DEFINITIVE INTERCONNECTION SYSTEM IMPACT STUDY 2016-001-5 STABILITY REPORT

By Generator Interconnection Department

Published February 2020

REVISION HISTORY

DATE	AUTHOR	VERSION
1/31/2017	SPP	Initial Report, Stability analysis has not been completed yet for groups 2, 6, 8, 9, & 16
2/8/2017	SPP	Added stand-alone results for all groups except 9, 15, and 16; stability results for groups 6 and 8. Final stand-alone and stability results are expected to be posted by Feb. 28, 2017.
2/28/2017	SPP	Reposted to include final revision 0 results
12/8/2017	SPP	DISIS-2016-001-1 Report revision 0 results due to higher queued and equally queued withdrawals. Excludes stability results for group 9 expected to be posted by Dec. 22, 2017.
12/15/2017	SPP	DISIS-2016-001-1 Report revision 1 results due cost allocation updates for Group 8. Group 6 stability final report revision to remove reference to 765kV.
12/22/2017	SPP	DISIS-2016-001-1 Report revision 2 results for Group 9 stability, Group 8 LOIS correction, and Group 9 cost allocations based on latest TO information.
7/29/2018	SPP	DISIS-2016-001-2 Report revision 0 results for groups 3, 6, and 8 power flow due to withdrawal of higher queued and equally queued requests.
11/13/2018	SPP	DISIS-2016-001-2 Report revision 1 to correct cost allocation for Group 6
3/15/2019	SPP	Report Issued for DISIS-2016-001-3, Groups 3, 6, and 7.

3/29/2019	SPP	Report Issued for DISIS-2016-001-4, Groups 8 and 9.
4/19/2019	SPP	Corrections to Group 9 Cost Allocation (Appendix E and F)
4/24/2019	SPP	Correction of power factor requirements in Section 9.1. Correction to Group 9 Cost Allocation (Appendix E), Previously Allocated R-Plan required for all Group 9 requests for stability.
12/12/2019	SPP	Report Issued for DISIS-2016-001-5, Groups 3, 6, 7, and 8.
12/16/2019	SPP	Report revised to update the % Allocated values from TBD to 0% for the Blackberry - Wolf Creek 345 kV in the "Assigned Upgrade Costs" tab and to add a note clarifying that Group 6 Stability results are pending.
02/19/2020	SPP	Groups 6 and 8 stability reports posted.

CONTENTS

OVERVIEW

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 March 31, 2016.

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.

This specific report pertains to the stability analysis for Definitive Interconnection System Impact Study 2016-001-5 Groups 6 and 8 per the SPP grouping methodology.

At the request of Interconnection Customers, a potential interim mitigation for the LaCygne to Waverly 345kV thermal constraint of inclusion of a series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits was evaluated by SPP. The powerflow analysis sensitivity determined that a 6 ohm series reactor on the Waverly to Wolf Creek 345kV circuit or a 5 ohm series reactor on the LaCygne to Waverly 345kV circuit would provide relief of the observed thermal constraint without resulting in additional steady-state thermal or voltage violations requiring mitigation by Generator Interconnection Requests included in DISIS-2016-001 Group 8. These results are supported by the stability analysis sensitivity included in the Group 8 Stability Analysis below.

As the series reactor was not assigned as mitigation in DISIS-2016-001-5, this Network Upgrade may be pursued by a single Upgrade Sponsor.

The process to sponsor a Network Upgrade on the SPP system, not identified and assigned as mitigation through a planning process (Integrated Transmission Planning, Generation Interconnection, or Transmission Service study), is outlined in Attachment J of the SPP OATT. A Sponsored Upgrade Study Agreement, Guidelines and FAQ may be found at spp.org (https://spp.org/spp-documents-filings/?id=19457).

The DISIS Manual Version 1.0 posted on http://opsportal.spp.org/Studies/Gen contains details about the DISIS process, methodology, definitions, and useful links. Please review the DISIS Manual or contact gistudies@spp.org for more information about the study process.

GROUP 6 STABILITY ANALYSIS

New requests for this study group as well as prior-queued requests are listed in the Requests tab of the DISIS Results Workbook.

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:

- TUCO units: GEN-2015-041 & GEN-2016-056

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 net output to 175 MW and switched off Tolk unit 2.

The Group 6 stability analysis for this area was performed by Mitsubishi Electric Power Products, Inc. (MEPPI). 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.

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

MITSUBISHI ELECTRIC POWER PRODUCTS, INC.
POWER SYSTEMS ENGINEERING DIVISION
530 KEYSTONE DRIVE
WARRENDALE, PA 15086, U.S.A.

Phone: (724) 778-5111 Fax: (724) 778-5149
Home Page: www.meppi.com

Southwest Public Service Company (SPS)

System Impact Study for DISIS-2016-001-5 Group 06 Requests

Technical Report

REP-0655
Revision #04

January 2020

Submitted By:
Mitsubishi Electric Power Products, Inc. (MEPPI)
Power Systems Engineering Division
Warrendale, PA

Report Revision Table

Revision	Reason for Revision	Date	Author
1	Issued Draft Report	10/16/2019	NWT
2	Updated generation dispatch - removed GEN-2015-020	11/13/2019	NWT
3	Addressed SPP Comments	12/17/2019	NWT
4	Accept SPP Comments	1/22/2020	NWT

Title: **System Impact Study for DISIS-2016-001-5 (Group 06) Requests: Technical Report REP-0655**
Date: January 2020
Author: Nicholas W. Tenza; Senior Engineer, Power Systems Engineering Division *Nicholas W. Tenza*
Approved: Donald J. Shoup; General Manager, Power Systems Engineering Division *Donald J. Shoup*

EXECUTIVE SUMMARY

Southwest Public Service Company (SPS) requested a stability analysis to examine the impacts of several study requests in SPP's Group 06 queue. The system impact study required a Stability Analysis detailing the impacts of the DISIS-2016-001-5 interconnecting projects as shown in Table ES-1.

Table ES-1
Interconnection Projects Evaluated

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2015-041	5	CT	Tuco 345kV (525832)
ASGI-2016-002	0.35	Wind	SP - Yuma 115kV
ASGI-2016-004	10	Wind	Palo Duro 115kV

SUMMARY OF STABILITY ANALYSIS

The Stability Analysis determined there were no contingencies that resulted in system instability or generation tripping offline for the examined seasonal peak conditions when all generation interconnection requests were at 100% output.

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SECTION 1: OBJECTIVES

The objective of this report is to provide SPS with the deliverables for the "System Impact Study for DISIS-2016-001-5 Group 06 requests." SPS requested an Interconnection System Impact Study for three (3) generation interconnections for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions, which requires a Stability Analysis and an Impact Study Report.

SECTION 2: BACKGROUND

The Siemens Power Technologies International PSS/E power system simulation program Version 33.10.0 was used for this study. SPP provided the stability database cases for the DISIS-2016-001-3 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions. Contingencies at the POI of each study request and at least one bus away were created and included three phase normally cleared faults, single phase stuck breaker faults, and prior outage conditions. The models include the study projects shown in Table 2-1 and the previously queued projects listed in Table 2-2. Refer to Appendix A for the steady-state and dynamic model data for the study projects. A power flow one-line diagram for each generation interconnection project is shown in Figures 2-1 through 2-3. Note that the one-line diagrams represent the 2017 Winter Peak case.

The Stability Analysis determined the impacts of the new interconnecting projects on the stability and voltage recovery of the nearby system and the ability of the interconnecting projects to meet FERC Order 661A. Three-phase faults and single line-to-ground faults were examined as listed in Table 2-3. The need for reactive compensation and system upgrades was investigated because stability and voltage recovery issues were identified.

Table 2-1
Interconnection Projects Evaluated

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2015-041	5MW uprate to GEN-2013-016 (total power = 196 MW summer/203 MW winter)	GENROU (525845)	Tuco 345kV (525832)
ASGI-2016-002	0.35 uprate to ASGI-2015-002; total power = 2.65MW)	GE 2.65MW (584723)(wind)	SP - Yuma Interchange 115/69kV (526469)
ASGI-2016-004	10	3 x Alstom 3.2 MW & 4 x Renewtech 100 kW (587574/587573)(wind)	Palo Duro 115 kV (524530)

Table 2-2
Previously Queued Nearby Interconnection Projects Included

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2001-033	180	Mitsubishi 1000	San Juan Mesa 230kV (524885)
GEN-2001-036	80	Mitsubishi 1000	Norton 115kV (524502)
GEN-2006-018	170	GENSAL	Tuco 230kV (525830)
GEN-2006-026	502	GENROU (527901, 527902, 527903)	Hobbs 115kV(527891) Hobbs 230kV (527894)
GEN-2010-006	180 Summer 205 Winter	GENROU	Jones_bus2 230kV(526337)
ASGI-2010-010	42	GENSAL	Lovington 115kV (528334)
ASGI-2010-020	29.9	GE 2.3MW	Tap LE-Tatum to LE-Crsroads 69kV (AS10-020-POI, 560360)
ASGI-2010-021	15	Mitsubishi MPS-1000A 1.0MW	Tap LE-Saundrtp to LE-Anderson 69kV (ASGI-021-POI, 560364)
GEN-2010-046	56	GENSAL	Tuco 230kV (525830)
ASGI-2011-001	27.3	Suzlon 2.1MW	Lovington 115kV (528334)
ASGI-2011-003	10	Sany 2.0MW	Hendricks 69kV (525943)
ASGI-2011-004	19.8	Sany 1.8MW	Crosby 69kV (525915)
GEN-2011-025	78.76	GE 1.79MW	Tap on Floyd County - Crosby County 115kV line (G11-025-POI, 562004)
GEN-2011-045	180 Summer 205 Winter	GENROU	Jones_bus2 230kV (526337)
GEN-2011-046	23 Summer 27 Winter	GENROU	Quay County 115kV (524472)
GEN-2011-048	165 Summer 175 Winter	GENROU	Mustang 230kV (527151)
GEN-2012-001	61.2	CCWE 3.6MW (WT4)	Tap Grassland to Borden 230kV (526679)
ASGI-2012-002	18.15	Vestas 1.65MW V82	Clovis 115kV (524808)
GEN-2012-020	477.12	GE 1.68MW	Tuco 230kV (525830)
GEN-2012-034	7 increase; total power = 157MW	GENROU (unit 4; 527164)	Mustang 230kV (527151)

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2012-035	7 increase; total power = 157MW	GENROU (unit 5; 527165)	Mustang 230kV (527151)
GEN-2012-036	7 increase; total power = 172MW Summer/185MW Winter	GENROU (unit 6; 527166)	Mustang 230kV (527151)
GEN-2012-037	196 Summer 203 Winter	GENROU (525844)	Tuco 345kV (525832)
ASGI-2012-002	18	Vestas 1.65MW V82	Clovis 115kV (524808)
GEN-2013-016	191 Summer 203 Winter	GENROU (583456)	Tuco 345kV (525832)
ASGI-2013-002	18.4	Siemens 2.3MW VS (583613)	Tucumcari 115kV (524509)
ASGI-2013-003	18.4	Siemens 2.3MW VS (583623)	Clovis 115kV (524808)
ASGI-2013-005	1.65 increase; total power = 19.8 MW	Vestas V82 1.65MW (583283)	FE-Clovis 115kV (524808)
GEN-2013-022	25.0	Solaron 500kW (583313)	Caprock 115kV (524486)
GEN-2013-027	148.35	Siemens 2.3/2.415	Tap on Yoakum to Tolk 230kV (562480)
GEN-2014-033	70	17 X GE Prolec 4MVA, 2 X GE Prolec 1 MVA, & 5 X Schneider XC680 0.680 MVA PV inverter	Chaves County 115kV
GEN-2014-035	30	8 X GE Prolec 4MVA PV inverter	Chaves County 115kV
ASGI-2015-002	2.3	GE 2.3MW (584723)	Yuma Interchange 115/69kV (526469)
GEN-2015-014	150.0	Vestas V110 2.0MW (584563)	Tap on Cochran – LG Plains 115kV (560030)

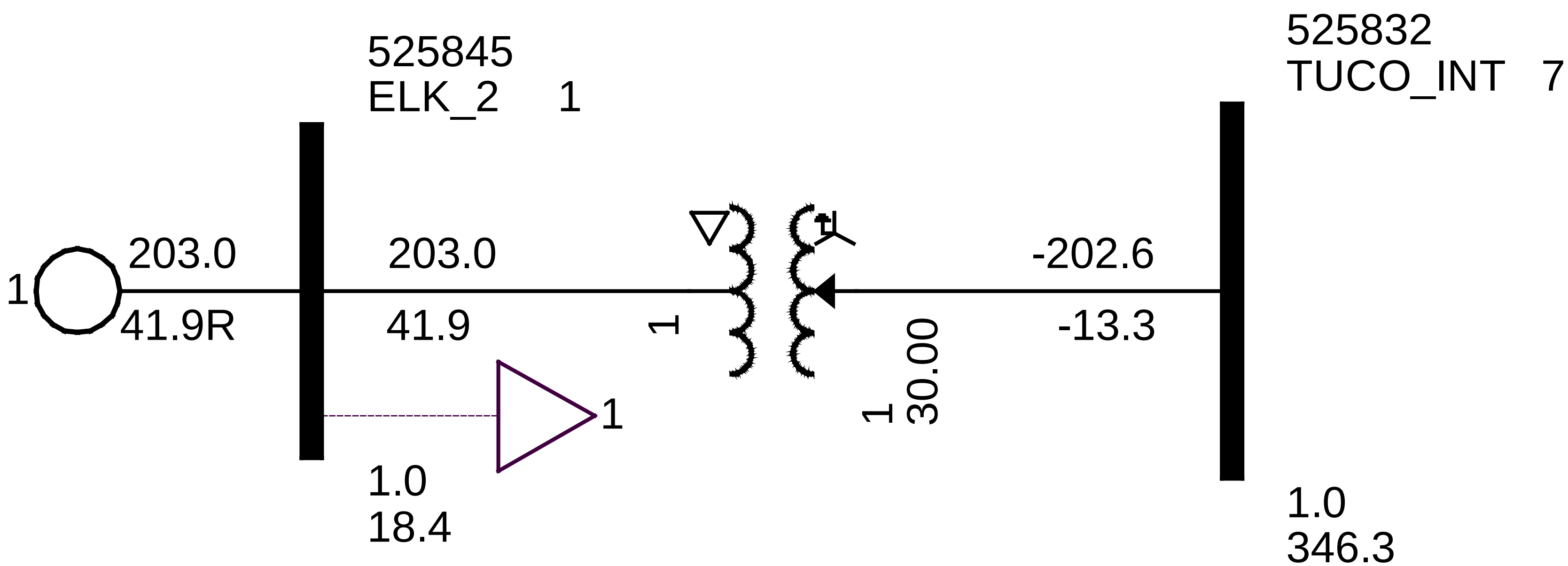

Figure 2-1. Power flow one-line diagram for interconnection project at the Tuco 345 kV POI (GEN-2015-041).

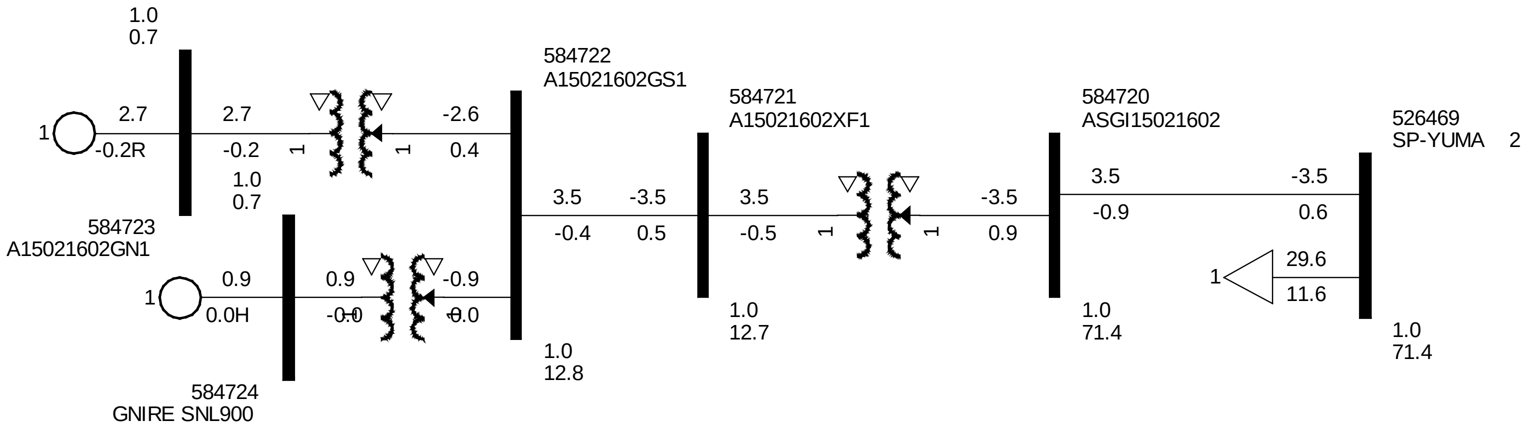

Figure 2-2. Power flow one-line diagram for interconnection project at the Yuma Interchange 69 kV POI (ASGI-2016-002).

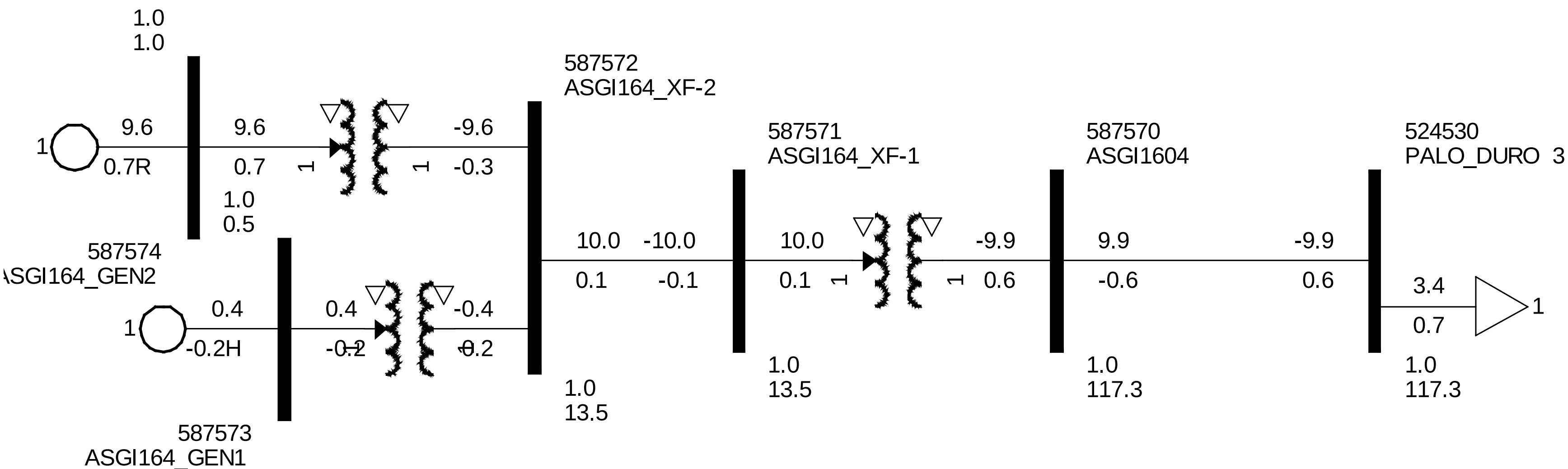

Figure 2-3. Power flow one-line diagram for interconnection project at the Palo Duro 115 kV POI (ASGI-2016-004).

Table 2-3
Case List with Contingency Description

Cont. Name	Description
FLT01-3PH	3 phase fault on the Wolfforth (526524) to Yuma (526475) 115 kV line, near Wolfforth a. Apply fault at the Yuma 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT02-3PH	3 phase fault on the Yuma (526475) to SP-Wolfforth Tap (526481) 115 kV line, near Yuma a. Apply fault at the Yuma 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT03-3PH	3 phase fault on the Wolfforth (526524) to Terry County (526736) 115 kV line, near Wolfforth a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT04-3PH	3 phase fault on the Wolfforth 115 kV (526524) to Wolfforth 230 kV (526525) to Wolfforth 13.2 kV (526522) XFMR CKT 1, near Wolfforth 115 kV. a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT05-3PH	3 phase fault on the Terry County (526736) to Denver North (527130) 115 kV line, near Terry County a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT06-3PH	3 phase fault on the Terry County (526736) to LG-Clauene (526491) 115 kV line, near Terry County a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT07-3PH	3 phase fault on the Terry County (526736) to Sulphur (527262) 115 kV line, near Terry County a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. Name	Description
FLT08-3PH	3 phase fault on the Terry County (526736) to Prentice (526792) 115 kV line, near Terry County a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT09-3PH	3 phase fault on the Terry County 115/69/13.2 kV (526736/526735/526733) transformer circuit 1, near Terry County 115 kV. a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT10-3PH	3 phase fault on the Wolfforth (526525) to Sundown (526435) 230 kV line, near Wolfforth a. Apply fault at the Wolfforth 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT11-3PH	3 phase fault on the Wolfforth (526525) to Lubbock South (526269) 230 kV line, near Wolfforth a. Apply fault at the Wolfforth 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT12-3PH	3 phase fault on the Wolfforth (526525) to Carlisle (526161) 230 kV line, near Wolfforth a. Apply fault at the Wolfforth 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT13-3PH	3 phase fault on the SP-Wolfforth Tap (526481) to LP-Doud Tap (526162) 115 kV line, near SP-Wolfforth Tap a. Apply fault at the SP-Wolfforth Tap 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT14-3PH	3 phase fault on the SP-Wolfforth Tap (526481) to SP-Wolfforth (526483) 115 kV line, near SP-Wolfforth Tap a. Apply fault at the SP-Wolfforth Tap 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. Name	Description
FLT15-SB	**Single phase fault with stuck breaker at Wolfforth (526524)** a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Wolfforth (526524) – Yuma (526475) 115 kV d. Wolfforth (526524) – Terry County (526736) 115 kV
FLT16-SB	**Single phase fault with stuck breaker at Wolfforth (526524)** a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Wolfforth 115 kV (526524)/230 kV (526525)/13.2 kV (526522) Xfmr d. Wolfforth (526524) – Terry County (526736) 115 kV
FLT17-SB	**Single phase fault with stuck breaker at SP-Wolfforth Tap (526481)** a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. SP-Wolfforth Tap (526481) – LP-Doud (526162) 115 kV d. SP-Wolfforth Tap (526481) – SP-Wolforth (526483) 115 kV
FLT18-SB	**Single phase fault with stuck breaker Terry County (526736)** a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Terry County (526736) – Prentice (526792) 115 kV d. Terry County (526736) – Sulphur (527262) 115 kV
FLT19-SB	**Single phase fault with stuck breaker Terry County (526736)** a. Apply fault at the Terry County 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Terry County (526736) – Denver (527130) 115 kV d. Terry County (526736) – LG-Clauene (526491) 115 kV
FLT20-PO	**Prior Outage of the Wolfforth (526524) to Terry County (526736) 115 kV line circuit 1;** 3 phase fault on the Wolfforth 115 kV (526524)/230 kV (526525)/13.2 kV (526522) transformer, near Wolfforth. a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT21-PO	**Prior Outage of the Wolfforth (526524) to Terry County (526736) 115 kV line circuit 1;** 3 phase fault on the Wolfforth (526524) to Yuma (526475) 115 kV line, near Wolfforth a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT22-PO	**Prior Outage of the Wolfforth (526524) to Yuma (526475) 115 kV line circuit 1;** 3 phase fault on the Wolfforth 115 kV (526524)/230 kV (526525)/13.2 kV (526522) transformer, near Wolfforth. a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Cont. Name	Description
FLT23-PO	**Prior Outage of the Wolfforth (526524) to Yuma (526475) 115 kV line circuit 1;** 3 phase fault on the Wolfforth (526524) to Terry County (526736) 115 kV line circuit 1, near Wolfforth. a. Apply fault at the Wolfforth 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT24-PO	**Prior Outage of the SP-Wolfforth Tap (526481) to SP-Wolfforth (526483) 115 kV line circuit 1;** 3 phase fault on the SP-Wolfforth Tap (526481) to LP-Doud (526162) 115 kV line circuit 1, near SP-Wolfforth Tap. a. Apply fault at the SP-Wolfforth Tap 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT25-3PH	3 phase fault on the Happy (525154) to Palo Duro (524530) 115 kV line, near Happy. a. Apply fault at the Palo Duro 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT26-3PH	3 phase fault on the Palo Duro (524530) to Randall (524364) 115 kV line, near Palo Duro. a. Apply fault at the Paulo Duro 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT27-3PH	3 phase fault on the Happy (525154) to Tulia Tap (525179) 115 kV line, near Happy. a. Apply fault at the Happy 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT28-3PH	3 phase fault on the Happy (525153) to Happy City Tap (525143) 69 kV line, near Happy City Tap. a. Apply fault at the Happy City Tap 69 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT29-3PH	3 phase fault on the Happy 115 kV (525154) to Happy 69 kV (525153) to Happy 13.2 kV (525151) XFMR CKT 1, near Happy 115 kV. a. Apply fault at the Happy 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Cont. Name	Description
FLT30-3PH	3 phase fault on the Randall (524364) to Manhattan (524224) 115 kV line, near Randall. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT31-3PH	3 phase fault on the Randall (524364) to Southeast (524338) 115 kV line, near Randall. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT32-3PH	3 phase fault on the Randall (524364) to Georgia (524322) 115 kV line, near Randall. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT33-3PH	3 phase fault on the Randall (524364) to Canyon East (524522) 115 kV line, near Randall. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT34-3PH	3 phase fault on the Randall 230 kV (524365) to Randall 115 kV (524364) to Randall 13.2 kV (524361) XFMR CKT 1, near Randall 115 kV. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT35-SB	**Single phase fault with stuck breaker at Happy (525154) 115 kV** a. Apply fault at the Happy 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Happy (525154) – Tulia Tap (525179) 115 kV d. Happy (525154) – Palo Duro (524530) 115 kV
FLT36-SB	**Single phase fault with stuck breaker at Happy (525154) 115 kV** a. Apply fault at the Happy 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Happy (525154) – Tulia Tap (525179) 115 kV d. Happy 115 kV (525154)/69 kV (525153)/13.2 kV (525151) Xfmr

