GEN-2015-073

Impact Restudy for Generator Modification (Turbine Change)

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By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
9/14/2018	SPP	Report issued.

SUMMARY

The GEN-2015-073 Interconnection Customer has requested a modification to its Interconnection Request. SPP has performed this system impact restudy to determine the effects of changing wind turbine generators from the previously studied fifty-eight (58) Vestas V126 3.45MW wind turbine generators to forty-eight (48) 48 Gamesa G132 3.465MW, thirteen (13) Siemens SWT2.3 2.415MW and one (1) Siemens SWT2.3 2.385MW wind turbine generators. The total nameplate remains the same at 200.1 MW. The point of interconnection (POI) for GEN-2015-073 is at Westar (WERE) Emporia Energy Center 345kV substation.

This study was performed by Power System Engineering, Inc. to determine whether the request for modification is considered Material. To determine this, study models that included Interconnection Requests through DISIS-2016-001-1 were used that analyzed the timeframes of 2016 winter, 2017 summer, and 2025 summer models.

The restudy showed that with the exception of Fault 59, a 3-phase fault with reclose on the Waverly to Lacygne 345 kV circuit, the 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. The study observed that the inclusion of GEN-2015-073 had no negative impact on the undamped oscillations simulated for Fault 59. 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. The requested modification is not considered Material.

A power factor analysis was previously performed and remains valid. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the POI. A low-wind/no-wind condition analysis was performed identifying a need for 16.7 MVAr of reactive compensation (This replaces the 14.8 MVAr previously identified with the original configuration.). This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during low-wind/no-wind conditions. Reactive compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS-2016-001-1 in place, GEN-2015-073 with the forty-eight (48) 48 Gamesa G132 3.465MW, thirteen (13) Siemens SWT2.3 2.415MW and one (1) Siemens SWT2.3 2.385MW wind turbine generators should be able to interconnect reliably to the SPP transmission grid.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. 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 transmission service or delivery rights. If the customer wishes to obtain deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the customer.

A: CONSULTANT'S MATERIAL MODIFICATION STUDY REPORT

See next page for the Consultant's Material Modification Study report.

Power System Engineering, Inc.

Full-service consultants

GEN-2015-073 Generator Modification Study (Turbine Change)

Prepared for:

Reading Wind Energy, LLC

Prepared by:

Power System Engineering, Inc.

September 10, 2018

GEN-2015-073 Generator Modification Study (Turbine Change)
for
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Executive Summary

PSE was retained by Reading Wind Energy, LLC (RWE) to perform a Generator Modification Study for Southwest Power Pool (SPP) project GEN-2015-073, a 200.1MW wind project interconnecting at the Westar Energy (WERE) Emporia 345kV substation in Lyon County, KS.

The previous GEN-2015-073 Generator Modification Study was performed to determine the impact of replacing the turbines originally specified with 58 Vestas V126 wind turbines. In the current study, RWE is requesting a change to 48 Gamesa G132 3.465MW wind turbines, 13 Siemens SWT2.3 2.415MW wind turbines, and 1 Siemens SWT2.3 2.385MW wind turbine. This study was performed to assess the dynamic stability impact of replacing the Vestas turbines with the Gamesa and Siemens turbines.

A stability analysis was performed on three (3) seasonal models including the 2016 Winter Peak (16WP), 2017 Summer Peak (17SP), and 2025 Summer Peak (25SP). These cases are modified versions of the 2015 model series of Model Development Working Group (MDWG) dynamic study models that include the upgrades and Interconnection Requests through DISIS-2016-001-1.

Utilizing the models as delivered, and with the exception of fault 59[1], our stability analysis has determined that generators in the monitored areas remained stable and within the pre-fault and post-fault voltage recovery criterion of 0.7 per unit to 1.2 per unit during each of the modeled disturbances. Additionally, the project wind farm was found to stay connected during the faults (see **Table 0-5)** that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A power factor analysis was performed during the previous generator modification study, and was not required to be repeated during this generator modification study. The final reactive power requirement in the GEN-2015-073 GIA will be the pro-forma 95% lagging to 95% leading at the POI.

