160** | |

**Deaf Smith - Plant X 230kV CKT 1 (SPS)** **$4,500,000**

Fix ~70 structures and two wavetraps at Plant X and Deaf Smith to achieve 953 amps (380 MVA) minimum

| | | |
|---|---|---|
| GEN-2015-020 | | $1,973,148 |
| GEN-2015-056 | | $2,526,852 |
| **Total Allocated Costs** | **$4,500,000** | |

**Deaf Smith Capacitive Reactive Power Support (SPS)** **$1,679,950**

Install +60Mvar Capacitor Bank(s) at Deaf Smith 230kV

| | | |
|---|---|---|
| GEN-2015-020 | | $736,620 |
| GEN-2015-056 | | $943,330 |
| **Total Allocated Costs** | **$1,679,950** | |

**GEN-2015-020 Interconnection Costs** **$9,288,597**

See One-Line Diagram.

| | | |
|---|---|---|
| GEN-2015-020 | | $9,288,597 |
| **Total Allocated Costs** | **$9,288,597** | |

**GEN-2015-055 Interconnection Costs** **$2,300,000**

See One-Line Diagram.

| | | |
|---|---|---|
| GEN-2015-055 | | $2,300,000 |
| **Total Allocated Costs** | **$2,300,000** | |

* Withdrawal of higher queued projects will cause a restudy and may result in higher costs

| GEN-2015-056 Interconnection Costs | | $5,636,099 |
|---|---|---|
| See One-Line Diagram. | | |
| GEN-2015-056 | $5,636,099 | |
| **Total Allocated Costs** | **$5,636,099** | |

| GEN-2015-071 Interconnection Costs | | $14,623,541 |
|---|---|---|
| See One-Line Diagram. | | |
| GEN-2015-071 | $14,623,541 | |
| **Total Allocated Costs** | **$14,623,541** | |

| Grapevine - Wheeler (SPS) - Sweetwater (AEPW) 230kV CKT 1 | | $8,800,000 |
|---|---|---|
| Replace wavetrap at Grapevine to achieve 814 amps (324 MVA), rebuild ~5 miles of 230kV and replace terminal equipment to achieve 1150 amps (458 MVA) minimum | | |
| GEN-2015-055 | $1,101,392 | |
| GEN-2015-071 | $7,698,608 | |
| **Total Allocated Costs** | **$8,800,000** | |

| Newhart - Plant X 230kV CKT 1 (SPS) | | $700,000 |
|---|---|---|
| Fix ~14 structures to achieve 1035 amps (413 MVA) minimum | | |
| GEN-2015-020 | $336,240 | |
| GEN-2015-056 | $363,760 | |
| **Total Allocated Costs** | **$700,000** | |

| Oklaunion Capacitive Reactive Power Support (AEPW) | | $2,369,160 |
|---|---|---|
| Install +100Mvar Capacitor Bank(s) at Oklaunion 345kV | | |
| GEN-2015-020 | $1,162,480 | |
| GEN-2015-056 | $1,206,680 | |
| **Total Allocated Costs** | **$2,369,160** | |

* Withdrawal of higher queued projects will cause a restudy and may result in higher costs

## G-T: THERMAL POWER FLOW ANALYSIS (CONSTRAINTS REQUIRING TRANSMISSION REINFORCEMENT)

Table is available below and Excel document is attached to this PDF file.

Legend:

| Column | Definition |
|---|---|
| Solution | Solution Method |
| Group | Model Case Identification:<br>• ##ALL: ERIS-HVER<br>• 00: ERIS-LVER<br>• ##NR or 00NR: NRIS |
| Scenario | Upgrade Scenario Identification |
| Season | Model Year and Season |
| Source | Gen ID producing the TDF above the limit for the constraint |
| Monitored Element | Monitored Bus Identification |
| Rate A | Planning Term Normal Rating |
| Rate B | Planning Term Emergency Rating |
| TDF | Transfer Distribution Factor for the Source |
| TC%LOADING | Post-transfer, loading percent for system intact or contingency |
| Contingency | Contingency Description |

| SOLUTION | GROUP | SCENARIO | SEASON | SOURCE | DIRECTION | MONITORED ELEMENT | RATEA (MVA) | RATEB(MVA) | TDF | TC%LOADING (% MVA) | CONTINGENCY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19935 | 121.496 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19935 | 121.496 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.2179 | 120.1073 | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.2179 | 120.1073 | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19937 | 119.0928 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19937 | 119.0928 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21792 | 118.322 | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21792 | 118.322 | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19563 | 110.7299 | 'NEWHART 230 - POTTER COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19563 | 110.7299 | 'NEWHART 230 - POTTER COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19565 | 108.7859 | 'NEWHART 230 - POTTER COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19565 | 108.7859 | 'NEWHART 230 - POTTER COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19849 | 104.8114 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19849 | 104.8114 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19851 | 103.4779 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19851 | 103.4779 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.121 | 101.2957 | System Intact |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.15127 | 101.2957 | System Intact |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.12103 | 99.9 | System Intact |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.15129 | 99.9 | System Intact |
| FDNS | 07ALL | 0 | 26SP | G15_055 | 'TO->FROM' | 'GRAPEVINE INTERCHANGE - STATELINE INTERCHANGE 230KV CKT 1' | 318.69 | 318.69 | 0.19912 | 101.6636 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'GRAPEVINE INTERCHANGE - STATELINE INTERCHANGE 230KV CKT 1' | 318.69 | 318.69 | 0.35978 | 101.6636 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20569 | 131.1164 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20569 | 131.1164 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.22105 | 131.1164 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.22105 | 131.1164 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20573 | 129.3417 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20573 | 129.3417 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.22109 | 129.3417 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.22109 | 129.3417 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23049 | 124.3218 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23049 | 124.3218 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25492 | 124.3218 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25492 | 124.3218 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23051 | 123.0938 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23051 | 123.0938 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25494 | 123.0938 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25494 | 123.0938 | 'DEAF SMITH COUNTY INTERCHANGE - PLANT X STATION 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.2123 | 114.4688 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.2123 | 114.4688 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21284 | 114.4688 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21284 | 114.4688 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21234 | 112.5496 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21234 | 112.5496 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21288 | 112.5496 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21288 | 112.5496 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20725 | 108.8635 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20725 | 108.8635 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21073 | 108.8635 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21073 | 108.8635 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23714 | 108.3197 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23714 | 108.3197 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24552 | 108.3197 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24552 | 108.3197 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20728 | 107.7009 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20728 | 107.7009 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21077 | 107.7009 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 21SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21077 | 107.7009 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20134 | 107.2807 | 'SWISHER COUNTY INTERCHANGE - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20134 | 107.2807 | 'SWISHER COUNTY INTERCHANGE - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20393 | 107.0777 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20393 | 107.0777 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21707 | 107.0777 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21707 | 107.0777 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23717 | 107.0541 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.23717 | 107.0541 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24555 | 107.0541 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24555 | 107.0541 | 'BUSHLAND INTERCHANGE - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24486 | 106.1433 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24486 | 106.1433 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25854 | 106.1433 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25854 | 106.1433 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20136 | 105.6466 | 'SWISHER COUNTY INTERCHANGE - TUCO INTERCHANGE 230KV CKT 1' |

| SOLUTION | GROUP | SCENARIO | SEASON | SOURCE | DIRECTION | MONITORED ELEMENT | RATEA (MVA) | RATEB(MVA) | TDF | TC%LOADING (% MVA) | CONTINGENCY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20136 | 105.6466 | 'SWISHER COUNTY INTERCHANGE - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19969 | 105.4563 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21279 | 105.4563 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24489 | 105.1347 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.24489 | 105.1347 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25857 | 105.1347 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.25857 | 105.1347 | 'TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20395 | 104.8501 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.20395 | 104.8501 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21709 | 104.8501 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21709 | 104.8501 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19971 | 103.5355 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21281 | 103.5355 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19969 | 102.3351 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19969 | 102.3351 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21279 | 102.3351 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21279 | 102.3351 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19971 | 100.37 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_020 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.19971 | 100.37 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21281 | 100.37 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 2 | 18SP | G15_056 | 'TO->FROM' | 'NEWHART 230 - PLANT X STATION 230KV CKT 1' | 318.69 | 318.69 | 0.21281 | 100.37 | 'BORDER 7345.00 - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_055 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.23845 | 120.0909 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.43212 | 120.0909 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.21382 | 110.7018 | 'CIMARRON - MINCO 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_055 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.1297 | 110.6855 | System Intact |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.1826 | 110.6855 | System Intact |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.21382 | 107.6569 | 'GRACEMONT - MINCO 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.24439 | 105.6143 | 'CHISHOLM6 230.00 - ELK CITY 230KV 230KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.24439 | 105.5934 | 'ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STATELINE INTERCHANGE - STLN-DEMARC6 230KV CKT 1' | 348.58 | 381.24 | 0.24439 | 105.5934 | 'ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_055 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.23845 | 115.9076 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.43212 | 115.9076 | 'CHISHOLM7 345.00 - GRACEMONT 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_055 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.1297 | 110.5522 | System Intact |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.1826 | 110.5522 | System Intact |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.21382 | 106.8455 | 'CIMARRON - MINCO 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.21382 | 103.9067 | 'GRACEMONT - MINCO 345KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.24439 | 101.9352 | 'CHISHOLM6 230.00 - ELK CITY 230KV 230KV CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.24439 | 101.915 | 'ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1' |
| FDNS | 07ALL | 0 | 26SP | G15_071 | 'TO->FROM' | 'STLN-DEMARC6 - SWEETWATER 230KV CKT 1' | 349 | 395 | 0.24439 | 101.915 | 'ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1' |

## *G-V: VOLTAGE POWER FLOW ANALYSIS (CONSTRAINTS REQUIRING TRANSMISSION REINFORCEMENT)*

Table is available below and Excel document is attached to this PDF file.

Legend:

| **Column** | **Definition** |
|---|---|
| Solution | Solution Method |
| Group | Model Case Identification:<br>• ##ALL: ERIS-HVER<br>• 00: ERIS-LVER<br>• ##NR or 00NR: NRIS |
| Scenario | Upgrade Scenario Identification |
| Season | Model Year and Season |
| Source | Gen ID producing the TDF above the limit for the constraint |
| Monitored Element | Monitored Bus Identification |
| BC Voltage (pu) | Pre-transfer, post-contingency voltage |
| TC Voltage (pu) | Post-transfer, post-contingency voltage |
| Voltage Differ (pu) | TC Voltage - BC Voltage |
| VINIT (pu) | Post-transfer, pre-contingency (system intact) voltage |
| VMIN (pu) | Lower Voltage Limit |
| VMAX (pu) | Upper Voltage Limit |
| TDF | Transfer Distribution Factor for the Source |
| Contingency | Contingency Description |