Cont. Name	Description
FLT37-SB	**Single phase fault with stuck breaker at Randall (524364) 115 kV** a. Apply fault at the Randall 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Randall (524364) – Georgia (524322) 115 kV d. Randall (524364) – Palo Duro (524530) 115 kV
FLT38-SB	**Single phase fault with stuck breaker at Randall (524364) 115 kV** a. Apply fault at the Randall 115 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Randall (524364) – Georgia (524322) 115 kV d. Randall (524364) – Canyon E (524522) 115 kV
FLT39-PO	**Prior Outage of the Happy (525154) to Tulia Tap (525179) 115 kV line circuit 1;** 3 phase fault on the Happy (525154) to Palo Duro (524530) 115 kV line circuit 1, near Palo Duro. a. Apply fault at the Palo Duro 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT40-PO	**Prior Outage of the Happy 115 kV (525154)/69 kV (525153)/13.2 kV (525152) Xfmr, circuit 2;** 3 phase fault on the Happy (525154) to Palo Duro (524530) 115 kV line circuit 1, near Palo Duro. a. Apply fault at the Palo Duro 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT41-PO	**Prior Outage of the Happy 115 kV (525154)/69 kV (525153)/13.2 kV (525152) Xfmr, circuit 2;** 3 phase fault on the Happy (525154) to Tulia Tap (525179) 115 kV line circuit 1, near Happy. a. Apply fault at the Happy 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT42-PO	**Prior Outage of the Randall (524364) to Georgia (524322) 115 kV line circuit 1;** 3 phase fault on the Happy (525154) to Palo Duro (524530) 115 kV line circuit 1, near Palo Duro. a. Apply fault at the Palo Duro 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT43-PO	**Prior Outage of the Happy (525154) to Palo Duro (524530) 115 kV line circuit 1;** 3 phase fault on the Randall (524364) to Manhattan (524224) 115 kV line circuit 1, near Randall. a. Apply fault at the Randall 115 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT44-3PH	3 phase fault on the Tuco (525832) to OKU (511456) 345 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. Name	Description
FLT45-3PH	3 phase fault on the Tuco (525832) to Border (515458) 345 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT46-3PH	3 phase fault on the Tuco 345/230/13.2 kV (525832/525830/525824) transformer circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT47-3PH	3 phase fault on the Border (515458) to Woodward (515375) 345 kV line circuit 1, near Border. a. Apply fault at the Border 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT48-3PH	3 phase fault on the OKU (511456) to LES (511468) 345 kV line circuit 1, near OKU. a. Apply fault at the OKU 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT49-3PH	3 phase fault on the Tuco (525830) to Antelope (525840) 230 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT50-3PH	3 phase fault on the Tuco (525830) to Swisher (525213) 230 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT51-3PH	3 phase fault on the Tuco (525830) to Carlisle (526161) 230 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. Name	Description
FLT52-3PH	3 phase fault on the Tuco (525830) to Tolk East (525524) 230 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT53-3PH	3 phase fault on the Tuco (525830) to Jones (526337) 230 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT54-3PH	3 phase fault on the Tuco 230/115/13.2 kV (525830/525828/525821) transformer circuit 1, near Tuco. a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT55-3PH	3 phase fault on the Potter County (523961) to Hitchland (523097) 345 kV line circuit 1, near Potter County. a. Apply fault at the Potter County 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT56-SB	**Single phase fault with stuck breaker at Tuco (525832)** a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Tuco 345/230/13.2 kV (525832/525830/525824) transformer d. Tuco (525832) – OKU (511456) 345 kV Circuit #1
FLT57-SB	**Single phase fault with stuck breaker at Tuco (525832)** a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Tuco 345/230/13.2 kV (525832/525830/525824) transformer d. Tuco (525832) – Border (515458) 345 kV Circuit #1
FLT58-SB	**Single phase fault with stuck breaker at Woodward (515375)** a. Apply fault at the Woodward 345 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Woodward (515375) – Thistle (539801) 345 kV d. Woodward (515375) – Tatonga (515407) 345 kV

Cont. Name	Description
FLT59-SB	**Single phase fault with stuck breaker at Woodward (515375)** a. Apply fault at the Woodward 345 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Woodward (515375) – Thistle (539801) 345 kV d. Woodward (515375) – Border (515458) 345 kV
FLT60-SB	**Single phase fault with stuck breaker at Tuco (525830)** a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Tuco (525830) – Antelope (525840) 230 kV d. Tuco (525830) – Swisher (525213) 230 kV
FLT61-SB	**Single phase fault with stuck breaker at Tuco (525830)** a. Apply fault at the Tuco 230 kV bus. b. Clear fault after 16 cycles and trip the following elements c. Tuco (525830) – Carlisle (526161) 230 kV d. Tuco (525830) – Jones (526337) 230 kV
FLT62-PO	**Prior Outage of the Tuco (525832) to Border (515458) 345 kV line circuit 1;** 3 phase fault on the Tuco (525832) to OKU (511456) 345 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT63-PO	**Prior Outage of the Tuco (525832) to Border (515458) 345 kV line circuit 1;** 3 phase fault on the Tuco 345/230 kV transformer (525832/525830/525824) circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT64-PO	**Prior Outage of the Tuco (525832) to OKU (511456) 345 kV line circuit 1;** 3 phase fault on the Tuco (525832) to Border (515458) 345 kV line circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT65-PO	**Prior Outage of the Tuco (525832) to OKU (511456) 345 kV line circuit 1;** 3 phase fault on the Tuco 345/230 kV transformer (525832/525830/525824) circuit 1, near Tuco. a. Apply fault at the Tuco 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

SECTION 3: STABILITY ANALYSIS

The objective of the Stability Analysis was to determine the impacts of the generator interconnections on the stability and voltage recovery on the SPS and surrounding transmission system. If problems with stability or voltage recovery were identified, the need for reactive compensation or system upgrades was investigated.

3.1 Approach

SPP provided MEPPI with the DISIS-2016-001-3 stability datasets and the following three power flow cases:

- 17W_DIS16013_G06_M2
- 18S_DIS16013_G06_M2
- 26S_DIS16013_G06_M2

Each case was examined prior to the Stability Analysis to ensure the case contained any previously queued projects listed in Table 2-3 and contained the correct assigned upgrades. The following DISIS-2015-002-7 upgrades were removed from the power flow cases prior to running the analysis:

- Border Capacitive Reactive Support (remove 100 MVAR)
- Deaf Smith Capacitive Reactive Support (remove 60 MVAR)
- Oklaunion Capacitive Reactive Support (remove 100 MVAR, existing HVDC 3x30 MVAR remain)

The following DISIS-2016-001-3 upgrades were removed from the power flow cases prior to running the analysis:

- Border to Chisholm 345kV line
- Crawfish Draw 345kV Substation (reinstate Border to Tuco 345 kV line and O.K.U. to Tuco 345 kV line)
- Crawfish Draw to Tolk 345kV line
- Tolk to Potter 345kV line

Refer to Table 3-1 above for the status of higher queued requests and DISIS-2016-001 requests.

Table 3-1
Projects Status for the Stability Analysis

Request	DISIS Queue	Status	Size	Point of Interconnection
GEN-2010-046	DISIS-2010-002	Offline	56 MW	Tuco Interchange (525830) 230kV
GEN-2015-020	DISIS-2015-002	Offline	100 MW	Oasis (524874) 115kV
GEN-2015-056	DISIS-2015-002	Offline	101.2 MW	Crossroads (527656) 345kV
GEN-2015-041	DISIS-2016-001	Online	196 MW (S) 203 MW (W)	Tuco (525832) 345kV
GEN-2016-015	DISIS-2016-001	Offline	100 MW	Andrews (528604) 230kV
GEN-2016-056	DISIS-2016-001	Offline	200 MW	Carlisle (526161) 230kV
GEN-2016-062	DISIS-2016-001	Offline	250.7 MW	Andrews (528604) 230kV
GEN-2016-069	DISIS-2016-001	Offline	31.35 MW	Chaves County (527482) 115kV
ASGI-2016-002	DISIS-2016-001	Online	0.35 MW	SP Yuma (526469) 69kV
ASGI-2016-004	DISIS-2016-001	Online	10 MW	Palo Duro (524530) 115kV

A select set of generators no longer in close proximity to study units were scaled to reflect the MDWG dispatch adjusted for system scaling to accommodate dispatch of study requests. Refer to Table 3-2 for a list of generation that was in close proximity to DISIS-2016-001-5 requests.

Table 3-2
Group 06 Conventional Generation Dispatch

Generation	Bus	Close proximity	17W	18S	26S
Plant X unit 1	525491	No	Offline	Offline	35.7
Plant X unit 2	525492	No	Offline	56.5	72.1
Plant X unit 3	525493	No	66.7	56.5	80.9
Plant X unit 4	525494	No	Offline	90.5	157.3
Tolk unit 1	525561	No	185.6	390.8	446.0
Tolk unit 2	525562	No	Offline	398.1	441.9
Tuco (Elks) unit 1	525844	Yes	203.0	196.0	196.0
Tuco (Elks) unit 2	525845	Yes	203.0	196.0	196.0
Mustang unit 1	527161	No	159.0	159.0	159.0
Mustang unit 2	527162	No	159.0	159.0	159.0
Mustang unit 3	527163	No	169.0	169.0	169.0
Mustang unit 4	527164	No	157.0	157.0	157.0
Mustang unit 5	527165	No	157.0	157.0	157.0
Mustang unit 6	527166	No	172.0	172.0	172.0
Hobbs Plant 1	527901	No	111.6	122.2	125.9
Hobbs Plant 2	527902	No	110.8	121.3	125.1
Hobbs Plant 3	527903	No	163.8	179.4	185.0

After implementing the previously assigned upgrades and study requests, the stability dataset was examined to ensure there was no suspect data in the study area. The dynamic datasets were also verified and stable initial system conditions (i.e., “flat lines”) were achieved. Three-phase and single phase-to-ground faults listed in Table 2-3 were examined. Single-phase fault impedances were calculated for each season to result in a voltage of approximately 60% of the pre-fault voltage. Refer to Table 3-3 for a list of the calculated single-phase fault impedances utilized.

Table 3-3
Calculated Single-Phase Fault Impedances for DISIS-2016-001-5 Contingencies

Ref. No.	Cont. Name	Single-Phase Fault Impedance (MVA)		
		2017 Winter	2018 Summer	2026 Summer
1	FLT15_SB	-1500.0	-1500.0	-1500.0
2	FLT16_SB	-1500.0	-1500.0	-1500.0
3	FLT17_SB	-1500.0	-1500.0	-1500.0
4	FLT18_SB	-1375.0	-1375.0	-1375.0
5	FLT19_SB	-1375.0	-1375.0	-1375.0
6	FLT35_SB	-750.0	-750.0	-718.8
7	FLT36_SB	-750.0	-750.0	-718.8
8	FLT37_SB	-2812.5	-2812.5	-2609.4
9	FLT38_SB	-2812.5	-2812.5	-2609.4
10	FLT56_SB	-4437.5	-4437.5	-4640.4
11	FLT57_SB	-4437.5	-4437.5	-4640.4
12	FLT58_SB	-8093.8	-8093.8	-8500.0
13	FLT59_SB	-8093.8	-8093.8	-8500.0
14	FLT60_SB	-5250.0	-5656.3	-5656.3
15	FLT61_SB	-5250.0	-5656.3	-5656.3

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

- 520 AEPW
- 524 OKGE
- 525 WFEC
- 526 SPS
- 531 MIDW
- 534 SUNC
- 536 WERE

Requested and previously queued generation outside the above study area was also monitored.
The results of the analysis determined if reactive compensation or system upgrades were required to obtain acceptable system performance. If additional reactive compensation was required, the

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

3.2 Stability Analysis Results

The Stability Analysis determined there were no contingencies that resulted in system instability or generation tripping offline for the examined seasonal peak conditions when all generation interconnection requests were at 100% output.

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

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

Table 3-4
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions

Ref. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
1	FLT01-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT02-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT03-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT04-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT05-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT06-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT07-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT08-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT09-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT10-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT11-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT12-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT13-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT14-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT15-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT16-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT17-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT18-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
19	FLT19-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT20-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT21-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT22-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT23-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT24-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT25-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT26-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT27-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT28-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT29-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT30-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT31-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT32-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT33-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions

Ref. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than 0.70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
34	FLT34-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT35-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT36-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT37-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT38-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT39-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT40-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT41-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT42-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT43-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT44-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT45-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT46-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT47-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT48-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT49-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT50-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT51-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT52-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT53-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT54-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT55-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT56-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT57-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT58-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT59-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT60-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT61-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT62-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT63-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
64	FLT64-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT65-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

FLT45-3PH, a three-phase fault resulting in the loss of Tuco to Border 345 kV, is a representative limiting contingency. For this contingency, all system bus voltages and generator rotor angles remained compliant with SPP performance criteria. Refer to Figure 3-1 for a representative voltage plot of Oklaunion and Tuco area voltages for the 2017 Winter Peak case and Figure 3-2 for a representative rotor angle plot for study area generators.

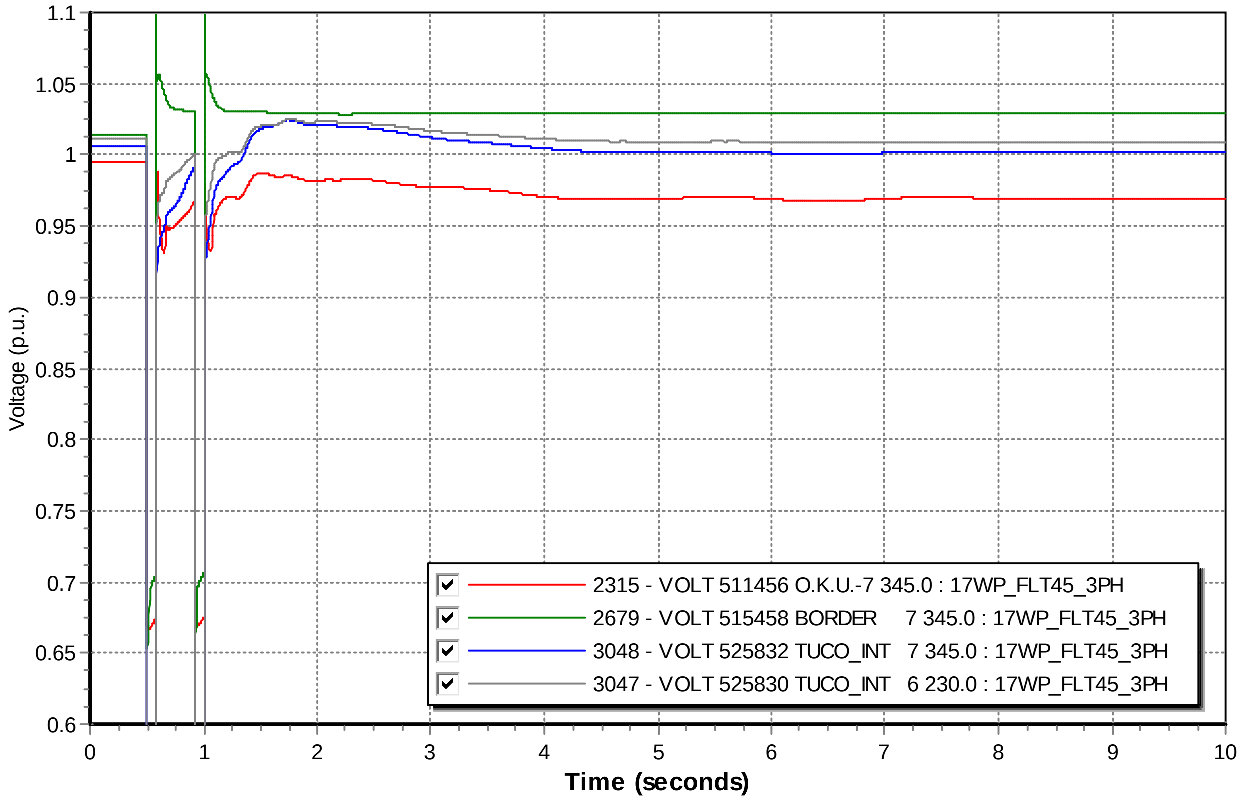

Figure 3-1: Representative plot of Tuco area bus voltages for FLT45 for 2017WP conditions.

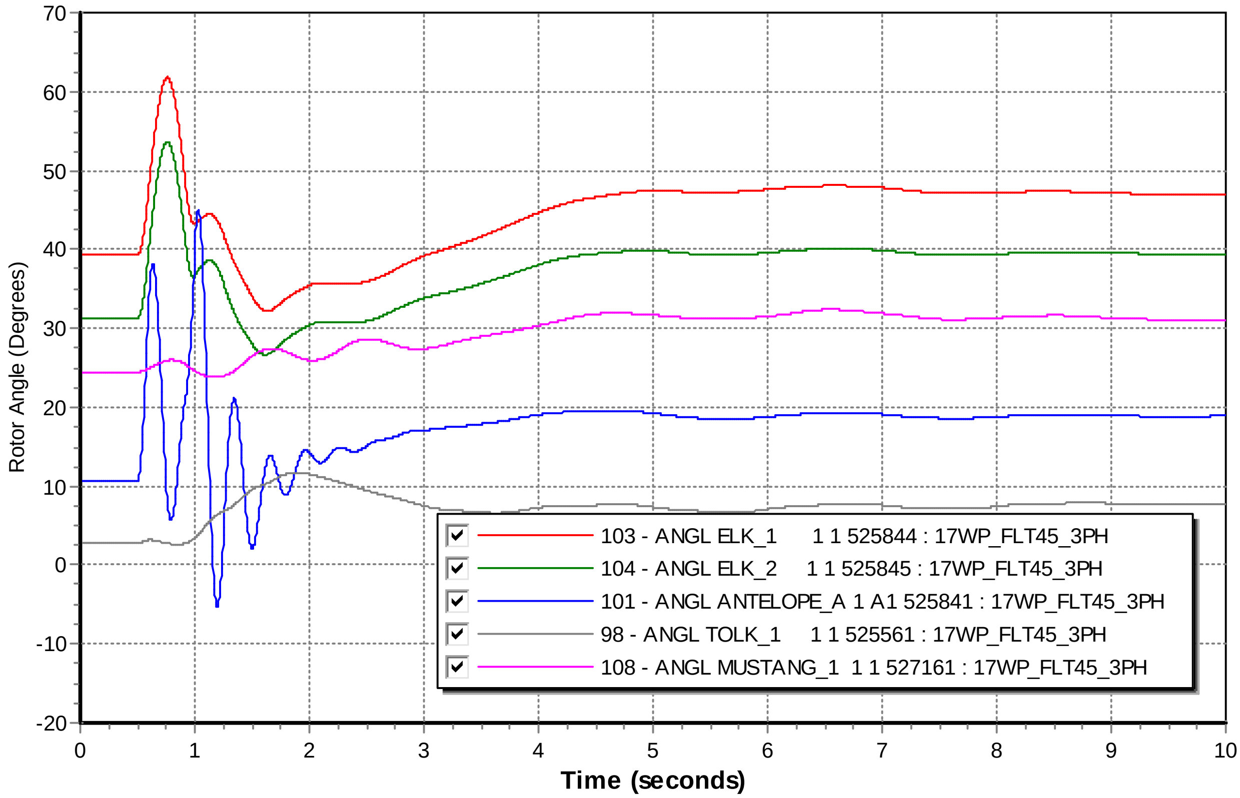

Figure 3-2: Representative plot of study area generation rotor angles for FLT45 for 2017WP conditions.

SECTION 4: CONCLUSIONS

The Stability Analysis determined there were no contingencies that resulted in system instability or generation tripping offline for the examined seasonal peak conditions when all generation interconnection requests were at 100% output.

GROUP 8 STABILITY ANALYSIS

New requests for this study group as well as prior-queued requests are listed in the Requests tab of the DISIS Results Workbook.

The Group 8 cases included the following system adjustments of dispatching, to maximum output, generation interconnected at the same or adjacent substations to a DISIS-2016-002 or current study (DISIS-2016-001) request:

- GRDA Energy Center: DISIS-2016-002 requests
- Northeastern units: DISIS-2016-002 requests
- Sooner units: GEN-2016-022, GEN-2016-031, GEN-2016-061, & GEN-2016-068
- Spring Creek units: DISIS-2016-002 requests
- West Pawhuska unit: DISIS-2016-002 requests

The Group 8 stability analysis for this area was performed by Mitsubishi Electric Power Products, Inc. (MEPPI).

