GEN-2015-034
Impact Restudy for Generator Modification (Turbine Change)

April 2017
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
3/30/2017	SPP	GEN-2015-034 Impact Restudy for Generator Modification Report Issued
4/14/2017	SPP	Add note stating that results for the Vestas V126 GS wind turbines also apply to the Vestas V136 GS wind turbines and that either one may be used

Executive Summary

The GEN-2015-034 Interconnection Customer has requested a modification to its Generator Interconnection Request (GIR) to change wind turbine generators. Originally, the GIR consisted of one hundred (100) Vestas V110 2.0MW wind turbines for a total 200.0 MW. The requested change is fifty-seven (57) Vestas V126[1] GS 3.45MW wind turbines and one (1) Vestas V126 GS 3.3MW wind turbine totaling 199.95MW. The point of interconnection (POI) is the Oklahoma Gas and Electric (OKGE) Ranch Road Substation 345kV.

The study models used were the 2016 winter, 2017 summer, and 2025 summer models that included Interconnection Requests through DISIS-2015-002.

Stability analysis has determined with all previously assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A power factor analysis was performed for the project on the current study 2016 winter peak, 2017 summer peak, and 2025 summer peak cases with identified system upgrades. As reactive power is required for GEN-2015-034, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

A reduced generation analysis was conducted to determine reactor inductive amounts to compensate the capacitive effects on the transmission system during low or reduced wind conditions caused by the interconnecting project's generator lead transmission line and collector systems. The interconnection customer's facility is required to install a reactor or an equivalent means of compensation that can inject approximately 11.8Mvar of inductive

---

[1] Subsequent to the first posting of this study, the Interconnection Customer requested to use the Vestas V136 GS wind turbine generators in place of the Vestas V126 GS wind turbine generators due to greater availability. A review of the two wind turbines shows that with the exception of the rotor diameters, they are electrically equivalent and will function nearly identically. Vestas has confirmed that the PSSE Version 32 model used for the stability simulation is identical for both the Vestas V126 GS and the Vestas V136 GS wind turbine generators. Therefore, the Vestas V126 GS results shown in this report will apply to the Vestas V136 GS also. The Interconnection Customer can use either the Vestas V126 GS or the Vestas V136 GS wind turbine generators.

reactance. Reactive compensation devices are typically installed on the low side of the project's substation 345/34.5kV transformer.

Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS 2015-002 in place, GEN-2015-034 with fifty-seven (57) Vestas V126 GS 3.45MW wind turbines and one (1) Vestas V126 GS 3.3MW wind turbine should be able to interconnect reliably to the SPP transmission grid. The change in wind turbine generator is not a Material Modification.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. Powerflow analysis was not performed. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Table of Contents

1. Introduction

The GEN-2015-034 Interconnection Customer has requested a modification to its Generator Interconnection Request to change its wind turbine generators from one hundred (100) Vestas V110 2.0 MW wind turbines to fifty-seven (57) Vestas V126 GS 3.45MW wind turbines and one (1) Vestas V126 GS 3.3MW wind turbine for a total 199.95 MW. The requested change is shown in **Table 1-1**.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-034	199.95	57 x Vestas V126 GS 3.45MW = 196.65MW, and 1 x Vestas V126 GS 3.3MW = 3.3MW	Ranch Road 345kV (515576)

The POI is the OKGE Ranch Road Substation 345kV. Other queued generation projects in the model are listed in **Table 1-2**.

Table 1-2: Other Queued Interconnection Requests in the Model

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2002-004	199.5	GE.1.5MW	Latham 345kV (532800)
GEN-2005-013	199.8	Vestes 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	100.8	Vestas V100 1.8MW	Tap on the Wolf Creek – LaCygne 345kV line (560004)
GEN-2010-005	299.2	GE 1.6MW & Vestas V110 2.0MW	Viola 345kV (532798)
ASGI-2010-006	150	GE1.5MW	Remington 138kV (301369)
GEN-2010-055	4.8	GENROU	Wekiwa 138kV (509757)
GEN-2011-057	150.4	GE 1.6MW	Creswell 138kV (532981)
GEN-2012-027	150.7	GE 1.62MW	Shidler 138kV (510403)
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	98.8	GE 1.62MW	Tap Bunch Creek-South 4th 138kV(562303)
GEN-2012-040	76.5	GE 1.7MW	Chilocco 138kV (521198)
GEN-2012-041	85 Summer 121.5 Winter	GENROU	Tap Rose Hill-Sooner 345kV (562318)

Table 1-2: Other Queued Interconnection Requests in the Model

Request	Capacity (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 (583743, 583746)	Tap on Tulsa N to GRDA1 345kV (562423)
GEN-2013-029	300	Vestas V100 VCSS 2MW (583753, 583756)	Renfrow 345kV(515543)
GEN-2014-001	200.6	GE 1.7MW 100m (583853,583856)	Tap Wichita to Emporia Energy Center 345kV (562476)
GEN-2014-028	35 (Uprate) (Pgen=259W/256 S)	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	200.0	Vestas V110 2.0MW	Ranch Road 345kV
GEN-2015-015	154.6	Siemens 2.3MW with Power Boost (115kW => 2.415MW)	Tap Medford Tap – Coyote 138kV
GEN-2015-016	200.0	Vestas V110 2.0MW	Tap Centerville – Marmaton 161kV
GEN-2015-024	220.0	GE 2.0MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-025	220.0	GE 2.0MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-028	3.0 uprate to GEN-2009-025 for total 62.8MW	Siemens 2.3MW with Power Boost (115kW => 2.415MW)	Nardins 69kV
GEN-2015-030	200.1	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-2015-047	300	Vestes V110-2MW (wind)	Sooner 345kV Tap (514803)
GEN-2015-052	300	Vestes V110-2MW (wind)	Tap on Opensky (515621) to RoseHill (532794) 345 kV (560053)
GEN-2015-062	4.5	G.E. 1.79MW (wind)	Breckenridge 138kV (514815)
GEN-2015-063	300	Vestes V110-2MW (wind)	Tap on Woodring (514715) to Matthewson (515497) 345 kV (560055)
GEN-2015-066	248	G.E. 2.3MW (wind)	Tap on Cleveland (512694) to Sooner (514803) 345 kV (560056)
GEN-2015-067	150	PV inverter user model (solar)	Sooner 138kV (514802)
GEN-2015-069	300	Vestes V110-2MW (wind)	Union Ridge 230kV (532874)
GEN-2015-073	200.1	Vestas V126 GS 3.45MW (wind)	Emporia 345kV (532768)
GEN-02015-083	125	G.E. 2.3MW (wind)	Belle Plain 138kV (533063)
GEN-2015-090	220	G.E. 2MW (wind)	Wichita (532796)-Thistle (539801) 345kV Tap (GEN-2015-024 (560033) 345kV)

A stability analysis was performed for the change in wind turbines. The analysis was performed on three (3) seasonal models including 2016 winter peak (16WP), the 2017 summer peak

(17SP), and the 2025 summer peak (25SP) cases. These cases are modified versions of the 2015 model series of Model Development Working Group (MDWG) dynamic study models that included upgrades and Interconnection Requests through DISIS-2015-002.

The stability analysis determines the impacts of the new interconnecting project on the stability and voltage recovery of the nearby systems and the ability of the interconnecting project to meet FERC Order 661A. If problems with stability or voltage recovery are identified, the need for reactive compensation or system upgrades is investigated. The contingencies listed in **Table 3-1** were used in the stability analysis.

The power factor analysis determines the power factor at the point of interconnection (POI) for the wind interconnection projects for pre-contingency and post-contingency conditions. The contingencies used in the power factor analysis are a subset of the stability analysis contingencies shown in **Table 3-1**.

A reduced (low wind/no wind) generation analysis was performed to determine reactor inductive amounts to compensate for the capacitive effects on the transmission system caused by the interconnecting project's generator lead transmission line and collector systems during low or reduced wind conditions.

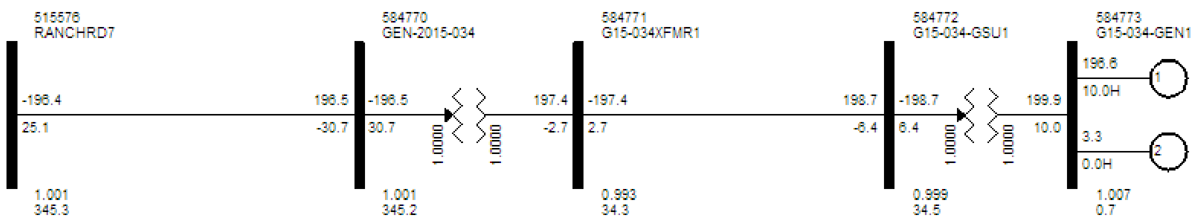
Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases. The results from the Short circuit analysis are shown in Appendix E.