| SOLUTION | GROUP | SCENARIO | SEASON | SOURCE | MONITORED ELEMENT | BC Voltage (PU) | TC Voltage (PU) | Voltage Differ (PU) | VINIT (PU) | VMIN (PU) | VMAX(PU) | TDF | CONTINGENCY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'BORDER 7345.00 345KV' | 0.885631 | 0.838006 | 0.0476248 | 0.9576 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'BORDER 7345.00 345KV' | 0.885631 | 0.838006 | 0.0476248 | 0.9576 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'BUSHLAND INTERCHANGE 230KV' | 0.961309 | 0.897887 | 0.0634218 | 0.98019 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'BUSHLAND INTERCHANGE 230KV' | 0.961309 | 0.897887 | 0.0634218 | 0.98019 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'CHAN+TASCOS6230.00 230KV' | 0.954326 | 0.884732 | 0.0695935 | 0.96951 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'CHAN+TASCOS6230.00 230KV' | 0.954326 | 0.884732 | 0.0695935 | 0.96951 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'DEAF SMITH COUNTY INTERCHANGE 230KV' | 0.912063 | 0.864164 | 0.0478998 | 0.935 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'DEAF SMITH COUNTY INTERCHANGE 230KV' | 0.912063 | 0.864164 | 0.0478998 | 0.935 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'DEAF SMITH COUNTY INTERCHANGE 230KV' | 0.916221 | 0.891818 | 0.0244029 | 0.935 | 0.9 | 1.05 | 0.2012 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'DEAF SMITH COUNTY INTERCHANGE 230KV' | 0.916221 | 0.891818 | 0.0244029 | 0.935 | 0.9 | 1.05 | 0.1924 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'G1149G1504 345.00 345KV' | 0.885631 | 0.838006 | 0.0476248 | 0.9576 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'G1149G1504 345.00 345KV' | 0.885631 | 0.838006 | 0.0476248 | 0.9576 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'NEWHART 230 230KV' | 0.940368 | 0.890638 | 0.0497301 | 0.9653 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'NEWHART 230 230KV' | 0.940368 | 0.890638 | 0.0497301 | 0.9653 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'OKLAUN HVDC7345.00 345KV' | 0.885217 | 0.857986 | 0.0272313 | 0.952 | 0.9 | 1.05 | 0.2012 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'OKLAUN HVDC7345.00 345KV' | 0.885217 | 0.857986 | 0.0272313 | 0.952 | 0.9 | 1.05 | 0.1924 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'OKLAUN HVDC7345.00 345KV' | 0.885217 | 0.857986 | 0.0272313 | 0.952 | 0.92 | 1.05 | 0.2012 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'OKLAUN HVDC7345.00 345KV' | 0.885217 | 0.857986 | 0.0272313 | 0.952 | 0.92 | 1.05 | 0.1924 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'OKLAUNION 345KV' | 0.885145 | 0.857916 | 0.0272291 | 0.95193 | 0.9 | 1.05 | 0.2012 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'OKLAUNION 345KV' | 0.885145 | 0.857916 | 0.0272291 | 0.95193 | 0.9 | 1.05 | 0.1924 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'OKLAUNION 345KV' | 0.885145 | 0.857916 | 0.0272291 | 0.95193 | 0.92 | 1.05 | 0.2012 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'OKLAUNION 345KV' | 0.885145 | 0.857916 | 0.0272291 | 0.95193 | 0.92 | 1.05 | 0.1924 | 'BORDER 7345.00 - WOODWARD DISTRICT EHV 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'SHAMROCK 115KV' | 0.942532 | 0.908806 | 0.0337264 | 0.98089 | 0.92 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'SHAMROCK 115KV' | 0.942532 | 0.908806 | 0.0337264 | 0.98089 | 0.92 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'SHAMROCK 69KV' | 0.921362 | 0.891455 | 0.0299069 | 0.95548 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'SHAMROCK 69KV' | 0.921362 | 0.891455 | 0.0299069 | 0.95548 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'SHAMROCK 69KV' | 0.921362 | 0.891455 | 0.0299069 | 0.95548 | 0.92 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'SHAMROCK 69KV' | 0.921362 | 0.891455 | 0.0299069 | 0.95548 | 0.92 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'SWISHER COUNTY INTERCHANGE 230KV' | 0.945663 | 0.899093 | 0.0465707 | 0.97152 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'SWISHER COUNTY INTERCHANGE 230KV' | 0.945663 | 0.899093 | 0.0465707 | 0.97152 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_056 | 'XIT_INTG 6230.00 230KV' | 0.943028 | 0.870756 | 0.0722722 | 0.95879 | 0.9 | 1.05 | 0.25077 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |
| FDNS | 06ALL | 0 | 21SP | G15_020 | 'XIT_INTG 6230.00 230KV' | 0.943028 | 0.870756 | 0.0722722 | 0.95879 | 0.9 | 1.05 | 0.24142 | 'OKLAUNION - TUCO INTERCHANGE 345KV CKT 1' |

## *H-T: THERMAL POWER FLOW ANALYSIS (OTHER CONSTRAINTS NOT REQUIRING TRANSMISSION REINFORCEMENT)*

Available upon request

## *H-T-AS: AFFECTED SYSTEM THERMAL POWER FLOW ANALYSIS (CONSTRAINTS FOR POTENTIAL UPGRADES)*

Available upon request

## *H-V-AS: AFFECTED SYSTEM VOLTAGE POWER FLOW ANALYSIS (CONSTRAINTS FOR POTENTIAL UPGRADES)*

Available upon request

## I: DYNAMIC STABILITY ANALYSIS REPORTS


**Submitted to**

**Southwest Power Pool**

Report On

# Definitive Interconnection System Impact Study DISIS-2015-002 Study Group 6 ReStudy#7

Revision R1

Date of Submittal
February 21, 2019

**anedenconsulting.com**

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## APPENDICES

# Executive Summary

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to complete the reactive power and dynamic stability analyses as part of the Definitive Interconnection System Impact Study DISIS-2015-002 ReStudy #7 (ReStudy#7) for South Texas Panhandle/New Mexico Area, defined as Group 6. The purpose of the analyses was to identify impacts to the transmission system caused by the active interconnection requests in Group 6 and develop mitigation upgrades or measures to resolve any detrimental impacts.

The DISIS-2015-002 Group 6 currently includes two generation interconnection requests shown in Table ES-1 below.

**Table ES-1: DISIS-2015-002-7 Group 6 Interconnection Requests Evaluated**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-020 | 100 | Eaton Power Xpert Solar 1.67MW (solar) | Oasis 115kV (524874) |
| GEN-2015-056 | 101.2 | GE 2.3 MW (wind) | Crossroads 345kV (527656) (Tap Eddy (527802) to Tolk (525549) |

Aneden performed reactive power and dynamic stability analyses using DISIS-2015-002-7 study models developed to reflect the system conditions for the current study generation interconnection requests - 2017 winter peak (2017WP), 2018 summer peak (2018SP) and 2026 summer peak (2026SP). All analyses were performed using the Siemens PTI PSS/E software version 33.7 and the results are summarized below.

The following mitigation upgrades were identified in the steady state analysis performed by SPP:

1. Border 345kV 100MVAR capacitor bank
2. Deaf Smith 230kV 60MVAR capacitor bank
3. Oklaunion 345kV 100MVAR capacitor bank

The mitigation upgrades listed above were included in the subsequent reactive power and dynamic stability analyses presented in this report.

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, performed using all three models showed the following shunt reactor sizes may be needed at each project collector substation high voltage bus:

1. GEN-2015-020 – 0.6 MVAR
2. GEN-2015-056 – 8.6 MVAR

The dynamic stability analysis was performed using the three loading scenarios 2017WP, 2018SP and 2026SP simulating up to 129 fault conditions that included three-phase, single-line-to-ground faults with stuck breakers and three phase faults on prior outage cases.

The dynamic stability analysis was performed without any of the mitigation upgrades listed above in order to identify the potential system criteria violations prior to developing mitigation solutions.

The system was stable during the simulated fault conditions and there were no transient voltage and post-contingency voltage violations in the pre-mitigation cases.

The results of the dynamic stability analysis showed that after implementing the steady state identified upgrades listed above, there was no generation tripping or system instability observed as a result of interconnecting all study projects at 100% for all fault conditions. There were also no machine rotor angle damping or transient voltage recovery violations observed in the simulated (non-prior outage) fault events. Additionally, the Group 6 interconnection requests stayed connected during the (non-prior outage) fault events that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

# 1.0 Introduction

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to complete the reactive power analysis and dynamic stability analysis as part of the Definitive Interconnection System Impact Study DISIS-2015-002 ReStudy #7 (ReStudy#7) for South Texas Panhandle/New Mexico Area, defined as Group 6. The purpose of the analyses was to identify impacts to the transmission system caused by the active interconnection requests in Group 6 and develop mitigation upgrades or measures to resolve any detrimental impacts.

The active DISIS-2015-002 Group 6 projects studied in this ReStudy#7 are listed below in Table 1-1 below.

**Table 1-1: Active DISIS-2015-002 Group 6 Interconnection Requests**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-020 | 100 | Eaton Power Xpert Solar 1.67MW (solar) | Oasis 115kV (524874) |
| GEN-2015-056 | 101.2 | GE 2.3 MW (wind) | Crossroads 345kV (527656) (Tap Eddy (527802) to Tolk (525549) |

## 1.1 Scope

The Study included reactive power and dynamic stability analyses. The methodology, assumptions and results of the analyses are presented in the following four main sections:

1. Study Assumptions and Criteria
2. Reactive Power Analysis
3. Dynamic Stability Analysis
4. Conclusions

## 1.2 Study Limitations

The assessments and conclusions provided in this report are based on assumptions and information provided to Aneden by others. While the assumptions and information provided may be appropriate for the purposes of this report, Aneden does not guarantee that those conditions assumed will occur. In addition, Aneden did not independently verify the accuracy or completeness of the information provided. As such, the conclusions and results presented in this report may vary depending on the extent to which actual future conditions differ from the assumptions made or information used herein.

# 2.0 Study Assumptions and Criteria

The reactive power and dynamic stability analyses were performed using the PTI PSS/E software version 33.7. The main assumptions and criteria applied in the study are summarized in the sections below.

## 2.1 Study System

The study system for the dynamic stability analysis consisted of generators and transmission buses at or above 115 kV within 5 buses of the DISIS-2015-002 Group 6 projects in the monitored areas listed in Table 2-1 below.

**Table 2-1: Monitored Areas**

| Area Number | Name |
|---|---|
| 520 | AEPW |
| 524 | OKGE |
| 525 | WFEC |
| 526 | SPS |
| 531 | MIDW |
| 534 | SUNC |
| 536 | WERE |

## 2.2 Study Models

The reactive power and dynamic stability analyses were completed using the models developed from the 2016 SPP Model Development Working Group (MDWG) PSS/E models. Table 2-2 summarizes the study models used for each analysis.

**Table 2-2: Study Models**

| Case Name | Reactive Power | Dynamic Stability |
|---|---|---|
| 17W_DIS15027_G06 | X | X |
| 18S_DIS15027_G06 | X | X |
| 26S_DIS15027_G06 | X | X |

## 2.3 Group 6 Interconnection Request Configurations

The model configurations for both Group 6 in the study models are shown in Figure 2-1 and Figure 2-2.

**Figure 2-1: GEN-2015-020 Single Line Diagram**

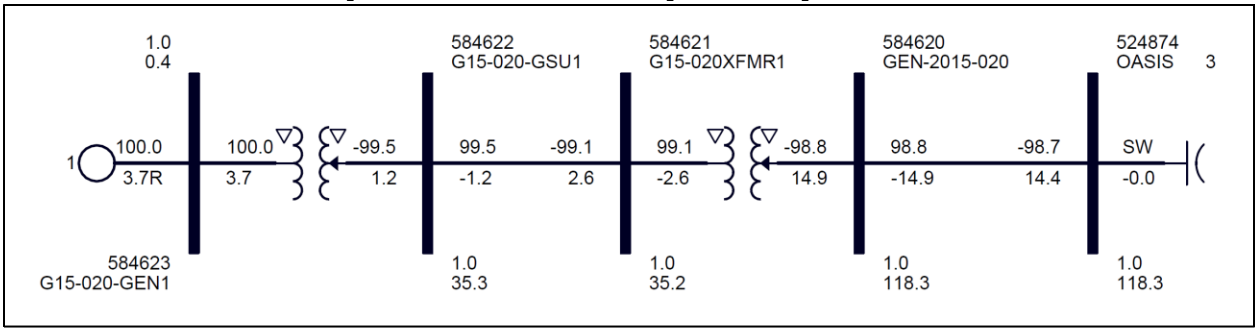
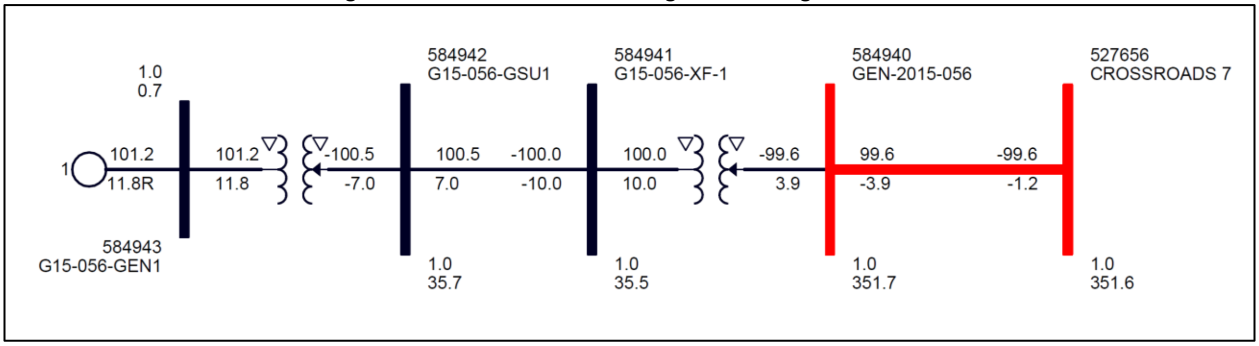


**Figure 2-2: GEN-2015-056 Single Line Diagram**




## 2.4 Dynamic Performance Requirements

The dynamic stability analysis results were assessed according to the following excerpt from SPP's Disturbance Performance Requirements. The complete document is provided in Appendix A.