The prior DISIS-2016-001-1 Group 08 analysis identified steady-state voltage violations for FLT101-PO; prior outage of the Belle Plaine to Farber 138k line followed by the loss of the Sumner to TIMJCT 138kV line. This violation was not observed in this DISIS-2016-001-5 Group 08 analysis as the capacitor banks, which were dispatched as part of the mitigation plan following the prior outage, were dispatched in the DISIS-2016-001-5 study cases prior to any events.

The prior DISIS-2016-001-1 Group 08 analysis identified instability for FLT122-PO and FLT123-PO, which both include the prior outage of Middleton Tap to Peckham Tap 345kV, requiring a system adjustment of 110MW of generation curtailment; GEN-2016-071 reduced to as low as 90 MW. The fault event FLT125-PO in the DISIS-2016-001-5 Group 08 analysis did not require a system adjustment and is attributed to the prior analysis being conducted with the 2015 MDWG models whereas the current analysis was conducted with the 2016 MDWG models.

The fault event FLT126-PO in the DISIS-2016-001-5 Group 08 analysis identified generation curtailment of approximately 110 MW of generation between GEN-2011-057 and GEN-2016-071 is required following the prior outage of either Middleton Tap to Peckham Tap or Creswell to Oxford 138kV circuit. The generation curtailment is required to maintain system stability for the subsequent loss of the other circuit. Actual system conditions may require output reduction of both GEN-2011-057 and GEN-2016-071 to maintain the reliability of the transmission network.

NERC MOD-026 and MOD-027 model validation studies were recently completed for the Wolf Creek Nuclear plant. This DISIS-2016-001-5 Group 08 analysis incorporates the most updated models for the Wolf Creek Nuclear plant.

With the new requests modeled and the Wolf Creek NERC MOD-026 and MOD-027 model updates, new violations of stability damping criteria and loss of synchronism were observed for TPL-001-4 P1 and P6 fault events on the Waverly to Wolf Creek 345kV circuit.

Mitigation of the P1 event is the existing TPL Corrective Action Plan to implement an OP Guide that reduces the output of the Wolf Creek and Waverly generating facilities.

Mitigation of the P6 events is a system adjustment involving curtailment of up to approximately 1,105 MW of generation in Group 8 following the prior outage of the Waverly to Wolf Creek 345kV circuit.

The following power flow analysis upgrades and an excitation system upgrade were evaluated and found to be adequate mitigation for the observed stability issues:

- Wolf Creek to Emporia 345kV circuit (Estimated lead time of 4.5 years)
- Wolf Creek to Blackberry 345kV circuit (Estimated completion date listed in the Upgrades Summary tab of the DISIS Results Workbook)
- Tuning or replacing the Wolf Creek AVR (Estimated lead time of 4.5 years)

A sensitivity stability analysis for the inclusion of a series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits was conducted at the request of Interconnection Customers as a potential interim mitigation for the LaCygne to Waverly 345kV thermal constraint with an estimated lead time of 3 years. The sensitivity observed that the inclusion of series reactors did not provide mitigation for the observed stability issues nor an observable impact on the stability response of the transmission system.

An upgrade to include series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits will require a technical conference with the Generator Owners of the Waverly Wind and Wolf Creek Nuclear Generating Facilities as well as the Transmission Owners and SPP to determine the additional studies, potentially including an EMTP analysis, required to evaluate further feasibility of this upgrade.

The DISIS-2016-001-5 identified upgrades are listed in the Upgrades Summary tab of the DISIS Results Workbook and includes only the Wolf Creek to Blackberry 345kV circuit from the potential upgrades described in the Group 8 stability analysis.

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

MITSUBISHI ELECTRIC POWER PRODUCTS, INC.
POWER SYSTEMS ENGINEERING DIVISION
530 KEYSTONE DRIVE
WARRENDALE, PA 15086, U.S.A.

Phone: (724) 778-5111 Fax: (724) 778-5149
Home Page: www.meppi.com

Southwest Power Pool, Inc. (SPP)

DISIS-2016-001-5 (Group 08) Definitive Impact Study

Final Report

REP-0633
Revision #03

February 2020

Submitted By:
Mitsubishi Electric Power Products, Inc. (MEPPI)
Power Systems Engineering Division
Warrendale, PA

Title: **DISIS-2016-001-5 (Group 08) Definitive System Impact Study: Final Report REP-0633**
Date: February 2020

Author: Sarvesh Gadre; Engineer I, Power Systems Engineering Division *Sarvesh Gadre*
Reviewed: Nicholas W. Tenza; Senior Engineer, Power Systems Engineering Division *Nicholas W. Tenza*

EXECUTIVE SUMMARY

SPP requested an additional stability analysis to Definitive Interconnection System Impact Study (DISIS) for DISIS-2016-001-5 Group 08 generation. Additionally, the NERC MOD-026 and MOD-027 model validation studies were recently completed for the Wolf Creek Nuclear plant. This study incorporates the most updated models for the Wolf Creek Nuclear plant. Table ES-1 shows the current study requests included in this study.

Table ES-1
Interconnection Projects Included in Analysis

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2016-009	29	GENROU (Steam; 587073, 587074)	Osage 69Kv (514742)
GEN-2016-022	151.8	Vestas V126 3.45MW (wind; 587163)	Ranch Road 345kV (515576)
GEN-2016-031	1.5MW uprate of GEN-2015-001(total = 201.3MW)	Uprate GEN-2015-001 Vestas V126 3.0MW to Vestas V126 3.3MW (wind; 515691)	Ranch Road 345kV (515576)
GEN-2016-032	200	Vestas V110 2MW (wind; 587213)	Tap Marshall (514733)- Cottonwood Creek (514827) 138kV, (G16-032-TAP, 560077) (Updated POI of Crescent 138kV not reflected in study)
GEN-2016-061	250.7	GE 2.3 MW (wind; 587413)	Tap Woodring (514715) – Sooner (514803) 345kV (G16-061-TAP, 560084)
GEN-2016-068	250	GE 2.0MW (wind; 587463 & 587466)	Woodring 345kV (514715)
GEN-2016-071	198.2	GE 2.3MW & GE 2.5MW (wind; 587483 & 587486)	MIDLTNT4 138kV (514804)
GEN-2016-073	220	GE 2.0MW (wind; 587503)	Tap on Thistle (539801) to Wichita (532796) 345kV, ckt1&2 (Buffalo Flats 345kV; 560033)

SUMMARY OF STABILITY ANALYSIS

The Stability Analysis determined that the Wolf Creek NERC MOD-026 and MOD-027 model validation updates resulted in system and rotor angle instability for a fault on the Waverly to Wolf Creek 345kV circuit. This was observed both as a TPL-001-4 P1 event along with several P6 events with a prior outage of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV circuits. The study corroborated the prior DISIS-2016-001-1 stability analysis results that did not identify stability issues prior to the inclusion of the Wolf Creek MOD validation model updates.

With the inclusion of the Wolf Creek MOD validation model updates, the P1 event system response to a fault on the Waverly to Wolf Creek 345kV circuit was found to be unstable with undamped oscillations of the Wolf Creek rotor angle that does not meet the SPP Disturbance Performance Requirements. This response was determined to be present with the DISIS-2016-001 Group 8 requests excluded from the model. Mitigation for the instability is the existing TPL Corrective Action Plan to implement an OP Guide that reduces the output of the Wolf Creek and Waverly generating facilities.

At the request of SPP, a sensitivity for the inclusion of a series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits was conducted. The sensitivity observed that the inclusion of series reactors did not provide mitigation for the observed stability issues nor an observable impact on the stability response of the transmission system.

Generation curtailment of approximately 110 MW of generation between GEN-2011-057 and GEN-2016-071 is required following the prior outage of either Middleton Tap to Peckham Tap or Creswell to Oxford 138kV circuit. The generation curtailment is required to maintain system stability for the subsequent loss of the other circuit.

Generation curtailment of approximately 1,105 MW of generation in Group 8 is required following the prior outage of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV. The generation curtailment is required to maintain system stability for the subsequent loss of Wolf Creek to Waverly 345kV circuit or Waverly to LaCygne 345kV circuit and to maintain the System Operating Limit for Wolf Creek at a minimum of 700 MW net output.

Several upgrade options were observed to mitigate the system instability observed for all contingencies. These mitigation options include:

- Wolf Creek to Emporia 345kV circuit (Scenario 9)
- Wolf Creek to Blackberry 345kV circuit (Scenario 10)
- Tuning or replacing the Wolf Creek AVR (Scenario 11)

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SECTION 1: OBJECTIVES

The objective of this report is to provide Southwest Power Pool, Inc. (SPP) with the deliverables for the “DISIS-2016-001-5 (Group 08) System Impact Study.” SPP requested an Interconnection System Impact Study to evaluate the impact of the Wolf Creek NERC MOD-026 and MOD-027 model updates for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions. This analysis required a Stability Analysis and an Impact Study Report.

SECTION 2: BACKGROUND

The Siemens Power Technologies International PSS/E power system simulation program Version 33.10.0 was used for this study. SPP provided the DISIS-2016-002-1 stability database cases for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions. The DISIS-2016-002-1 models were updated to reflect DISIS-2016-001-5 conditions. Each DISIS-2016-001-5 generator equivalent PSS/E model was already included in the models. The lower queued DISIS-2016-002-1 requests and upgrades were removed from the study cases. Generation was offset by scaling across the SPP footprint. The models include the Group 08 DISIS-2016-001-5 projects shown in Table 2-1 and the previously queued projects listed in Table 2-2. A power flow one-line diagram for each DISIS-2016-001-5 generation interconnection project is shown in Figures 2-1 through 2-7. Note that the one-line diagrams represent the 2017 Winter Peak case.

SPP Performance Criteria violations for stability and voltage recovery were identified and the need for reactive compensation or system upgrades was investigated. Three-phase faults and single line-to-ground faults were examined as listed in Table 2-3. Note contingency numbers 158 through 171 were added to evaluate the need for curtailment following mitigation implementation.

Table 2-1
Interconnection Projects Evaluated

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2016-009	29	GENROU (Steam; 587073, 587074)	Osage 69kV (514742)
GEN-2016-022	151.8	Vestas V126 3.45MW (wind; 587163)	Ranch Road 345kV (515576)
GEN-2016-031	1.5MW uprate of GEN-2015-001(total = 201.3MW)	Uprate GEN-2015-001 Vestas V126 3.0MW to Vestas V126 3.3MW (wind; 515691)	Ranch Road 345kV (515576)
GEN-2016-032	200	Vestas V110 2MW (wind; 587213)	Tap Marshall (514733)- Cottonwood Creek (514827) 138kV, (G16-032-TAP, 560077) (Updated POI of Crescent 138kV not reflected in study)
GEN-2016-061	250.7	GE 2.3 MW (wind; 587413)	Tap Woodring (514715) – Sooner (514803) 345kV (G16-061-TAP, 560084)
GEN-2016-068	250	GE 2.0MW (wind; 587463 & 587466)	Woodring 345kV (514715)
GEN-2016-071	198.2	GE 2.3MW & GE 2.5MW (wind; 587483 & 587486)	MIDLTNT4 138kV (514804)
GEN-2016-073	220	GE 2.0MW (wind; 587503)	Tap on Thistle (539801) to Wichita (532796) 345kV, ckt1&2 (Buffalo Flats 345kV; 560033)

Table 2-2
Previously Queued Nearby Interconnection Projects Included

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2002-004	199.5 (LGIA revision capacity of 153MW not reflected in study)	GE.1.5MW	Latham 345kV (532800)
GEN-2005-013	199.8	Vestas V90 1.8MW	Caney River 345kV (532780)
GEN-2007-025	299.2	GE 1.6MW	Viola 345kV (532798)
GEN-2008-013	300	G.E. 1.68MW	Hunter 345kV (515476)
GEN-2008-021	1261 Summer 1283 Winter	GENROU	Wolf Creek 345kV (532797)
GEN-2008-098	100.8	Vestas V100 1.8MW	Tap on the Wolf Creek – LaCygne 345kV line (560004)
GEN-2009-025	59.8	Siemens 2.3MW	Tap on the Deerck – Sincblk 69KV line (515528)
GEN-2010-003	98.7	Vestas V100 1.8MW	Tap on the Wolf Creek – LaCygne 345kV line (560004)
GEN-2010-005	299.2	GE 1.6MW	Viola 345kV (532798)
ASGI-2010-006	150	GE1.5MW	Remington 138kV (301369)
GEN-2010-055	4.8	GENROU	Wekiwa 138kV (509757)
GEN-2011-057	150.0	Vestas VCSS 2.0MW (533141)	Creswell 138kV (532981)
KCPL Distributed: Osawatomie	76.0	GENROU (543078)	Paola 161kV
GEN-2012-032	300	Vestas V112 3.0MW	Tap Rose Hill-Sooner 345kV (562318)
GEN-2012-033	98.055	GE 1.715MW & GE 1.79MW	Tap Bunch Creek-South 4th 138kV(562303)
GEN-2012-041	85 Summer 121.5 Winter	GENROU	Tap Rose Hill-Sooner 345kV (562318)

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2013-012	4 x 168.0MW Summer 4 x 215MW Winter	GENROU (514910) (514911) (514912) (514942)	Redbud 345kV (514909)
GEN-2013-028	516.4 Summer 559.5 Winter	GENROU (512614, 512615)	Tap on Tulsa N to GRDA1 345kV (562423)
GEN-2013-029	299	Siemens 2.3MW (515660, 515661)	Renfrow 345kV(515543)
GEN-2014-001	199.5	Gamesa 2.1MW (583853,583856)	Tap Wichita to Emporia Energy Center 345kV (562476)
GEN-2014-028	35 (Uprate) (Pgen=259W/256S)	GENROU	Riverton 161kV (547469)
GEN-2014-064	248.4	GE 2.3MW	Otter 138kV (514708)
ASGI-2014-014	56.4W/54.3S	GENROU	Ferguson 69kV (512664)
GEN-2015-001	199.8	Vestas V126 3.3MW Vestas V126 3.0MW (wind; 584453 & 584453)	Ranch Road 345kV
GEN-2015-015	154.575	Siemens 2.625MW & Siemens 2.3MW	Tap Medford Tap – Coyote 138kV
GEN-2015-016	199.275	Siemens Gamesa G132i 3.55MW Siemens Gamesa G126 2.625MW	Tap Centerville – Marmaton 161kV
GEN-2015-024	217.8	GE 1.8MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-025	215.95	GE 1.8MW & GE 1.79MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2015-030	200.1 (GIA termination not reflected in study)	GE 2.3MW	Sooner 345kV
ASGI-2015-004	54.300 Summer 56.364 Winter	GENSAL	Coffeyville Municipal Light & Power Northern Industrial Park Substation 69kV (512735)
GEN-2015-034	200	Vestas V136 GS 3.45MW & Vestas V136 GS 3.35MW	Ranch Road 345kV (515576)
GEN-2015-047	297.8	GE 2.5MW & GE 2.3MW	Sooner 345kV Tap (514803)
GEN-2015-052	300	Vestas V110-2MW	Tap on Opensky (515621) to RoseHill (532794) 345 kV (560053)
GEN-2015-062	4.505	Uprate GEN-2012-033 G.E. 1.715MW to GE 1.80MW	Breckenridge 138kV (514815)
GEN-2015-063	299.25	Acciona AW 125 3.15 MW	Tap on Woodring (514715) to Matthewson (515497) 345 kV (560055)
GEN-2015-066	248.4	G.E. 2.3MW	Tap on Cleveland (512694) to Sooner (514803) 345 kV (560056)
GEN-2015-069	299.25	Acciona 3.15MW	Union Ridge 230kV (532874)
GEN-2015-073	200.1	Siemens 2.415MW, Siemens 2.385MW, & Gamesa G132 3.465MW	Emporia/Lang 345kV (532768)
GEN-2015-090	218.5	Siemens 2.3MW & G.E. 2.3MW	Wichita (532796)-Thistle (539801) 345kV Tap (GEN-2015-024 (560033) 345kV)

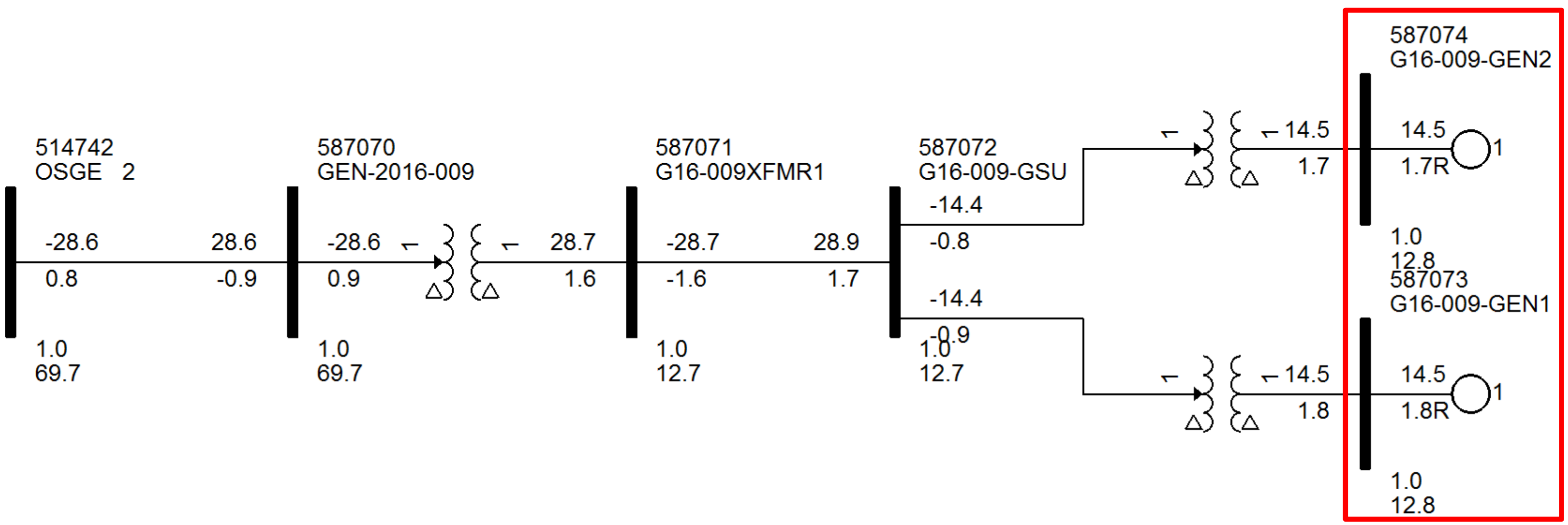

Figure 2-1. Power flow one-line diagram for interconnection project at the Osage 69 kV POI (GEN-2016-009).

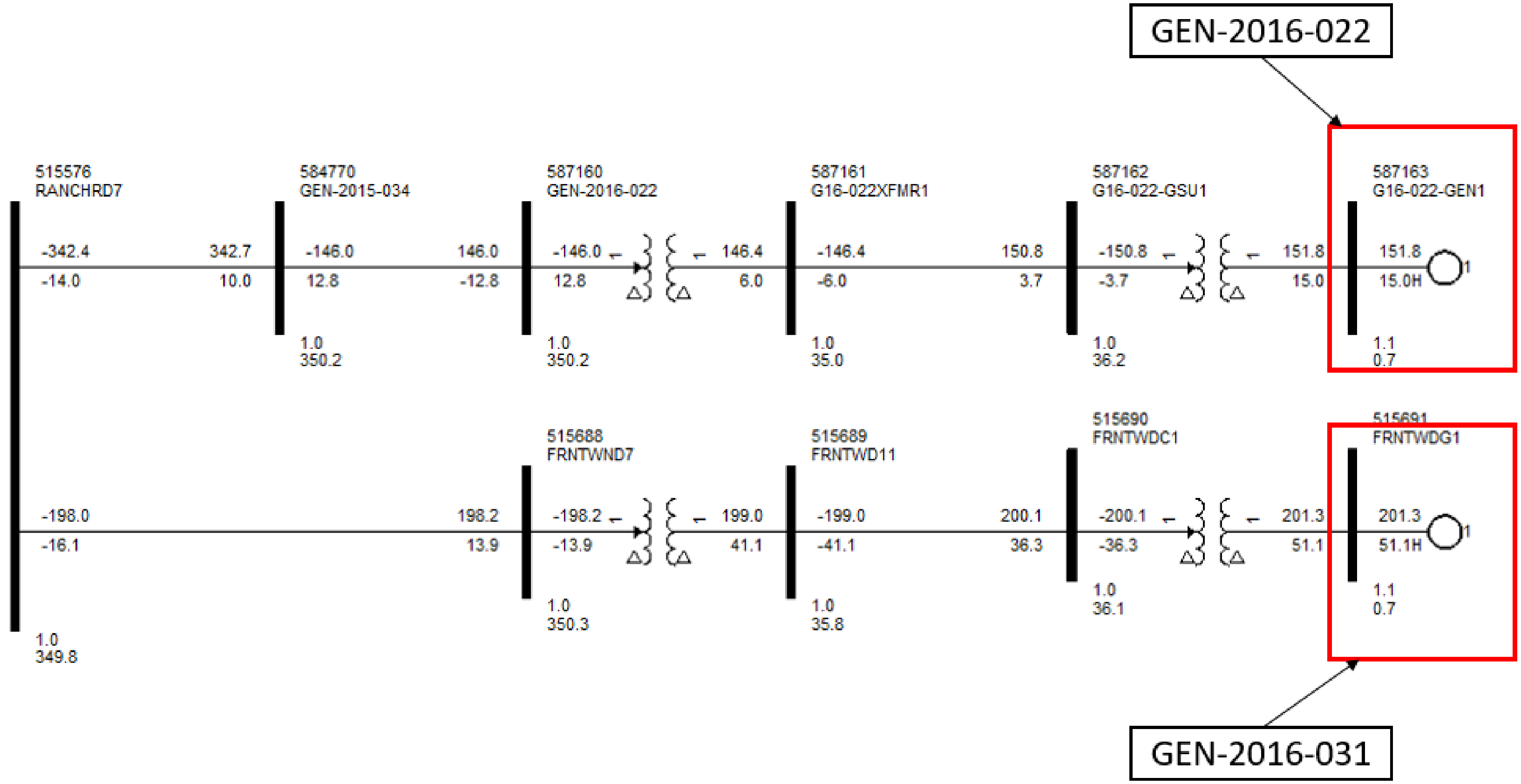

Figure 2-2. Power flow one-line diagram for interconnection project at the Ranch Road 345 kV POI (GEN-2016-022 & GEN-2016-031).