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

2. Facilities

A one-line PSS/E slider drawing from the 16WP case is shown in **Figure 2-1** for GEN-2015-034.

Figure 2-1*:* GEN-2015-034 One-line Diagram



3. Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

Model Preparation

Transient stability analysis was performed using modified versions of the 2015 series of Model Development Working Group (MDWG) dynamic study models including the 2016 winter peak, 2017 summer peak, and the 2025 summer peak seasonal models. The cases are then loaded with prior queued interconnection requests and network upgrades assigned to those interconnection requests. Finally other queued projects as shown in **Table 1-2** and the study generation are dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

Disturbances

Ninety (90) contingencies were identified for use in this study and are listed in **Table 3-1**. These contingencies are faults at locations defined by SPP Generation Interconnection Staff. These contingencies include three-phase and single-phase N-1. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

Except for transformer faults, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically modeled as three-phase faults, unless otherwise noted. The sequence of events for a transformer fault is as follows:

1. apply fault for five (5) cycles
2. clear the fault by tripping the affected transformer facility (unless otherwise noted there will be no re-closing into a transformer fault)

The SPP areas monitored during the stability analysis were:

- 520: American Electric Power (AEPW)

- 524: Oklahoma Gas and Electric Company (OKGE)
- 525: Western Farmers Electric Cooperative (WFEC)
- 526: Southwestern Public Service (SPS)
- 531: Midwest Energy, Inc. (MIDW)
- 534: Sunflower Electric Power Corp. (SUNC)
- 536: Westar Energy, Inc. (WERE)
- 541: Kansas City Power and Light (KCPL)