"Machine Rotor Angles shall exhibit well damped angular oscillations following a disturbance on the Bulk Electric System for all NERC TPL-001-4 P1 through P7 events. Machines with rotor angle deviations greater than or equal to 16 degrees (measured as absolute maximum peak to absolute minimum peak) shall be evaluated against SPPR1 or SPPR5 requirements below. Machines with rotor angle deviations less than 16 degrees which do not exhibit convergence shall be evaluated on an individual basis. Rotor angle deviations will be calculated relative to the system swing machine.

Well damped angular oscillations shall meet one of the following two requirements when calculated directly from the rotor angle:

1. Successive Positive Peak Ratio One (SPPR1) must be less than or equal to 0.95 where

SPPR1 is calculated as follows:

$$\text{SPPR1} = \frac{\text{Peak Rotor Angle of 2nd Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.95$$

-or- Damping Factor % = (1 – SPPR1) x 100% ≥ 5%

The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

Damping Ratio ≥ 0.0081633

2. Successive Positive Peak Ratio Five (SPPR5) must be less than or equal to 0.774 where

SPPR5 is calculated as follows:

$$\text{SPPR5} = \frac{\text{Peak Rotor Angle of 6th Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.774$$

-or- Damping Factor % = (1 – SPPR5) x 100% ≥ 22.6%

The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

Damping Ratio ≥ 0.0081633

Bus voltages on the Bulk Electric System shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared. Bus voltages shall not swing above 1.20 per unit after the fault is cleared, unless affected transmission system elements are designed to handle the rise above 1.2 per unit."

# 3.0 Reactive Power Analysis

The reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, was performed for the Group 6 projects to determine the reactive power contribution from each project's interconnection line and collector transformer and cables during low/no generator output conditions while each project is still connected to the grid and to size shunt reactors that would reduce the project reactive power contribution to the POI to approximately zero. The reactive power analysis was performed using the three DISIS-2015-002-7 Group 6 study models, 2017WP, 2018SP and 2026SP with the additional network upgrades identified in the Stability Analysis presented in Section 4.0.

## 3.1 Methodology and Criteria

Each Group 6 project generator was switched out of service while other collector system elements remained in-service. A shunt reactor was tested at the study project substation high side bus to bring the MVAr flow into the POI down to approximately zero.

## 3.2 Results

The results from the reactive power analysis showed that the Group 6 projects each required varying shunt reactance at the high side of the project substation, to reduce the POI MVAr to zero. This represents the contributions from each project's collector systems. Figure 3-1 and Figure 3-2 illustrate the shunt reactor size required to reduce the MVAr flow into the POI to approximately zero. Reactive compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

**Table 3-1: Shunt Reactors for Low Wind Study**

| Machine | POI Bus Number | POI Bus Name | Reactor Size (MVAr) | | |
|---|---|---|---|---|---|
| | | | 17WP | 18SP | 26SP |
| GEN-2015-020 | 524874 | OASIS 3 | 0.6 | 0.6 | 0.6 |
| GEN-2015-056 | 527656 | CROSSROADS 7 | 8.6 | 8.6 | 8.6 |

**Figure 3-1: GEN-2015-020 Shunt Reactor**

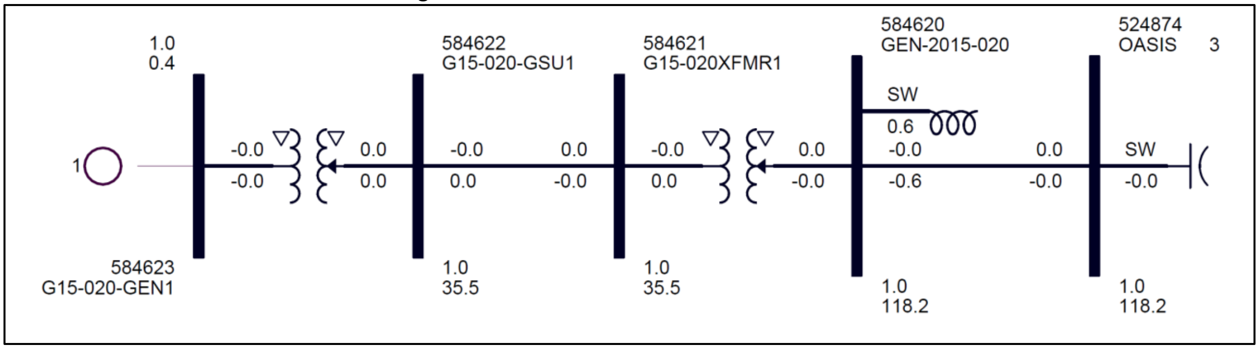
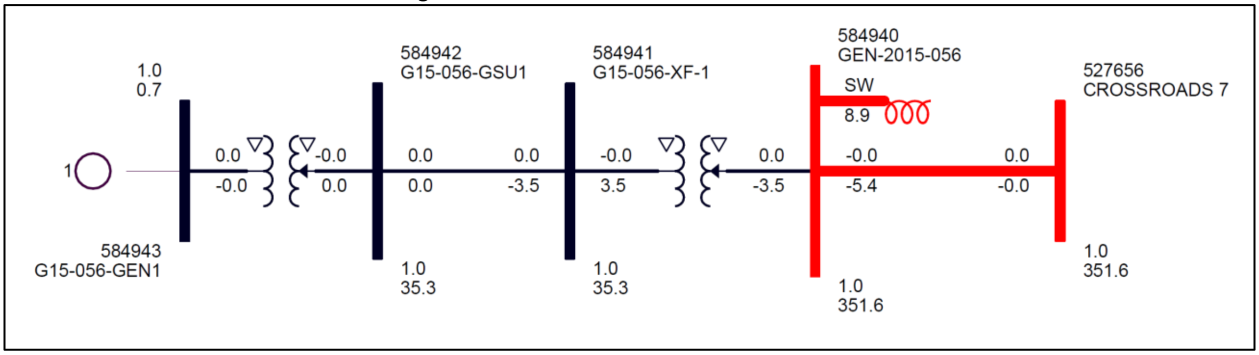


**Figure 3-2: GEN-2015-056 Shunt Reactor**



# 4.0 Dynamic Stability Analysis

Aneden performed a dynamic stability analysis to assess the system performance and identify any system stability issues associated with DISIS-2015-002 ReStudy#7 Group 6 interconnection requests. The analysis was performed according to SPP's Disturbance Performance Requirements. The Group 6 project dynamic modeling data is provided in Appendix B. The simulation plots can be found in Appendix C.

## 4.1 Methodology and Criteria

The dynamic stability analysis was performed using the DISIS-2015-002 (Group 6) study models described in Section 2.2 above. The power flow models and associated dynamics database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the immediate system and the dynamic data. The dynamics model data for the DISIS-2015-002 (Group 6) requests is provided in Appendix B. The stability analysis was performed using PSS/E version 33.7.

During the fault simulations, the active power (PELEC), reactive power (QELEC), terminal voltage (ETERM), and frequency (FREQ) were monitored for the Group 6 generation interconnection requests. The machine rotor angle for synchronous machines and speed for asynchronous machines within five (5) buses away from the POI of each of the Group 6 projects and within the study area including 520 (AEPW), 524 (OKGE), 525 (WFEC), 526 (SPS), 531 (MIDW), 534 (SUNC) and 536 (WERE) were monitored. In addition, the voltages of all 115 kV and above buses within the study area were monitored.

## 4.2 Fault Definitions

Aneden developed one hundred twenty-nine (129) faults including three-phase line faults with reclosing, three-phase transformer faults with normal clearing and single-line-to-ground (SLG) fault with stuck breaker. The single-line-to-ground fault impedance values were determined by applying a fault on the base case large enough to produce a 0.6 pu voltage value on the faulted bus. The fault events are described in Table 4-1 below. These contingencies were applied to the 2017 winter peak, 2018 summer peak, and the 2026 summer peak models.