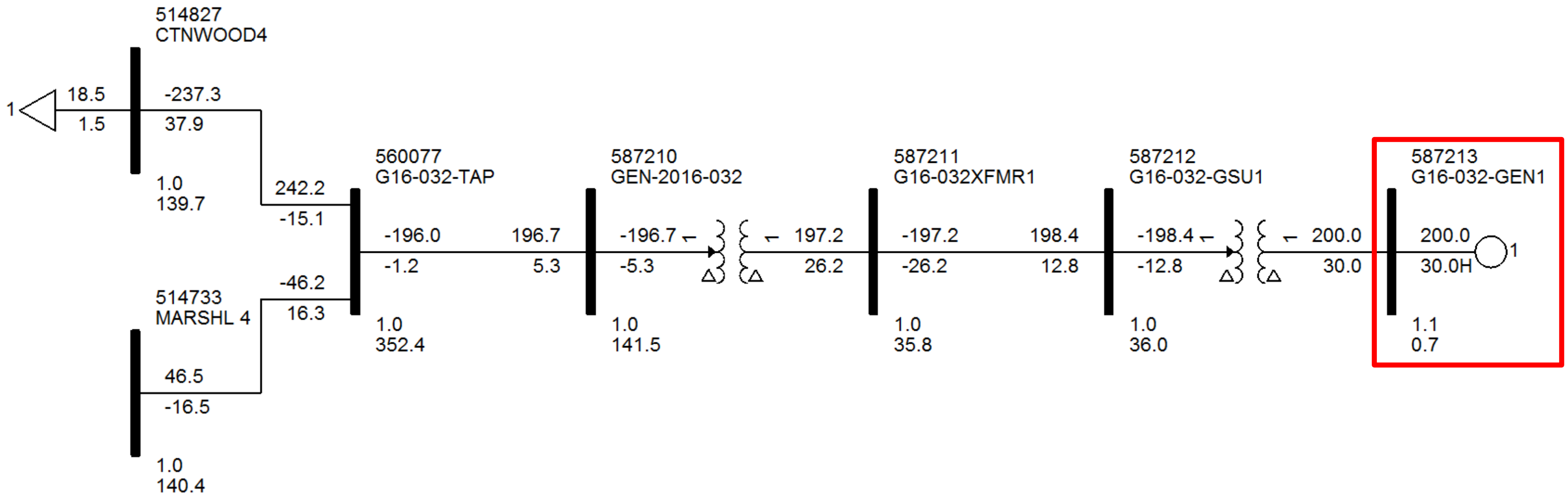

Figure 2-3. Power flow one-line diagram for interconnection project at the Marshall to Cottonwood Creek 138 kV POI (GEN-2016-032).

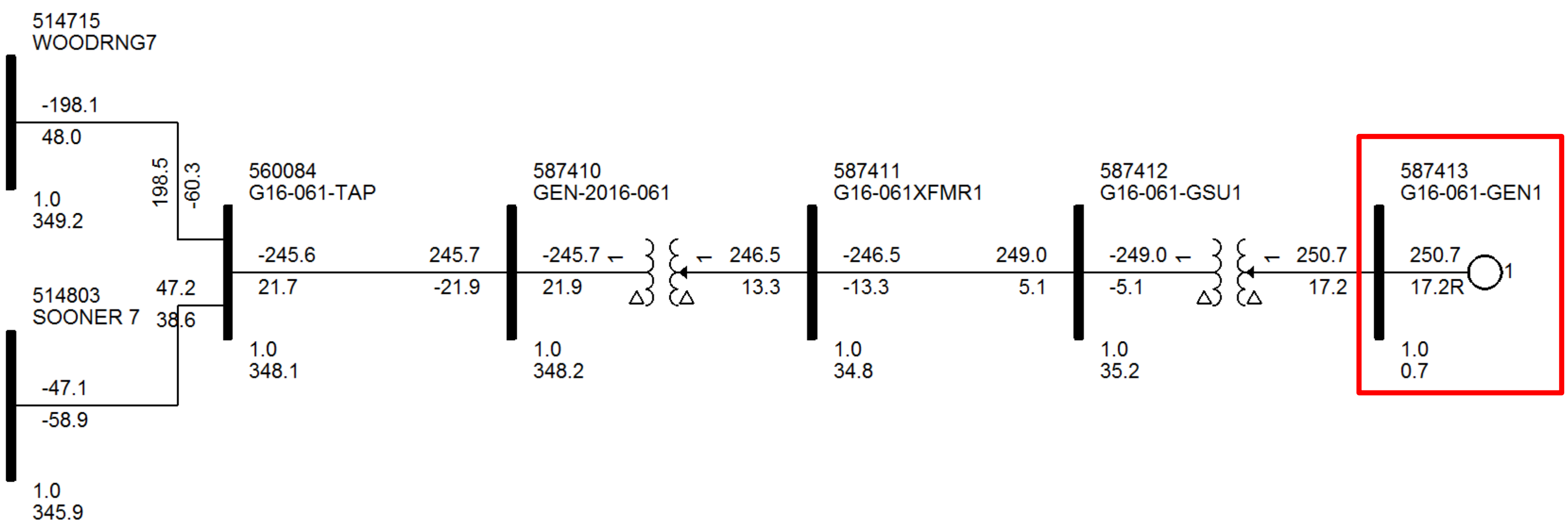

Figure 2-4. Power flow one-line diagram for interconnection project at the Woodring to Sooner 345 kV POI (GEN-2016-061).

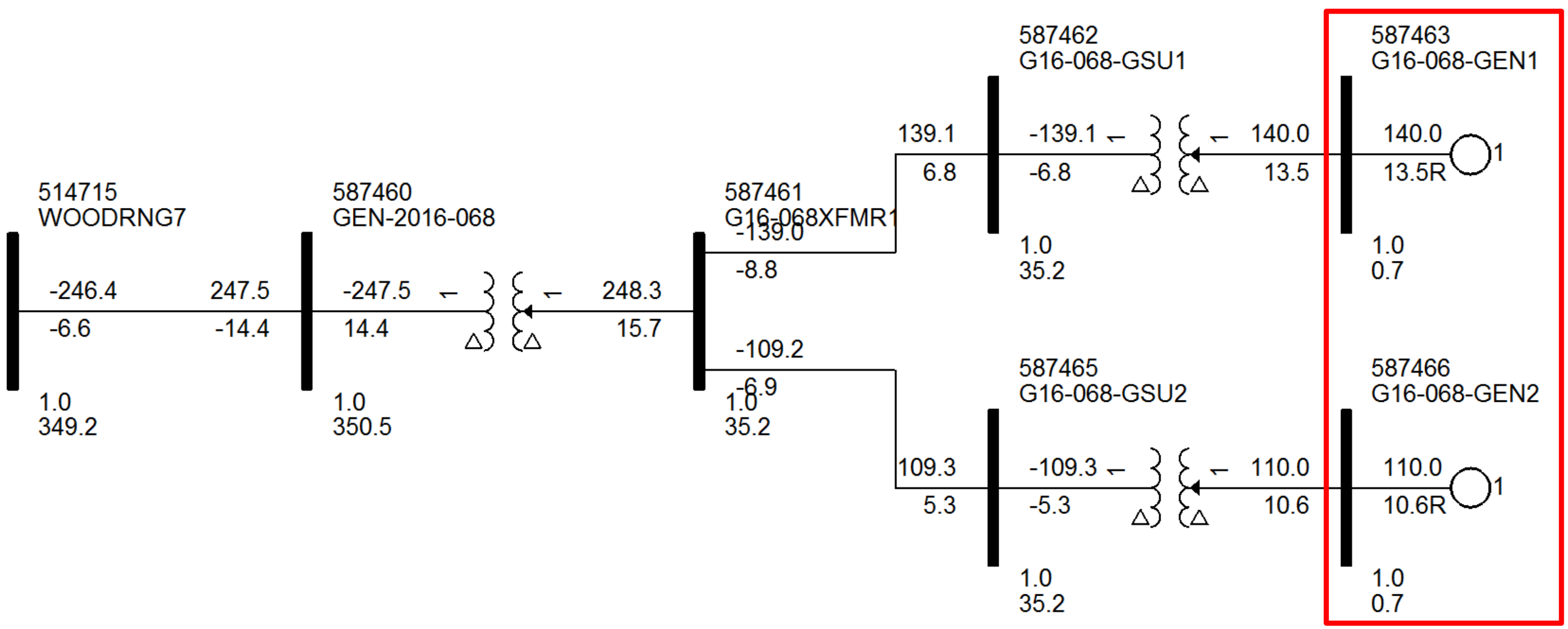

Figure 2-5. Power flow one-line diagram for interconnection project at Woodring 345 kV POI (GEN-2016-068).

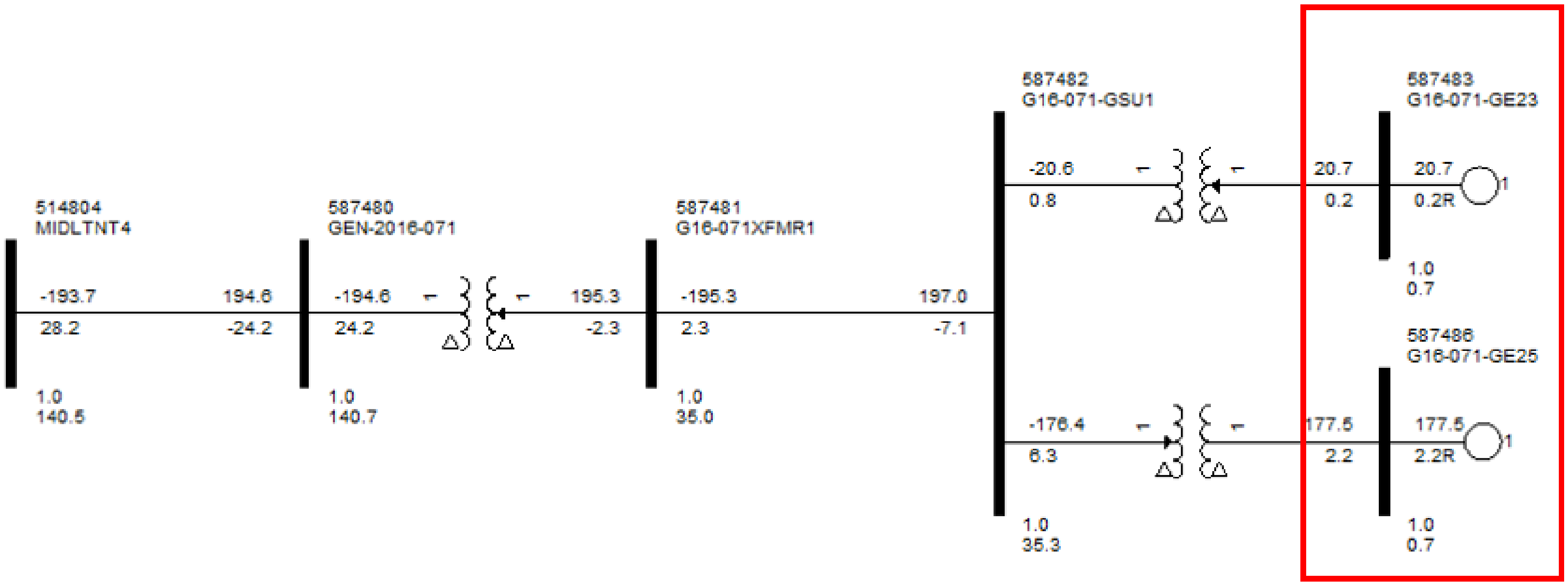

Figure 2-6. Power flow one-line diagram for interconnection project at Middleton Tap 138 kV POI (GEN-2016-071).

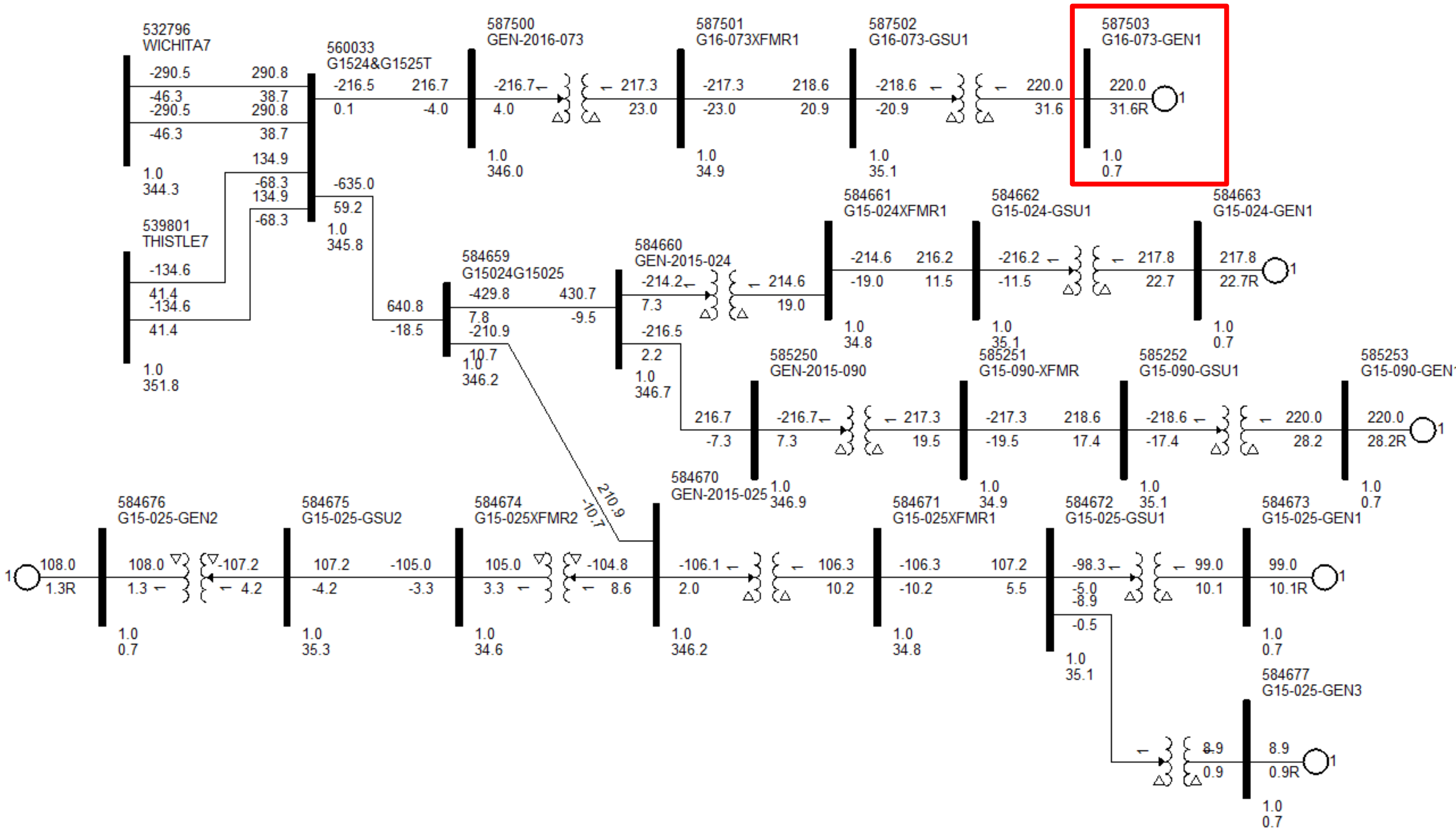

Figure 2-7. Power flow one-line diagram for interconnection project at Thistle to Wichita 345 kV POI (GEN-2016-073).

Table 2-3
Case List with Contingency Description

Cont. No.	Cont. Name	Description
1	FLT01-3PH	3 phase fault on the Osage (514742) to CONBLKT (515402) 69kV circuit 1 line, near Osage. a. Apply fault at the Osage 69kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT02-3PH	3 phase fault on the Osage (514743) 138/(514742) 69/(515744) 13.2kV transformer, near Osage 69kV. a. Apply fault at the Osage 69kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
3	FLT03-3PH	3 phase fault on the Osage (514742) to OMWW (529249) 69kV circuit 1 line, near Osage. a. Apply fault at the Osage 69kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT04-3PH	3 phase fault on the Osage (514743) to White Eagle (514761) 138kV circuit 1 line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
5	FLT05-3PH	3 phase fault on the Osage (514743) to Sooner Pump Tap (514798) 138kV circuit 1 line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT06-3PH	3 phase fault on the Osage (514743) to Marland Tap (514770) 138kV circuit 1 line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
7	FLT07-3PH	3 phase fault on the Osage (514743) to Webber Tap (510376) 138kV circuit 1 line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT08-3PH	3 phase fault on the Osage (514743) to Standing Bear (514758) 138kV circuit 1 line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
9	FLT09-SB	**Stuck Breaker on Osage – CONBLKT2 69kV circuit 1 line** a. Apply single-phase fault at Osage (514742) on the 69kV bus. b. After 16 cycles, trip the Osage 138 (514743)/69/(515744) 13.2kV transformer c. Trip the Osage – CONBLKT2 (515402) 69kV circuit 1 line, and remove the fault
10	FLT10-SB	**Stuck Breaker on Osage Transformer circuit 1 line** a. Apply single-phase fault at Osage (514742) on the 69kV bus. b. After 16 cycles, trip the Osage 138/69/13.2kV (514743/514742/515744) transformer c. Trip the Osage 138/69/13.2kV (514743/514742/515744) transformer, and remove the fault
11	FLT11-SB	**Stuck Breaker on Osage – Marland Tap 138kV circuit 1 line** a. Apply single-phase fault at Osage (514743) on the 138kV bus. b. After 16 cycles, trip the Osage – Marland Tap (514770) 138kV circuit 1 line c. Trip the Osage – Webber Tap (510376) 138kV circuit 1 line, and remove the fault
12	FLT12-PO	**Prior outage on the Osage (514742) – CONBLKT2 (515402) 69kV line** 3 phase fault on the Osage 138/69/13.2kV (514743/514742/515744) transformer, near Osage. a. Apply fault at the Osage 69kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
13	FLT13-PO	**Prior outage on the Osage 138/69/13.2kV (514743/514742/515744) transformer** 3 phase fault on the Osage 138/69/13.2kV (514743/514742/515745) transformer, near Osage. a. Apply fault at the Osage 69kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Cont. No.	Cont. Name	Description
14	FLT14-PO	**Prior outage on the Osage (514743) – Standing Bear (514758) 138kV line** 3 phase fault on the Osage (514743) – White Eagle (514761) 138kV line, near Osage. a. Apply fault at the Osage 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
15	FLT15-3PH	3 phase fault on the Waverly (532799) to LaCygne (542981) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear Waverly end of the line after 3.6 cycles c. Clear the LaCygne end of the line after an additional 0.65 cycles
16	FLT16-3PH	3 phase fault on the laCygne (542981) to Waverly (532799) 345kV line, near laCygne. a. Apply fault at the laCygne 345kV bus. b. Clear Waverly end of the line after 3.6 cycles c. Clear the LaCygne end of the line after an additional 0.65 cycles
17	FLT17-3PH	3 phase fault on the Waverly (532799) to Wolf Creek (532797) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
18	FLT18-3PH	3 phase fault on the Waverly (532799) to Wolf Creek (532797) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
19	FLT19-3PH	3 phase fault on the Rose Hill (532794) to Wolf Creek (532797) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
20	FLT20-3PH	3 phase fault on the Benton (532791) to Wolf Creek (532797) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
21	FLT21-3PH	3 phase fault on Wolf Creek 345/69/17kV (532797/533653/532962) transformer, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
22	FLT22-3PH	3 phase fault on the LaCygne (542981) to West Gardner (542965) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
23	FLT23-3PH	3 phase fault on the LaCygne (542981) to Stilwell (542968) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
24	FLT24-3PH	3 phase fault on the LaCygne (542981) to Neosho (532793) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
25	FLT25-SB	**Stuck Breaker on LaCygne – Waverly 345kV circuit 1 line** a. Apply single-phase fault at LaCygne (542981) on the 345kV bus. b. After 11 cycles, trip the LaCygne – Waverly (532799) 345kV circuit 1 line c. Trip the LaCygne – West Gardner (542965) 345kV circuit 1 line, and remove the fault
26	FLT26-SB	**Stuck Breaker on LaCygne – West Gardner 345kV circuit 1 line** a. Apply single-phase fault at LaCygne (542981) on the 345kV bus. b. After 11 cycles, trip the LaCygne – West Gardner (542965) 345kV circuit 1 line c. Trip LaCygne Unit 1, and remove the fault.