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
0	FLT_000_NOFAULT	No Fault Conditions
1	FLT_01_Viola_Renfrow_345kV_3PH	3 phase fault on the Viola (532798) to Renfrow (515543) 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.
2	FLT_02_Viola_Wichita_345kV_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.
3	FLT_03_Renfrow_Hunter_345kV_3PH	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.
4	FLT_04_Renfrow_Renfrow_345_138kV_3PH	3 phase fault on the Renfrow 345kV (515543) to Renfrow 138kV (515544) to Renfrow 13.8kV (515545) transformer, near Renfrow 345kV. a. Apply fault at the Renfrow 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
5	FLT_05_Hunter_Woodring_345kV_3PH	3 phase fault on the Hunter (515476) to Woodring (514715) 345kV line, near Hunter. a. Apply fault at the Hunter 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.
6	FLT_06_Woodring_Sooner_345kV_3PH	3 phase fault on Woodring (514715) to Sooner (514803) 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.
7	FLT_07_Woodring_G15063Tap_345kV_3PH	3 phase fault on Woodring (514715) to G1506Tap (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.
8	FLT_08_Woodring_Woodring_345_138kV_3PH	3 phase fault on the Woodring 345kV (514715) to Woodring 138kV (514714) to Woodring 13.8kV (515770) transformer, near Woodring 345kV. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
9	FLT_09_Mathewson_Northwest_345kV_3PH	3 phase fault on the Mathewson (515497) to Northwest (514880) 345kV line, near Mathewson. a. Apply fault at the Mathewson 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
10	FLT_10_Mathewson_Cimarron_345kV_3PH	3 phase fault on the Mathewson (515497) to Cimarron (514901) 345kV line, near Mathewson. a. Apply fault at the Mathewson 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.
11	FLT_11_Mathewson_Tatonga_345kV_3PH	3 phase fault on the Mathewson (515497) to Tatonga (515407) 345kV line, near Mathewson. a. Apply fault at the Mathewson 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.
12	FLT_12_Sooner_SpringCreek_345kV_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.
13	FLT_13_Sooner_G15066T_345kV_3PH	3 phase fault on the Sooner (514803) to G15066T (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.
14	FLT_14_Sooner_Sooner_345_138kV_3PH	3 phase fault on the Sooner 345kV (514803) to Sooner 138kV (514802) to Sooner 13.8kV (515760) transformer, near Sooner 345kV. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
15	FLT_15_RanchRoad_Sooner_345kV_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.
16	FLT_16_RanchRoad_OpenSky_345kV_3PH	3 phase fault on the Ranch Road (515576) to 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.
17	FLT_17_Rosehill_Benton_345kV_3PH	3 phase fault on the Rosehill (532794) to Benton (532791) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
18	FLT_18_Rosehill_WolfCreek_345kV_3PH	3 phase fault on the Rosehill (532794) to Wolf Creek (532797) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
19	FLT_19_Rosehill_Latham_345kV_3PH	3 phase fault on the Rosehill (532794) to Latham (532800) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
20	FLT_20_Rosehill_G15052T_345kV_3PH	3 phase fault on the Rosehill (532794) to G15052T (560053) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
21	FLT_21_Rosehill_Rosehill_345_138kV_3PH	3 phase fault on the Rosehill 345kV (532794) to Rosehill 138kV (533062) to Rosehill 13.8kV (532831) transformer, near Rosehill 345kV. a. Apply fault at the Rosehill 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
22	FLT_22_Northwest_SpringCreek_345kV_3PH	3 phase fault on the Northwest (514880) to Spring Creek (514881) 345kV line, near Northwest. a. Apply fault at the Northwest 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	FLT_23_Northwest_Cimarron_345kV_3PH	3 phase fault on the Northwest (514880) to Cimarron (514901) 345kV line, near Northwest. a. Apply fault at the Northwest 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	FLT_24_Northwest_Arcadia_345kV_3PH	3 phase fault on the Northwest (514880) to Arcadia (514908) 345kV line, near Northwest. a. Apply fault at the Northwest 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	FLT_25_Northwest_Northwest_345_138kV_3PH	3 phase fault on the Northwest 345kV (514880) to Northwest 138kV (514879) to Northwest 13.8kV (515742) transformer, near Northwest 345kV. a. Apply fault at the Northwest 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
26	FLT_26_Benton_WolfCreek_345kV_3PH	3 phase fault on the Benton (532791) to Wolf Creek (532796) 345kV line, near Benton. a. Apply fault at the Benton 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.
27	FLT_27_Benton_Benton_345_138kV_3PH	3 phase fault on the Benton 345kV (532791) to Benton 138kV (532986) to Benton 13.8kV (532821) transformer, near Benton 345kV. a. Apply fault at the Benton 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
28	FLT_28_Wichita_Reno_345kV_3PH	3 phase fault on the Wichita (532796) to Reno (532771) 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.
29	FLT_29_Wichita_Benton_345kV_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.
30	FLT_30_Wichita_G1524&1525T_345kV_3PH	3 phase fault on the Wichita (532796) to G1525&G1525T (560033) 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.
31	FLT_31_Wichita_Evans_345_138kV_3PH	3 phase fault on the Wichita 345kV (532796) to Evans 138kV (533040) to Evans 13.8kV (532830) transformer, near Wichita 345kV. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
32	FLT_32_Thistle_G1524&1525T_345kV_3PH	3 phase fault on the Thistle (539801) to G1524&G1525T (560033) 345kV line, 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.
33	FLT_33_Thistle_Woodward_345kV_3PH	3 phase fault on the Thistle (539801) to Woodward (515375) 345kV line, 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.
34	FLT_34_Thistle_ClarkCounty_345kV_3PH	3 phase fault on the Thistle (539801) to Clark County (539800) 345kV line, 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.
35	FLT_35_Thistle_Thistle_345_138kV_3PH	3 phase fault on the Thistle 345kV (539801) to Thistle 138kV (539804) to Thistle 13.8kV (539802) transformer, near Thistle 345kV. a. Apply fault at the Thistle 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
36	FLT_36_Reno_Summit_345kV_3PH	3 phase fault on the Reno (532771) to Summit (532773) 345kV line, near Reno. a. Apply fault at the Reno 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	FLT_37_Reno_Reno_345_115kV_3PH	3 phase fault on the Reno 345kV (532771) to Reno 138kV (533416) to Reno 14.4kV (532807) transformer, near Reno 345kV. a. Apply fault at the Reno 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
38	FLT_38_Summit_Blustem_345kV_3PH	3 phase fault on the Summit (532773) to Blustem (532767) 345kV line, near Summit. a. Apply fault at the Summit 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	FLT_39_Summit_ElmCreek_345kV_3PH	3 phase fault on the Summit (532773) to Elm Creek (539805) 345kV line, near Summit. a. Apply fault at the Summit 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	FLT_40_Summit_Summit_345_230kV_3PH	3 phase fault on the Summit 345kV (532773) to Summit 230kV (532873) to Summit 14.4kV (432813) transformer, near Summit 345kV. a. Apply fault at the Summit 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
41	FLT_41_EMPEC_Lang_345kV_3PH	3 phase fault on the EMPEC (532768) to Lang (532769) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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	FLT_42_EMPEC_Morris_345kV_3PH	3 phase fault on the EMPEC (532768) to Morris (532770) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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	FLT_43_EMPEC_Swissvale_345kV_3PH	3 phase fault on the EMPEC (532768) to Swissvale (532774) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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.
44	FLT_44_EMPEC_G14001Tap_345kV_3PH	3 phase fault on the EMPEC (532768) to G14001Tap (562476) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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	FLT_45_Morris_JECN_345kV_3PH	3 phase fault on the Morris (532770) to JECN (532766) 345kV line, near Morris. a. Apply fault at the Morris 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	FLT_46_Morris_Morris_345_230kV_3PH	3 phase fault on the Morris 345kV (532770) to Morris 230kV (532863) to Morris 14.4kV (532809) transformer, near Morris 345kV. a. Apply fault at the Morris 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
47	FLT_47_Swissvale_Wgardner_345kV_3PH (2016WP & 2017SP)	3 phase fault on the Swissvale (532774) to WGardner (542965) 345kV line, near Swissvale. a. Apply fault at the Swissvale 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.
48	FLT_47_Swissvale_Douglas_345kV_3PH (2025SP)	3 phase fault on the Swissvale (532774) to Douglas (532776) 345kV line, near Swissvale. a. Apply fault at the Swissvale 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.
49	FLT_48_Swissvale_Swissvale_345_230kV_3PH	3 phase fault on the Swissvale 345kV (532774) to Swissvale 230kV (532856) to Swissvale 14.4kV (532815) transformer, near Swissvale 345kV. a. Apply fault at the Swissvale 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
50	FLT_49_Wgardner_Stillwell_345kV_3PH	3 phase fault on the WGardner (542965) to Stillwell (542968) 345kV line, near WGardner. a. Apply fault at the WGardner 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.
51	FLT_50_Wgardner_Craig_345kV_3PH	3 phase fault on the WGardner (542965) to Craig (542977) 345kV line, near WGardner. a. Apply fault at the WGardner 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.
52	FLT_51_Wgardner_Lacygne_345kV_3PH	3 phase fault on the WGardner (542965) to LaCygne (542981) 345kV line, near WGardner. a. Apply fault at the WGardner 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	FLT_52_Wgardner_Wgardner_345_161kV_3PH	3 phase fault on the WGardner 345kV (532774) to WGardner 161kV (542966) to WGardner 14.4kV (543649) transformer, near WGardner 345kV. a. Apply fault at the WGardner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
54	FLT_53_Stillwell_Peculiar_345kV_3PH	3 phase fault on the Stillwell (542968) to Peculiar (541198) 345kV line, near Stillwell. a. Apply fault at the Stillwell 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	FLT_54_Stillwell_Lacygne_345kV_3PH	3 phase fault on the Stillwell (542968) to LaCygne (542981) 345kV line, near Stillwell. a. Apply fault at the Stillwell 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
56	FLT_55_Stillwell_Stillwell_345_161kV_3PH	3 phase fault on the Stillwell 345kV (542968) to Stillwell 161kV (542969) to Stillwell 14.4kV (543648) transformer, near Stillwell 345kV. a. Apply fault at the Stillwell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
57	FLT_56_Craig_87th_345kV_3PH	3 phase fault on the Craig (542977) to 87th (532775) 345kV line, near Craig. a. Apply fault at the Craig 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.
58	FLT_57_Craig_Craig_345_161kV_3PH	3 phase fault on the Craig 345kV (542977) to Craig 161kV (542978) to Craig 14.4kV (543641) transformer, near Craig 345kV. a. Apply fault at the Craig 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
59	FLT_58_Lacygne_Neosho_345kV_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.
60	FLT_59_Lacygne_Waverly_345kV_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 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.
61	FLT_60_Neosho_Blackberry_345kV_3PH	3 phase fault on the Neosho (532793) to Blackberry (300739) 345kV line, near Neosho. a. Apply fault at the Neosho 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.
62	FLT_61_Neosho_Delaware_345kV_3PH	3 phase fault on the Neosho (532793) to Delaware (510380) 345kV line, near Neosho. a. Apply fault at the Neosho 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.
63	FLT_62_Neosho_CaneyCreek_345kV_3PH	3 phase fault on the Neosho (532793) to Caney Creek (532780) 345kV line, near Neosho. a. Apply fault at the Neosho 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.
64	FLT_63_Viola_Renfrow_345kV_1PH	Single phase fault on the Viola (532798) to Renfrow (515543) 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
65	FLT_64_Viola_Wichita_345kV_1PH	Single 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.
66	FLT_65_Renfrow_Hunter_345kV_1PH	Single 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.
67	FLT_66_Hunter_Woodring_345kV_1PH	Single phase fault on the Hunter (515476) to Woodring (514715) 345kV line, near Hunter. a. Apply fault at the Hunter 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.
68	FLT_67_Woodring_Sooner_345kV_1PH	Single phase fault on Woodring (514715) to Sooner (514803) 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.
69	FLT_68_Woodring_G15063Tap_345kV_1PH	Single phase fault on Woodring (514715) to G1506Tap (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.
70	FLT_69_Sooner_SpringCreek_345kV_1PH	Single 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.
71	FLT_70_Sooner_G15066T_345kV_1PH	Single phase fault on the Sooner (514803) to G15066T (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.
72	FLT_71_RanchRoad_Sooner_345kV_1PH	Single 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.
73	FLT_72_RanchRoad_OpenSky_345kV_1PH	Single phase fault on the Ranch Road (515576) to 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
74	FLT_73_Rosehill_Benton_345kV_1PH	Single phase fault on the Rosehill (532794) to Benton (532791) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
75	FLT_74_Rosehill_WolfCreek_345kV_1PH	Single phase fault on the Rosehill (532794) to Wolf Creek (532797) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
76	FLT_75_Rosehill_Latham_345kV_1PH	Single phase fault on the Rosehill (532794) to Latham (532800) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
77	FLT_76_Rosehill_G15052T_345kV_1PH	Single phase fault on the Rosehill (532794) to G15052T (560053) 345kV line, near Rosehill. a. Apply fault at the Rosehill 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.
78	FLT_77_Wichita_Reno_345kV_1PH	Single phase fault on the Wichita (532796) to Reno (532771) 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.
79	FLT_78_Wichita_Benton_345kV_1PH	Single 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.
80	FLT_79_Wichita_G1524_1525T_345kV_1PH	Single phase fault on the Wichita (532796) to G1525&G1525T (560033) 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.
81	FLT_80_EMPEC_Lang_345kV_1PH	Single phase fault on the EMPEC (532768) to Lang (532769) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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.
82	FLT_81_EMPEC_Morris_345kV_1PH	Single phase fault on the EMPEC (532768) to Morris (532770) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
83	FLT_82_EMPEC_Swissvale_345kV_1PH	Single phase fault on the EMPEC (532768) to Swissvale (532774) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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.
84	FLT_83_EMPEC_G14001Tap_345kV_1PH	Single phase fault on the EMPEC (532768) to G14001Tap (562476) 345kV line, near EMPEC. a. Apply fault at the EMPEC 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.
85	FLT_84_Morris_JECN_345kV_1PH	Single phase fault on the Morris (532770) to JECN (532766) 345kV line, near Morris. a. Apply fault at the Morris 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	FLT_85_Wgardner_Stillwell_345kV_1PH	Single phase fault on the WGardner (542965) to Stillwell (542968) 345kV line, near WGardner. a. Apply fault at the WGardner 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	FLT_86_Wgardner_Craig_345kV_1PH	Single phase fault on the WGardner (542965) to Craig (542977) 345kV line, near WGardner. a. Apply fault at the WGardner 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	FLT_87_Wgardner_Lacygne_345kV_1PH	Single phase fault on the WGardner (542965) to LaCygne (542981) 345kV line, near WGardner. a. Apply fault at the WGardner 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	FLT_88A_Wgardner_Swissvale_345kV_1PH (2016WP& 2017SP)	3 phase fault on the WGardner (542965) to Swissvale (532774) 345kV line, near WGardner. a. Apply fault at the WGardner 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	FLT_88_Wgardner_Douglas_345kV_1PH (2025SP)	3 phase fault on the WGardner (542965) to Douglas (532776) 345kV line, near WGardner. a. Apply fault at the WGardner 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.

Results

The stability analysis was performed and the results are summarized in **Table 3-2**. The stability plots will be available upon customer request.