**Table 4-1: Fault Definitions**

| Fault ID | Fault Description |
|---|---|
| FLT01-3PH | 3 phase fault on Chaves County 115 kV (527482) to Samson 115 kV (527546) CKT 1, near Chaves County.<br>a. Apply fault at the Chaves County 115 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT02-3PH | 3 phase fault on Chaves County 115 kV (527482) to Urton 115 kV (527501) CKT 1, near Chaves County.<br>a. Apply fault at the Chaves County 115 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT03-3PH | 3 phase fault on the Chaves County 115 kV (527482) to Chaves County 230 kV (527483) to Chaves County 13.2 kV (527478) XFMR CKT 1, near Chaves County 115 kV.<br>a. Apply fault at the Chaves County 115 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted transformer. |
| FLT04-3PH | 3 phase fault on Chaves County 230 kV (527483) to San Juan Tap 230 kV (524885) CKT 1, near Chaves County.<br>a. Apply fault at the Chaves County 230 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT05-3PH | 3 phase fault on Chaves County 230 kV (527483) to Eddy North 230 kV (527799) CKT 1, near Chaves County.<br>a. Apply fault at the Chaves County 230 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT06-3PH | 3 phase fault on Samson 115 kV (527546) to Roswellian 115 kV (527564) CKT 1, near Samson.<br>a. Apply fault at the Samson 115 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT07-3PH | 3 phase fault on Urton 115 kV (527501) to Roswell City 115 kV (527522) CKT 1, near Urton.<br>a. Apply fault at the Urton 115 kV bus.<br>b. Clear fault after 5 cycles and trip the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT10-SB | Single phase fault with stuck breaker at Chaves County (527482)<br>a. Apply fault at the Chaves 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Chaves County 115 kV (527482)/ 230 kV (527483)/13.2 kV (527479) transformer<br>d. Chaves County (527482) - Samson (527546) 115 kV |
| FLT11-3PH | 3 phase fault on the FE-Bailey County (525028) to FE-Curry (524822) 115 kV line circuit 1, near FE-Bailey County.<br>a. Apply fault at the FE-Bailey County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT13-3PH | 3 phase fault on the FE-Bailey County 115 kV (525028) to Bailey County 2 69 kV (525027) to Bailey transformer 1 13.2 kV (525025) XFMR CKT 1, near FE-Bailey County 115 kV.<br>a. Apply fault at the FE-Bailey County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT14-3PH | 3 phase fault on the FE-Bailey County (525028) to EMU&VLY Tap (525019) 115 kV line circuit 1, near FE-Bailey County.<br>a. Apply fault at the FE-Bailey County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT15-3PH | 3 phase fault on the FE-Curry (524822) to DS#20 (524669) 115 kV line circuit 1, near FE-Curry.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT16-3PH | 3 phase fault on the FE-Curry (524822) to Norris Tap (524764) 115 kV line circuit 1, near FE-Curry.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT17-3PH | 3 phase fault on the FE-Curry (524822) to E_Clovis (524773) 115 kV line circuit 1, near FE-Curry.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT18-3PH | 3 phase fault on the FE-Curry (524822) to FE_Clovis2 (524838) 115 kV line circuit 1, near FE-Curry.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT19-3PH | 3 phase fault on the FE-Curry (524822) to Roosevelt (524908) 115 kV line circuit 2, near FE-Curry.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT20-3PH | 3 phase fault on the FE-Curry 115 kV (524822) to Curry 69 kV (524821) to Curry 13.2 kV (524819) XFMR CKT 1, near FE-Curry 115 kV.<br>a. Apply fault at the FE-Curry 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT21-3PH | 3 phase fault on the Oasis (524874) to Perimeter (524797) 115 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT22-3PH | 3 phase fault on the Oasis (524874) to FE-Chzplt (524863) 115 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT23-3PH | 3 phase fault on the FE-Chzplt (524863) to Norris Tap (524764) 115 kV line circuit 1, near FE-Chzplt.<br>a. Apply fault at the FE-Chzplt 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT24-3PH | 3 phase fault on the Perimeter (524797) to Cannon Top (524790)115 kV line circuit 1, near Perimeter.<br>a. Apply fault at the Perimeter 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT25-3PH | 3 phase fault on the Oasis (524874) to Portales (524924) 115 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT26-3PH | 3 phase fault on the Portales (524924) to Roosevelt (524908) 115 kV line circuit 1, near Oasis.<br>a. Apply fault at the Portales 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT27-3PH | 3 phase fault on the Portales 115 kV (524924) to Portales 69 kV (524923) to Portales 13.2 kV (524921) XFMR CKT 1, near Portales 115 kV.<br>a. Apply fault at the Portales 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT28-3PH | 3 phase fault on the Oasis 115 kV (524874) to Oasis 230 kV (524875) to Oasis 13.2 kV (524872) XFMR CKT 1, near Oasis 115 kV.<br>a. Apply fault at the Oasis 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT29-3PH | 3 phase fault on the Oasis (524875) to San Juan Tap (524885) 230 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT30-3PH | 3 phase fault on the Oasis (524875) to SW_4k33 (524915) 230 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT31-3PH | 3 phase fault on the Oasis (524875) to Pleasant Hill (524770) 230 kV line circuit 1, near Oasis.<br>a. Apply fault at the Oasis 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT34-3PH | 3 phase fault on the Swisher (525213) to Amarillo South (524415) 230 kV line circuit 1, near Swisher.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT35-3PH | 3 phase fault on the Amarillo South (524415) to Swisher (525213) 230 kV line circuit 1, near Amarillo South.<br>a. Apply fault at the Amarillo South 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT36-3PH | 3 phase fault on the Swisher 230 kV (525213) to Swisher 115 kV (525212) to Swisher 13.2 kV (525211) XFMR CKT 1, near Swisher 230 kV.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT37-3PH | 3 phase fault on the Swisher (525213) to Tuco Int (525830) 230 kV line circuit 1, near Swisher.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT38-3PH | 3 phase fault on the Swisher (525213) to Newhart (525461) 230 kV line circuit 1, near Swisher.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT39-3PH | 3 phase fault on the Amarillo South 230 kV (524415) to Amarillo South 115 kV (524414) to Amarillo South 13.2 kV (524410) XFMR CKT 1, near Amarillo South 230 kV.<br>a. Apply fault at the Amarillo 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT40-3PH | 3 phase fault on the Amarillo South (524415) to Nichols (524044) 230 kV line circuit 1, near Amarillo South.<br>a. Apply fault at the Amarillo South 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT41-3PH | 3 phase fault on the Amarillo South (524415) to Randal (524365) 230 kV line circuit 1, near Amarillo South.<br>a. Apply fault at the Amarillo South 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT42-SB | Single phase fault with stuck breaker at Swisher (525213)<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Swisher 230 kV (525213)/ 115 kV (525212)/13.2 kV (525211) transformer<br>d. Swisher (525213) – Crawfish Draw (560021 230 kV |
| FLT43-3PH | 3 phase fault on the Tuco Int (525832) to OKU (511456) 345 kV line circuit 1, near Tuco Int.<br>a. Apply fault at the Tuco Int 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 30 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT45-3PH | 3 phase fault on the Tuco Int (525832) to Border (515458) 345 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT46-3PH | 3 phase fault on the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525824) XFMR CKT 1, near Tuco 345 kV bus.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the transformer |
| FLT48-3PH | 3 phase fault on the OKU (511456) to Oklaun (599891) 345 kV line circuit 1, near OKU.<br>a. Apply fault at the OKU 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line and remove the fault.<br>c. Block the DC tie at OKU. |
| FLT49-3PH | 3 phase fault on the OKU (511456) to L.E.S (511468) 345 kV line circuit 1, near OKU.<br>a. Apply fault at the OKU 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line, block the HVDC.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT52-3PH | 3 phase fault on the Plant X (525481) to Deaf Smith (524623) 230 kV line circuit 1, near Plant X.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT54-3PH | 3 phase fault on the Deaf Smith (524623) to Bushland (524267) 230 kV line circuit 1, near Deaf Smith.<br>a. Apply fault at the Deaf Smith 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT55-3PH | 3 phase faults on the Deaf Smith 230 kV (524623) to Deaf Smith 115 kV (524622) to Deaf Smith 13.2 kV (524620) XFMR CKT 1, near Deaf Smith 230 kV.<br>a. Apply fault at the Deaf Smith 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT56-3PH | 3 phase fault on the Plant X (525481) to Tolk East (525524) 230 kV line circuit 2, near Plant X.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT57-3PH | 3 phase fault on the Plant X (525481) to Newhart (525461) 230 kV line circuit 1, near Plant X.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT58-3PH | 3 phase fault on the Plant X (525481) to Tolk West (525531) 230 kV line circuit 1, near Plant X.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.. |
| FLT59-3PH | 3 phase fault on the Plant X (525481) to Sundown (526435) 230 kV line circuit 1, near Plant X.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT60-3PH | 3 phase fault on the Plant X 230 kV (525481) to Plant X 115 kV (525480) to Plant X 13.2 kV (525479) XFMR CKT 1, near Plant X 230 kV.<br>a. Apply fault at the Plant X 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT61-SB | Single phase fault with stuck breaker on the Tolk West (525531) to Plant X (525481) 230 kV circuit #1 line, near Tolk West.<br>a. Apply fault at the Tolk West 230 kV bus.<br>b. Run 5 cycles, and then open Plant X end of the faulted line.<br>c. Run 10 cycles, and then clear the fault and disconnect Tolk West 230 kV bus (525531). |
| FLT62-SB | Single phase fault with stuck breaker on the Tolk East (525524) to Plant X (525481) 230 kV line circuit #2, near Tolk East.<br>a. Apply fault at the Tolk East 230 kV bus.<br>b. Run 5 cycles, and then open Plant X end of the faulted line.<br>c. Run 10 cycles, and then clear the fault and disconnect Tolk East 230 kV bus (525524). |
| FLT63-3PH | 3 phase fault on the Mustang (527149) to Amocowasson (526784) 230 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT64-3PH | 3 phase fault on the Mustang 230 kV (527149) to Mustang 115 kV (527146) to Mustang 13.2 kV (527143) XFMR CKT 1, near Mustang 230 kV.<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT65-3PH | 3 phase fault on the Mustang (527149) to Yoakum (526935) 230 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT66-3PH | 3 phase fault on the Mustang (527149) to Seminole (527276) 230 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT67-3PH | 3 phase fault on the Seminole 230 kV (527276) to Seminole 115 kV (527275) to Seminole 13.2 kV (527273) XFMR CKT 1, near Seminole 230 kV.<br>a. Apply fault at the Seminole 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT68-3PH | 3 phase fault on the Amocowasson (526784) to BRU_SUB 6 (527009) 230 kV line circuit 1, near Amocowasson.<br>a. Apply fault at the Amocowasson 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT69-3PH | 3 phase fault on the Yoakum (526935) to G13-027-TAP (562480) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT70-3PH | 3 phase fault on the Yoakum 230 kV (526935) to Yoakum 115 kV (526934) to Yoakum 13.2 kV (526932) XFMR CKT 2, near Yoakum 230 kV.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT71-3PH | 3 phase fault on the Mustang (527146) to Denver North (527130) 115 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT72-3PH | 3 phase fault on the Mustang (527146) to Seagraves (527202) 115 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT73-3PH | 3 phase fault on the Mustang (527146) to Denver South (527136) 115 kV line circuit 2, near Mustang.<br>a. Apply fault at the Mustang 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT74-3PH | 3 phase fault on the Mustang (527146) to Shell Co (527062) 115 kV line circuit 1, near Mustang.<br>a. Apply fault at the Mustang 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT75-3PH | 3 phase fault on the Yoakum (526935) to Amoco-SS (526460) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT76-3PH | 3 phase fault on the Yoakum (526935) to BRU_SUB 6 (527009) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT77-3PH | 3 phase fault on the Yoakum (526935) to GEN-2015-079 Tap (560059) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT78-SB | Single phase fault with stuck breaker at Mustang (527149)<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Mustang 230 kV (527149) /115 kV (527146)/13.2 kV (527143) transformer<br>d. Mustang (527149) - Amocowasson (526784) 230 kV |
| FLT79-SB | Single phase fault with stuck breaker on the Tolk West (525531) to GEN-2013-027 (562480) 230 kV line, near Tolk West.<br>a. Apply fault at the Tolk West 230 kV bus.<br>b. Run 5 cycles, and then open GEN-2013-027 end of the faulted line.<br>c. Run 10 cycles, and then clear the fault and disconnect Tolk West 230 kV bus (525531). |
| FLT80-SB | Single phase fault with stuck breaker on the Yoakum (526935) to GEN-2013-027 (562480) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Run 5 cycles, and then open GEN-2013-027 end of the faulted line.<br>c. Run 10 cycles, and then clear the fault and open Yoakum end of the line in (b) and trip Yoakum (526935) to Yoakum 115 (526934)/13.2 kV (526931) transformer circuit #1. |
| FLT81-SB | Single phase fault with stuck breaker on the Yoakum (526935) to Amoco-SS (526460) 230 kV line, near Yoakum.<br>a. Apply fault at the Yoakum 230 kV bus.<br>b. Run 5 cycles, and then open Amoco-SS end of the faulted line.<br>c. Run 10 cycles, and then clear the fault and trip Yoakum 230 kV (526935) bus. |
| FLT84-3PH | 3 phase fault on the Woodward (515375) to Border (515458) 345 kV line circuit 1, near Woodward.<br>a. Apply fault at the Woodward 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT85-3PH | 3 phase fault on the Tuco (525830) to Carlisle (526161) 230 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT86-3PH | 3 phase fault on the Tuco (525830) to Tolk East (525524) 230 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT87-3PH | 3 phase fault on the Tuco (525830) to Jones (526337) 230 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT88-3PH | 3 phase fault on the Tuco 230 kV (525830) to Tuco 115 kV (525828) to Tuco 13.2 kV (525819) XFMR CKT 2, near Tuco 230 kV.<br>a. Apply fault at the Tuco 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT91-SB | Single phase fault with stuck breaker at Tuco (525832)<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Tuco 345 kV (525832) /230 kV (525830) /13.2 kV (525824) transformer<br>d. Tuco (525832) -- OKU (511456) 345 kV |
| FLT92-3PH | 3 phase fault on the Crossroads (527656) to Tolk (525549) 345 kV line circuit 1, near Crossroads.<br>a. Apply fault at the Crossroads 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT93-3PH | 3 phase fault on the Crossroads (527656) to Eddy County (527802) 345 kV line circuit 1, near Crossroads.<br>a. Apply fault at the Crossroads 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT94-3PH | 3 phase fault on the Tolk 345 kV (525549) to Tolk Tap 230 kV (525543) to Tolk 13.2 kV (525537) XFMR CKT 1, near Tolk 345 kV.<br>a. Apply fault at the Tolk 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer |
| FLT95-3PH | 3 phase fault on the Eddy County 345 kV (527802) to Eddy North 230 kV (527799) to Eddy 13.2 kV (527796) XFMR CKT 1, near Eddy County 345 kV.<br>a. Apply fault at the Eddy County 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer |
| FLT96-3PH | 3 phase fault on the Atoka (527786) to CV-Dayton (527821) 115 kV line circuit 1, near Atoka.<br>a. Apply fault at the Atoka 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT97-3PH | 3 phase fault on the Atoka (527786) to CV-Irishhill (528116) 115 kV line circuit 1, near Atoka.<br>a. Apply fault at the Atoka 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT98-3PH | 3 phase fault on the Atoka (527786) to Eagle Creek (527711) 115 kV line circuit 1, near Atoka.<br>a. Apply fault at the Atoka 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT99-3PH | 3 phase fault on the CV-Dayton (527821) to Eddy South (527793) 115 kV line circuit 1, near CV-Dayton.<br>a. Apply fault at the CV-Dayton 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT100-3PH | 3 phase fault on the CV-Irishhill (528116) to CV-Lakewood (528109) 115 kV line circuit 1, near CV-Irishhill.<br>a. Apply fault at the CV-Irishhill 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT101-3PH | 3 phase fault on the Eagle Creek (527711) to Seven Rivers (528094) 115 kV line circuit 1, near Eagle Creek.<br>a. Apply fault at the Eagle Creek 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT102-3PH | 3 phase fault on the Eagle Creek (527711) to Eddy North (527798) 115 kV line circuit 1, near Eagle Creek.<br>a. Apply fault at the Eagle Creek 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT105-3PH | 3 phase fault on the Carlisle (526160) to LP-Doud Tap (526162) 115 kV line circuit 1, near Carlisle.<br>a. Apply fault at the Carlisle 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT106-3PH | 3 phase fault on the Carlisle 115 kV (526160) to Carlisle 230 kV (526161) to Carlisle 13.2 kV (526157) XFMR CKT 1, near Carlisle 115 kV bus.<br>a. Apply fault at the Carlisle 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the transformer |
| FLT107-3PH | 3 phase fault on the Carlisle (526160) to SP-Erskine (526109) 115 kV line circuit 1, near Carlisle.<br>a. Apply fault at the Carlisle 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT108-3PH | 3 phase fault on the Carlisle (526160) to Murphy (526192) 115 kV line circuit 1, near Carlisle.<br>a. Apply fault at the Carlisle 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT109-3PH | 3 phase fault on the LG-Clauene (526491) to Terry County (526736) 115 kV line circuit 1, near LG-Clauene.<br>a. Apply fault at the LG-Clauene 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT111-3PH | 3 phase fault on the Terry County (526736) to Prentice (526792) 115 kV line circuit 1, near Terry County.<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT112-3PH | 3 phase fault on the Terry County (526736) to Denver North (527130) 115 kV line circuit 1, near Terry County.<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT113-3PH | 3 phase fault on the Terry County (526736) to Sulphur (527262) 115 kV line circuit 1, near Terry County.<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT114-3PH | 3 phase fault on the Terry County 115 kV (526736) to Terry County 69 kV (526735) to Terry County 13.2 kV (526733) XFMR CKT 1, near Terry County 115 kV.<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT115-3PH | 3 phase fault on the Terry County (526736) to Wolf Forth (526524) 115 kV line circuit 1, near Terry County.<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT116-3PH | 3 phase fault on the LG-Clauene (526491) to LG-Leveland (526484) 115 kV line circuit 1, near LG-Clauene.<br>a. Apply fault at the LG-Clauene 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT117-3PH | 3 phase fault on the Seagraves (527202) to Sulphur (527262) 115 kV line circuit 1, near Seagraves.<br>a. Apply fault at the Seagraves 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT118-3PH | 3 phase fault on the Seagraves (527202) to LG-Plshill (527194) 115 kV line circuit 1, near Seagraves.<br>a. Apply fault at the Seagraves 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT119-3PH | 3 phase fault on the Denver South (527136) to San Andreas (527105) 115 kV line circuit 1, near Denver South.<br>a. Apply fault at the Denver South 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT120-3PH | 3 phase fault on the Denver South (527136) to Shell C2 (527036) 115 kV line circuit 1, near Denver South.<br>a. Apply fault at the Denver South 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT121-3PH | 3 phase fault on the Denver South 115 kV (527136) to Denver City 69 kV (527125) to Denver South 13.2 kV (527123) XFMR CKT 2, near Denver South 115 kV.<br>a. Apply fault at the Denver South 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT126-3PH | 3 phase fault on the GEN-2015-079 Tap (560059) to Hobbs (527894) 230 kV line circuit 1, near GEN-2015-079 Tap.<br>a. Apply fault at the GEN-2015-079 Tap 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT127-3PH | 3 phase fault on the Hobbs (527894) to Andrews (528604) 230 kV line circuit 1, near Hobbs.<br>a. Apply fault at the Hobbs 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT128-3PH | 3 phase fault on the Hobbs (527894) to Cunningham (527867) 230 kV line circuit 1, near Hobbs.<br>a. Apply fault at the Hobbs 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT129-3PH | 3 phase fault on the Hobbs 230 kV (527894) to Hobbs 115 kV (527891) to Hobbs 13.2 kV (527889) XFMR CKT 2, near Hobbs 230 kV.<br>a. Apply fault at the Hobbs 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT131-SB | Single phase fault with stuck breaker at Chaves County (527482)<br>a. Apply fault at the Chaves 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Chaves County 230 kV (527483)/ 115 kV (527482)/13.2 kV (527478) transformer<br>d. Chaves County (527482) - Urton (527501) 115 kV |
| FLT133-SB | Single phase fault with stuck breaker at Oasis (524874)<br>a. Apply fault at the Oasis 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Oasis (524874) - FE-CHZPLT (524863) 115 kV<br>d. Oasis (524874) - Portales (524924) 115 kV |
| FLT134-SB | Single phase fault with stuck breaker at Amarillo South (524415)<br>a. Apply fault at the Amarillo South 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Amarillo South (524415) - Nichols (524044) 230 kV<br>d. Amarillo South (524415) - Randall (524365) 230 kV |
| FLT135-SB | Single phase fault with stuck breaker at Tuco Int (525832)<br>a. Apply fault at the Tuco Int 345 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Tuco Int (525832) - Border (515458) 345 kV<br>d. Tuco Int (525832) - Yoakum (526936) 345 kV |
| FLT136-SB | Single phase fault with stuck breaker at Deafsmith (524623)<br>a. Apply fault at the Deafsmith 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Deafsmith 230 kV (524623)/115 kV (524622)/13.8 kV (524620) transformer<br>d. Deafsmith (524623) - Bushland (524267) 230 kV |
| FLT137-SB | Single phase fault with stuck breaker at Mustang (527149)<br>a. Apply fault at the Mustang 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Mustang (527149) - Seminole (527276) 230 kV<br>d. Mustang (527149) - Yoakum (526935) 230 kV |
| FLT138a-SB | Single phase fault with stuck breaker at EDDY_CNTY (527802)<br>a. Apply fault at the Eddy County 345 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Eddy County 345 kV (527802)/230 kV (527799)/13.2 kV (527796) transformer<br>d. Eddy County (527802) - Crossroads (527656) 345 kV |
| FLT138b-SB | Single phase fault with stuck breaker at Tolk (525549)<br>a. Apply fault at the Tolk 345 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Tolk 345 kV (525549)/230 kV (525543)/13.2 kV (525537) transformer<br>d. Tolk (525549) - Crossroads (527656) 345 kV |
| FLT139-SB | Single phase fault with stuck breaker at Atoka (527786)<br>a. Apply fault at the Atoka 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Atoka (527786) - Eagle Creek (527711) 115 kV<br>d. Atoka (527786) - Irish Hill (528116) 115 kV |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT140-SB | Single phase fault with stuck breaker at Carlisle (526160)<br>a. Apply fault at the Carlisle 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Carlisle (526160) - Murphy (526192) 115 kV<br>d. Carlisle (526160) - Erskine (526109) 115 kV |
| FLT141-SB | Single phase fault with stuck breaker at Terry County (526736)<br>a. Apply fault at the Terry County 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Terry County (526736) - Wolfforth (526524) 115 kV<br>d. Terry County (526736) - Denver (527130) 115 kV |
| FLT142-SB | Single phase fault with stuck breaker at Mustang (527146)<br>a. Apply fault at the Mustang 115 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Mustang (527146) - Seagraves (527202) 115 kV<br>d. Mustang (527146) - Denver S (527136) 115 kV |
| FLT143-SB | Single phase fault with stuck breaker at Hobbs (527894)<br>a. Apply fault at the Hobbs 230 kV bus.<br>b. Clear fault after 16 cycles and trip the following elements<br>c. Hobbs (527894) - Andrews (528604) 230 kV<br>d. Hobbs (527894) - Cunningham (527867) 230 kV |
| FLT37-PO1 | Prior Outage of Tuco Int (525832) to OKU (511456) 345 kV line circuit 1<br>3 phase fault on the Swisher (525213) to Tuco Int (525830) 230 kV line circuit 1, near Swisher.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT45-PO1 | Prior Outage of Tuco Int (525832) to OKU (511456) 345 kV line circuit 1<br>3 phase fault on the Tuco Int (525832) to Border (515458) 345 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT46-PO1 | Prior Outage of Tuco Int (525832) to OKU (511456) 345 kV line circuit 1<br>3 phase fault on the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525824) XFMR CKT 1, near Tuco 345 kV bus.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the transformer |
| FLT37-PO2 | Prior Outage of the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525825) XFMR CKT 2, near Tuco 345 kV bus.<br>3 phase fault on the Swisher (525213) to Tuco Int (525830) 230 kV line circuit 1, near Swisher.<br>a. Apply fault at the Swisher 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT43-PO2 | Prior Outage of the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525825) XFMR CKT 2, near Tuco 345 kV bus.<br>3 phase fault on the Tuco Int (525832) to OKU (511456) 345 kV line circuit 1, near Tuco Int.<br>a. Apply fault at the Tuco Int 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT45-PO2 | Prior Outage of the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525825) XFMR CKT 2, near Tuco 345 kV bus.<br>3 phase fault on the Tuco Int (525832) to Border (515458) 345 kV line circuit 1, near Tuco.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT46-PO2 | Prior Outage of the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525825) XFMR CKT 2, near Tuco 345 kV bus.<br>3 phase fault on the Tuco 345 kV (525832) to Tuco 230 kV (525830) to Tuco 13.2 kV (525824) XFMR CKT 1, near Tuco 345 kV bus.<br>a. Apply fault at the Tuco 345 kV bus.<br>b. Clear fault after 5 cycles by tripping the transformer |