Cont. No.	Cont. Name	Description
27	FLT27-SB	**Stuck Breaker on Wolf Creek – Waverly 345kV circuit 1 line** a. Apply single-phase fault at Wolf Creek (532797) on the 345kV bus. b. After 3.6 cycles, trip the Wolf Creek – Waverly (532799) 345kV circuit 1 line c. After 6.6 additional cycles, trip Wolf Creek 345/69kV transformer (532797/533653/532962) and remove fault.
28	FLT28-SB	**Stuck Breaker on Wolf Creek – Benton 345kV circuit 1 line** a. Apply single-phase fault at Wolf Creek (532797) on the 345kV bus. b. After 3.6 cycles, trip the Wolf Creek – Benton (532791) 345kV circuit 1 line c. After 6.6 additional cycles, remove fault.
29	FLT29-SB	**Stuck Breaker on Wolf Creek – Rose Hill 345kV circuit 1 line** a. Apply single-phase fault at Wolf Creek (532797) on the 345kV bus. b. After 3.6 cycles, trip the Wolf Creek – Rose Hill (532794) 345kV circuit 1 line c. After 6.6 additional cycles, remove fault.
30	FLT30-SB	**Stuck Breaker on Wolf Creek – Waverly 345kV circuit 1 line** a. Apply single-phase fault at Wolf Creek (532797) on the 345kV bus. b. After 3.6 cycles, trip the Wolf Creek – Waverly (532799) 345kV circuit 1 line c. After 6.6 additional cycles, remove fault.
31	FLT31-SB	**Stuck Breaker on Wolf Creek 345/69kV transformer circuit 1 line** a. Apply single-phase fault at Wolf Creek (532797) on the 345kV bus. b. After 3.6 cycles, trip Wolf Creek 345/69kV transformer (532797/533653/532962) c. After 6.6 additional cycles, remove fault.
32	FLT32-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Reduce Wolf Creek gen (532797) to 800MW. c. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3.6 cycles, then trip the line in (b) and remove fault.
33	FLT33-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Reduce Wolf Creek gen (532797) to 800MW. c. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3.6 cycles, then trip the line in (b) and remove fault.
34	FLT34-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Reduce Wolf Creek gen (532797) to 800MW. c. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – West Gardner (542965) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
35	FLT35-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Reduce Wolf Creek gen (532797) to 800MW. c. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – Stilwell (542968) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
36	FLT36-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Reduce Wolf Creek gen (532797) to 800MW. c. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – Neosho (532793) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
37	FLT37-PO	**Prior outage of the LaCygne (542981) – West Gardner (542965) 345kV line** 3 phase fault on the LaCygne (542981) – Neosho (532793) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
38	FLT38-3PH	3 phase fault on the Open Sky (515621) to Ranch Road (515576) 345kV line, near Ranch Road. a. Apply fault at the Ranch Road 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
39	FLT39-3PH	3 phase fault on the Open Sky (515621) to G15-052T (560053) 345kV line, near Open Sky. a. Apply fault at the Open Sky 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
40	FLT40-3PH	3 phase fault on the Ranch Road (515576) to Sooner (514803) 345kV line, near Ranch Road. a. Apply fault at the Ranch Road 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
41	FLT41-3PH	3 phase fault on the G15-052T (560053) to Rose Hill (532794) 345kV line, near Rose Hill. a. Apply fault at the Rose Hill 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
42	FLT42-3PH	3 phase fault on the Sooner (514803) to Spring Creek (514881) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
43	FLT43-3PH	3 phase fault on the Sooner (514803) to G15-066T (560056) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
44	FLT44-3PH	3 phase fault on the Sooner (514803) to G16-061-Tap (560084) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
45	FLT45-3PH	3 phase fault on the Sooner (514803) to G16-061-Tap (560084) 345kV line, near G16-061-Tap. a. Apply fault at the G16-061-Tap 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
46	FLT46-3PH	3 phase fault on the Sooner 345/138/13.8kV (514803/514802/515760) transformer, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
47	FLT47-SB	**Stuck Breaker on Ranch Road – Open Sky 345kV circuit 1 line** a. Apply single-phase fault at Open Sky (515621) on the 345kV bus. b. After 16 cycles, trip the Open Sky – Ranch Road (515576) 345kV circuit 1 line c. Trip the Open Sky – G15-052T (560053) 345kV circuit 1 line, and remove the fault
48	FLT48-SB	**Stuck Breaker on Rose Hill – Benton 345kV circuit 1 line** a. Apply single-phase fault at Rose Hill (532794) on the 345kV bus. b. After 16 cycles, trip the Rose Hill – Benton (532791) 345kV circuit 1 line c. Trip the Rose Hill – G15-052T (560053) 345kV circuit 1 line, and remove the fault
49	FLT49-SB	**Stuck Breaker on Sooner – Spring Creek 345kV circuit 1 line** a. Apply single-phase fault at Sooner (514803) on the 345kV bus. b. After 16 cycles, trip the Sooner – Spring Creek (514881) 345kV circuit 1 line c. Trip the Sooner – Ranch Road (515576) 345kV circuit 1 line, and remove the fault
50	FLT50-SB	**Stuck Breaker on Sooner – G15-066T 345kV circuit 1 line** a. Apply single-phase fault at Sooner (514803) on the 345kV bus. b. After 16 cycles, trip the Sooner – G15-066T (560056) 345kV circuit 1 line c. Trip the Sooner – Ranch Road (515576) 345kV circuit 1 line, and remove the fault
51	FLT51-SB	**Stuck Breaker on Sooner – G15-066T 345kV circuit 1 line** a. Apply single-phase fault at Sooner (514803) on the 345kV bus. b. After 16 cycles, trip the Sooner – G15-066T (560056) 345kV circuit 1 line c. Trip the Sooner – G16-061-Tap (560084) 345kV circuit 1 line, and remove the fault
52	FLT52-PO	**Prior outage of the Rose Hill (532794) – G15-052T (560053) 345kV line** 3 phase fault on the Ranch Road (515576) – Open Sky (515621) 345kV line, near Ranch Road. a. Apply fault at the Ranch Road 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
53	FLT53-PO	**Prior outage of the Sooner (514803) – G15-066T (560056) 345kV line** 3 phase fault on the Ranch Road (515576) – Open Sky (515621) 345kV line, near Ranch Road. a. Apply fault at the Ranch Road 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
54	FLT54-PO	**Prior outage of the Sooner (514803) – G15-066T (560056) 345kV line** 3 phase fault on the Ranch Road (515576) – Sooner (514803) 345kV line, near Ranch Road. a. Apply fault at the Ranch Road 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
55	FLT55-3PH	3 phase fault on the Midian (532990) to Butler (532987) 138kV line, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
56	FLT56-3PH	3 phase fault on the Midian (532990) to Benton (532986) 138kV line, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
57	FLT57-3PH	3 phase fault on the Midian 138/69/13.2kV (532990/533597/533082) transformer, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
58	FLT58-3PH	3 phase fault on the Butler (532987) to Butler Tap (532989) 138kV line, near Butler. a. Apply fault at the Butler 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
59	FLT59-3PH	3 phase fault on the Butler (532987) to Altoona (533001) 138kV line, near Butler. a. Apply fault at the Butler 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
60	FLT60-3PH	3 phase fault on the Butler 138/69kV (532987/533583) transformer, near Butler. a. Apply fault at the Butler 138kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
61	FLT61-3PH	3 phase fault on the Benton (532986) to Chisholm (533035) 138kV line, near Benton. a. Apply fault at the Benton 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
62	FLT62-3PH	3 phase fault on the Benton (532986) to 29th (533024) 138kV line, near Benton. a. Apply fault at the Benton 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
63	FLT63-3PH	3 phase fault on the Benton (532986) to Belaire (532988) 138kV line, near Benton. a. Apply fault at the Benton 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
64	FLT64-3PH	3 phase fault on the Benton 345/138/13.8kV (532791/532986/532821) transformer, near Benton. a. Apply fault at the Benton 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
65	FLT65-SB	**Stuck Breaker on Midian – Benton 138kV circuit 1 line** a. Apply single-phase fault at Midian (532990) on the 138kV bus. b. After 16 cycles, trip the Midian – Benton (532986) 138kV circuit 1 line c. Trip the Midian – Butler (532987) 138kV circuit 1 line, and remove the fault
66	FLT66-SB	**Stuck Breaker on Midian – Benton 138kV circuit 1 line** a. Apply single-phase fault at Midian (532990) on the 138kV bus. b. After 16 cycles, trip the Midian – Benton (532986) 138kV circuit 1 line c. Trip the Midian 138/69/13.2kV (532990/533597/533082) transformer, and remove the fault
67	FLT67-SB	**Stuck Breaker on Midian – Butler 138kV circuit 1 line** a. Apply single-phase fault at Midian (532990) on the 138kV bus. b. After 16 cycles, trip the Midian – Butler (532987) 138kV circuit 1 line c. Trip the Midian 138/69/13.2kV (532990/533597/533082) transformer, and remove the fault
68	FLT68-PO	**Prior outage of the Midian (532990) – Butler (532987) 138kV line** 3 phase fault on the Midian (532990) – Benton (532986) 138kV line, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
69	FLT69-PO	**Prior outage of the Midian (532990) – Butler (532987) 138kV line** 3 phase fault on the Midian 138/69/13.2kV (532990/533597/533082) transformer, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
70	FLT70-PO	**Prior outage of the Midian (532990) – Benton (532986) 138kV line** 3 phase fault on the Midian 138/69/13.2kV (532990/533597/533082) transformer, near Midian. a. Apply fault at the Midian 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

Cont. No.	Cont. Name	Description
71	FLT71-3PH	3 phase fault on the G16-032-Tap (560077) to Marshall (514733) 138kV line, near G16-032-Tap. a. Apply fault at the G16-032-Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
72	FLT72-3PH	3 phase fault on the G16-032-Tap (560077) to Cottonwood Creek (514827) 138kV line, near G16-032-Tap. a. Apply fault at the G16-032-Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
73	FLT73-3PH	3 phase fault on the Cottonwood Creek (514827) to Cresent (515377) 138kV line, near Cottonwood Creek. a. Apply fault at the Cottonwood Creek 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
74	FLT74-3PH	3 phase fault on the Cottonwood Creek (514827) to Pine St (514829) 138kV line, near Cottonwood Creek. a. Apply fault at the Cottonwood 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
75	FLT75-3PH	3 phase fault on the Cottonwood Creek (514827) to Arcadia (514907) 138kV line, near Cottonwood Creek. a. Apply fault at the Cottonwood 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
76	FLT76-3PH	3 phase fault on the Cottonwood Creek (514827) to Liberty Lake (515373) 138kV line, near Cottonwood Creek. a. Apply fault at the Cottonwood 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
77	FLT77-3PH	3 phase fault on the Marshall (514733) to Woodring (514714) 138kV line, near Marshall. a. Apply fault at the Marshall 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
78	FLT78-SB	**Stuck Breaker on Marshall – G16-032-Tap 138kV circuit 1 line** a. Apply single-phase fault at Marshall (514733) on the 138kV bus. b. After 16 cycles, trip the Marshall – G16-032-Tap (560077) 138kV circuit 1 line c. Trip the Marshall – Woodring (514714) 138kV circuit 1 line, and remove the fault
79	FLT79-SB	**Stuck Breaker on Cottonwood Creek – G16-032-Tap 138kV circuit 1 line** a. Apply single-phase fault at Cottonwood Creek (514827) on the 138kV bus. b. After 16 cycles, trip the Cottonwood Creek – G16-032-Tap (560077) 138kV circuit 1 line c. Trip the Cottonwood Creek – Arcadia (514907) 138kV circuit 1 line, and remove the fault
80	FLT80-SB	**Stuck Breaker on Cottonwood Creek – G16-032-Tap 138kV circuit 1 line** a. Apply single-phase fault at Cottonwood Creek (514827) on the 138kV bus. b. After 16 cycles, trip the Cottonwood Creek – G16-032-Tap (560077) 138kV circuit 1 line c. Trip the Cottonwood Creek – Liberty Lake (515373) 138kV circuit 1 line, and remove the fault
81	FLT81-SB	**Stuck Breaker on Cottonwood Creek – Arcadia 138kV circuit 1 line** a. Apply single-phase fault at Cottonwood Creek (514827) on the 138kV bus. b. After 16 cycles, trip the Cottonwood Creek – Arcadia (514907) 138kV circuit 1 line c. Trip the Cottonwood Creek – Liberty Lake (515373) 138kV circuit 1 line, and remove the fault
82	FLT82-PO	**Prior outage of the Cottonwood Creek (514827) – Liberty Lake (515373) 138kV line** 3 phase fault on the G16-032-Tap (560077) – Cottonwood Creek (514827) 138kV line, near G16-032-Tap. a. Apply fault at the G16-032-Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
83	FLT83-PO	**Prior outage of the Cottonwood Creek (514827) – Liberty Lake (515373) 138kV line** 3 phase fault on the G16-032-Tap (560077) – Marshall (514733) 138kV line, near G16-032-Tap. a. Apply fault at the G16-032-Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
84	FLT84-PO	**Prior outage of the Woodring (514714) – Wauko Tap (514711) 138kV line** 3 phase fault on the G16-032-Tap (560077) – Marshall (514733) 138kV line, near G16-032-Tap. a. Apply fault at the G16-032-Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
85	FLT85-3PH	3 phase fault on the Ranch Road (515576) to Sooner (514803) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
86	FLT86-3PH	3 phase fault on the Spring Creek (514881) to Northwest (514880) 345kV line, near Spring Creek. a. Apply fault at the Spring Creek 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
87	FLT87-3PH	3 phase fault on the G15-066T (560056) to Cleveland (512694) 345kV line, near G15-066T. a. Apply fault at the G15-066T 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
88	FLT88-3PH	3 phase fault on the G16-061-Tap (560084) to Woodring (514715) 345kV line, near G16-061-Tap. a. Apply fault at the G16-061-Tap 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
89	FLT89-PO	**Prior outage of the Sooner (514803) – G15-066T (560056) 345kV line** 3 phase fault on the Sooner (514803) – G16-061-Tap (560084) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
90	FLT90-PO	**Prior outage of the Sooner (514803) – G15-066T (560056) 345kV line** 3 phase fault on the Sooner (514803) – Spring Creek (514881) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
91	FLT91-PO	**Prior outage of the Sooner (514803) – Ranch Road (515576) 345kV line** 3 phase fault on the Sooner (514803) – Spring Creek (514881) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
92	FLT92-PO	**Prior outage of the Sooner (514803) – Ranch Road (515576) 345kV line** 3 phase fault on the Sooner 345/138/13.8kV (514803/514802/515760) transformer, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer and remove fault.
93	FLT93-3PH	3 phase fault on the Belle Plaine (533063) to Sumner (532984) 138kV line, near Belle Plaine. a. Apply fault at the Belle Plaine 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
94	FLT94-3PH	3 phase fault on the Belle Plaine (533063) to Farber (533042) 138kV line, near Belle Plaine. a. Apply fault at the Belle Plaine 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
95	FLT95-3PH	3 phase fault on the Farber (533042) to El Paso (533039) 138kV line, near Farber. a. Apply fault at the Farber 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
96	FLT96-3PH	3 phase fault on the Sumner (532984) to Oxford (532982) 138kV line, near Sumner. a. Apply fault at the Sumner 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
97	FLT97-3PH	3 phase fault on the Sumner (532984) to TIMBJCT (532992) 138kV line, near Sumner. a. Apply fault at the Sumner 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
98	FLT98-SB	**Stuck Breaker on Sumner – Viola 138kV circuit 1 line** a. Apply single-phase fault at Sumner (532984) on the 138kV bus. b. After 16 cycles, trip the Sumner – Oxford (532982) 138kV circuit 1 line c. Trip the Sumner – TIMBJCT (532992) 138kV circuit 1 line, and remove the fault
99	FLT99-PO	**Prior outage of the Sumner (532984) – TIMBJCT (532992) 138kV line** 3 phase fault on the Belle Plaine (533063) – Farber (533042) 138kV line, near Belle Plaine. a. Apply fault at the Belle Plaine 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
100	FLT100-PO	**Prior outage of the Sumner (532984) – Oxford (532982) 138kV line** 3 phase fault on the Belle Plaine (533063) – Farber (533042) 138kV line, near Belle Plaine. a. Apply fault at the Belle Plaine 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
101	FLT101-PO	**Prior outage of the Belle Plaine (533063) – Farber (533042) 138kV line** 3 phase fault on the Sumner (532984) – TIMBJCT (532992) 138kV line, near Sumner. a. Apply fault at the Sumner 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
102	FLT102-3PH	3 phase fault on the Woodring (514715) to Hunters (515476) 345kV line, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
103	FLT103-3PH	3 phase fault on the Woodring (514715) to G15-063T (560055) 345kV line, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
104	FLT104-3PH	3 phase fault on the Woodring 345/138/13.8kV (514715/514714/515770) transformer, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
105	FLT105-SB	**Stuck Breaker on Woodring – G15-061-Tap 345kV circuit 1 line** a. Apply single-phase fault at Woodring (514715) on the 345kV bus. b. After 16 cycles, trip the Woodring – G16-061-Tap (560084) 345kV circuit 1 line c. Trip the Woodring – G15-063T (560055) 345kV circuit 1 line, and remove the fault

Cont. No.	Cont. Name	Description
106	FLT106-PO	**Prior outage of the Woodring (514715) – Hunters (515476) 345kV line** 3 phase fault on the G16-061-Tap (560084) – Sooner (514803) 345kV line, near G16-061-Tap. a. Apply fault at the G16-061-Tap 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
107	FLT107-3PH	3 phase fault on the G15-063T (560055) to Mathewson (515497) 345kV line, near G15-063T. a. Apply fault at the G15-063T 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
108	FLT108-3PH	3 phase fault on the Hunters (515476) to Chisholm (515477) 345kV line, near Hunters. a. Apply fault at the Hunters 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
109	FLT109-3PH	3 phase fault on the Woodring (514714) to Fairmont Tap (514709) 138kV line, near Woodring. a. Apply fault at the Woodring 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
110	FLT110-SB	**Stuck Breaker on Woodring – G15-061-Tap 345kV circuit 1 line** a. Apply single-phase fault at Woodring (514715) on the 345kV bus. b. After 16 cycles, trip the Woodring – G16-061-Tap (560084) 345kV circuit 1 line c. Trip the Woodring – Hunters (515476) 345kV circuit 1 line, and remove the fault
111	FLT111-SB	**Stuck Breaker on Woodring – G15-063T 345kV circuit 1 line** a. Apply single-phase fault at Woodring (514715) on the 345kV bus. b. After 16 cycles, trip the Woodring – G15-063T (560055) 345kV circuit 1 line c. Trip the Woodring – Hunters (515476) 345kV circuit 1 line, and remove the fault
112	FLT112-PO	**Prior outage of the Woodring (514715) – Hunters (515476) 345kV line** 3 phase fault on the Woodring (514715) – G15-063T (560055) 345kV line, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
113	FLT113-PO	**Prior outage of the Woodring (514715) – G16-061-Tap (560084) 345kV line** 3 phase fault on the Woodring 345/138/13.8kV (514715/514714/515770) transformer, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
114	FLT114-3PH	3 phase fault on the Middleton Tap (514804) to Peckham Tap (515381) 138kV line, near Middleton Tap. a. Apply fault at the Middleton Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
115	FLT115-3PH	3 phase fault on the Middleton Tap (514804) to Creswell (532981) 138kV line, near Middleton Tap. a. Apply fault at the Middleton Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
116	FLT116-3PH	3 phase fault on the Peckham Tap (515381) to Newkirk (514759) 138kV line, near Peckham Tap. a. Apply fault at the Peckham Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
117	FLT117-3PH	3 phase fault on the Creswell (532981) to Oxford (532982) 138kV line, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
118	FLT118-3PH	3 phase fault on the Creswell 138/69/13.2kV (532981/533543/533080) transformer, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer and remove fault.
119	FLT119-3PH	3 phase fault on the Creswell (532981) to Slate Creek (533070) 138kV line, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
120	FLT120-3PH	3 phase fault on the Kildare (514760) to Chikaskia (514757) 138kV line, near Kildare. a. Apply fault at the Kildare 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
121	FLT121-SB	**Stuck Breaker on Peckham Tap – Middleton Tap 138kV circuit 1 line** a. Apply single-phase fault at Peckham Tap (515381) on the 138kV bus. b. After 16 cycles, trip the Peckham Tap – Middleton Tap (514804) 138kV circuit 1 line c. Trip the Peckham Tap – Newkirk (514759) 138kV circuit 1 line, and remove the fault
122	FLT122-SB	**Stuck Breaker on Creswell – Middleton Tap 138kV circuit 1 line** a. Apply single-phase fault at Creswell (532981) on the 138kV bus. b. After 16 cycles, trip the Creswell – Middleton Tap (514804) 138kV circuit 1 line c. Trip the Creswell – Slate Creek (533070) 138kV circuit 1 line, and remove the fault
123	FLT123-SB	**Stuck Breaker on Creswell – Oxford 138kV circuit 1 line** a. Apply single-phase fault at Creswell (532981) on the 138kV bus. b. After 16 cycles, trip the Creswell – Oxford (532982) 138kV circuit 1 line c. Trip the Creswell – Slate Creek (533070) 138kV circuit 1 line, and remove the fault
124	FLT124-PO	**Prior outage of the Middleton Tap (514804) – Peckham Tap (515381) 345kV line** 3 phase fault on the Creswell (532981) – Slate Creek (533070) 138kV line, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
125	FLT125-PO	**Prior outage of the Middleton Tap (514804) – Peckham Tap (515381) 345kV line** 3 phase fault on the Creswell 138/69/13.2kV (532981/533543/533080) transformer, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
126	FLT126-PO	**Prior outage of the Middleton Tap (514804) – Peckham Tap (515381) 345kV line** 3 phase fault on the Creswell (532981) – Oxford (532982) 138kV line, near Creswell. a. Apply fault at the Creswell 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
127	FLT127-PO	**Prior outage of the Middleton Tap (514804) – Creswell (532981) 345kV line** 3 phase fault on the Kildare (514760) to Chikaskia (514757) 138kV line, near Kildare. a. Apply fault at the Kildare 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
128	FLT128-3PH	3 phase fault on the Renfro (515543) to Hunters (515476) 345kV line, near Renfro. a. Apply fault at the Renfro 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
129	FLT129-3PH	3 phase fault on the Renfrow (515543) to Viola (532798) 345kV line, near Renfro. a. Apply fault at the Renfro 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
130	FLT130-3PH	3 phase fault on the Viola (532798) to Wichita (532796) 345kV line, near Viola. a. Apply fault at the Viola 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
131	FLT131-3PH	3 phase fault on the Wichita (532796) to Benton (532791) 345kV line, near Wichita. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
132	FLT132-3PH	3 phase fault on the Wichita (532796) to G14-001 Tap (562476) 345kV line, near Wichita. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
133	FLT133-3PH	3 phase fault on the Emporia EC (532768) to G14-001 Tap (562476) 345kV line, near G14-001. a. Apply fault at the G14-001 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
134	FLT134-3PH	3 phase fault on the Renfrow (515543) 345/(515544) 138/(515545) 13.8kV transformer, near Renfrow 345. a. Apply fault at the Renfrow 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
135	FLT135-3PH	3 phase fault on the Renfrow (515544) to Sand Ridge (520409) 138kV circuit 1 line, near Renfrow. a. Apply fault at the Renfrow 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
136	FLT136-SB	**Stuck Breaker on Renfrow – Viola 345kV circuit 1 line** a. Apply single-phase fault at Renfrow (515543) on the 345kV bus. b. After 16 cycles, trip the Renfrow 345/138/13.8kV (515543/515544/515545) transformer c. Trip the Renfrow – Viola (532798) 345 kV circuit 1 line, and remove the fault
137	FLT137-SB	**Stuck Breaker on Renfrow – Hunters 345kV circuit 1 line** a. Apply single-phase fault at Renfrow (515543) on the 345kV bus. b. After 16 cycles, trip the Renfrow 345/138/13.8kV (515543/515544/515545) transformer c. Trip the Renfrow – Hunter (515476) 345 kV circuit 1 line, and remove the fault
138	FLT138-SB	**Stuck Breaker on Renfrow – Hunter 345kV circuit 1 line** a. Apply single-phase fault at Renfrow (515543) on the 345kV bus. b. After 16 cycles, trip the Renfrow – Viola (532798) 345 kV circuit 1 line, and remove the fault c. Trip the Renfrow – Hunter (515476) 345 kV circuit 1 line, and remove the fault
139	FLT139-PO	**Prior outage on the Renfrow (515543) 345/ (515544) 138/ (515545) 13.8kV transformer** 3 phase fault on the Renfrow (515543) to Viola (532798) 345kV line, near Renfrow. a. Apply fault at the Renfrow 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
140	FLT140-PO	**Prior outage on the Renfrow (515543) 345/ (515544) 138/ (515545) 13.8kV transformer** 3 phase fault on the Renfrow (515543) to Hunter (515476) 345kV line, near Renfrow. a. Apply fault at the Renfrow 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
141	FLT141-PO	**Prior outage on the Renfrow (515543) 345/ (515544) 138/ (515545) 13.8kV transformer** 3 phase fault on the Viola (532798) to Wichita (532796) 345kV line, near Viola. a. Apply fault at the Viola 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
142	FLT142-PO	**Prior outage on the Renfrow (515544) – Sand Ridge (520409) 138kV line** 3 phase fault on the Renfrow (515544) to Grant Co (515546) 138kV line, near Renfrow. a. Apply fault at the Renfrow 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
143	FLT143-3PH	3 phase fault on the Wichita (532796) to Reno (532771) 345kV line circuit 1, near Wichita. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
144	FLT144-3PH	3 phase fault on the Thistle (539801) to Woodward (515375) 345kV line circuit 1, near Thistle. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
145	FLT145-3PH	3 phase fault on the Thistle (539801) to G16-005-Tap (560072) 345kV line circuit 1, near Thistle. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
146	FLT146-3PH	3 phase fault on the Thistle 345/138/13.8kV (539801/539804/539802) transformer, near Thistle. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer and remove fault.
147	FLT147-SB	**Stuck Breaker on Wichita – Reno 345kV circuit 1 line** a. Apply single-phase fault at Wichita (532796) on the 345kV bus. b. After 16 cycles, trip the Wichita – Benton (532791) 345kV line circuit 1 c. Trip the Wichita – Reno (532771) 345 kV line, and remove the fault
148	FLT148-PO	**Prior outage on the Wichita (532796) – Benton (532791) 345kV line** 3 phase fault on the Wichita (532796) to Viola (532798) 345kV line, near Wichita. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
149	FLT149-PO	**Prior outage on the Waverly (532799) – LaCygne (542981) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
150	FLT150-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758MW gross (700 MW Net). 3 phase fault on the Waverly (532799) – LaCygne (542981) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
151	FLT151-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
152	FLT152-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.