A reduced wind generation analysis was conducted to determine the inductive support required to compensate for the capacitive effects on the bulk transmission system caused by the GEN-2015-073 gen-tie transmission line and collector systems during low or reduced wind conditions. As a result of this analysis, GEN-2015-073 is required to install a reactor or an equivalent means of compensation that can absorb approximately 16.7Mvar.

A short circuit analysis was also conducted using the 16WP, 17SP, and 25SP cases. The maximum fault current calculated for GEN-2015-073 is 42.8kA in 25SP, up from a maximum of 42.1kA with the Vestas V126 wind turbines. The results from the short circuit analysis are shown in Appendix A.

Under the assumptions outlined in this report, GEN-2015-073 with 48 Gamesa G132 3.465MW wind turbines, 13 Siemens SWT2.3 2.415MW wind turbines, and 1 Siemens SWT2.3 2.385MW wind turbine should be able to reliably interconnect to the SPP transmission grid. The change in wind turbine generators does not constitute a material modification for this project.

[1] Fault 59 results in undamped oscillations due to prior queued generators. GEN-2015-073 is not responsible for these oscillations.

This study was completed as a requested modification to change generator technology, manufacturer, and layout; additional power flow analysis beyond that required for this purpose was not performed. This study analyzed many of the most probable stability faults, but it did not utilize an all-inclusive list, and thus did not account for every operational situation.

This study does not guarantee delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be submitted on Southwest Power Pool's OASIS by the Customer.

Facilities

A one-line PSS/E slider drawing from the 25SP case is shown in **Figure 0-1** for GEN-2015-073.

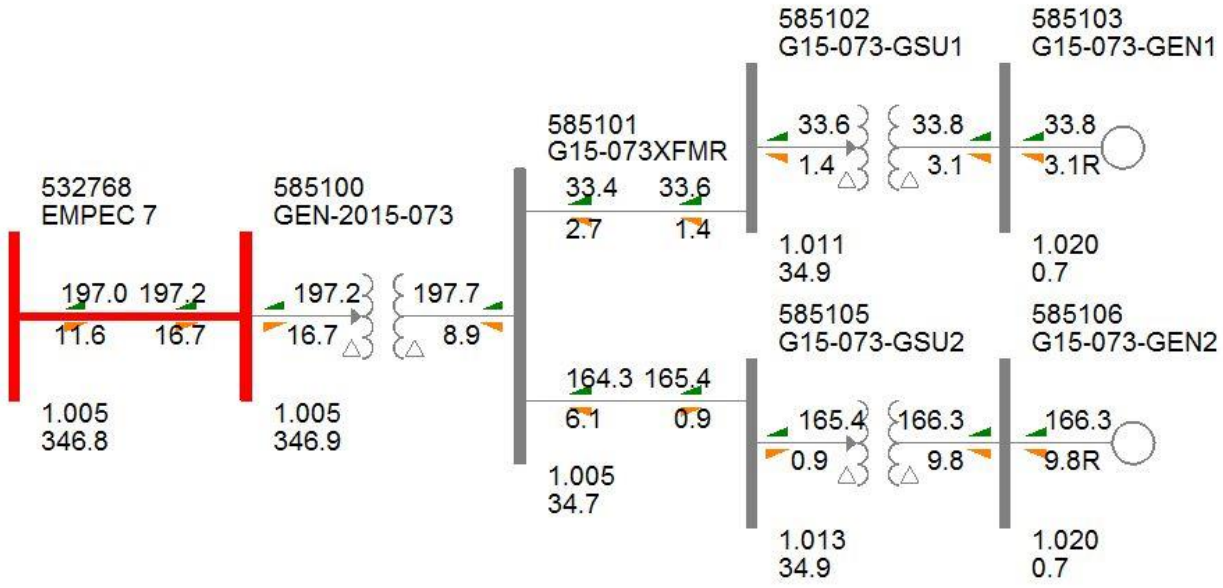

Figure 0-1: GEN-2015-073 One-line Diagram

The thermal units in **Table 0-1** were monitored during the stability simulations as requested by SPP.