## 4.1 Pre-Mitigation Results

Table 4-2 shows the results with transient voltage recovery and stability or damping assessments observed in each of the study models prior to including additional upgrades. There were no system performance violations associated with the Group 6 study.

**Table 4-2: Pre-Mitigation Dynamic Stability Results**

| Fault ID | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT01-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT02-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT03-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT04-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT05-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT06-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT07-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT10-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT11-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT13-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT14-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT15-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT16-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT17-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT18-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT19-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT20-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT21-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT22-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT23-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT24-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT25-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT26-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT27-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT28-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT29-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT30-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT31-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT34-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT35-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT36-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT37-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT38-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT39-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT40-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT41-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT42-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT43-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT45-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT46-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT48-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT49-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT52-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT54-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT55-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT56-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT57-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT58-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT59-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT60-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |

**Table 4-2 Continued**

| Fault ID | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT61-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT62-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT63-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT64-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT65-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT66-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT67-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT68-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT69-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT70-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT71-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT72-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT73-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT74-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT75-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT76-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT77-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT78-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT79-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT80-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT81-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT84-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT85-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT86-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT87-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT88-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT91-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT92-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT93-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT94-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT95-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT96-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT97-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT98-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT99-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT100-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT101-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT102-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT105-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT106-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT107-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT108-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT109-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT111-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT112-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT113-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT114-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT115-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT116-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT117-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT118-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT119-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT120-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT121-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT126-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT127-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT128-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT129-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT131-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT133-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT134-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT135-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT136-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT137-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT138a-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT138b-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT139-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT140-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT141-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT142-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT143-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |

## 4.2 Post-Mitigation Results

Table 4-3 shows the results of the fault events applied to each of the study models with the network upgrades identified in the steady state analysis performed by SPP included in the study models:

1. Border 345kV 100MVAR capacitor bank
2. Deaf Smith 230kV 60MVAR capacitor bank
3. Oklaunion 345kV 100MVAR capacitor bank

The associated stability plots are provided in Appendix C.