Cont. No.	Cont. Name	Description
153	FLT153-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Waverly (532799) – LaCygne (542981) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
154	FLT154-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
155	FLT155-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
156	FLT156-PO	**Prior outage on the Wolf Creek (532797) – Waverly (532799) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
157	FLT157-PO	**Prior outage on the Wolf Creek (532797) – Waverly (532799) 345kV line** Scale generation at Waverly wind farm to 0 MW. Scale generation at Wolf creek to 758 MW gross (700 MW Net). 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
158	FLT32A-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3.6 cycles, then trip the line in (b) and remove fault.
159	FLT33A-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 3.6 cycles, then trip the line in (b) and remove fault.
160	FLT34A-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – West Gardner (542965) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Cont. No.	Cont. Name	Description
161	FLT35A-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – Stilwell (542968) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
162	FLT36A-PO	**Prior outage of the LaCygne (542981) – Waverly (532799) 345kV line** a. Trip LaCygne (542981) – Waverly (532799) 345kV line b. Solve for powerflow steady state Then the following stability contingency: 3 phase fault on the LaCygne (542981) – Neosho (532793) 345kV line, near LaCygne. a. Apply fault at the LaCygne 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
163	FLT149A-PO	**Prior outage on the Waverly (532799) – LaCygne (542981) 345kV line** 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
164	FLT150A-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** 3 phase fault on the Waverly (532799) – LaCygne (542981) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
165	FLT151A-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
166	FLT152A-PO	**Prior outage on the Wolf Creek (532797) – Benton (532791) 345kV line** 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
167	FLT153A-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** 3 phase fault on the Waverly (532799) – LaCygne (542981) 345kV line, near Waverly. a. Apply fault at the Waverly 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
168	FLT154A-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
169	FLT155A-PO	**Prior outage on the Wolf Creek (532797) – Rose Hill (532794) 345kV line** 3 phase fault on the Wolf Creek (532797) – Waverly (532799) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
170	FLT156A-PO	**Prior outage on the Wolf Creek (532797) – Waverly (532799) 345kV line** 3 phase fault on the Wolf Creek (532797) – Benton (532791) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.
171	FLT157A-PO	**Prior outage on the Wolf Creek (532797) – Waverly (532799) 345kV line** 3 phase fault on the Wolf Creek (532797) – Rose Hill (532794) 345kV line, near Wolf Creek. a. Apply fault at the Wolf Creek 345kV bus. b. Clear fault after 3.6 cycles by tripping the faulted line.

SECTION 3: STABILITY ANALYSIS

The objective of the Stability Analysis was to determine the impacts of the generator interconnections on the stability and voltage recovery on the SPP transmission system.

3.1 Approach

SPP provided MEPPI with the following three power flow cases:

- MDWG16-17WP_DIS16021_G08
- MDWG16-18SP_DIS16021_G08
- MDWG16-26SP_DIS16021_G08

The DISIS-2016-002-1 stability databases were used as the basis for this analysis. The databases were updated to reflect DISIS-2016-001-5 conditions by removing the lower queued DISIS-2016-002 requests and associated upgrades across all groups. Each DISIS-2016-001-5 request was already included in the databases provided. The following system adjustments of dispatching, to maximum output, generation interconnected at the same or adjacent substations to a DISIS-2016-002 study request were included in the study models:

- GRDA Energy Center: DISIS-2016-002 requests
- Northeastern units: DISIS-2016-002 requests
- Sooner units: GEN-2016-022, GEN-2016-031, GEN-2016-061, & GEN-2016-068
- Spring Creek units: DISIS-2016-002 requests
- West Pawhuska unit: DISIS-2016-002 requests

After the above updates were made in each stability database, a 5-ohm series reactor was implemented on the Waverly to LaCygne 345kV line and a 6-ohm series reactor was implemented on the Wolf Creek to Waverly 345kV line as a separate scenario.

Additionally, the NERC MOD-026 and MOD-027 model validation studies were recently completed for the Wolf Creek Nuclear plant. This study incorporates the most updated models for the Wolf Creek Nuclear plant as follows:

- Generator: GENTPJ
- Excitation System: EXAC3
- Turbine-Governor: None
- Voltage Regulator Current Compensation: COMP
- Minimum Excitation Limiter: MNLEX3
- Maximum Excitation Limiter: MAXEX2

After the above updates were made, each case was examined prior to the Stability Analysis to ensure the case contained the DISIS-2016-001-5 projects and any previously queued projects listed in Tables 2-1 and 2-2 respectively. There was no suspect power flow data in the study area. The dynamic datasets were also verified and stable initial system conditions (i.e., "flat lines") were achieved. Three-phase and single phase-to-ground faults listed in Table 2-3 were examined. Single-phase fault impedances were calculated for each season to result in a voltage of approximately 60% of the pre-fault voltage. Refer to Table 3-6 for a list of the calculated single-phase fault impedances utilized.

Table 3-1
Calculated Single-Phase Fault Impedances

Cont No.	Cont. Name	Single-Phase Fault Impedance(MVA)		
		2017 Winter	2018 Summer	2026 Summer
9	FLT09-1PH	-1200.0	-1250.0	-1360.0
10	FLT10-1PH	-1200.0	-1250.0	-1360.0
11	FLT11-1PH	-2480.0	-2525.0	-2600.0
24	FLT24-1PH	-5500.0	-5680.0	-5845.0
25	FLT25-1PH	-5500.0	-5680.0	-5845.0
26	FLT26-1PH	-2650.0	-2790.0	-3340.0
42	FLT42-1PH	-3400.0	-3770.0	-3810.0
43	FLT43-1PH	-3480.0	-3800.0	-3900.0
44	FLT44-1PH	-6200.0	-6730.0	-6730.0
45	FLT45-1PH	-6200.0	-6730.0	-6730.0
46	FLT46-1PH	-6200.0	-6730.0	-6730.0
60	FLT60-1PH	-1648.0	-1770.0	-1770.0
61	FLT61-1PH	-1648.0	-1770.0	-1770.0
62	FLT62-1PH	-1648.0	-1770.0	-1770.0
73	FLT73-1PH	-1280.0	-1280.0	-1280.0
74	FLT74-1PH	-2640.0	-2680.0	-2680.0
75	FLT75-1PH	-2640.0	-2680.0	-2680.0
76	FLT76-1PH	-2640.0	-2680.0	-2680.0
93	FLT95-1PH	-1030.0	-1130.0	-1530.0
100	FLT102-1PH	-6780.0	-6830.0	-6870.0
105	FLT107-1PH	-6780.0	-6830.0	-6870.0
106	FLT108-1PH	-6780.0	-6830.0	-6870.0
116	FLT118-1PH	-1140.0	-1170.0	-1255.0
117	FLT119-1PH	-690.0	-700.0	-760.0
118	FLT120-1PH	-690.0	-700.0	-760.0
131	FLT135-1PH	-4460.0	-4770.0	-4860.0
132	FLT136-1PH	-4460.0	-4770.0	-4860.0
133	FLT137-1PH	-4460.0	-4770.0	-4860.0
142	FLT146-1PH	-5030.0	-6630.0	-7010.0

* Refer to Table 2-3 for a description of the contingency scenario

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

- 520 AEPW
- 524 OKGE
- 525 WFEC
- 526 SPS
- 531 MIDW
- 534 SUNC
- 536 WERE
- 540 GMO
- 541 KCPL

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

The results of the analysis determined that no upgrades were required to obtain acceptable system performance. However, some system adjustments were made for certain prior outage conditions and for a post fault steady state voltage level. The system adjustments are described later in this report. The contingencies simulated ensure the wind or solar farm meets FERC Order 661A low voltage requirements and return the wind or solar farm to its pre-disturbance operating voltage.

3.2 Stability Analysis Results

The Stability Analysis determined that because of the Wolf Creek NERC MOD-026 and MOD-027 model updates, system/voltage instability, generation tripping offline, and poor post-fault recovery were observed for several prior outage contingencies across all seasons. The mitigation of series reactors did not improve the response for the prior outage of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV. It has been determined that both the upgrade of tuning the Wolf Creek Automated Voltage Regulator (EXAC3 model) and the upgrade of Wolf Creek to Emporia 345kV or Wolf Creek to Blackberry 345kV circuit each independently mitigates all system/voltage instability observed for faults near Wolf Creek for DISIS-2016-001-5 conditions.

Refer to Table 3-2 for a summary of the Stability Analysis results with the updated Wolf Creek model and without the series reactors or any other additional mitigation for the contingencies listed in Table 2-3. Table 3-2 states whether the system remained stable or generation tripped offline, if acceptable voltage recovery was observed after the fault was cleared, and if the voltage recovered to above 0.9 p.u. and below 1.1 p.u. post fault steady-state conditions. Voltage recovery criteria includes ensuring that the transient voltage recovery is between 0.7 p.u. within 2.5 seconds after the fault is cleared and 1.2 p.u. at any point after the fault is cleared and ending in a steady-state voltage (for N-1 contingencies) at the pre-contingent level or at least above 0.9 p.u. and below 1.1. p.u.

Refer to Appendix B, Appendix C, and Appendix D for a complete set of plots for all contingencies for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions, respectively, with the use of the updated Wolf Creek model and no additional mitigation.

Table 3-2
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
1	FLT01-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT02-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT03-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT04-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT05-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT06-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT07-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT08-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT09-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT10-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT11-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT12-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT13-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT14-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT15-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT16-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT17-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT18-3PH	-	-	Non-Compliant	Poor damping	-	-	Non-Compliant	Poor damping	-	-	Non-Compliant	Poor damping
19	FLT19-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT20-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT21-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT22-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT23-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT24-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT25-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT26-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT27-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT28-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT29-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT30-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT31-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT32-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT33-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
34	FLT34-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT35-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT36-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT37-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT38-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT39-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT40-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT41-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT42-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT43-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT44-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT45-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT46-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT47-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT48-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT49-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT50-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT51-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT52-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT53-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT54-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT55-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT56-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT57-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT58-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT59-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT60-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT61-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT62-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT63-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
64	FLT64-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT65-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
66	FLT66-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
67	FLT67-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
68	FLT68-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
69	FLT69-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
70	FLT70-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
71	FLT71-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
72	FLT72-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
73	FLT73-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
74	FLT74-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
75	FLT75-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
76	FLT76-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
77	FLT77-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
78	FLT78-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
79	FLT79-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
80	FLT80-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
81	FLT81-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
82	FLT82-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
83	FLT83-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
84	FLT84-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
85	FLT85-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
86	FLT86-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
87	FLT87-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
88	FLT88-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
89	FLT89-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
90	FLT90-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
91	FLT91-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
92	FLT92-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
93	FLT93-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
94	FLT94-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
95	FLT95-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
96	FLT96-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
97	FLT97-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
98	FLT98-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
99	FLT99-PO			Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
100	FLT100-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
101	FLT101-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
102	FLT102-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
103	FLT103-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
104	FLT104-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
105	FLT105-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
106	FLT106-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
107	FLT107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
108	FLT108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
109	FLT109-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
110	FLT110-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
111	FLT111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
112	FLT112-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
113	FLT113-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
114	FLT114-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
115	FLT115-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
116	FLT116-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
117	FLT117-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
118	FLT118-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
119	FLT119-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
120	FLT120-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
121	FLT121-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
122	FLT122-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
123	FLT123-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
124	FLT124-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
125	FLT125-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
126	FLT126-PO	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability
127	FLT127-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
128	FLT128-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
129	FLT129-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
130	FLT130-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
131	FLT131-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
132	FLT132-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
133	FLT133-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
134	FLT134-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
135	FLT135-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
136	FLT136-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
137	FLT137-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
138	FLT138-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
139	FLT139-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
140	FLT140-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
141	FLT141-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
142	FLT142-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
143	FLT143-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
144	FLT144-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
145	FLT145-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
146	FLT146-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
147	FLT147-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-2 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model and No Mitigation (Scenario 5)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
148	FLT148-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
149	FLT149-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
150	FLT150-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
151	FLT151-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
152	FLT152-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
153	FLT153-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
154	FLT154-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
155	FLT155-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
156	FLT156-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
157	FLT157-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

For fault FLT18-3PH, a three-phase fault resulting in the loss of Wolf Creek to Waverly 345kV line with the fault at Wolf Creek 345kV, poor rotor angle damping is observed. A sensitivity analysis was performed to confirm if the poor rotor angle damping is observed prior to the addition of Group 08 study requests.

Refer to Figure 3-1 for a representative plot of Wolf Creek generator real and reactive power for a comparison of generation dispatch with the Group 08 study requests in-service and with the Group 08 study requests out-of-service. Refer to Figure 3-2 for a representative plot of the Wolf Creek 345kV rotor angle for the same sensitivity analysis. It has been determined that the rotor angle oscillation observed for the loss of Wolf Creek to Waverly 345kV is present with the DISIS-2016-001 Group 8 requests excluded from the model.

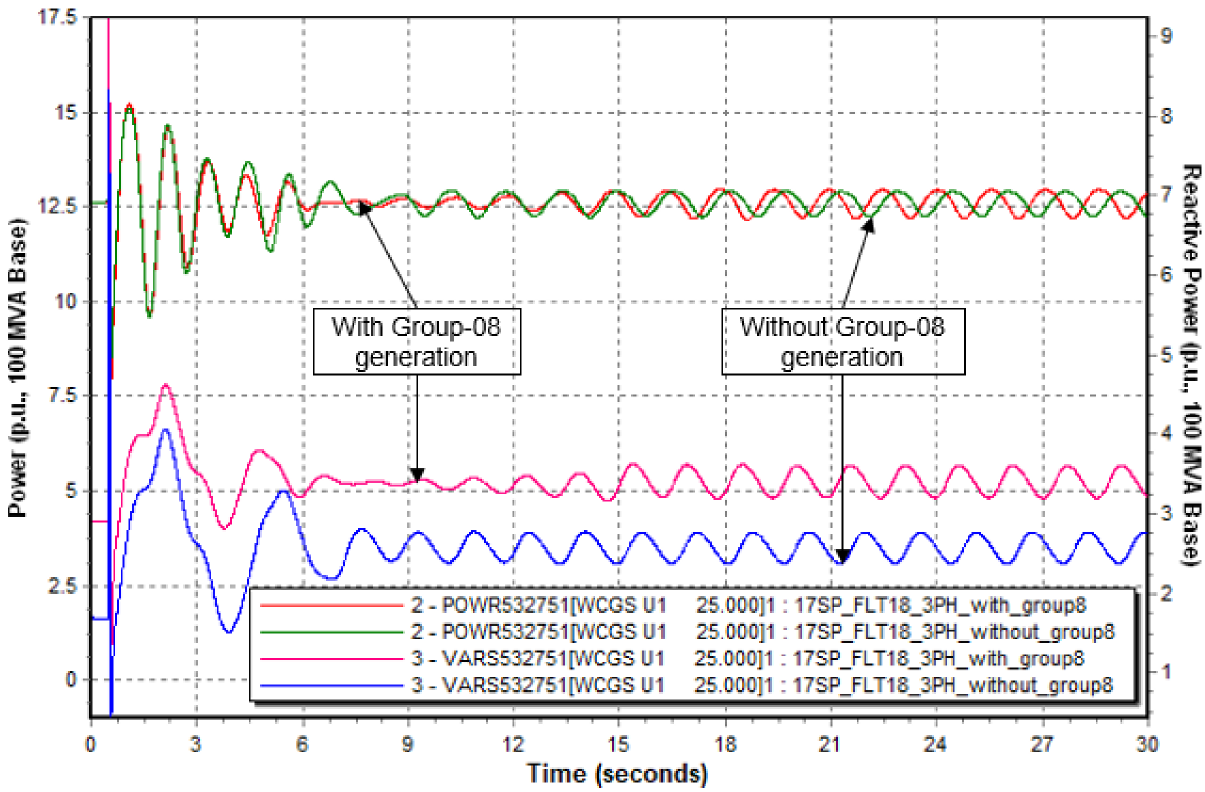

Figure 3-1: Representative plot of Wolf Creek real and reactive power for 2017 Winter Peak conditions for FLT18-3PH

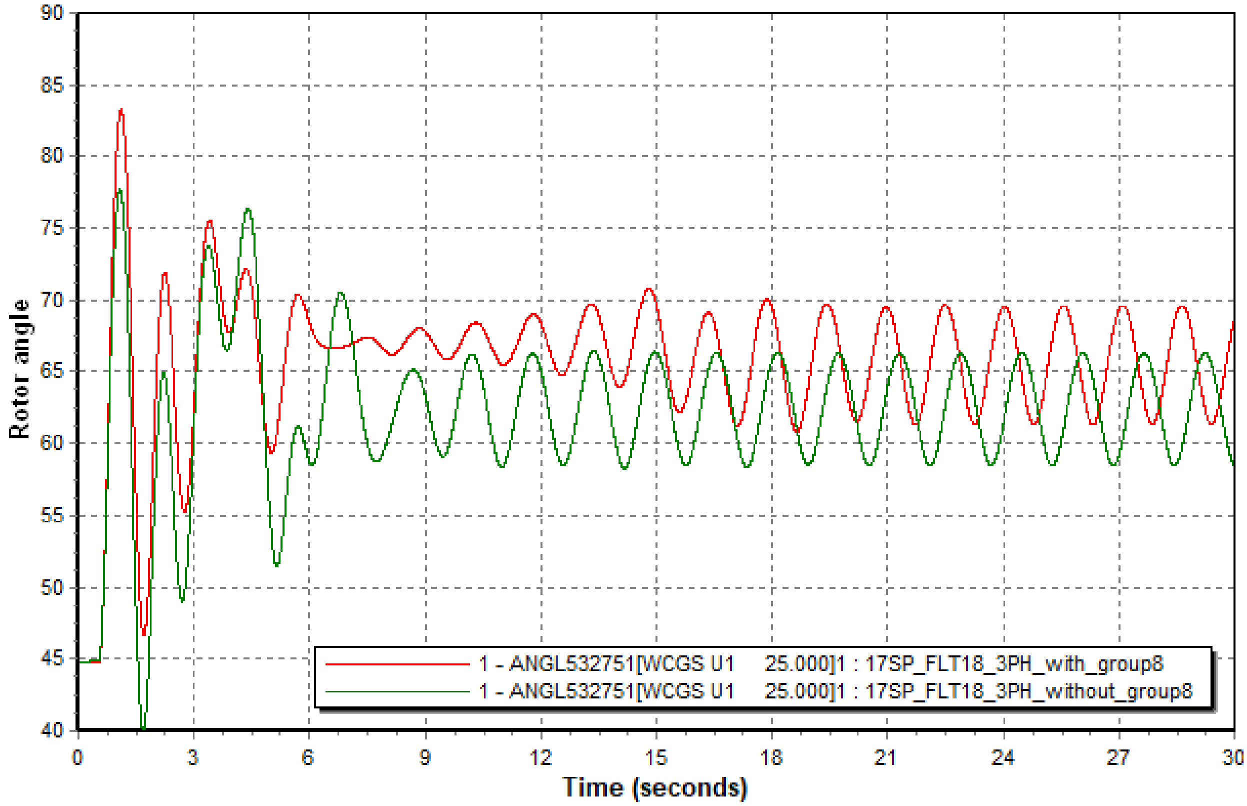

Figure 3-2: Representative Rotor angle plot of the Wolf Creek 345kV bus for 2017 Winter Peak conditions for FLT18-3PH

The loss of Wolf Creek to Waverly 345kV results in a weak grid condition at Wolf Creek 345kV and exposes the Wolf Creek generating unit to undamped rotor angle oscillations as observed in Figure 3-2. Although it has been determined that the rotor angle oscillations are present with the DISIS-2016-001 Group 8 requests excluded from the model, it has been determined that an upgrade of tuning the Wolf Creek Automated Voltage Regulator (AVR) will dampen the rotor angle oscillations. Refer to Figure 3-3 for a representation of the Wolf Creek rotor angle comparing the existing MOD study exciter model (updated model as defined in this report) to the tuned exciter model. The tuned exciter model (EXAC3) was updated by tuning the gain, Ka, and the rate feedback gain, Kn. It can be observed that with a weak grid condition and a high gain, rotor angle oscillations are observed. By reducing the gain, Ka, of the exciter model, the oscillations are observed to be damped.

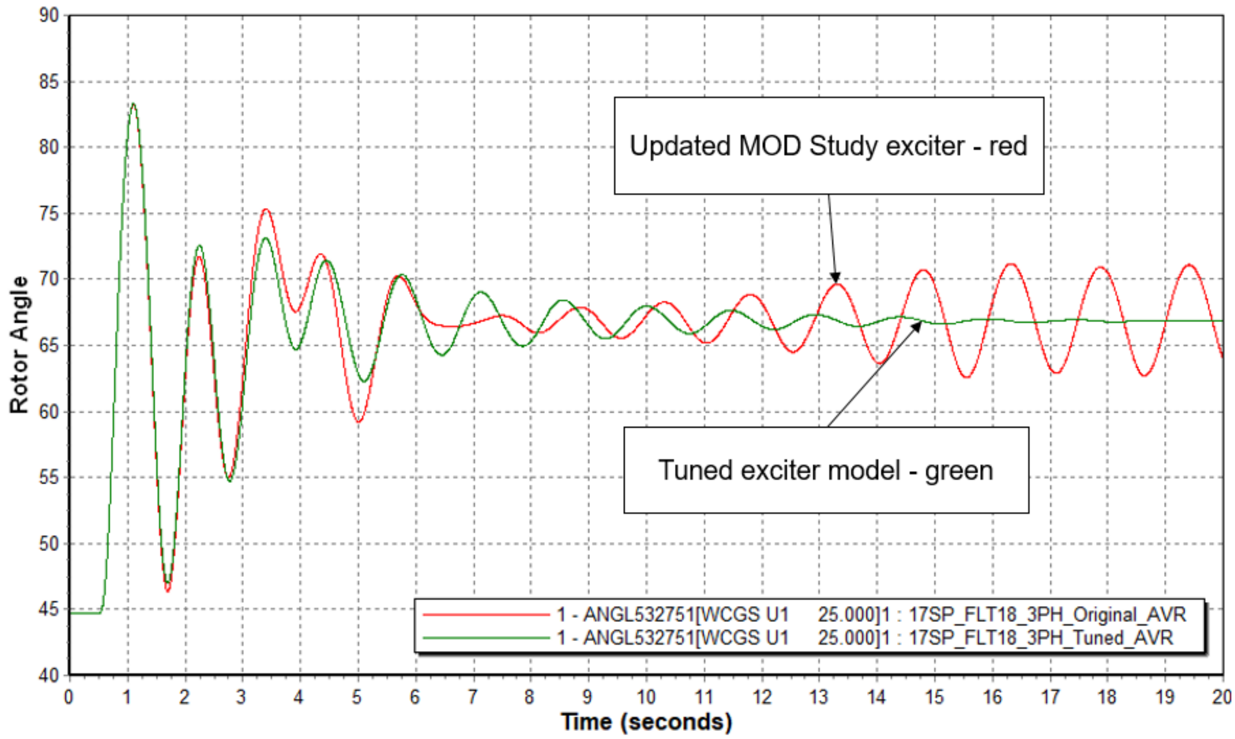

Figure 3-3: Representative Rotor angle plot of the Wolf Creek generator for 2017 Winter Peak conditions for FLT18-3PH

Note FLT101-PO, which is a prior outage of the Belle Plaine to Farber 138k line followed by the loss of the Sumner to TIMJCT 138kV line, did not result in any voltage violations in this analysis as was observed in the DISIS-2016-001-1 Group 08 analysis. The capacitor banks, which were dispatched as part of the mitigation plan following the prior outage, were dispatched in the DISIS-2016-001-5 study cases prior to any events.

Additionally, FLT125-PO and FLT126-PO, which both include the prior outage of Middleton Tap to Peckham Tap 138kV, resulted in generation curtailment of GEN-2016-071 in the DISIS-2016-001-1 Group 08 analysis. It was determined for FLT126-PO that generation curtailment of GEN-2011-057 and GEN-2016-071 of up to 110 MW is required for this Group 08 analysis. With this system adjustment, the system recovers within SPP Performance Criteria for the prior outage of either Middleton Tap to Peckham Tap or Creswell to Oxford 138kV circuit followed by a fault event resulting in loss of the other circuit.