Table 3-2: Summary of Results

Contingency Number and Name		2016WP	2017SP	2025SP
0	FLT_000_NOFAULT	STABLE	STABLE	STABLE
1	FLT_01_Viola_Renfrow_345kV_3PH	STABLE	STABLE	STABLE
2	FLT_02_Viola_Wichita_345kV_3PH	STABLE	STABLE	STABLE
3	FLT_03_Renfrow_Hunter_345kV_3PH	STABLE	STABLE	STABLE
4	FLT_04_Renfrow_Renfrow_345_138kV_3PH	STABLE	STABLE	STABLE
5	FLT_05_Hunter_Woodring_345kV_3PH	STABLE	STABLE	STABLE
6	FLT_06_Woodring_Sooner_345kV_3PH	STABLE	STABLE	STABLE
7	FLT_07_Woodring_G15063Tap_345kV_3PH	STABLE	STABLE	STABLE
8	FLT_08_Woodring_Woodring_345_138kV_3PH	STABLE	STABLE	STABLE
9	FLT_09_Mathewson_Northwest_345kV_3PH	STABLE	STABLE	STABLE
10	FLT_10_Mathewson_Cimarron_345kV_3PH	STABLE	STABLE	STABLE
11	FLT_11_Mathewson_Tatonga_345kV_3PH	STABLE	STABLE	STABLE
12	FLT_12_Sooner_SpringCreek_345kV_3PH	STABLE	STABLE	STABLE
13	FLT_13_Sooner_G15066T_345kV_3PH	STABLE	STABLE	STABLE
14	FLT_14_Sooner_Sooner_345_138kV_3PH	STABLE	STABLE	STABLE
15	FLT_15_RanchRoad_Sooner_345kV_3PH	STABLE	STABLE	STABLE
16	FLT_16_RanchRoad_OpenSky_345kV_3PH	STABLE	STABLE	STABLE
17	FLT_17_Rosehill_Benton_345kV_3PH	STABLE	STABLE	STABLE
18	FLT_18_Rosehill_WolfCreek_345kV_3PH	STABLE	STABLE	STABLE
19	FLT_19_Rosehill_Latham_345kV_3PH	STABLE	STABLE	STABLE
20	FLT_20_Rosehill_G15052T_345kV_3PH	STABLE	STABLE	STABLE
21	FLT_21_Rosehill_Rosehill_345_138kV_3PH	STABLE	STABLE	STABLE
22	FLT_22_Northwest_SpringCreek_345kV_3PH	STABLE	STABLE	STABLE
23	FLT_23_Northwest_Cimarron_345kV_3PH	STABLE	STABLE	STABLE
24	FLT_24_Northwest_Arcadia_345kV_3PH	STABLE	STABLE	STABLE
25	FLT_25_Northwest_Northwest_345_138kV_3PH	STABLE	STABLE	STABLE
26	FLT_26_Benton_WolfCreek_345kV_3PH	STABLE	STABLE	STABLE
27	FLT_27_Benton_Benton_345_138kV_3PH	STABLE	STABLE	STABLE
28	FLT_28_Wichita_Reno_345kV_3PH	STABLE	STABLE	STABLE
29	FLT_29_Wichita_Benton_345kV_3PH	STABLE	STABLE	STABLE
30	FLT_30_Wichita_G1524&1525T_345kV_3PH	STABLE	STABLE	STABLE
31	FLT_31_Wichita_Evans_345_138kV_3PH	STABLE	STABLE	STABLE
32	FLT_32_Thistle_G1524&1525T_345kV_3PH	STABLE	STABLE	STABLE
33	FLT_33_Thistle_Woodward_345kV_3PH	STABLE	STABLE	STABLE
34	FLT_34_Thistle_ClarkCounty_345kV_3PH	STABLE	STABLE	STABLE
35	FLT_35_Thistle_Thistle_345_138kV_3PH	STABLE	STABLE	STABLE
36	FLT_36_Reno_Summit_345kV_3PH	STABLE	STABLE	STABLE
37	FLT_37_Reno_Reno_345_115kV_3PH	STABLE	STABLE	STABLE
38	FLT_38_Summit_Blustem_345kV_3PH	STABLE	STABLE	STABLE
39	FLT_39_Summit_ElmCreek_345kV_3PH	STABLE	STABLE	STABLE
40	FLT_40_Summit_Summit_345_230kV_3PH	STABLE	STABLE	STABLE
41	FLT_41_EMPEC_Lang_345kV_3PH	STABLE	STABLE	STABLE
42	FLT_42_EMPEC_Morris_345kV_3PH	STABLE	STABLE	STABLE
43	FLT_43_EMPEC_Swissvale_345kV_3PH	STABLE	STABLE	STABLE
44	FLT_44_EMPEC_G14001Tap_345kV_3PH	STABLE	STABLE	STABLE
45	FLT_45_Morris_JECN_345kV_3PH	STABLE	STABLE	STABLE
46	FLT_46_Morris_Morris_345_230kV_3PH	STABLE	STABLE	STABLE
47	FLT_47_Swissvale_Wgardner_345kV_3PH (2016WP & 2017SP)	STABLE	STABLE	STABLE
48	FLT_47_Swissvale_Douglas_345kV_3PH (2025SP)	STABLE	STABLE	STABLE
49	FLT_48_Swissvale_Swissvale_345_230kV_3PH	STABLE	STABLE	STABLE

Table 3-2: Summary of Results

Contingency Number and Name		2016WP	2017SP	2025SP
50	FLT_49_Wgardner_Stillwell_345kV_3PH	STABLE	STABLE	STABLE
51	FLT_50_Wgardner_Craig_345kV_3PH	STABLE	STABLE	STABLE
52	FLT_51_Wgardner_Lacygne_345kV_3PH	STABLE	STABLE	STABLE
53	FLT_52_Wgardner_Wgardner_345_161kV_3PH	STABLE	STABLE	STABLE
54	FLT_53_Stillwell_Peculiar_345kV_3PH	STABLE	STABLE	STABLE
55	FLT_54_Stillwell_Lacygne_345kV_3PH	STABLE	STABLE	STABLE
56	FLT_55_Stillwell_Stillwell_345_161kV_3PH	STABLE	STABLE	STABLE
57	FLT_56_Craig_87th_345kV_3PH	STABLE	STABLE	STABLE
58	FLT_57_Craig_Craig_345_161kV_3PH	STABLE	STABLE	STABLE
59	FLT_58_Lacygne_Neosho_345kV_3PH	STABLE	STABLE	STABLE
60	FLT_59_Lacygne_Waverly_345kV_3PH	STABLE	STABLE	STABLE
61	FLT_60_Neosho_Blackberry_345kV_3PH	STABLE	STABLE	STABLE
62	FLT_61_Neosho_Delaware_345kV_3PH	STABLE	STABLE	STABLE
63	FLT_62_Neosho_CaneyCreek_345kV_3PH	STABLE	STABLE	STABLE
64	FLT_63_Viola_Renfrow_345kV_1PH	STABLE	STABLE	STABLE
65	FLT_64_Viola_Wichita_345kV_1PH	STABLE	STABLE	STABLE
66	FLT_65_Renfrow_Hunter_345kV_1PH	STABLE	STABLE	STABLE
67	FLT_66_Hunter_Woodring_345kV_1PH	STABLE	STABLE	STABLE
68	FLT_67_Woodring_Sooner_345kV_1PH	STABLE	STABLE	STABLE
69	FLT_68_Woodring_G15063Tap_345kV_1PH	STABLE	STABLE	STABLE
70	FLT_69_Sooner_SpringCreek_345kV_1PH	STABLE	STABLE	STABLE
71	FLT_70_Sooner_G15066T_345kV_1PH	STABLE	STABLE	STABLE
72	FLT_71_RanchRoad_Sooner_345kV_1PH	STABLE	STABLE	STABLE
73	FLT_72_RanchRoad_OpenSky_345kV_1PH	STABLE	STABLE	STABLE
74	FLT_73_Rosehill_Benton_345kV_1PH	STABLE	STABLE	STABLE
75	FLT_74_Rosehill_WolfCreek_345kV_1PH	STABLE	STABLE	STABLE
76	FLT_75_Rosehill_Latham_345kV_1PH	STABLE	STABLE	STABLE
77	FLT_76_Rosehill_G15052T_345kV_1PH	STABLE	STABLE	STABLE
78	FLT_77_Wichita_Reno_345kV_1PH	STABLE	STABLE	STABLE
79	FLT_78_Wichita_Benton_345kV_1PH	STABLE	STABLE	STABLE
80	FLT_79_Wichita_G1524_1525T_345kV_1PH	STABLE	STABLE	STABLE
81	FLT_80_EMPEC_Lang_345kV_1PH	STABLE	STABLE	STABLE
82	FLT_81_EMPEC_Morris_345kV_1PH	STABLE	STABLE	STABLE
83	FLT_82_EMPEC_Swissvale_345kV_1PH	STABLE	STABLE	STABLE
84	FLT_83_EMPEC_G14001Tap_345kV_1PH	STABLE	STABLE	STABLE
85	FLT_84_Morris_JECN_345kV_1PH	STABLE	STABLE	STABLE
86	FLT_85_Wgardner_Stillwell_345kV_1PH	STABLE	STABLE	STABLE
87	FLT_86_Wgardner_Craig_345kV_1PH	STABLE	STABLE	STABLE
88	FLT_87_Wgardner_Lacygne_345kV_1PH	STABLE	STABLE	STABLE
89	FLT_88A_Wgardner_Swissvale_345kV_1PH (2016WP& 2017SP)	STABLE	STABLE	STABLE
90	FLT_88_Wgardner_Douglas_345kV_1PH (2025SP)	STABLE	STABLE	STABLE

FERC LVRT Compliance

FERC Order 661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0

pu. The faults listed below in **Table 3-3** were tested to meet Order 661A LVRT provisions. GEN-2015-034 was found to be in compliance with FERC Order 661A.