Table 0-1: Monitored Thermal Units

Bus Number	Bus Name
532740	EMPEC121
532741	EMPEC341
532742	EMPEC5 1
532743	EMPEC6 1
532744	EMPEC7 1
532652	JEC U2
532653	JEC U3
532651	JEC U1
532721	EEC U1
532722	EEC U2
532729	EVAN SVC
532663	LEC U5
532723	EEC GT1
532724	EEC GT2
532725	EEC GT3
532751	WCGS U1
542955	LAC G1 1
542956	LAC G2 1

In addition to GEN-2015-073, the non-thermal units in **Table 0-2** were monitored during these stability simulations as requested by SPP.

Table 0-2: Monitored Non-Thermal Units

Bus Number	Bus Name		Bus Number	Bus Name
583853	G14-001-GEN1		599086	CHSHMV21-WTG
583856	G14-001-GEN2		599089	CHSHMV12-WTG
533123	FR2E1WF1		599090	CHSHMV22-WTG
533124	FR2E2WF1		532720	CANEYWF1
585073	G15-069-GEN1		582208	G11-008-GEN1
587503	G16-073-GEN1		583093	G11-049-GEN1
530594	SMKYP1G1		583096	G1149&1504G2
530600	SMKYP2G1		583373	G12-024-GEN1
533125	FR2W1WF1		584703	G15-029-GEN1
533126	FR2W2WF1		585203	G15-083-GEN1
583753	G13-029-GEN1		587023	G16-003-GEN1
583756	G13-029-GEN2		587463	G16-068-GEN1
584663	G15-024-GEN1		587466	G16-068-GEN2
584673	G15-025-GEN1		599025	MRWY-WG1
584676	G15-025-GEN2		599046	FLTRDG-WG1
584677	G15-025-GEN3		599059	SELIG WTG1
599013	ELKRVR-WTG1		599064	KEENAN-WTG1
599014	ELKRVR-WTG2		599065	KEENAN-WTG2
532957	WAVERGEN1		599081	OUSPRT-WTG1
577200	G10-003-GEN1		599099	CRSRD-WTG1
578533	FR3WTG1		599101	CRSRD-WTG2
584903	G15-052-GEN1		599103	CRSRDX-WTG2
585253	G15-090-GEN1		599130	KAYWND-WTG1
587044	G16-005-GEN1		599132	KAYWND-WTG2
599085	CHSHMV11-WTG		599136	MMTHPLN

Power System Stability Analysis

Methodology

The dynamic stability performance of the transmission system was examined using the SPP MDWG 2015 Series 16WP, 17SP, and 25SP stability packages provided by SPP and built for use with PSS/E v32.2.4. The GEN-2015-073 POI studied was the Emporia 345kV substation in Lyon County, KS, the same as in the previous modification study.

The new simulation files for the Gamesa G132 and Siemens SWT2.3 wind turbines were developed by adding the new DYRE data to the existing snapshot via DYRE ADD and compiling the USRMDL.dll to include the new library files (GLib0120_14_v32.lib, GMD0352_14_v32.lib, and SWT_32_rev8_SWT42_V32_Rev1.lib).

Model Changes

For proper simulation of the new turbines and to ensure the original user models for the Vestas V126 turbines are offline, a second generator was modeled at each bus to represent the Gamesa or Siemens turbines, respectively. In addition, a single main station transformer was modeled replacing the two main station transformers previously modeled, and the second collector line was moved to the 34.5kV bus of the single main station transformer.