3.3 Stability Analysis Results: Sensitivity

The Stability Analysis was observe to show system and angular instability for a fault on the Waverly to Wolf Creek 345kV circuit both as a P1 event, along with several P6 events with a prior outage of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV. To determine the impact of the updated model for the Wolf Creek Nuclear plant (presented in Section 3.1) and the impact of the series reactors on the Wolf Creek to Waverly to LaCygne 345kV circuit along with other mitigation options, refer to Table 3-3.

Table 3-3
Scenario Descriptions for Mitigation Options

Scenario	Wolf Creek Model	LaCygne to Waverly 345kV Series Reactors	Waverly to Wolf Creek 345kV Series Reactors	Other Mitigation
1	Original	5 ohm	6 ohm	N/A
2	Updated	5 ohm	6 ohm	N/A
3	Original	N/A	N/A	N/A
4	Original	5 ohm	N/A	N/A
5	Updated	N/A	N/A	N/A
6	Updated	5 ohm	N/A	N/A
7	Updated	N/A	6 ohm	N/A
8	Updated	15 ohm	18 ohm	N/A
9	Updated	N/A	N/A	Wolf Creek – Emporia 345kV Line
10	Updated	N/A	N/A	Wolf Creek – Blackberry 345kV Line
11	Updated	N/A	N/A	Wolf Creek exciter (EXAC3 tuned)

Note the “Original” Wolf Creek model refers to the existing model in the DISIS-2016-002-1 stability database updated to reflect DISIS-2016-001-5 conditions prior to the NERC MOD-026 and MOD-027 model validation efforts. Scenario 6 and Scenario 7 above were performed to determine which reactor location is appropriate and Scenario 8 was performed to determine if there are adverse impacts to marginally larger series reactors.

The tables listed on the following pages state whether the system remained stable or generation tripped offline, if acceptable voltage recovery was observed after the fault was cleared, and if the voltage recovered to above 0.9 p.u. and below 1.1 p.u. post fault steady-state conditions. Voltage recovery criteria includes ensuring that the transient voltage recovery is between 0.7 p.u. within 2.5 seconds after the fault is cleared and 1.2 p.u. at any point after the fault is cleared and ending in a steady-state voltage (for N-1 contingencies) at the pre-contingent level or at least above 0.9 p.u. and below 1.1. p.u.

Table 3-4
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
1	FLT01-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT02-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT03-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT04-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT05-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT06-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT07-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT08-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT09-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT10-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT11-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT12-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT13-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT14-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT15-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT16-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT17-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT18-3PH	-	-	Non-Compliant	Poor damping	-	-	Non-Compliant	Poor damping	-	-	Non-Compliant	Poor damping
19	FLT19-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT20-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT21-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT22-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT23-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT24-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT25-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT26-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT27-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT28-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT29-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT30-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT31-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT32-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT33-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
34	FLT34-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT35-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT36-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT37-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT38-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT39-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT40-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT41-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT42-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT43-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT44-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT45-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT46-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT47-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT48-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT49-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT50-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT51-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT52-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT53-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT54-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT55-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT56-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT57-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT58-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT59-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT60-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT61-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT62-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT63-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
64	FLT64-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT65-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
66	FLT66-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
67	FLT67-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
68	FLT68-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
69	FLT69-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
70	FLT70-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
71	FLT71-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
72	FLT72-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
73	FLT73-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
74	FLT74-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
75	FLT75-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
76	FLT76-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
77	FLT77-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
78	FLT78-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
79	FLT79-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
80	FLT80-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
81	FLT81-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
82	FLT82-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
83	FLT83-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
84	FLT84-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
85	FLT85-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
86	FLT86-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
87	FLT87-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
88	FLT88-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
89	FLT89-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
90	FLT90-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
91	FLT91-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
92	FLT92-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
93	FLT93-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
94	FLT94-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
95	FLT95-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
96	FLT96-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
97	FLT97-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
98	FLT98-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
99	FLT99-PO			Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
100	FLT100-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
101	FLT101-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
102	FLT102-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
103	FLT103-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
104	FLT104-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
105	FLT105-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
106	FLT106-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
107	FLT107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
108	FLT108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
109	FLT109-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
110	FLT110-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
111	FLT111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
112	FLT112-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
113	FLT113-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
114	FLT114-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
115	FLT115-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
116	FLT116-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
117	FLT117-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
118	FLT118-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
119	FLT119-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
120	FLT120-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
121	FLT121-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
122	FLT122-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
123	FLT123-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
124	FLT124-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
125	FLT125-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
126	FLT126-PO	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability
127	FLT127-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
128	FLT128-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
129	FLT129-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
130	FLT130-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
131	FLT131-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
132	FLT132-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
133	FLT133-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
134	FLT134-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
135	FLT135-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
136	FLT136-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
137	FLT137-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
138	FLT138-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
139	FLT139-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
140	FLT140-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
141	FLT141-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
142	FLT142-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
143	FLT143-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
144	FLT144-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
145	FLT145-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
146	FLT146-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
147	FLT147-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-4 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Updated Wolf Creek Model with Series Reactors (Scenario 2)

Cont. No.	Cont. Name	2017 Winter Peak Voltage Recovery Less than .70 p.u.	2017 Winter Peak Voltage Recovery Greater than 1.20 p.u.	2017 Winter Peak Post Fault Steady-State Voltage	2017 Winter Peak System Stability	2018 Summer Peak Voltage Recovery Less than .70 p.u.	2018 Summer Peak Voltage Recovery Greater than 1.20 p.u.	2018 Summer Peak Post Fault Steady-State Voltage	2018 Summer Peak System Stability	2026 Summer Peak Voltage Recovery Less than .70 p.u.	2026 Summer Peak Voltage Recovery Greater than 1.20 p.u.	2026 Summer Peak Post Fault Steady-State Voltage	2026 Summer Peak System Stability
148	FLT148-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
149	FLT149-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
150	FLT150-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
151	FLT151-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
152	FLT152-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
153	FLT153-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
154	FLT154-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
155	FLT155-PO	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step	-	-	Voltage instability	Gen Out-of-Step
156	FLT156-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
157	FLT157-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
1	FLT01-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT02-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT03-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT04-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT05-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT06-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT07-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT08-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT09-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT10-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT11-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT12-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT13-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT14-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT15-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT16-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT17-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT18-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
19	FLT19-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT20-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT21-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT22-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT23-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT24-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT25-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT26-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT27-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT28-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT29-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT30-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT31-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT32-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT33-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
34	FLT34-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT35-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT36-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT37-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT38-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT39-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT40-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT41-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT42-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT43-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT44-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT45-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT46-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT47-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT48-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT49-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT50-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT51-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT52-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT53-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT54-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT55-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT56-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT57-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT58-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT59-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT60-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT61-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT62-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT63-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
64	FLT64-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT65-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
66	FLT66-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
67	FLT67-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
68	FLT68-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
69	FLT69-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
70	FLT70-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
71	FLT71-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
72	FLT72-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
73	FLT73-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
74	FLT74-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
75	FLT75-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
76	FLT76-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
77	FLT77-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
78	FLT78-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
79	FLT79-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
80	FLT80-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
81	FLT81-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
82	FLT82-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
83	FLT83-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
84	FLT84-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
85	FLT85-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
86	FLT86-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
87	FLT87-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
88	FLT88-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
89	FLT89-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
90	FLT90-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
91	FLT91-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
92	FLT92-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
93	FLT93-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
94	FLT94-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
95	FLT95-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
96	FLT96-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
97	FLT97-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
98	FLT98-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
99	FLT99-PO			Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
100	FLT100-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
101	FLT101-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
102	FLT102-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
103	FLT103-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
104	FLT104-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
105	FLT105-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
106	FLT106-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
107	FLT107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
108	FLT108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
109	FLT109-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
110	FLT110-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
111	FLT111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
112	FLT112-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
113	FLT113-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
114	FLT114-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
115	FLT115-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
116	FLT116-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
117	FLT117-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
118	FLT118-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
119	FLT119-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
120	FLT120-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
121	FLT121-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
122	FLT122-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
123	FLT123-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
124	FLT124-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
125	FLT125-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
126	FLT126-PO	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability
127	FLT127-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
128	FLT128-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
129	FLT129-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
130	FLT130-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
131	FLT131-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
132	FLT132-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
133	FLT133-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
134	FLT134-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
135	FLT135-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
136	FLT136-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
137	FLT137-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
138	FLT138-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
139	FLT139-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
140	FLT140-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
141	FLT141-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
142	FLT142-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
143	FLT143-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
144	FLT144-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
145	FLT145-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
146	FLT146-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
147	FLT147-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-5 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model without Series Reactors (Scenario 3)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
148	FLT148-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
149	FLT149-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
150	FLT150-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
151	FLT151-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
152	FLT152-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
153	FLT153-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
154	FLT154-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
155	FLT155-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
156	FLT156-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
157	FLT157-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
1	FLT01-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
2	FLT02-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
3	FLT03-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
4	FLT04-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
5	FLT05-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
6	FLT06-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
7	FLT07-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
8	FLT08-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
9	FLT09-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
10	FLT10-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
11	FLT11-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
12	FLT12-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
13	FLT13-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
14	FLT14-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
15	FLT15-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
16	FLT16-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
17	FLT17-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
18	FLT18-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
19	FLT19-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
20	FLT20-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
21	FLT21-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
22	FLT22-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
23	FLT23-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
24	FLT24-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
25	FLT25-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
26	FLT26-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
27	FLT27-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
28	FLT28-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
29	FLT29-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
30	FLT30-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
31	FLT31-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
32	FLT32-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
33	FLT33-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
34	FLT29-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
35	FLT30-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
36	FLT31-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
37	FLT32-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
38	FLT33-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
39	FLT34-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
40	FLT35-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
41	FLT36-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
42	FLT37-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
43	FLT38-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
44	FLT39-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
45	FLT40-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
46	FLT41-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
47	FLT42-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
48	FLT43-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
49	FLT44-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
50	FLT45-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
51	FLT46-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
52	FLT47-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
53	FLT48-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
54	FLT49-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
55	FLT50-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
56	FLT51-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
57	FLT52-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
58	FLT53-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
59	FLT54-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
60	FLT55-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
61	FLT56-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
62	FLT57-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
63	FLT58-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
64	FLT64-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
65	FLT65-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
66	FLT66-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
67	FLT67-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
68	FLT68-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
69	FLT69-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
70	FLT70-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
71	FLT71-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
72	FLT72-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
73	FLT73-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
74	FLT74-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
75	FLT75-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
76	FLT76-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
77	FLT77-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
78	FLT78-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
79	FLT79-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
80	FLT80-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
81	FLT81-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
82	FLT82-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
83	FLT83-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
84	FLT84-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
85	FLT85-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
86	FLT86-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
87	FLT87-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
88	FLT88-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
89	FLT89-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
90	FLT90-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
91	FLT91-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
92	FLT92-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
93	FLT93-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
94	FLT94-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
95	FLT95-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
96	FLT96-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
97	FLT97-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
98	FLT98-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
99	FLT99-PO			Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
100	FLT100-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
101	FLT101-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
102	FLT102-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
103	FLT103-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
104	FLT104-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
105	FLT105-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
106	FLT106-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
107	FLT107-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
108	FLT108-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
109	FLT109-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
110	FLT110-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
111	FLT111-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
112	FLT112-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
113	FLT113-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
114	FLT114-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
115	FLT115-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
116	FLT116-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
117	FLT117-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
118	FLT118-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
119	FLT119-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
120	FLT120-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
121	FLT121-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
122	FLT122-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
123	FLT123-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
124	FLT124-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
125	FLT125-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
126	FLT126-PO	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability	-	-	Voltage Instability	Generator instability
127	FLT127-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
128	FLT128-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
129	FLT129-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
130	FLT130-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
131	FLT131-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
132	FLT132-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
133	FLT133-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
134	FLT134-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
135	FLT135-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
136	FLT136-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
137	FLT137-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
138	FLT138-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
139	FLT139-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
140	FLT140-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
141	FLT141-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
142	FLT142-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
143	FLT143-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
144	FLT144-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
145	FLT145-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
146	FLT146-3PH	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
147	FLT147-SB	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Table 3-6 (continued)
Stability Analysis Summary of Results for 2017 Winter, 2018 Summer, and 2026 Summer Peak Conditions: Original Wolf Creek Model with Series Reactors (Scenario 1)

Cont. No.	Cont. Name	2017 Winter Peak				2018 Summer Peak				2026 Summer Peak			
		Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability	Voltage Recovery		Post Fault Steady-State Voltage	System Stability
		Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.			Less than .70 p.u.	Greater than 1.20 p.u.		
148	FLT148-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
149	FLT149-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
150	FLT150-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
151	FLT151-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
152	FLT152-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
153	FLT153-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
154	FLT154-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
155	FLT155-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
156	FLT156-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable
157	FLT157-PO	-	-	Compliant	Stable	-	-	Compliant	Stable	-	-	Compliant	Stable

Sensitivity: Summary of Results

It was observed for all eleven (11) scenarios that most P1, P4, and P6 events recovered within SPP Performance Criteria. However, for a fault event at Wolf Creek 345kV resulting in the loss of Wolf Creek to Waverly 345kV line the results showed poor rotor angle damping of the Wolf Creek generator. Also prior outage scenarios of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV resulted in angular instability and the Wolf Creek generator losing synchronism with the system due to high impedance export paths (weak grid) for scenarios with the updated Wolf Creek model for the scenarios with and without series reactors.

Mitigations evaluated include the Wolf Creek to Emporia 345kV line and Wolf Creek to Blackberry 345kV line, which each add an additional outlet circuit for Wolf Creek. It is also observed that with the tuned AVR (EXAC3 tuned), Wolf Creek generator rotor angle shows positive damping. For these two line mitigation and tuned AVR (EXAC3 tuned) options, Wolf Creek remained in synchronism and all voltages recovered within SPP Performance Criteria.

The inclusion of a series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits did not provide mitigation for the observed stability issues nor an observable impact on the stability response of the transmission system.

Refer to Table 3-7 through 3-9 to observe the comparison of prior outage faults at Wolf Creek 345kV for 2017 Winter Peak, 2018 Summer Peak, 2026 Summer Peak conditions, respectively, for the following scenarios:

- Scenario 1: Original Wolf Creek model with both series reactors
- Scenario 2: Updated Wolf Creek model with both series reactors
- Scenario 3: Original Wolf Creek model without any series reactors
- Scenario 5: Updated Wolf Creek model without any series reactors
- Scenario 9: Updated Wolf Creek model with Wolf Creek – Emporia 345kV Line
- Scenario 10: Updated Wolf Creek model with Wolf Creek – Black Berry 345kV Line
- Scenario 11: Updated Wolf Creek model with tuned exciter (EXAC3 tuned)

Refer to Appendix E, Appendix F, and Appendix G for a complete set of plots for all contingencies for 2017 Winter Peak, 2018 Summer Peak, and 2026 Summer Peak conditions, respectively, with the use of the updated Wolf Creek model and the Wolf Creek to Blackberry 345kV line.

Table 3-7
Wolf Creek and System Response for 3PH and Prior Outage Faults at Wolf Creek 345kV for 2017 Winter Peak Conditions

Ref. No.	Fault description	System Response and Recovery						
		Scenario 1	Scenario 2	Scenario 3	Scenario 5	Scenario 9	Scenario 10	Scenario 11
1	3 phase fault on the Waverly (532799) to Wolf Creek (532797) 345kV line Apply fault at the Wolf Creek 345kV bus. Clear fault after 3.6 cycles by tripping the faulted line	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
2	**Prior outage to Waverly-La Cygne 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
3	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
4	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
5	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
6	**Prior outage to Wolf Creek-Rose Hill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
7	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
8	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
9	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
10	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response

Table 3-8
Wolf Creek and System Response for 3PH and Prior Outage Faults at Wolf Creek 345kV for 2018 Summer Peak Conditions

Ref. No.	Fault description	System Response and Recovery						
		Scenario 1	Scenario 2	Scenario 3	Scenario 5	Scenario 9	Scenario 10	Scenario 11
1	3 phase fault on the Waverly (532799) to Wolf Creek (532797) 345kV line Apply fault at the Wolf Creek 345kV bus. Clear fault after 3.6 cycles by tripping the faulted line	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
2	**Prior outage to Waverly-La Cygne 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
3	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
4	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
5	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
6	**Prior outage to Wolf Creek-Rose Hill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
7	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
8	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
9	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
10	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response

Table 3-9
Wolf Creek and System Response for 3PH and Prior Outage Faults at Wolf Creek 345kV for 2026 Summer Peak Conditions

Ref. No.	Fault description	System Response and Recovery						
		Scenario 1	Scenario 2	Scenario 3	Scenario 5	Scenario 9	Scenario 10	Scenario 11
1	3 phase fault on the Waverly (532799) to Wolf Creek (532797) 345kV line Apply fault at the Wolf Creek 345kV bus. Clear fault after 3.6 cycles by tripping the faulted line	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
2	**Prior outage to Waverly-La Cygne 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
3	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
4	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
5	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
6	**Prior outage to Wolf Creek-Rose Hill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
7	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
8	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Unstable	Acceptable Response	Unstable	Acceptable Response	Acceptable Response	Acceptable Response
9	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response
10	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** **Scale generation at bus 532957 (Waverly Wind Farm) to 0 MW output** **Scale generation at bus 532751 (Wolf Creek Generation) to 758 MW gross output (700 MW net)** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response	Acceptable Response

For FLT150-PO, a prior outage of Wolf Creek to Benton 345kV line, dispatch of Waverly Wind Farm to 0 MW, and dispatch of Wolf Creek Nuclear Plant to 758 MW gross (700 MW Net) output, followed by the loss of Waverly to LaCygne 345kV line, and with the updated Wolf Creek model, system instability was observed for the scenario with and without the series reactors. Refer to Figure 3-4 and Figure 3-5 for a representative plot of Wolf Creek generator real and reactive power, respectively, for Scenarios 1, 2, 3, 5, 9, and 10 for 17WP conditions. Refer to Figure 3-6 for a representative plot of the rotor angle for the scenarios listed above.

Additional analysis demonstrates that curtailment of up to 1,105 MW of Group 8 requests, following the prior outage, provides mitigation for these prior outage P6 events.

For 17WP conditions, it can be observed that for Scenario 5 (updated Wolf Creek generator model with no series reactor) and Scenario 2 (updated Wolf Creek generator model with series reactors in-service), the Wolf Creek rotor angle is not damped, is going out-of-step, and instability is observed.

Mitigation: Wolf Creek Outlet Circuit Addition

It can also be observed that Scenario 9 and Scenario 10, which are additions of the Wolf Creek to Emporia 345kV line and Wolf Creek to Blackberry 345kV line, respectively, help maintain system stability and the Wolf Creek generator recovers within acceptable SPP Performance Criteria.

In addition, with the Wolf Creek to Emporia 345kV line and Wolf Creek to Blackberry 345kV line, the identified curtailment of Group 8 requests without the mitigation is not necessary to address this instability. Additionally the output reduction of Waverly Wind Farm and the Wolf Creek Nuclear Plant is will no longer be required for all fault events evaluated. With an upgrade that provides an additional Wolf Creek 345kV outlet circuit, the TPL Corrective Action Plan and associated OP Guide may require re-evaluation by the Transmission Owner to determine the appropriate adjustments. Refer to Table 3-10 for the 2017 Winter Peak sensitivity results with the additional Wolf Creek outlet circuits and with no generation curtailment following prior outages at Wolf Creek 345kV. The results presented in Table 3-10 are representative of 2018 Summer Peak and 2026 Summer Peak conditions.

Table 3-10
Sensitivity Results for Additional Wolf Creek Outlets

Ref. No.	Fault Description	System Response and Recovery	
		Scenario 9	Scenario 10
1	**Prior outage to Waverly-La Cygne 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
2	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Acceptable Response
3	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
4	**Prior outage to Wolf Creek-Benton 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
5	**Prior outage to Wolf Creek-Rose Hill 345kV Circuit 1** Apply 3-phase fault on Waverly-LaCygne 345 kV Circuit 1, near Waverly for 3.6 cycles. Open Waverly breakers 345-471 & 345-475. Open Waverly-LaCygne 345 kV line.	Acceptable Response	Acceptable Response
6	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
7	**Prior outage to Wolf Creek-Rosehill 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Waverly 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
8	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Benton 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response
9	**Prior outage to Wolf Creek-Waverly 345kV Circuit 1** Apply 3-phase fault for 3.6 cycles on Wolf Creek-Rose Hill 345kV Circuit 1 and then clear fault by tripping the Faulted circuit.	Acceptable Response	Acceptable Response

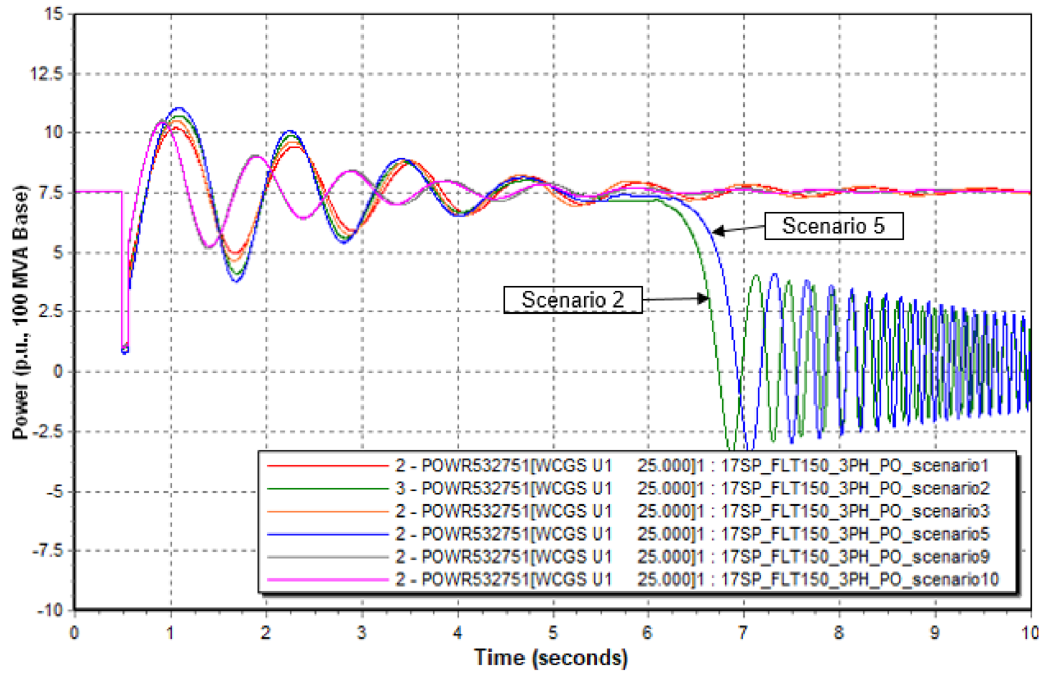

Figure 3-4: Representative plot of Wolf Creek real power for 2017 Winter Peak conditions for FLT 150-PO.