Table 3-3 LVRT Contingencies

Contingency Number and Name	Description
FLT_15_RanchRoad_Sooner_345kV_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.
FLT_16_RanchRoad_OpenSky_345kV_3PH	3 phase fault on the Ranch Road (515576) to 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.

4. Power Factor Analysis

The power factor analysis was performed for each project included in this study and is designed to demonstrate the reactive power requirements at the point of interconnection (POI) using the current study upgrade cases. For all projects that require reactive power, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the POI.

Model Preparation

The study project as well as other projects modeled at the same POI was turned off for the power factor analysis. The projects were replaced by an equivalent generator located at the POI producing the total MW of the project at that POI and 0.0 Mvar capability.

A Mvar generator without limits was modeled at the interconnection project POI to hold a voltage schedule at the POI consistent with the greater of the voltage schedule in the base case or unity (1.0 pu) voltage.

Disturbances

Each N-1 contingency evaluated in the Stability Analysis found in **Table 3-1** was also included in the determination of the power factor requirements.

Results

The power factor ranges are summarized in **Table 4-1** and the resultant ranges are shown **Table D-1** located in Appendix D. The analysis showed that reactive power is required for the study project, the final requirement in the Generation Interconnection Agreement (GIA) for each project will be the pro-forma 95% lagging to 95% leading at the POI.

For analyzing power factor results a positive Q (Mvar) output indicates that the equivalent generator is supplying reactive power to the system, implying a lagging power factor. A negative Q (Mvar) output indicates that the equivalent generator is absorbing reactive power from the system, implying a leading power factor.

Table 4-1*: Summary of Power Factor Analysis at the POI*

Request	Capacity (MW)	Point of Interconnection (POI)	Fuel	Generator	Lagging (providing Mvars)	Leading (absorbing Mvars)
GEN-2015-034	199.95	Ranch Road 345kV (515576)	Wind	Vestas V126 GS 3.45MW and 3.3MW	0.95	0.95

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

5. Reduced Wind Generation Analysis

A low wind analysis was performed for GEN-2015-034. SPP performed this low wind analysis to determine the capacitive reactive power injected at the POI.

The study generator and capacitors (if any) were turned off in the base case. **Figure 5-1** shows the resulting reactive power injection (approximately 11.9Mvar) at the POI that is due to the capacitance of the project's transmission line and collector cables. **Figure 5-2** shows an 11.8Mvar reactor on the low side of the project's 345/34.5kV transformer which offsets the capacitive injection at the POI. The interconnection customer's facility is required to install a reactor or an equivalent means of compensation that can inject approximately 11.8Mvar of inductive reactance. Reactive compensation devices are typically installed on the low side of the project's substation 345/34.5kV transformer.

Figure 5-1*:* **GEN-2015-034 with generators turned off**

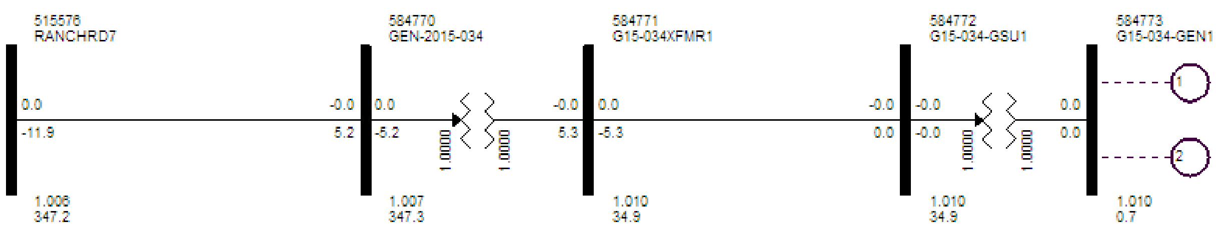
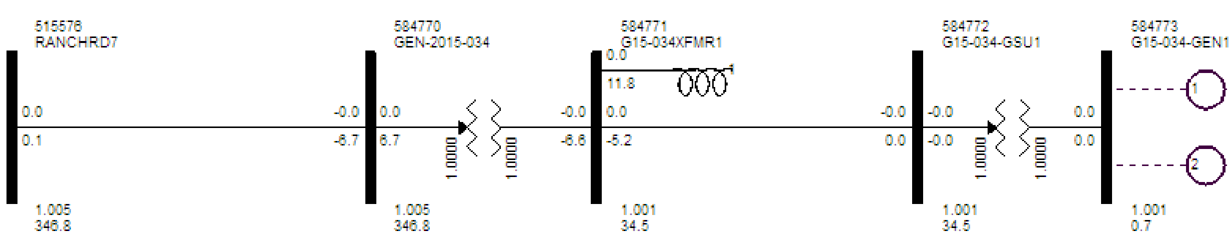


Figure 5-2*:* **GEN-2015-034 with shunt reactor at low side of project 345/34.5kV transformer and with generators turned off**



6. Short Circuit Analysis

The short circuit analysis was performed on the 2017 and 2025 Summer Peak power flow cases using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the point of interconnection other buses up to and including five levels away from the POI.

Short Circuit Analysis was conducting using flat conditions with the following PSS/E ASCCC program settings:

- BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
- GENERATOR P=0, Q=0
- TRANSFORMER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
- LINE CHARGING=0.0 IN +/-/0 SEQUENCE
- LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
- LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
- DC LINES AND FACTS DEVICES BLOCKED
- TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

Results

The results of the short circuit analysis are shown in **Appendix E, Table E-1 *GEN-2015-034 Short Circuit Analysis Results (2017SP)*** and **Table E-2 *GEN-2015-034 Short Circuit Analysis Results (2025SP)***.

7. Conclusion

The GEN-2015-034 Interconnection Customer has requested a modification to its Generator Interconnection Request (GIR) to change wind turbine generators. Originally, the GIR consisted of one hundred (100) Vestas V110 2.0MW wind turbines for a total 200.0 MW. The requested change is fifty-seven (57) Vestas V126 GS 3.45MW wind turbines and one (1) Vestas V126 GS 3.3MW wind turbine totaling 199.95MW. The point of interconnection (POI) is the Oklahoma Gas and Electric (OKGE) Ranch Road Substation 345kV.

Stability analysis has determined that with all previously assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A power factor analysis was performed for the wind turbine modification request. As reactive power is required for GEN-2015-034, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the POI.

A reduced generation analysis was conducted to determine reactor inductive amounts to compensate the capacitive effects on the transmission system during low or reduced wind conditions caused by the interconnecting project's generator lead transmission line and collector systems. The interconnection customer's facility is required to install a reactor or an equivalent means of compensation that can inject approximately 11.8Mvar of inductive reactance. Reactive compensation devices are typically installed on the low side of the project's substation 345/34.5kV transformer.