PSE also updated the collector system with the following data in order to represent 48 Gamesa 3.465MW wind turbines, 13 Siemens 2.415MW wind turbines, and 1 Siemens 2.385MW wind turbine:

- Gen-Tie Transmission Line: R = 0.00038 per unit, X = 0.00329 per unit, B = 0.06335 per unit on a 100 MVA base with a length of 4.5 miles.
- Main Station Transformer (34.5/345kV): Winding MVA = 144 MVA, R = 0.00132 per unit, and X = 0.06596 per unit on a 100 MVA base.
- Gamesa Equivalent 34.5kV Collector Line: R = 0.0044 per unit, X = 0.00745 per unit, B = 0.0882 per unit on a 100 MVA base.
- Gamesa Equivalent Generator Step Up (GSU) Transformer (0.69/34.5kV): Winding MVA = 180 MVA, R = 0.00334 per unit, and X = 0.04014 per unit on a 100 MVA base.
- Siemens Equivalent 34.5kV Collector Line: R = 0.01453 per unit, X = 0.0179 per unit, B = 0.01552 per unit on a 100 MVA base.
- Siemens Equivalent Generator Step Up (GSU) Transformer (0.69/34.5kV): Winding MVA = 38.5 MVA, R = 0.01819 per unit, and X = 0.15478 per unit on a 100 MVA base.

Faults Studied

Specific Faults for GEN-2015-073 were not provided with the stability package. Therefore, the dynamic performance was evaluated using the faults defined in the previous generator modification study report in addition to several faults identified by PSE. A total of 109 three-phase (3PH) or single-phase (1PH) N-1 faults were simulated on each case as appropriate. The single-phase line faults were simulated by applying fault admittance 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 admittance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage.

The sequence of events for a 3PH and 1PH line fault is as follows:

Run for 2 seconds for stability

Apply fault at particular location

Continue fault for five (5) cycles, clear the fault by tripping the faulted line

Run for twenty (20) cycles, re-close the previous line into the fault

Continue fault for five (5) cycles

Trip the faulted facility and remove the fault

Run to 20 seconds for stability

The sequence of events for 3PH transformer faults is as follows:

1. Run for 2 seconds for stability
2. Apply fault on the 345kV Winding
3. Continue fault for five (5) cycles

Clear the fault by tripping the faulted transformer

Run to 20 seconds for stability

A detailed description of these faults is provided in **Table 0-3**. Stability plots for each of these faults are included in Appendix B.

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)
- 540: Greater Missouri Operations Company
- 541: Kansas City Power and Light (KCPL)

Table 0-3: Faults

Fault File	Description
FLT_000_NOFAULT	No Fault Conditions

Fault File	Description
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.
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.
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.
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.
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.
FLT_06_Woodring_G16061Tap_345kV_3PH	3 phase fault on Woodring (514715) to G16061 Tap (560084) 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.
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.
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.

Fault File	Description
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.
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.
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.
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.
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.
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.
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.

Fault File	Description
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.
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.
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.
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.
FLT_21_Rosehill_345_138kV_1_3PH	3 phase fault on the Rosehill 345kV (532794) to Rosehill 138kV (533062) to Rosehill 13.8kV (532826) transformer #1, near Rosehill 345kV. a. Apply fault at the Rosehill 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
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.
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.
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.

Fault File	Description
FLT_25_Northwest_345_138kV_2_3PH	3 phase fault on the Northwest 345kV (514880) to Northwest 138kV (514879) to Northwest 13.8kV (515742) transformer #2, near Northwest 345kV. a. Apply fault at the Northwest 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_26_Benton_WolfCreek_345kV_3PH	3 phase fault on the Benton (532791) to Wolf Creek (532797) 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.
FLT_27_Benton_345_138kV_2_3PH	3 phase fault on the Benton 345kV (532791) to Benton 138kV (532986) to Benton 13.8kV (532822) transformer #2, near Benton 345kV. a. Apply fault at the Benton 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
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.
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.
FLT_30_Wichita_G1524&1525T_345kV_3PH[2]	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.
FLT_31_Wichita_345_138kV_11_3PH	3 phase fault on the Wichita 345kV (532796) to Evans 138kV (533040) to Evans 13.8kV (532829) transformer #11, near Wichita 345kV. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_32_Thistle_G1524&1525T_345kV_3PH[2]	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.

[2] Double circuit line modeled; only faults on circuit #1 included.