**Table 4-3: Post-Mitigation Dynamic Stability Results**

| Fault ID | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT01-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT02-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT03-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT04-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT05-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT06-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT07-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT10-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT11-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT13-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT14-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT15-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT16-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT17-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT18-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT19-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT20-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT21-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT22-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT23-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT24-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT25-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT26-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT27-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT28-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT29-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT30-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT31-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT34-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT35-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT36-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT37-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT38-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT39-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT40-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT41-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT42-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT43-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT45-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT46-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT48-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT49-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT52-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT54-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT55-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT56-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT57-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT58-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT59-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT60-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT61-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT62-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT63-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT64-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT65-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |

**Table 4-3 continued**

| Fault ID | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT66-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT67-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT68-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT69-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT70-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT71-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT72-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT73-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT74-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT75-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT76-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT77-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT78-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT79-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT80-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT81-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT84-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT85-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT86-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT87-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT88-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT91-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT92-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT93-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT94-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT95-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT96-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT97-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT98-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT99-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT100-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT101-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT102-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT105-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT106-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT107-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT108-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT109-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT111-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT112-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT113-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT114-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT115-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT116-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT117-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT118-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT119-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT120-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT121-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT126-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT127-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT128-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT129-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT131-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT133-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT134-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT135-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT136-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT137-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT138a-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT138b-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT139-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT140-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT141-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT142-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT143-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT37-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT45-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT46-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT37-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT43-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT45-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT46-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |

# 5.0 Conclusions

The purpose of this ReStudy#7 was to evaluate the impacts of the DISIS-2015-002 Group 6 active generation interconnection projects on the SPP transmission system shown in Table 5-1 and assess mitigation upgrades or measures that may be required to maintain system stability and system performance per SPP's Disturbance Performance Requirements. The reactive power and dynamic stability analyses were performed for the evaluation using the PTI PSS/E version 33.7 software. The 2017 winter peak, 2018 summer peak and 2026 summer peak models were used in the study.

**Table 5-1: Group 6 Interconnection Requests**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-020 | 100 | Eaton Power Xpert Solar 1.67MW (solar) | Oasis 115kV (524874) |
| GEN-2015-056 | 101.2 | GE 2.3 MW (wind) | Crossroads 345kV (527656) (Tap Eddy (527802) to Tolk (525549) |

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, performed using all three models showed that the projects may require shunt reactors on their collector substation high voltage bus:

1. GEN-2015-020 – 0.6 MVAR
2. GEN-2015-056 – 8.6 MVAR

The shunt reactors are needed to reduce the reactive power transfer at the POI to approximately zero during low/no-wind or low-irradiance conditions while the generation interconnection project remained connected to the grid.

The dynamic stability analysis was performed using the three loading scenarios 2017WP, 2018SP and 2026SP simulating up to 129 faults that included three-phase and single-line-to-ground faults including faults with stuck breakers. The pre-mitigation results showed that there were no transient voltage recovery and stability/damping criteria violations observed confirming the need for network upgrades.

The steady state upgrades developed by SPP to resolve steady state system performance violations were tested with the dynamic stability models and the results showed that there were no machine rotor angle damping or transient voltage recovery violations observed in the simulated fault events.


**Submitted to**

**Southwest Power Pool**

Report On

**Definitive Interconnection System Impact Study**
**DISIS-2015-002 Study Group 7**
**ReStudy#7**

Revision R1

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**anedenconsulting.com**

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## APPENDICES

# Executive Summary

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to complete the reactive power and the dynamic stability analyses as part of the Definitive Interconnection System Impact Study DISIS-2015-002 ReStudy #7 (ReStudy#7) for Southwestern Oklahoma Area defined as Group 7. The purpose of the analyses was to identify impacts to the transmission system caused by the active interconnection requests in Group 7 and develop mitigation upgrades or measures to resolve any detrimental impacts.

The DISIS-2015-002 Group 7 currently includes two generation interconnection requests shown in Table ES-1 below.

**Table ES-1: DISIS-2015-002-7 Interconnection Projects Evaluated**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-055 | 40.0 | Advanced Energy - AE (solar) | Erick 138 kV (520903) |
| GEN-2015-071 | 200.0 | Vestas (wind) | Chisholm 345 kV (511553) |

Aneden perform reactive power and dynamic stability analyses using DISIS-2015-002-7 study models developed to reflect the system conditions for the current study generation interconnection requests - 2017 winter peak (2017WP), 2018 summer peak (2018SP) and 2026 summer peak (2026SP). All analyses were performed using the Siemens PTI PSS/E software version 33.7 and the results are summarized below.

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, performed using all three models showed the following shunt reactor sizes may be needed at each project collector substation high voltage bus:

1. GEN-2015-055 – 1.8 MVAR
2. GEN-2015-071 – 11.7 MVAR

The dynamic stability analysis was performed to identify the potential system criteria violations prior to developing mitigation solutions. The dynamic stability analysis was performed using the three loading scenarios 2017WP, 2018SP and 2026SP simulating up to 64 fault conditions that included three-phase, single-line-to-ground faults with stuck breakers and three phase faults on prior outage cases.

The results of the dynamic stability analysis showed that GEN-2015-071 was unstable with the prior outage on the Chisolm to Gracemont 345 kV line followed by the loss of either the Chisolm to Elk City 230 kV line or the Sweetwater to Wheeler 230 kV line. Additionally, instability was observed with the prior outage of either the Chisolm to Elk City 230 kV line or the Sweetwater to Wheeler 230 kV line followed by the loss of the Chisolm to Gracemont 345 kV line. As a result, GEN-2015-071 may have to be curtailed during the outage of the Chisolm to Gracemont 345 kV line, Chisolm to Elk City 230 kV line, or the Sweetwater to Wheeler 230 kV line to maintain system reliability during subsequent outages.

# 1.0 Introduction

Aneden Consulting (Aneden) was retained by the Southwest Power Pool (SPP) to complete the reactive power analysis and dynamic stability analysis as part of the Definitive Interconnection System Impact Study DISIS-2015-002 ReStudy #7 (ReStudy#7) for Southwestern Oklahoma Area, defined as Group 7. The purpose of the analyses was to identify impacts to the transmission system caused by the active interconnection requests in Group 7 and develop mitigation upgrades or measures to resolve any detrimental impacts.

The active DISIS-2015-002 Group 7 projects studied in this ReStudy#7 are listed below in Table 1-1 below.

**Table 1-1: Active DISIS-2015-002 Group 7 Interconnection Requests**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-055 | 40.0 | Advanced Energy - AE (solar) | Erick 138 kV (520903) |
| GEN-2015-071 | 200.0 | Vestas (wind) | Chisholm 345 kV (511553) |

## 1.1 Scope

The Study included reactive power and dynamic stability analyses. The methodology, assumptions and results of the analyses are presented in the following four main sections:

1. Study Assumptions and Criteria
2. Reactive Power Analysis
3. Dynamic Stability Analysis
4. Conclusions

## 1.2 Study Limitations

The assessments and conclusions provided in this report are based on assumptions and information provided to Aneden by other supporting parties. While the assumptions and information provided may be appropriate for the purposes of this report, Aneden does not guarantee that those conditions assumed will occur. In addition, Aneden did not independently verify the accuracy or completeness of the information provided. As such, the conclusions and results presented in this report may vary depending on the extent to which actual future conditions differ from the assumptions made or information used herein.

# 2.0 Study Assumptions and Criteria

The reactive power and dynamic stability analyses were performed using the PTI PSS/E software version 33.7. The main assumptions and criteria applied in the study are summarized in the sections below.

## 2.1 Study System

The study system for the dynamic stability analysis consisted of generators and transmission buses at or above 115 kV within 5 buses of the DISIS-2015-002 Group 7 projects in the monitored areas listed in Table 2-1 below.

**Table 2-1: Monitored Areas**

| Area Number | Name |
|---|---|
| 520 | AEPW |
| 524 | OKGE |
| 525 | WFEC |
| 526 | SPS |
| 531 | MIDW |
| 534 | SUNC |
| 536 | WERE |

## 2.2 Study Models

The reactive power and dynamic stability analyses were completed using the models developed from the 2016 SPP Model Development Working Group (MDWG) PSS/E models. Table 2-2 summarizes the study models used for each analysis.

**Table 2-2: Study Models**

| Case Name | Reactive Power | Dynamic Stability |
|---|---|---|
| 17W_DIS15027_G07 | X | X |
| 18S_DIS15027_G07 | X | X |
| 26S_DIS15027_G07 | X | X |

## 2.3 Group 7 Interconnection Request Configurations

The modeling configurations for both Group 7 projects in the study models are shown in Figure 2-1 and Figure 2-2.

**Figure 2-1: GEN-2015-055 Single Line Diagram**

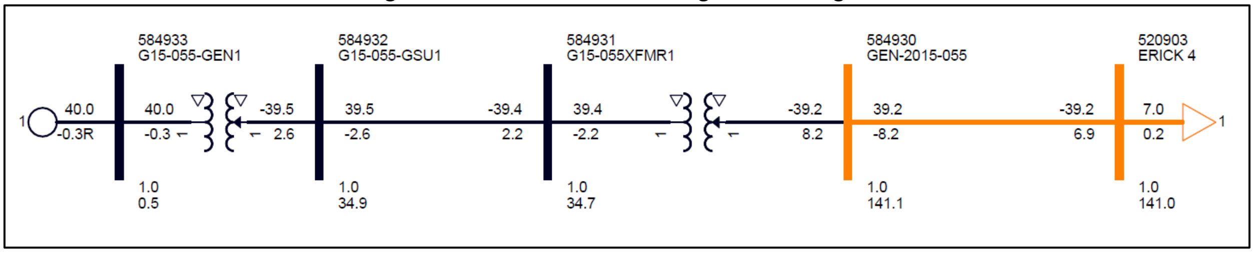
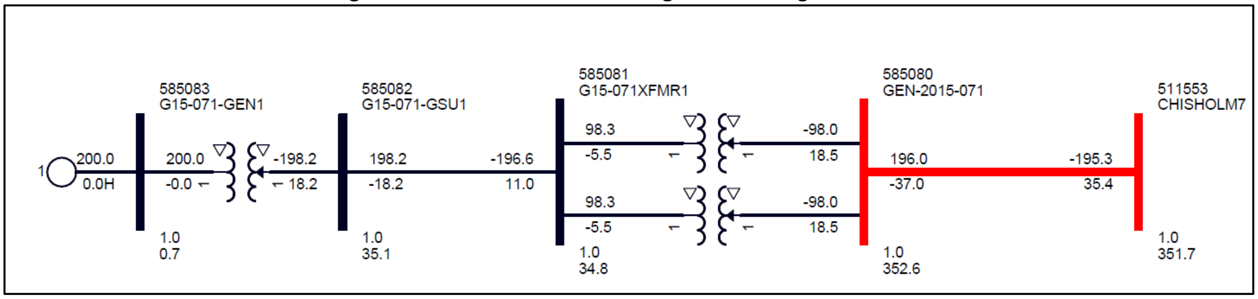


**Figure 2-2: GEN-2015-071 Single Line Diagram**




## 2.4 Dynamic Performance Requirements

The dynamic stability analysis results were assessed according to the following excerpt from SPP's Disturbance Performance Requirements. The complete document is provided in Appendix A.

"Machine Rotor Angles shall exhibit well damped angular oscillations following a disturbance on the Bulk Electric System for all NERC TPL-001-4 P1 through P7 events. Machines with rotor angle deviations greater than or equal to 16 degrees (measured as absolute maximum peak to absolute minimum peak) shall be evaluated against SPPR1 or SPPR5 requirements below. Machines with rotor angle deviations less than 16 degrees which do not exhibit convergence shall be evaluated on an individual basis. Rotor angle deviations will be calculated relative to the system swing machine.

Well damped angular oscillations shall meet one of the following two requirements when calculated directly from the rotor angle:

1. Successive Positive Peak Ratio One (SPPR1) must be less than or equal to 0.95 where

SPPR1 is calculated as follows:

$$\text{SPPR1} = \frac{\text{Peak Rotor Angle of 2nd Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.95$$

-or- Damping Factor % = (1 – SPPR1) x 100% $\geq$ 5%

The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

Damping Ratio $\geq$ 0.0081633

2. Successive Positive Peak Ratio Five (SPPR5) must be less than or equal to 0.774 where

SPPR5 is calculated as follows:

$$\text{SPPR5} = \frac{\text{Peak Rotor Angle of 6th Positive Peak minus Minimum Value}}{\text{Peak Rotor Angle of 1st Positive Peak minus Minimum Value}} \leq 0.774$$

-or- Damping Factor % = (1 – SPPR5) x 100% ≥ 22.6%

The machine rotor angle damping ratio may be determined by appropriate modal analysis (i.e. Prony Analysis) where the following equivalent requirement must be met:

Damping Ratio ≥ 0.0081633

Bus voltages on the Bulk Electric System shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared. Bus voltages shall not swing above 1.20 per unit after the fault is cleared, unless affected transmission system elements are designed to handle the rise above 1.2 per unit."