Short Circuit analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS 2015-002 in place, GEN-2015-034 with fifty-seven (57) Vestas V126 GS 3.45MW wind turbines and one (1) Vestas V126 GS 3.3MW wind turbine should be able to interconnect reliably to the SPP transmission grid. The change in wind turbine generator is not a Material Modification.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. Powerflow analysis was not performed. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Appendix A – 2016 Winter Peak Stability Plots

(Available on request)

Appendix B – 2017 Summer Peak Stability Plots

(Available on request)

Appendix C – 2025 Summer Peak Stability Plots

(Available on request)

Appendix D – Power Factor Analysis Results

Table D-1: GEN-2015-034 Power Factor Analysis Results

Leading power factor is absorbing vars; Lagging power factor is providing vars										
GEN-2015-034 Turbine Restudy POI - RANCHRD7 345.00 (515576) Power at POI (MW): 199.95		2016 Winter Peak POI Voltage = 1.001 pu			2017 Summer Peak POI Voltage = 1.001 pu			2025 Summer Peak POI Voltage = 1.001 pu		
	Contingency Name	Mvars at POI	Power Factor		Mvars at POI	Power Factor		Mvars at POI	Power Factor	
0	FLT_00_NoFault	-5.282	1.000	LEAD	-27.734	0.991	LEAD	-10.195	0.999	LEAD
1	FLT_01_Viola_Renfrow_345kV	-4.499	1.000	LEAD	-26.607	0.991	LEAD	-7.761	0.999	LEAD
2	FLT_02_Viola_Wichita_345kV	9.463	0.999	LAG	-11.377	0.998	LEAD	-5.426	1.000	LEAD
3	FLT_03_Renfrow_Hunter_345kV	-4.453	1.000	LEAD	-28.513	0.990	LEAD	-10.386	0.999	LEAD
4	FLT_04_Renfrow_Renfrow_345_138kV	-4.775	1.000	LEAD	-27.227	0.991	LEAD	-10.279	0.999	LEAD
5	FLT_05_Hunter_Woodring_345kV	0.158	1.000	LAG	-28.361	0.990	LEAD	-10.722	0.999	LEAD
6	FLT_06_Woodring_Sooner_345kV	2.492	1.000	LAG	-18.016	0.996	LEAD	1.397	1.000	LAG
7	FLT_07_Woodring_G15063Tap_345kV	7.466	0.999	LAG	-17.690	0.996	LEAD	-0.931	1.000	LEAD
8	FLT_08_Woodring_Woodring_345_138kV	-3.937	1.000	LEAD	-27.007	0.991	LEAD	-10.048	0.999	LEAD
9	FLT_09_Mathewson_Northwest_345kV	-4.078	1.000	LEAD	-26.927	0.991	LEAD	-9.418	0.999	LEAD
10	FLT_10_Mathewson_Cimarron_345kV	-4.306	1.000	LEAD	-26.904	0.991	LEAD	-9.647	0.999	LEAD
11	FLT_11_Mathewson_Tatonga_345kV	0.527	1.000	LAG	-23.984	0.993	LEAD	-8.167	0.999	LEAD
12	FLT_12_Sooner_SpringCreek_345kV	7.751	0.999	LAG	-11.322	0.998	LEAD	6.401	0.999	LAG
13	FLT_13_Sooner_G15066T_345kV	-9.451	0.999	LEAD	-25.709	0.992	LEAD	-7.316	0.999	LEAD
14	FLT_14_Sooner_Sooner_345_138kV	-6.031	1.000	LEAD	-30.090	0.989[1]	LEAD	-12.811	0.998	LEAD
15	FLT_15_RanchRoad_Sooner_345kV	45.732	0.975	LAG	27.961	0.990	LAG	46.706	0.974[2]	LAG
16	FLT_16_RanchRoad_OpenSky_345kV	-8.032	0.999	LEAD	-25.497	0.992	LEAD	-9.138	0.999	LEAD
17	FLT_17_Rosehill_Benton_345kV	0.737	1.000	LAG	-22.108	0.994	LEAD	-3.114	1.000	LEAD
18	FLT_18_Rosehill_WolfCreek_345kV	4.231	1.000	LAG	-20.641	0.995	LEAD	-2.190	1.000	LEAD
19	FLT_19_Rosehill_Latham_345kV	-4.157	1.000	LEAD	-26.223	0.992	LEAD	-9.135	0.999	LEAD
20	FLT_20_Rosehill_G15052T_345kV	32.573	0.987	LAG	16.048	0.997	LAG	33.110	0.987	LAG
21	FLT_21_Rosehill_Rosehill_345_138kV	-6.139	1.000	LEAD	-28.722	0.990	LEAD	-10.431	0.999	LEAD
22	FLT_22_Northwest_SpringCreek_345kV	-0.255	1.000	LEAD	-9.418	0.999	LEAD	9.889	0.999	LAG
23	FLT_23_Northwest_Cimarron_345kV	-4.670	1.000	LEAD	-27.153	0.991	LEAD	-9.377	0.999	LEAD
24	FLT_24_Northwest_Arcadia_345kV	-2.879	1.000	LEAD	-27.731	0.991	LEAD	-10.772	0.999	LEAD
25	FLT_25_Northwest_Northwest_345_138kV	-6.011	1.000	LEAD	-27.862	0.990	LEAD	-10.882	0.999	LEAD
26	FLT_26_Benton_WolfCreek_345kV	1.514	1.000	LAG	-23.258	0.993	LEAD	-4.784	1.000	LEAD
27	FLT_27_Benton_Benton_345_138kV	-6.158	1.000	LEAD	-28.390	0.990	LEAD	-10.991	0.998	LEAD
28	FLT_28_Wichita_Reno_345kV	1.240	1.000	LAG	-24.671	0.992	LEAD	-7.260	0.999	LEAD
29	FLT_29_Wichita_Benton_345kV	2.727	1.000	LAG	-20.525	0.995	LEAD	0.377	1.000	LAG
30	FLT_30_Wichita_G1524&1525T_345kV	-4.009	1.000	LEAD	-27.072	0.991	LEAD	-9.612	0.999	LEAD
31	FLT_31_Wichita_Evans_345_138kV	-2.667	1.000	LEAD	-28.699	0.990	LEAD	-11.664	0.998	LEAD
32	FLT_32_Thistle_G1524&1525T_345kV	-2.968	1.000	LEAD	-26.460	0.991	LEAD	-8.907	0.999	LEAD
33	FLT_33_Thistle_Woodward_345kV	-5.304	1.000	LEAD	-27.752	0.991	LEAD	-10.185	0.999	LEAD
34	FLT_34_Thistle_ClarkCounty_345kV	-4.362	1.000	LEAD	-27.253	0.991	LEAD	-9.731	0.999	LEAD
35	FLT_35_Thistle_Thistle_345_138kV	-5.384	1.000	LEAD	-27.401	0.991	LEAD	-10.013	0.999	LEAD
36	FLT_36_Reno_Summit_345kV	-2.782	1.000	LEAD	-25.818	0.992	LEAD	-8.984	0.999	LEAD
37	FLT_37_Reno_Reno_345_115kV	-4.981	1.000	LEAD	-27.596	0.991	LEAD	-10.106	0.999	LEAD

Leading power factor is absorbing vars; Lagging power factor is providing vars										
	GEN-2015-034 Turbine Restudy POI - RANCHRD7 345.00 (515576) Power at POI (MW): 199.95	2016 Winter Peak POI Voltage = 1.001 pu			2017 Summer Peak POI Voltage = 1.001 pu			2025 Summer Peak POI Voltage = 1.001 pu		
	Contingency Name	Mvars at POI	Power Factor		Mvars at POI	Power Factor		Mvars at POI	Power Factor	
38	FLT_38_Summit_JECN_345kV	-4.926	1.000	LEAD	-27.555	0.991	LEAD	-10.132	0.999	LEAD
39	FLT_39_Summit_ElmCreek_345kV	-4.643	1.000	LEAD	-27.270	0.991	LEAD	-9.858	0.999	LEAD
40	FLT_40_Summit_Summit_345_230kV	-5.768	1.000	LEAD	-27.734	0.991	LEAD	-10.243	0.999	LEAD
41	FLT_41_EMPEC_Lang_345kV	-5.317	1.000	LEAD	-27.615	0.991	LEAD	-10.077	0.999	LEAD
42	FLT_42_EMPEC_Morris_345kV	-4.268	1.000	LEAD	-27.203	0.991	LEAD	-9.758	0.999	LEAD
43	FLT_43_EMPEC_Swissvale_345kV	-1.870	1.000	LEAD	-25.803	0.992	LEAD	-8.820	0.999	LEAD
44	FLT_44_EMPEC_G14001Tap_345kV	-2.017	1.000	LEAD	-25.066	0.992	LEAD	-8.172	0.999	LEAD
45	FLT_45_Morris_JECN_345kV	-4.767	1.000	LEAD	-27.612	0.991	LEAD	-10.111	0.999	LEAD
46	FLT_46_Morris_Morris_345_230kV	-5.287	1.000	LEAD	-27.614	0.991	LEAD	-10.084	0.999	LEAD
47	FLT_47_Swissvale_Wgardner_345kV	-3.338	1.000	LEAD	-26.649	0.991	LEAD	-9.668	0.999	LEAD
48	FLT_48_Swissvale_Swissvale_345_230kV	-5.420	1.000	LEAD	-27.724	0.991	LEAD	-10.189	0.999	LEAD
49	FLT_49_Wgardner_Stillwell_345kV	-5.026	1.000	LEAD	-27.583	0.991	LEAD	-10.105	0.999	LEAD
50	FLT_50_Wgardner_Craig_345kV	-4.414	1.000	LEAD	-27.055	0.991	LEAD	-9.540	0.999	LEAD
51	FLT_51_Wgardner_Lacygne_345kV	-3.640	1.000	LEAD	-26.224	0.992	LEAD	-8.499	0.999	LEAD
52	FLT_52_Wgardner_Wgardner_345_161kV	-4.953	1.000	LEAD	-27.459	0.991	LEAD	-9.971	0.999	LEAD
53	FLT_53_Stillwell_Peculiar_345kV	-3.730	1.000	LEAD	-26.691	0.991	LEAD	-9.289	0.999	LEAD
54	FLT_54_Stillwell_Lacygne_345kV	-1.259	1.000	LEAD	-24.421	0.993	LEAD	-6.768	0.999	LEAD
55	FLT_55_Stillwell_Stillwell_345_161kV	-5.056	1.000	LEAD	-27.547	0.991	LEAD	-10.019	0.999	LEAD
56	FLT_56_Craig_87th_345kV	-5.075	1.000	LEAD	-27.442	0.991	LEAD	-9.976	0.999	LEAD
57	FLT_57_Craig_Craig_345_161kV	-5.142	1.000	LEAD	-27.607	0.991	LEAD	-10.097	0.999	LEAD
58	FLT_58_Lacygne_Neosho_345kV	-2.137	1.000	LEAD	-24.738	0.992	LEAD	-7.746	0.999	LEAD
59	FLT_59_Lacygne_Waverly_345kV	38.852	0.982	LAG	1.353	1.000	LAG	16.520	0.997	LAG
60	FLT_60_Neosho_Blackberry_345kV	-4.160	1.000	LEAD	-27.684	0.991	LEAD	-10.151	0.999	LEAD
61	FLT_61_Neosho_Delaware_345kV	-3.806	1.000	LEAD	-26.915	0.991	LEAD	-9.230	0.999	LEAD
62	FLT_62_Neosho_CaneyCreek_345kV	5.905	1.000	LAG	-18.454	0.996	LEAD	-2.370	1.000	LEAD