Fault File	Description
FLT_33_Thistle_Woodward_345kV_3PH[2]	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.
FLT_34_Thistle_GEN16005 Tap_345kV_3PH[2]	3 phase fault on the Thistle (539801) to GEN-2016-005 Tap (560072) 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.
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.
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.
FLT_37_Reno_345_115kV_2_3PH	3 phase fault on the Reno 345kV (532771) to Reno 138kV (533416) to Reno 14.4kV (532810) transformer #2, near Reno 345kV. a. Apply fault at the Reno 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
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.
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.
FLT_40_Summit_Summit_345_230kV_3PH	3 phase fault on the Summit 345kV (532773) to Summit 230kV (532873) to Summit 14.4kV (532813) transformer, near Summit 345kV. a. Apply fault at the Summit 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Fault File	Description
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.
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.
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.
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.
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.
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.
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.
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.

Fault File	Description
FLT_48_Swissvale_345_230kV_1_3PH	3 phase fault on the Swissvale 345kV (532774) to Swissvale 230kV (532856) to Swissvale 14.4kV (532815) transformer #1, near Swissvale 345kV. a. Apply fault at the Swissvale 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
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.
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.
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.
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.
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.
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.
FLT_55_Stillwell_345_161kV_11_3PH	3 phase fault on the Stillwell 345kV (542968) to Stillwell 161kV (542969) to Stillwell 14.4kV (543647) transformer #11, near Stillwell 345kV. a. Apply fault at the Stillwell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Fault File	Description
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.
FLT_57_Craig_345_161kV_33_3PH	3 phase fault on the Craig 345kV (542977) to Craig 161kV (542978) to Craig 14.4kV (543643) transformer #33, near Craig 345kV. a. Apply fault at the Craig 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
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.
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.
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.
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.
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.
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.

Fault File	Description
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.
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.
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.
FLT_67_Woodring_G14-061Tap_345kV_1PH	Single phase fault on Woodring (514715) to G614-061Tap (560084) 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.
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.
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.
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.

Fault File	Description
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.
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.
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.
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.
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.
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.
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.

Fault File	Description
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.
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.
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.
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.
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.
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.
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.

Fault File	Description
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.
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.
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.
FLT_88_Wgardner_Douglas_345kV_3PH (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.
FLT_89_Wgardner_Swissvale_345kV_3PH (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.
FLT_90_Douglas_345_115kV_1_3PH (2025SP)	3 phase fault on the Douglas 345kV (532776) to Douglas 115kV (533285) to Douglas 14.4kV (532835) transformer #1, near Douglas 345kV. a. Apply fault at the Douglas 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_91_G14-001Tap_Wichita_345kV_3PH	3 phase fault on the G14-001 Tap (562476) to Wichita (532796) 345kV line, near G14-001 Tap. a. Apply fault at the G14-001 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.
FLT_92_G14-001Tap_Wichita_345kV_1PH	Single phase fault on the G14-001 Tap (562476) to Wichita (532796) 345kV line, near G14-001 Tap. a. Apply fault at the G14-001 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.