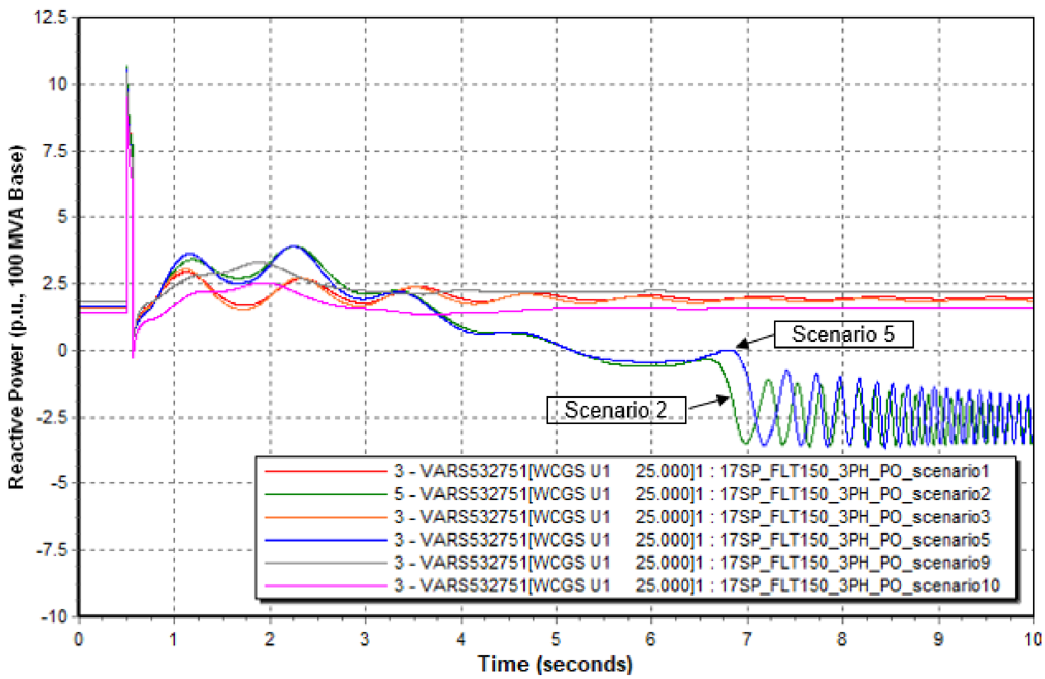

Figure 3-5: Representative plot of Wolf Creek reactive power for 2017 Winter Peak conditions for FLT150-PO.

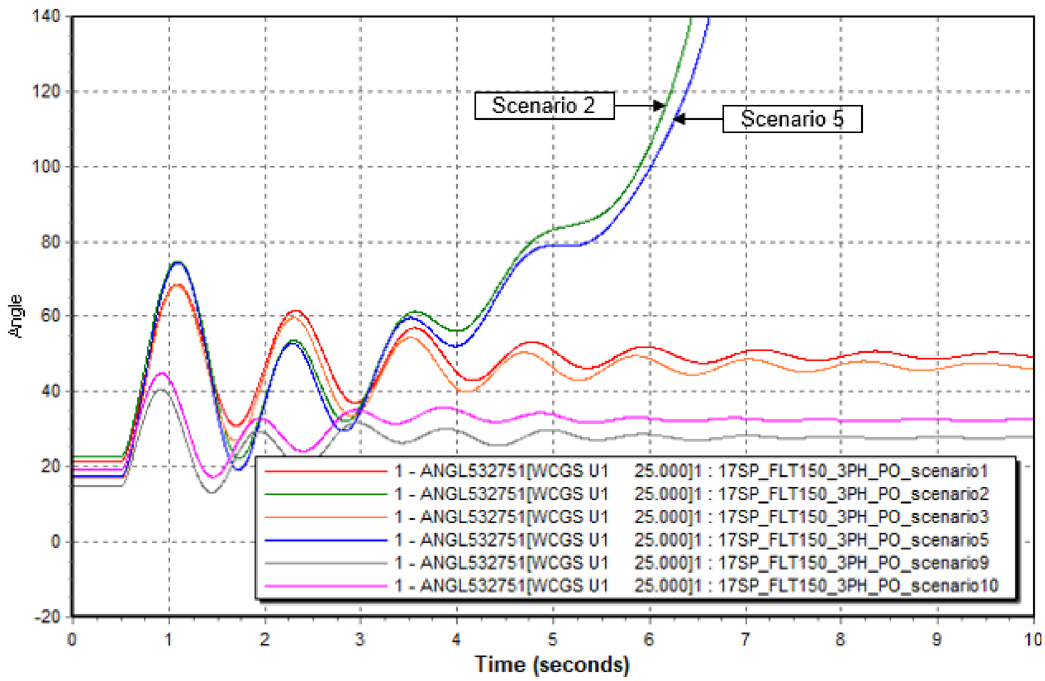

Figure 3-6: Representative plot of Wolf Creek rotor angle for 2017 Winter Peak conditions for FLT150-PO.

For 26SP conditions, it can be observed that for Scenario 5 (updated Wolf Creek generator model with no series reactor) and Scenario 2 (updated Wolf Creek generator model with series reactors in-service), the Wolf Creek rotor angle is not damped, is going out-of-step, and instability is observed. It can also be seen that Scenario 9 and Scenario 10, which are additions of the Wolf Creek to Emporia 345kV line and Wolf Creek to Blackberry 345kV line, respectively, help maintain system stability and the Wolf Creek generator recovers within acceptable SPP Performance Criteria.

Refer to Figure 3-7 and Figure 3-8 for a representative plot of Wolf Creek generator real and reactive power, respectively, for Scenarios 1, 2, 3, 5, 9, and 10 for 26SP conditions. Refer to Figure 3-9 for a representative plot of the rotor angle for the scenarios listed above.

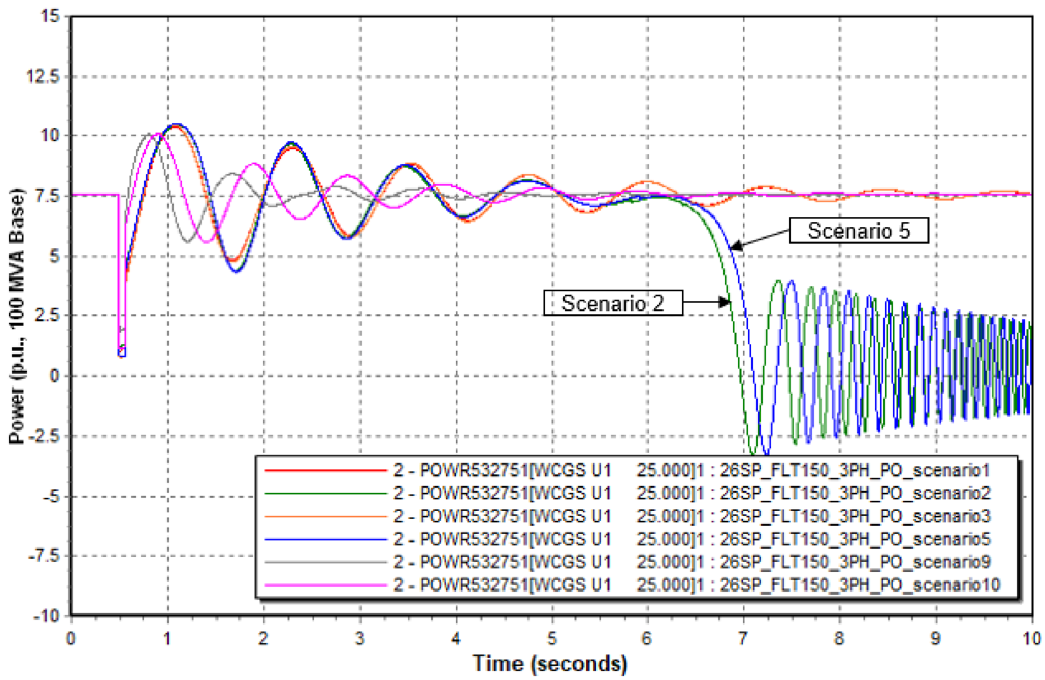

Figure 3-7: Representative plot of Wolf Creek real power for 2026 Summer Peak conditions for FLT150-PO.

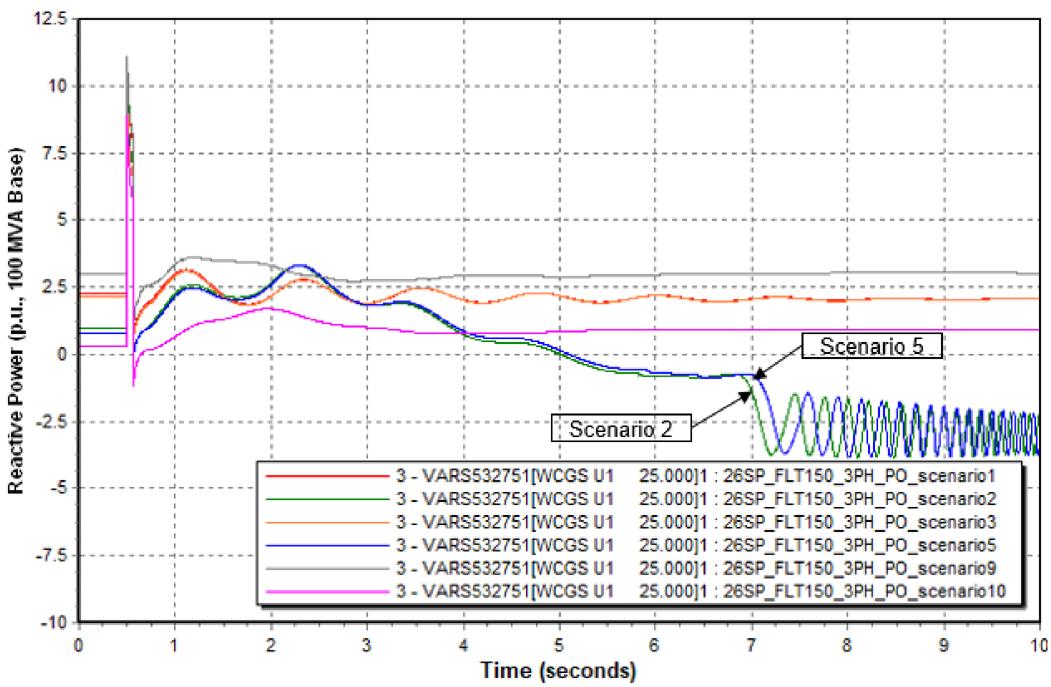

Figure 3-8: Representative plot of Wolf Creek reactive power for 2026 Summer Peak conditions for FLT150-PO.

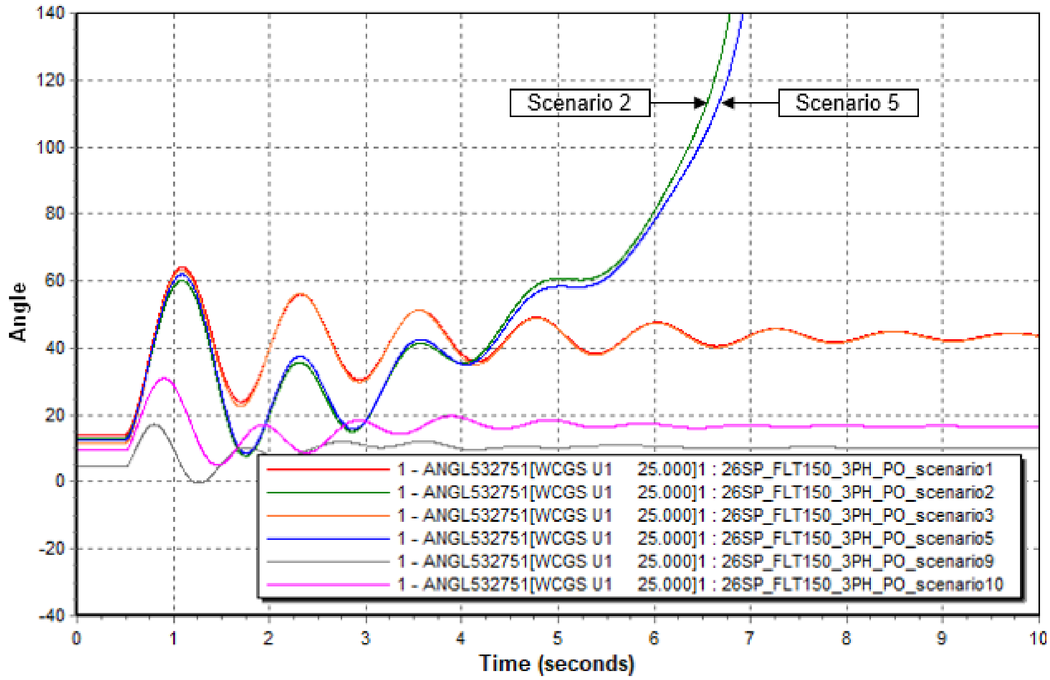

Figure 3-9: Representative plot of Wolf Creek rotor angle for 2026 Summer Peak conditions for FLT150-PO.

Mitigation: Tuned Excitation Control System

For the tuned exciter model option, the assumption was made that the existing Wolf Creek exciter can be tuned or the control system replaced to mitigate the oscillations. Based on review of the existing excitation system model (EXAC3), the primary gain to be tuned was Ka, followed by investigation of the rate feedback parameter, Kn, to further improve the response. Considering the existing value of gain Ka was found excessive for system conditions (poorly damped oscillations), a reduced gain of Ka was chosen to maintain a fast voltage response and improved rotor angle damping.

Refer to Figure 3-10 for a representative rotor angle plot comparing the existing Wolf Creek AVR (Scenario 5) response to the tuned Wolf Creek AVR (Scenario 11) response. It can be observed that the tuned Wolf Creek exciter model mitigation helps maintain system stability.

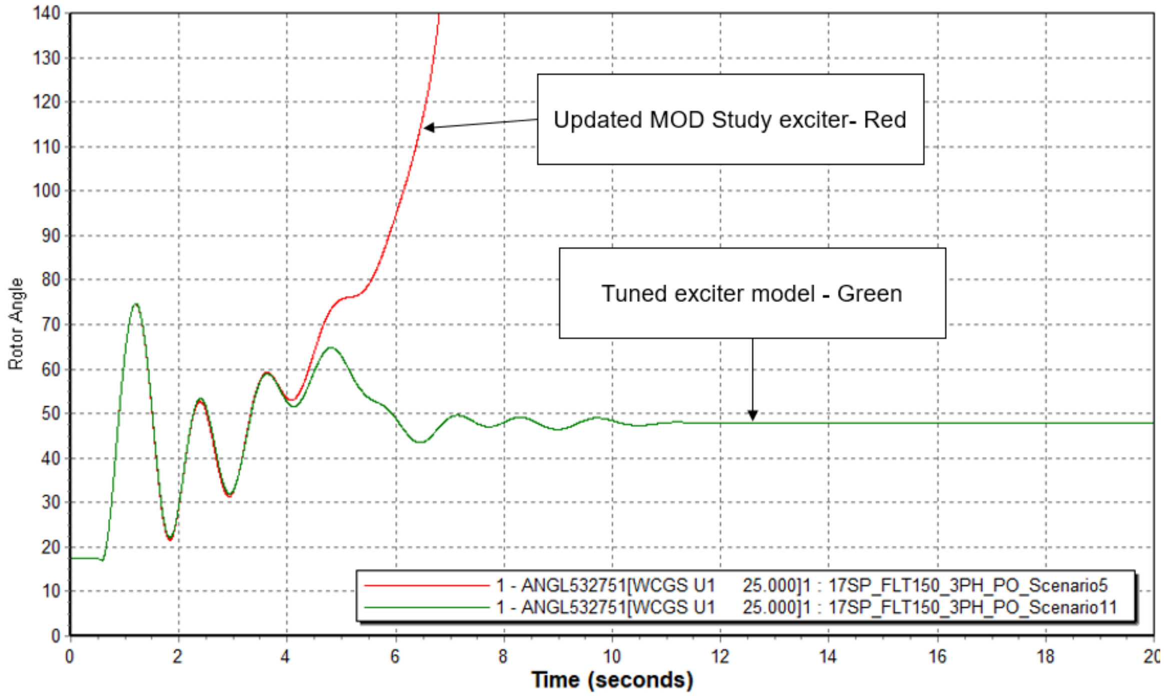

Figure 3-10: Representative plot of Wolf Creek rotor angle for 2017 Winter Peak conditions for FLT150-PO for Scenario 5 and Scenario11.

Refer to Figure 3-11 and Figure 3-12 for representative rotor angle plots that compare the updated MOD EXAC3 Wolf Creek model (Scenario 5) to the tuned EXAC3 Wolf Creek model (Scenario 11), respectively. Each figure is plotting the rotor angle response of Wolf Creek for the following faults:

- FLT18-3PH (P1): Loss of Wolf Creek to Waverly
- FLT150-PO (P6): PO of Wolf Creek to Benton followed by Loss of Waverly to LaCygne
- FLT151-PO (P6): PO of Wolf Creek to Benton followed by Loss of Wolf Creek to Waverly
- FLT153-PO (P6): PO of Wolf Creek to Rose Hill followed by Loss of Waverly to LaCygne
- FLT154-PO (P6): PO of Wolf Creek to Rose Hill followed by Loss of Wolf Creek to Waverly

It can be observed that tuning the Wolf Creek exciter (EXAC3 model) results in system stability and the Wolf Creek unit remaining synchronized with the transmission system. Additionally, with the tuned AVR, the stability constraint P1 event is fully mitigated and the P6 events following the prior outage are mitigated with a system adjustment of Wolf Creek Nuclear Plant net output reducing to 750MW with Waverly Wind Farm remaining at full output. With an upgrade that provides a tuned AVR at Wolf Creek, the TPL Corrective Action Plan and associated OP Guide may require re-evaluation by the Transmission Owner to determine the appropriate adjustments.

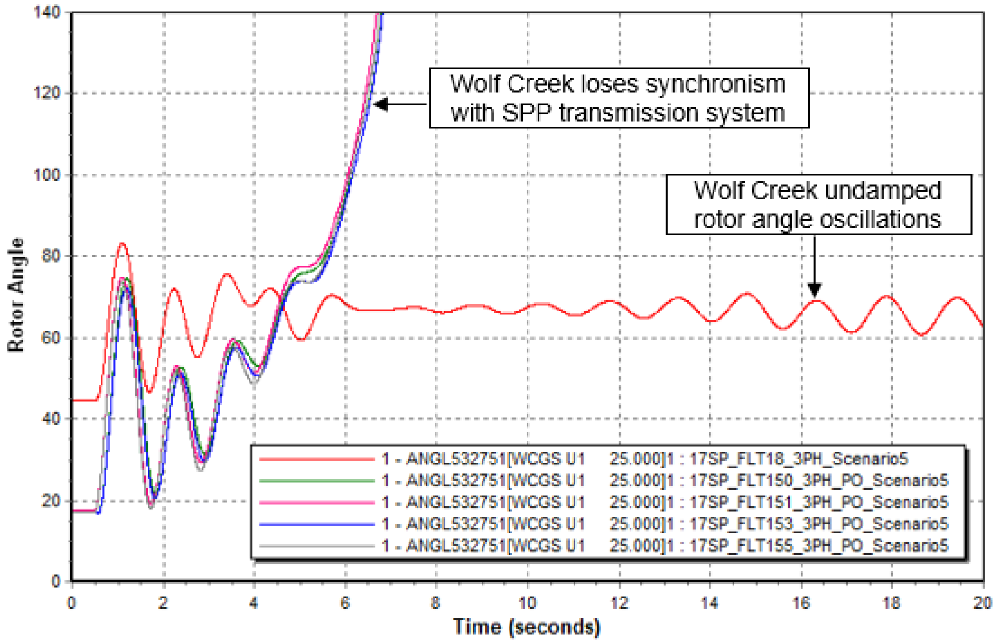

Figure 3-11: Representative plot of Wolf Creek rotor angle for 2017 Winter Peak conditions for FLT18-3PH, FLT150-PO, FLT151-PO, FLT153-PO, FLT155-PO for Scenario 5.

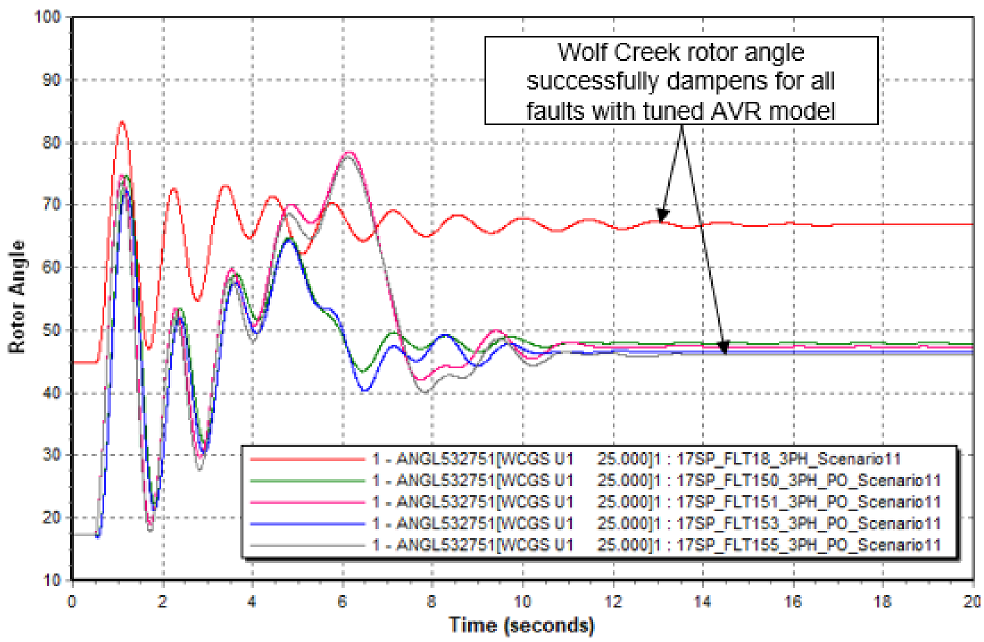

Figure 3-12: Representative plot of Wolf Creek rotor angle for 2017 Winter Peak conditions for FLT18-3PH, FLT150-PO, FLT151-PO, FLT153-PO, FLT155-PO for Scenario 11.

SECTION 4: CONCLUSIONS

Summary of Stability Analysis

The Stability Analysis determined that the Wolf Creek NERC MOD-026 and MOD-027 model updates resulted in system and rotor angle instability for several prior outage contingencies at Wolf Creek 345kV across all seasons.

Generation curtailment of approximately 110 MW of generation between GEN-2011-057 and GEN-2016-071 is required following the prior outage of either Middleton Tap to Peckham Tap or Creswell to Oxford 138kV circuit. The generation curtailment is required to maintain system stability for the subsequent loss of the other circuit.

Generation curtailment of approximately 1,105 MW of generation in Group 8 is required following the prior outage of Wolf Creek to Benton 345kV or Wolf Creek to Rosehill 345kV. The generation curtailment is required to maintain system stability for the subsequent loss of Wolf Creek to Waverly 345kV circuit or Waverly to LaCygne 345kV circuit and to maintain the System Operating Limit for Wolf Creek at a minimum of 700 MW net output.

The inclusion of a series reactor on the Waverly to LaCygne 345kV and Wolf Creek to Waverly 345kV circuits did not provide mitigation for the observed stability issues nor an observable impact on the stability response of the transmission system.

Note the mitigation option of tuning of the Wolf Creek exciter and upgrades of Wolf Creek to Emporia 345kV circuit or Wolf Creek to Blackberry 345kV circuit mitigated the system instability for all prior outage faults at Wolf Creek 345kV and was determined to provide acceptable system performance for all other contingencies.