1. Most leading power factor
2. Most lagging power factor

Appendix E – Short Circuit Analysis Results

Table E-1: GEN-2015-034 Short Circuit Analysis Results (2017SP)

```
                              PSS(R)E-32.2.2 ASCC SHORT CIRCUIT CURRENTS          TUE, FEB
14 2017  17:10
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 17S WITH MMWG 15S, MRO 16W TOPO/16S PROF, SERC 16S

OPTIONS USED:
    - FLAT CONDITIONS
         - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
         - GENERATOR P=0, Q=0
         - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
         - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
         - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
         - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
         - DC LINES AND FACTS DEVICES BLOCKED
         - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

                                   THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
515576 [RANCHRD7    345.00] AMP    13752.1   -86.64
514803 [SOONER 7    345.00] AMP    24554.8   -86.49
515621 [OPENSKY7    345.00] AMP    12757.4   -86.62
529200 [OMCDLEC7    345.00] AMP    13726.8   -86.64
584450 [GEN-2015-001345.00] AMP    13752.1   -86.64
584770 [GEN-2015-034345.00] AMP    11726.8   -86.23
514715 [WOODRNG7    345.00] AMP    16959.2   -84.81
514802 [SOONER 4    138.00] AMP    31300.9   -86.78
514825 [KAYWIND7    345.00] AMP    12724.3   -86.61
514881 [SPRNGCK7    345.00] AMP    21364.0   -85.53
560053 [G15-052T    345.00] AMP    13120.0   -86.45
560056 [G15-066T    345.00] AMP    17956.6   -86.54
584690 [GEN-2015-030345.00] AMP    18710.1   -85.92
584880 [GEN-2015-047345.00] AMP    11487.6   -83.76
512694 [CLEVLND7    345.00] AMP    14818.2   -86.33
514704 [MILLERT4    138.00] AMP    20115.3   -85.57
514707 [PERRY  4    138.00] AMP    10935.3   -83.28
514714 [WOODRNG4    138.00] AMP    18627.1   -83.28
514798 [SNRPMPT4    138.00] AMP    20131.7   -85.53
514880 [NORTWST7    345.00] AMP    29247.2   -86.04
515447 [MORISNT4    138.00] AMP    13644.8   -82.93
515476 [HUNTERS7    345.00] AMP    12085.2   -84.69
532794 [ROSEHIL7    345.00] AMP    18824.7   -85.80
560055 [G15-063T    345.00] AMP    16815.0   -84.89
584900 [GEN-2015-052345.00] AMP    13069.8   -86.42
585040 [GEN-2015-066345.00] AMP    17792.1   -86.52
585050 [GEN-2015-067138.00] AMP    21782.4   -86.20
509852 [T.NO.--7    345.00] AMP    23391.4   -86.30
512729 [CLEVLND 4   138.00] AMP    16665.3   -85.45
514706 [COWCRK 4    138.00] AMP    11232.9   -82.99
514708 [OTTER  4    138.00] AMP     9517.5   -82.41
514709 [FRMNTAP4    138.00] AMP    17452.3   -82.86
514711 [WAUKOTP4    138.00] AMP    14930.7   -81.70
514733 [MARSHL 4    138.00] AMP     7781.9   -80.53
514737 [OTOE   4    138.00] AMP    16081.6   -83.28
514743 [OSAGE  4    138.00] AMP    15538.2   -81.74
```

```
514799 [SNRPMP 4    138.00] AMP    11172.9   -80.57
514879 [NORTWST4    138.00] AMP    42154.2   -85.93
514901 [CIMARON7    345.00] AMP    29604.8   -85.76
514908 [ARCADIA7    345.00] AMP    24821.7   -86.47
515006 [MORRISN4    138.00] AMP    13614.7   -82.92
515011 [STILWTR4    138.00] AMP    13288.1   -80.15
515412 [DMNCRKT4    138.00] AMP    13449.0   -84.33
515477 [CHSHLMV7    345.00] AMP    12069.2   -84.69
515497 [MATHWSN7    345.00] AMP    27500.2   -85.77
515543 [RENFROW7    345.00] AMP    11221.6   -84.65
532791 [BENTON 7    345.00] AMP    19033.4   -85.71
532797 [WOLFCRK7    345.00] AMP    15971.2   -86.81
532800 [LATHAMS7    345.00] AMP    10459.6   -85.56
533062 [ROSEHIL4    138.00] AMP    30970.3   -86.16
585010 [GEN-2015-063345.00] AMP    16756.6   -84.86
300138 [4CLEVLND    138.00] AMP    16667.2   -85.42
509755 [WEKIWA-7    345.00] AMP    18586.8   -86.20
509895 [T.NO.2-4    138.00] AMP    34187.2   -84.98
510376 [WEBBTAP4    138.00] AMP     7472.0   -78.68
510406 [N.E.S.-7    345.00] AMP    18713.4   -86.41
512865 [GREC TAP5   345.00] AMP    25552.0   -87.32
514710 [WAUKOMI4    138.00] AMP     9517.3   -80.44
514712 [FAIRMON4    138.00] AMP    13631.4   -82.22
514713 [WRVALLY4    138.00] AMP     8652.8   -82.14
514731 [SO4TH  4    138.00] AMP    14807.6   -81.20
514758 [STDBEAR4    138.00] AMP    13170.9   -81.68
514761 [WHEAGLE4    138.00] AMP    14865.2   -81.80
514770 [MARLNDT4    138.00] AMP    10522.1   -76.97
514801 [MINCO  7    345.00] AMP    16146.8   -85.16
514827 [CTNWOOD4    138.00] AMP    16532.1   -80.44
514828 [KETCHTP4    138.00] AMP    25888.6   -84.56
514854 [BRADEN 4    138.00] AMP    30550.6   -85.14
514873 [LNEOAK 4    138.00] AMP    26286.7   -84.58
514898 [CIMARON4    138.00] AMP    41618.8   -85.01
514907 [ARCADIA4    138.00] AMP    40716.4   -85.65
514909 [REDBUD 7    345.00] AMP    23806.0   -86.79
514934 [DRAPER 7    345.00] AMP    20299.2   -85.16
515045 [SEMINOL7    345.00] AMP    25853.9   -86.19
515181 [UNVRSTY4    138.00] AMP    13410.2   -79.89
515400 [DMANCRK4    138.00] AMP     7955.1   -80.21
515407 [TATONGA7    345.00] AMP    10773.5   -86.78
515471 [NW164TH4    138.00] AMP    34638.7   -85.66
515512 [SPVALLY4    138.00] AMP     8666.2   -77.82
515544 [RENFROW4    138.00] AMP    13395.7   -84.83
515610 [FSHRTAP7    345.00] AMP    15890.4   -85.09
521006 [MARSHAL4    138.00] AMP     7745.6   -80.47
532780 [CANEYRV7    345.00] AMP     9887.0   -85.50
532796 [WICHITA7    345.00] AMP    23718.1   -86.10
532798 [VIOLA   7   345.00] AMP    11409.3   -85.09
532799 [WAVERLY7    345.00] AMP    14712.8   -86.51
532801 [ELKRVR17    345.00] AMP     9235.9   -85.46
532986 [BENTON 4    138.00] AMP    27908.2   -85.85
532991 [WEAVER 4    138.00] AMP    21745.4   -83.96
533039 [ELPASO 4    138.00] AMP    24291.5   -84.19
533068 [STEARMN4    138.00] AMP    19342.0   -84.21
583750 [GEN-2013-029345.00] AMP    10000.2   -84.61
584170 [GEN-2014-064138.00] AMP     9445.4   -82.38
```