Fault File	Description
FLT_93_JECN_Blustem_345kV_3PH (2017SP & 2025SP)	3 phase fault on the JECN (532766) to Blustem (532767) 345kV line, near JECN. a. Apply fault at the JECN 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_94_Rosehill_345_138kV_3_3PH	3 phase fault on the Rosehill 345kV (532794) to Rosehill 138kV (533062) to Rosehill 13.8kV (532831) transformer #3, near Rosehill 345kV. a. Apply fault at the Rosehill 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_95_Rosehill_345_138kV_5_3PH	3 phase fault on the Rosehill 345kV (532794) to Rosehill 138kV (533062) to Rosehill 13.8kV (532827) transformer #5, near Rosehill 345kV. a. Apply fault at the Rosehill 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_96_Northwest_345_138kV_3_3PH	3 phase fault on the Northwest 345kV (514880) to Northwest 138kV (514879) to Northwest 13.8kV (515743) transformer #3, near Northwest 345kV. a. Apply fault at the Northwest 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_97_Northwest_345_138kV_4_3PH	3 phase fault on the Northwest 345kV (514880) to Northwest 138kV (514879) to Northwest 13.8kV (514885) transformer #4, near Northwest 345kV. a. Apply fault at the Northwest 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_98_Benton_345_138kV_1_3PH	3 phase fault on the Benton 345kV (532791) to Benton 138kV (532986) to Benton 13.8kV (532821) transformer #1, near Benton 345kV. a. Apply fault at the Benton 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_99_Wichita_345_138kV_12_3PH	3 phase fault on the Wichita 345kV (532796) to Evans 138kV (533040) to Evans 13.8kV (532830) transformer #12, near Wichita 345kV. a. Apply fault at the Wichita 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_100_Reno_345_115kV_1_3PH	3 phase fault on the Reno 345kV (532771) to Reno 138kV (533416) to Reno 14.4kV (532807) transformer #1, near Reno 345kV. a. Apply fault at the Reno 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_101_Summit_JECN_345kV_3PH (2016WP)	3 phase fault on the Summit (532773) to JECN (532766) 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.
FLT_102_Swissvale_345_230kV_2_3PH	3 phase fault on the Swissvale 345kV (532774) to Swissvale 230kV (532856) to Swissvale 14.4kV (532819) transformer #2, near Swissvale 345kV. a. Apply fault at the Swissvale 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Fault File	Description
FLT_103_Stillwell_345_161kV_22_3PH	3 phase fault on the Stillwell 345kV (542968) to Stillwell 161kV (542969) to Stillwell 14.4kV (543648) transformer #22, near Stillwell 345kV. a. Apply fault at the Stillwell 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_104_Craig_345_161kV_11_3PH	3 phase fault on the Craig 345kV (542977) to Craig 161kV (542978) to Craig 14.4kV (543641) transformer #11, near Craig 345kV. a. Apply fault at the Craig 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_105_Craig_345_161kV_22_3PH	3 phase fault on the Craig 345kV (542977) to Craig 161kV (542978) to Craig 14.4kV (543642) transformer #22, near Craig 345kV. a. Apply fault at the Craig 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
FLT_107_Wgardner_Douglas_345kV_1PH (2025SP)	Single 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.
FLT_106_Wgardner_Swissvale_345kV_1PH (2016WP& 2017SP)	Single 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.

Results

Stability Fault Summary

The summary of the transient stability results for each fault are provided in **Table 0-4**.