# 3.0 Reactive Power Analysis

The reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, was performed for the Group 7 projects to determine the reactive power contribution from each project's interconnection line and collector transformer and cables during low/no generator output conditions while each project is still connected to the grid and to size shunt reactors that would reduce the project reactive power contribution to the POI to approximately zero. The reactive power analysis was performed using the three DISIS-2015-002-7 Group 7 study models, 2017WP, 2018SP and 2026SP.

## 3.1 Methodology and Criteria

Each Group 7 project generator was switched out of service while other collector system elements remained in-service. A shunt reactor was tested at the study project substation high side bus to bring the MVAr flow into the POI down to approximately zero.

## 3.2 Results

The results from the reactive power analysis showed that the Group 7 projects each required varying shunt reactance at the high side of the project substation, to reduce the POI MVAr to zero. This represents the contributions from each project's collector systems. Figure 3-1 and Figure 3-2 illustrate the shunt reactor sizes required. Reactive compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

**Table 3-1: Shunt Reactors for Low Wind Study**

| Machine | POI Bus Number | POI Bus Name | Reactor Size (MVAr) | | |
|---|---|---|---|---|---|
| | | | 17WP | 18SP | 26SP |
| GEN-2015-055 | 520903 | Erick 138 kV | 1.8 | 1.8 | 1.8 |
| GEN-2015-071 | 511553 | Chisholm 345 kV | 11.7 | 11.7 | 11.7 |

**Figure 3-1: GEN-2015-055 Shunt Reactor**

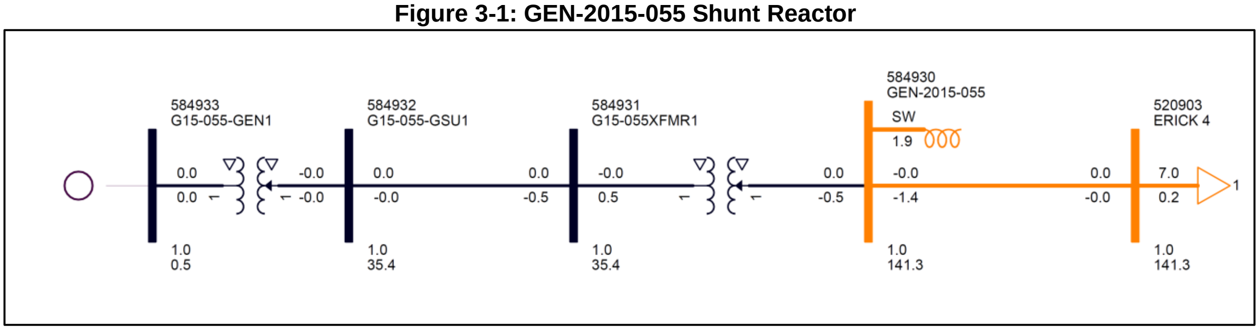
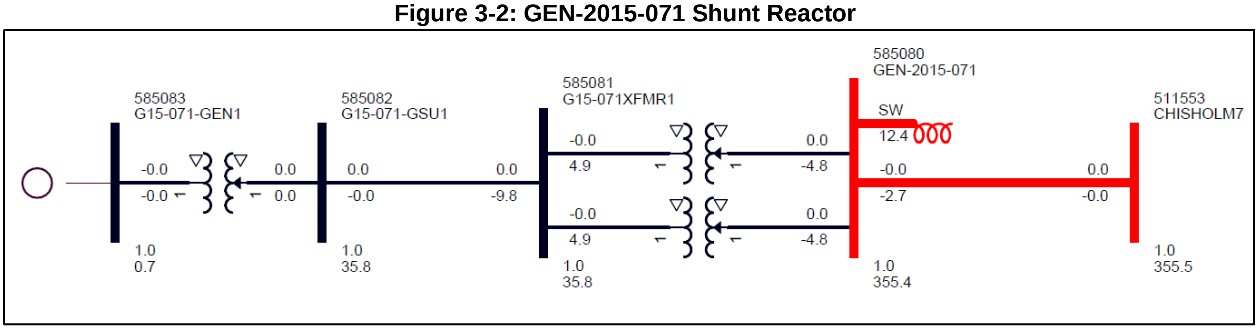



**Figure 3-2: GEN-2015-071 Shunt Reactor**



# 4.0 Dynamic Stability Analysis

Aneden performed a dynamic stability analysis to assess the system performance and identify any system stability issues associated with DISIS-2015-002 ReStudy#7 Group 7 interconnection requests. The analysis was performed according to SPP's Disturbance Performance Requirements. The Group 7 project dynamic modeling data is provided in Appendix B. The simulation plots can be found in Appendix C.

## 4.1 Methodology and Criteria

The dynamic stability analysis was performed using the DISIS-2015-002 (Group 7) study models described in Section 2.2 above. The power flow models and associated dynamics database were initialized (no-fault test) to confirm that there were no errors in the initial conditions of the immediate system and the dynamic data. The dynamics model data for the DISIS-2015-002 (Group 7) requests is provided in Appendix B. The stability analysis was performed using PSS/E version 33.7.

During the fault simulations, the active power (PELEC), reactive power (QELEC), terminal voltage (ETERM), and frequency (FREQ) were monitored for the Group 7 generation interconnection requests. The machine rotor angle for synchronous machines and speed for asynchronous machines within five (5) buses away from the POI of each of the Group 7 projects and within the study area including 520 (AEPW), 524 (OKGE), 525 (WFEC), 526 (SPS), 531 (MIDW), 534 (SUNC) and 536 (WERE) were monitored.

## 4.2 Fault Definitions

Aneden developed sixty-four (64) faults including three-phase line faults with reclosing, three-phase transformer faults with normal clearing and single-line-to-ground (SLG) fault with stuck breaker. The single-line-to-ground fault impedance values were determined by applying a fault on the base case large enough to produce a 0.6 pu voltage value on the faulted bus. The fault events are described in Table 4-1 below. Fault descriptions from the previous GEN-2015-002 Group 7 studies were included along with some newly defined faults. These contingencies were applied to the 2017 winter peak, 2018 summer peak, and the 2026 summer peak models.