Table E-2: GEN-2015-034 Short Circuit Analysis Results (2025SP)

```
                              PSS(R)E-32.2.2 ASCC SHORT CIRCUIT CURRENTS          TUE, FEB
14 2017  17:13
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

OPTIONS USED:
    - FLAT CONDITIONS
         - BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
         - GENERATOR P=0, Q=0
         - TRANSFOMRER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
         - LINE CHARGING=0.0 IN +/-/0 SEQUENCE
         - LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
         - LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
         - DC LINES AND FACTS DEVICES BLOCKED
         - TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

                                   THREE PHASE FAULT
X---------- BUS ----------X           /I+/    AN(I+)
515576 [RANCHRD7    345.00] AMP    13791.9   -86.64
514803 [SOONER 7    345.00] AMP    24754.9   -86.49
515621 [OPENSKY7    345.00] AMP    12795.8   -86.62
529200 [OMCDLEC7    345.00] AMP    13766.4   -86.64
584450 [GEN-2015-001345.00] AMP    13791.9   -86.64
584770 [GEN-2015-034345.00] AMP    11755.0   -86.23
514715 [WOODRNG7    345.00] AMP    17310.7   -84.83
514802 [SOONER 4    138.00] AMP    31805.6   -86.81
514825 [KAYWIND7    345.00] AMP    12762.4   -86.62
514881 [SPRNGCK7    345.00] AMP    21877.0   -85.53
560053 [G15-052T    345.00] AMP    13192.5   -86.46
560056 [G15-066T    345.00] AMP    18051.6   -86.54
584690 [GEN-2015-030345.00] AMP    18824.9   -85.92
584880 [GEN-2015-047345.00] AMP    11525.8   -83.74
512694 [CLEVLND7    345.00] AMP    14882.7   -86.33
514704 [MILLERT4    138.00] AMP    20415.9   -85.61
514707 [PERRY  4    138.00] AMP    11006.3   -83.26
514714 [WOODRNG4    138.00] AMP    18753.3   -83.27
514798 [SNRPMPT4    138.00] AMP    20463.2   -85.59
514880 [NORTWST7    345.00] AMP    30455.7   -86.09
515447 [MORISNT4    138.00] AMP    13863.3   -82.89
515476 [HUNTERS7    345.00] AMP    12445.0   -84.73
532794 [ROSEHIL7    345.00] AMP    19128.0   -85.82
560055 [G15-063T    345.00] AMP    17261.2   -84.94
584900 [GEN-2015-052345.00] AMP    13141.7   -86.43
585040 [GEN-2015-066345.00] AMP    17885.3   -86.52
585050 [GEN-2015-067138.00] AMP    22025.7   -86.22
509852 [T.NO.--7    345.00] AMP    23591.5   -86.30
512729 [CLEVLND 4   138.00] AMP    16716.6   -85.45
514706 [COWCRK 4    138.00] AMP    11310.1   -82.96
514708 [OTTER  4    138.00] AMP     9547.2   -82.39
514709 [FRMNTAP4    138.00] AMP    17564.3   -82.85
514711 [WAUKOTP4    138.00] AMP    15017.6   -81.70
514733 [MARSHL 4    138.00] AMP     7799.1   -80.52
514737 [OTOE   4    138.00] AMP    16273.3   -83.28
514743 [OSAGE  4    138.00] AMP    16532.8   -82.02
514799 [SNRPMP 4    138.00] AMP    11274.4   -80.55
514879 [NORTWST4    138.00] AMP    42651.7   -85.98
514901 [CIMARON7    345.00] AMP    31053.7   -85.95
514908 [ARCADIA7    345.00] AMP    26013.8   -86.56
```

```
515006 [MORRISN4    138.00] AMP    13831.9   -82.89
515011 [STILWTR4    138.00] AMP    13869.7   -80.01
515412 [DMNCRKT4    138.00] AMP    13716.1   -84.39
515477 [CHSHLMV7    345.00] AMP    12428.0   -84.73
515497 [MATHWSN7    345.00] AMP    29723.6   -86.08
515543 [RENFROW7    345.00] AMP    11853.9   -84.75
532791 [BENTON 7    345.00] AMP    19393.9   -85.74
532797 [WOLFCRK7    345.00] AMP    16039.4   -86.82
532800 [LATHAMS7    345.00] AMP    10515.9   -85.56
533062 [ROSEHIL4    138.00] AMP    31772.9   -86.17
585010 [GEN-2015-063345.00] AMP    17199.4   -84.91
300138 [4CLEVLND    138.00] AMP    16718.6   -85.43
509755 [WEKIWA-7    345.00] AMP    18776.0   -86.22
509895 [T.NO.2-4    138.00] AMP    34375.2   -84.98
510376 [WEBBTAP4    138.00] AMP     7573.0   -78.68
510406 [N.E.S.-7    345.00] AMP    18839.9   -86.42
512865 [GREC TAP5   345.00] AMP    25876.8   -87.33
514710 [WAUKOMI4    138.00] AMP     9566.1   -80.46
514712 [FAIRMON4    138.00] AMP    13704.2   -82.21
514713 [WRVALLY4    138.00] AMP     8689.3   -82.12
514731 [SO4TH  4    138.00] AMP    14889.4   -81.19
514758 [STDBEAR4    138.00] AMP    13834.9   -81.86
514761 [WHEAGLE4    138.00] AMP    15609.1   -81.90
514770 [MARLNDT4    138.00] AMP    10904.4   -76.93
514801 [MINCO  7    345.00] AMP    16523.2   -85.22
514827 [CTNWOOD4    138.00] AMP    16585.2   -80.44
514828 [KETCHTP4    138.00] AMP    25940.9   -84.56
514854 [BRADEN 4    138.00] AMP    30728.9   -85.17
514873 [LNEOAK 4    138.00] AMP    26421.4   -84.60
514898 [CIMARON4    138.00] AMP    41978.6   -85.08
514907 [ARCADIA4    138.00] AMP    41149.4   -85.73
514909 [REDBUD 7    345.00] AMP    25343.7   -86.83
514934 [DRAPER 7    345.00] AMP    20456.4   -85.14
515045 [SEMINOL7    345.00] AMP    26026.8   -86.17
515181 [UNVRSTY4    138.00] AMP    13706.0   -79.81
515400 [DMANCRK4    138.00] AMP     8047.9   -80.20
515407 [TATONGA7    345.00] AMP    16417.5   -86.54
515471 [NW164TH4    138.00] AMP    34957.1   -85.70
515512 [SPVALLY4    138.00] AMP     8859.5   -77.69
515544 [RENFROW4    138.00] AMP    13620.7   -84.89
515610 [FSHRTAP7    345.00] AMP    16252.3   -85.15
521006 [MARSHAL4    138.00] AMP     7762.7   -80.47
532780 [CANEYRV7    345.00] AMP     9931.3   -85.50
532796 [WICHITA7    345.00] AMP    24680.8   -86.24
532798 [VIOLA   7   345.00] AMP    13506.5   -85.45
532799 [WAVERLY7    345.00] AMP    14764.2   -86.51
532801 [ELKRVR17    345.00] AMP     9279.4   -85.46
532986 [BENTON 4    138.00] AMP    28458.3   -85.85
532991 [WEAVER 4    138.00] AMP    22305.4   -84.07
533039 [ELPASO 4    138.00] AMP    25582.3   -84.20
533068 [STEARMN4    138.00] AMP    19903.0   -84.17
583750 [GEN-2013-029345.00] AMP    10492.1   -84.69
584170 [GEN-2014-064138.00] AMP     9474.7   -82.36
```