**Table 4-1: Fault Definitions**

| Fault ID | Fault Description |
|---|---|
| FLT01-3PH | 3 phase fault on the Erick (520903) to Buloj (520402) 138kV line, near Erick.<br>a. Apply fault at the Erick 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT02-3PH | 3 phase fault on the Erick (520903) to (AEPW) Sayre-4 (511504) 138kV line, near Erick.<br>a. Apply fault at the Erick 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT03-3PH | 3 phase fault on the Elk City (511458) to Falcon Road (511511) 138kV line, near Elk City.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT04-3PH | 3 phase fault on the Elk City (511458) to Clinton Junction (511485) 138kV line, near Elk City.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT05-3PH | 3 phase fault on the Elk City 230kV (511490) to Elk City 138kV (511458) to Elk City 13.8kV (511482) transformer, near Elk City 230kV.<br>a. Apply fault at the Elk City 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line. |
| FLT06-3PH | 3 phase fault on the Ellis (511561) to Morewood Switch (521001) 138kV line, near Ellis.<br>a. Apply fault at the Ellis 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT07-3PH | 3 phase fault on the Morewood Switch (521001) to Nine Mile (521128) 138kV line, near Morewood Switch.<br>a. Apply fault at the Morewood 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT08-3PH | 3 phase fault on the Clinton AF Tap (511446) to Hobart Junct. (511463) 138kV line, near Clinton AF Tap.<br>a. Apply fault at the Clinton AF Tap 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT09-3PH | 3 phase fault on the Hobart Junct. (511463) to Carnegie South (511445) 138kV line, near Hobart Junct.<br>a. Apply fault at the Hobart Junct. 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT10-3PH | 3 phase fault on the Hobart Junct. (511463) to (OMPA) Altus (529302) 138kV line, near Hobart Junct.<br>a. Apply fault at the Hobart Junct. 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT11-3PH | 3 phase fault on the Altus (511440) to (OMPA) Parklane (529345) 138kV line, near Altus.<br>a. Apply fault at the Altus 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT27-3PH | 3 phase fault on the Chisholm (511557) to Elk City (511490) 230kV line, near Chisholm.<br>a. Apply fault at the Chisholm 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT28-3PH | 3 phase fault on the Chisholm (511557) to Sweetwater (511541) 230kV line, near Chisholm.<br>a. Apply fault at the Chisholm 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT29-3PH | 3 phase fault on the Wheeler (523777) to Grapevine (523771) 230kV line, near Wheeler.<br>a. Apply fault at the Wheeler 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT30-3PH | 3 phase fault on the Chisholm (511553) to Gracemont (515800) 345kV line, near Chisholm.<br>a. Apply fault at the Chisholm 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT31-3PH | 3 phase fault on the Chisholm (511553) 345kV to Chisholm (511557) 230kV to Chisholm (511558) 13.8kV transformer, near Chisholm.<br>a. Apply fault at the Chisholm 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line. |
| FLT32-3PH | 3 phase fault on the Gracemont (515800) to Minco (514801) 345kV line, near Gracemont.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT33-3PH | 3 phase fault on the L.E.S. (511468) to Terry Road (511568) 345kV line, near L.E.S..<br>a. Apply fault at the L.E.S. 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT34-3PH | 3 phase fault on the L.E.S. (511468) to O.K.U. (511456) 345kV line, near L.E.S.<br>a. Apply fault at the L.E.S. 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT35-3PH | 3 phase fault on the O.K.U. (511456) to Tuco (525832) 345kV line, near O.K.U.<br>a. Apply fault at the O.K.U. 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT36-3PH | 3 phase fault on the TUCO_Int (525832) 345kV/ (525830) 230kV/ (525824) 13.2kV transformer, near the 345kV bus.<br>a. Apply fault at the TUCO_Int 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT37-3PH | 3 phase fault on the Cimarron (514901) to Mathewson (515497) 345kV line, ckt 1, near Cimarron.<br>a. Apply fault at the Cimarron 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT38-3PH | 3 phase fault on the Cimarron (514901) to Northwest (514880) 345kV line, near Cimarron.<br>a. Apply fault at the Cimarron 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT39-3PH | 3 phase fault on the Cimarron (514901) to Draper (514934) 345kV line, near Cimarron.<br>a. Apply fault at the Cimarron 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT40-3PH | 3 phase fault on the Border (515458) to TUCO (525832) 345kV line, near Border.<br>a. Apply fault at the Border 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT41-3PH | 3 phase fault on the Northwest (514880) to Arcadia (514908) 345kV line, near Northwest.<br>a. Apply fault at the Northwest 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT48-3PH | 3 phase fault on the Gracemont (515800) to L.E.S. (560064) 345kV line, near Gracemont 345kV.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT62-3PH | 3 phase fault on the Gracemont (515800) to G15-093T (585270) 345kV line, near Gracemont.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line. Trip G15-093<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9001-3PH | 3 phase fault on the Elk City 138/69/13.8 kV Transformer (511458/511459/511493), near Elk City 138kV.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9002-3PH | 3 phase fault on the Morewood Switch (521001) 138kV / (521000) 69kV / (521172) 13.8 kV Transformer, near Morewood Switch 138kV.<br>a. Apply fault at the Morewood Switch 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9003-3PH | 3 phase fault on the RHWIND4 (521116) to Ellis (511561) 138kV line, near RHWIND4.<br>a. Apply fault at the RHWIND4 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9004-3PH | 3 phase fault on the RHWIND4 (521116) to Elk City (511458) 138kV line, near RHWIND4.<br>a. Apply fault at the RHWIND4 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9005-3PH | 3 phase fault on the Clinton AF Tap (511446) to Elk City (511458) 138kV line, near Clinton AF Tap.<br>a. Apply fault at the Clinton AF Tap 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9006-3PH | 3 phase fault on the SWEETWT6 (511541) to STLN-DEMARC6 (523779) 230 kV line, near SWEETWT6.<br>a. Apply fault at the SWEETWT6 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9007-3PH | 3 phase fault on the WHEELER (523777) 230kV / (523776) 115kV / (523774) 13.2 kV Transformer, near WHEELER 230kV.<br>a. Apply fault at the WHEELER 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9008-3PH | 3 phase fault on the Gracemont (515800) 340kV / (515802) 138kV / (515801) 13.8 kV Transformer, near Gracemont 345kV.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9009-3PH | 3 phase fault on the Minco (514801) to Cimaron (514901) 345 kV line, near Minco.<br>a. Apply fault at the Minco 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT9010-3PH | 3 phase fault on the Cimaron (514901) 345kV / (514898) 138kV / (515714) 13.8 kV Transformer, near Cimaron 345kV.<br>a. Apply fault at the Cimaron 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9011-3PH | 3 phase fault on the L.E.S. (511468) 340kV / (511467) 138kV / (511414) 13.8 kV Transformer, near L.E.S. 345kV.<br>a. Apply fault at the L.E.S. 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT44-SB | a. Apply a single phase fault on Sayre-4 (511504) 138kV bus.<br>b. Wait 16 cycles and remove fault.<br>c. Trip Sayer-4 (511504) to Erick (520903) 138kV line.<br>d. Trip Sayer-4 (511504) to Falcon Road (511511) 138kV line. |
| FLT45-SB | a. Apply a single phase fault on Morewood Switch (521001) 138kV bus.<br>b. Wait 16 cycles and remove fault.<br>c. Trip Morewood Switch (521001) to Morewood (521002) 138kV line.<br>d. Trip Morewood Switch (521001) to Ellis (511561) 138kV line. |
| FLT51-SB | a. Apply a single phase fault on Gracemont (515800) 345kV bus.<br>b. Wait 16 cycles and remove fault.<br>c. Trip Gracemont (515800) to Chisholm (511553) 345kV line.<br>d. Trip Gracemont (515800) to Minco (514801) 345kV line. |
| FLT63-SB | a. Apply a single phase fault on Buloj (520402) 138kV bus.<br>b. Wait 16 cycles and remove fault.<br>c. Trip Erick (520903) to Buloj (520402) 138kV line<br>d. Trip Sweetwater (521060) to Buloj (520402) 138kV line |
| FLT64-SB | a. Apply a single phase fault on CHISHOLM6 (511557) 230kV bus.<br>b. Wait 16 cycles and remove fault.<br>c. Trip Chisholm (511553) 345kV/ (511557) 230kV / (511558) 13.2kV transformer.<br>d. Trip Chisholm (511557) 230kV Bus |
| FLT06-PO1 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the Ellis (511561) to Morewood Switch (521001) 138kV line, near Ellis.<br>a. Apply fault at the Ellis 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT07-PO1 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the Morewood Switch (521001) to Nine Mile (521128) 138kV line, near Morewood Switch.<br>a. Apply fault at the Morewood 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9002-PO1 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the Morewood Switch (521001) 138kV / (521000) 69kV / (521172) 13.8 kV Transformer, near Morewood Switch 138kV.<br>a. Apply fault at the Morewood Switch 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9004-PO1 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the RHWIND4 (521116) to Elk City (511458) 138kV line, near RHWIND4.<br>a. Apply fault at the RHWIND4 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT04-PO2 | **Prior Outage: Switch out the Erick (520903) to Buloj (520402) 138kV line.**<br>3 phase fault on the Elk City (511458) to Clinton Junction (511485) 138kV line, near Elk City.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT05-PO2 | **Prior Outage: Switch out the Erick (520903) to Buloj (520402) 138kV line.**<br>3 phase fault on the Elk City 230kV (511490) to Elk City 138kV (511458) to Elk City 13.8kV (511482) transformer, near Elk City 230kV.<br>a. Apply fault at the Elk City 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line. |
| FLT9001-PO2 | **Prior Outage: Switch out the Erick (520903) to Buloj (520402) 138kV line.**<br>3 phase fault on the Elk City 138/69/13.8 kV Transformer (511458/511459/511493), near Elk City 138kV.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT9003-PO2 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the RHWIND4 (521116) to Ellis (511561) 138kV line, near RHWIND4.<br>a. Apply fault at the RHWIND4 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9004-PO2 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the RHWIND4 (521116) to Elk City (511458) 138kV line, near RHWIND4.<br>a. Apply fault at the RHWIND4 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9005-PO2 | **Prior Outage: Switch out the Falcon Road (511511) to Elk City (511458) 138kV line.**<br>3 phase fault on the Clinton AF Tap (511446) to Elk City (511458) 138kV line, near Clinton AF Tap.<br>a. Apply fault at the Clinton AF Tap 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT32-PO3 | **Prior Outage: Switch out Chisholm (511553) 345kV/ (511557) 230kV/ (511558) 13.8kV transformer.**<br>3 phase fault on the Gracemont (515800) to Minco 345kV line, near Gracemont.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT48-PO3 | **Prior Outage: Switch out Chisholm (511553) 345kV/ (511557) 230kV/ (511558) 13.8kV transformer.**<br>3 phase fault on the Gracemont (515800) to L.E.S. (560064) 345kV line, near Gracemont 345kV.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9008-PO3 | **Prior Outage: Switch out Chisholm (511553) 345kV/ (511557) 230kV/ (511558) 13.8kV transformer.**<br>3 phase fault on the Gracemont (515800) 340kV / (515802) 138kV / (515801) 13.8 kV Transformer, near Gracemont 345kV.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| FLT31-PO4 | **Prior Outage: Switch out the Gracemont (515800) to Minco (514801) 345kV line.**<br>3 phase fault on the Chisholm (511553) 345kV to Chisholm (511557) 230kV to Chisholm 13.8kV transformer, near Chisholm.<br>a. Apply fault at the Chisholm 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line. |
| FLT48-PO4 | **Prior Outage: Switch out the Gracemont (515800) to Minco (514801) 345kV line.**<br>3 phase fault on the Gracemont (515800) to L.E.S. (560064) 345kV line, near Gracemont 345kV.<br>a. Apply fault at the Gracemont 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

**Table 4-1 continued**

| Fault ID | Fault Description |
|---|---|
| FLT27-PO5 | **Prior Outage: Switch out the Gracemont (515800) to Chisholm (511553) 345kV line.**<br>3 phase fault on the Chisholm (511557) to Elk City (511490) 230kV line, near Chisholm.<br>a. Apply fault at the Chisholm 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT28-PO5 | **Prior Outage: Switch out the Gracemont (515800) to Chisholm (511553) 345kV line.**<br>3 phase fault on the Chisholm (511557) to Sweetwater (511541) 230kV line, near Chisholm.<br>a. Apply fault at the Chisholm 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT9006-PO5 | **Prior Outage: Switch out the Gracemont (515800) to Chisholm (511553) 345kV line.**<br>3 phase fault on the SWEETWT6 (511541) to STLN-DEMARC6 (523779) 230 kV line, near SWEETWT6.<br>a. Apply fault at the SWEETWT6 230kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT30-PO6 | **Prior Outage: Switch out the Chisholm (511557) to Elk City (511490) 230kV line.**<br>3 phase fault on the Gracemont (515800) to Chisholm (511553) 345kV line, near Chisholm.<br>a. Apply fault at the Chisholm 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT30-PO7 | **Prior Outage: Switch out the SWEETWT6 (511541) to STLN-DEMARC6 (523779) 230 kV line.**<br>3 phase fault on the Gracemont (515800) to Chisholm (511553) 345kV line, near Chisholm.<br>a. Apply fault at the Chisholm 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

## 4.3 Pre-Mitigation Results

Table 4-2 shows the results of the dynamic stability analysis without any additional network upgrades. The results show that GEN-2015-071 may be unstable following the prior outage of the Chisolm to Gracemont 345 kV line followed by a three-phase fault on either the Chisolm to Elk City 230 kV line or the Sweetwater to Wheeler 230 kV line.

Additionally, the local system was unstable with the prior outage of either the Chisolm to Elk City 230 kV line or the Sweetwater to Wheeler 230 kV line followed by the loss of the Chisolm to Gracemont 345 kV line. As a result, GEN-2015-071 may have to be curtailed during the outage of the Chisolm to Gracemont 345 kV line, Chisolm to Elk City 230 kV line, or the Sweetwater to Wheeler 230 kV line to maintain system reliability during subsequent outages.

As a result of the outage of the Elk City 138/69/13.8 kV Transformer, low steady state voltages were observed on the 69kV system near Elk City. The impact of the DISIS-2015-002-7 Group 7 requests on the voltage is negligible thus does not require mitigation by the Group 7 Interconnection Requests.

**Table 4-2: Pre-Mitigation Dynamic Stability Results**

| Cont. Name | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT01-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT02-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT03-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT04-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT05-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT06-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT07-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT08-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT09-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT10-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT11-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT27-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT28-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT29-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT30-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT31-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT32-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT33-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT34-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT35-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT36-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT37-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT38-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT39-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT40-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT41-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT48-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT62-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9001-3PH | Pass | Pass | Stable | Pass | Fail* | Stable | Pass | Fail* | Stable |
| FLT9002-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9003-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9004-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9005-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9006-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9007-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9008-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9009-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9010-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9011-3PH | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT44-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT45-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT51-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT63-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT64-SB | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT06-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT07-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9002-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9004-PO1 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT04-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT05-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9001-PO2 | Pass | Pass | Stable | Pass | Fail* | Stable | Pass | Fail* | Stable |
| FLT9003-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9004-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9005-PO2 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT32-PO3 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT48-PO3 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9008-PO3 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT31-PO4 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT48-PO4 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |

**Table 4-2 continued**

| Cont. Name | 17W | | | 18S | | | 26S | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability | Volt. Recov. | Post Cont. Volt | Stability |
| FLT27-PO5 | Pass | Pass | Unstable | Pass | Pass | Unstable | Pass | Pass | Unstable |
| FLT28-PO5 | Pass | Pass | Stable | Pass | Pass | Stable | Pass | Pass | Stable |
| FLT9006-PO5 | Pass | Pass | Unstable | Pass | Pass | Unstable | Pass | Pass | Unstable |
| FLT30-PO6 | Pass | Pass | GEN Trip*** | Pass | Pass | GEN Trip*** | Pass | Pass | GEN Trip*** |
| FLT30-PO7 | Pass | Pass | Unstable | Pass | Pass | Unstable | Pass | Pass | Unstable |

*Existing system low voltage violations within the 69 kV system isolated by fault not impacted by the Group 7 projects
**GEN-2015-071 unstable with this fault, ***GEN-2015-071 unstable with this fault

# 5.0 Conclusions

The purpose of this ReStudy#7 was to evaluate the impacts of the DISIS-2015-002 (Group 7) active generation interconnection projects on the SPP transmission system as shown in Table 5-1 and assess mitigation upgrades or measures that may be required to maintain system stability and system performance per SPP's Disturbance Performance Requirements. The reactive power and dynamic stability analyses were performed for the evaluation using the PTI PSS/E version 33.7 software. The 2017 winter peak, 2018 summer peak and 2026 summer peak models were used in the study.

**Table 5-1: Group 7 Interconnection Request**

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---|---|---|---|
| GEN-2015-055 | 40.0 | Advanced Energy - AE (solar) | Erick 138 kV (520903) |
| GEN-2015-071 | 200.0 | Vestas (wind) | Chisholm 345 kV (511553) |

The results of the reactive power analysis, also known as the low-wind/no-wind condition analysis or low-irradiance analysis, performed using all three models showed that the projects may require shunt reactors on their collector substation high voltage bus:

1. GEN-2015-055 – 1.8 MVAR
2. GEN-2015-071 – 11.7 MVAR

The shunt reactors are needed to reduce the reactive power transfer at the POI to approximately zero during low/no-wind or low-irradiance conditions while the generation interconnection project remained connected to the grid.

The dynamic stability analysis was performed using the three loading scenarios 2017WP, 2018SP and 2026SP simulating up to 64 faults that included three-phase and single-line-to-ground faults including faults with stuck breakers. The pre-mitigation results showed GEN-2015-071 may have to be curtailed following the outage of the Chisolm to Gracemont 345 kV line, Chisolm to Elk City 230 kV line, or the Sweetwater to Wheeler 230 kV line to maintain system reliability during subsequent outages.