Table 0-4: GEN-2015-073 Stability Fault Summary

		Stability Status		
Fault	**Fault Description**	**16WP**	**17SP**	**25SP**
FLT_00	No Fault	Stable	Stable	Stable
FLT_01	3PH at Viola, Trip Viola to Renfrow 345kV	Stable	Stable	Stable
FLT_02	3PH at Viola, Trip Viola to Wichita 345kV	Stable	Stable	Stable
FLT_03	3PH at Renfrow, Trip Renfrow to Hunter 345kV	Stable	Stable	Stable
FLT_04	3PH at Renfrow, Trip Renfrow 3-WND XFMR #1	Stable	Stable	Stable
FLT_05	3PH at Hunter, Trip Hunter to Woodring 345kV	Stable	Stable	Stable
FLT_06	3PH at Woodring, Trip Woodring to G16061Tap 345kV	Stable	Stable	Stable
FLT_07	3PH at Woodring, Trip Woodring to G15063Tap 345kV	Stable	Stable	Stable
FLT_08	3PH at Woodring, Trip Woodring 3-WND XFMR #1	Stable	Stable	Stable
FLT_09	3PH at Mathewson, Trip Mathewson to Northwest 345kV	Stable	Stable	Stable
FLT_10	3PH at Mathewson, Trip Mathewson to Cimarron 345kV	Stable	Stable	Stable
FLT_11	3PH at Mathewson, Trip Mathewson to Tatonga 345kV	Stable	Stable	Stable
FLT_12	3PH at Sooner, Trip Sooner to SpringCreek 345kV	Stable	Stable	Stable
FLT_13	3PH at Sooner, Trip Sooner to G15066T 345kV	Stable	Stable	Stable
FLT_14	3PH at Sooner, Trip Sooner 3-WND XFMR #1	Stable	Stable	Stable
FLT_15	3PH at RanchRoad, Trip RanchRoad to Sooner 345kV	Stable[3]	Stable	Stable
FLT_16	3PH at RanchRoad, Trip RanchRoad to OpenSky 345kV	Stable	Stable	Stable
FLT_17	3PH at Rosehill, Trip Rosehill to Benton 345kV	Stable	Stable	Stable
FLT_18	3PH at Rosehill, Trip Rosehill to WolfCreek 345kV	Stable	Stable	Stable
FLT_19	3PH at Rosehill, Trip Rosehill to Latham 345kV	Stable	Stable	Stable
FLT_20	3PH at Rosehill, Trip Rosehill to G15052T 345kV	Stable	Stable	Stable
FLT_21	3PH at Rosehill, Trip Rosehill 3-WND XFMR #1	Stable	Stable	Stable
FLT_22	3PH at Northwest, Trip Northwest to Sp.Creek 345kV	Stable	Stable	Stable
FLT_23	3PH at Northwest, Trip Northwest to Cimarron 345kV	Stable	Stable	Stable
FLT_24	3PH at Northwest, Trip Northwest to Arcadia 345kV	Stable	Stable	Stable
FLT_25	3PH at Northwest, Trip Northwest 3-WND XFMR #2	Stable	Stable	Stable
FLT_26	3PH at Benton, Trip Benton to WolfCreek 345kV	Stable	Stable	Stable
FLT_27	3PH at Benton, Trip Benton 3-WND XFMR #2	Stable	Stable	Stable
FLT_28	3PH at Wichita, Trip Wichita to Reno 345kV	Stable	Stable	Stable
FLT_29	3PH at Wichita, Trip Wichita to Benton 345kV	Stable	Stable	Stable
FLT_30	3PH at Wichita, Trip Wichita to G1524&1525T 345kV	Stable	Stable	Stable
FLT_31	3PH at Wichita, Trip Wichita 3-WND XFMR #11	Stable	Stable	Stable
FLT_32	3PH at Thistle, Trip Thistle to G1524&1525T 345kV	Stable	Stable	Stable
FLT_33	3PH at Thistle, Trip Thistle to Woodward 345kV	Stable	Stable	Stable
FLT_34	3PH at Thistle, Trip Thistle to GEN16005Tap 345kV	Stable	Stable	Stable
FLT_35	3PH at Thistle, Trip Thistle 3-WND XFMR #1	Stable	Stable	Stable

[3] Potential voltage violations due to poor response from prior queued generators

		Stability Status		
Fault	**Fault Description**	**16WP**	**17SP**	**25SP**
FLT_36	3PH at Reno, Trip Reno to Summit 345kV	Stable	Stable	Stable
FLT_37	3PH at Reno, Trip Reno 3-WND XFMR #2	Stable	Stable	Stable
FLT_38	3PH at Summit, Trip Summit to Blustem 345kV	Stable	Stable	Stable
FLT_39	3PH at Summit, Trip Summit to ElmCreek 345kV	Stable	Stable	Stable
FLT_40	3PH at Summit, Trip Summit 3-WND XFMR #1	Stable	Stable	Stable
FLT_41	3PH at EMPEC, Trip EMPEC to Lang 345kV	Stable	Stable	Stable
FLT_42	3PH at EMPEC, Trip EMPEC to Morris 345kV	Stable	Stable	Stable
FLT_43	3PH at EMPEC, Trip EMPEC to Swissvale 345kV	Stable	Stable	Stable
FLT_44	3PH at EMPEC, Trip EMPEC to G14001Tap 345kV	Stable	Stable	Stable
FLT_45	3PH at Morris, Trip Morris to JECN 345kV	Stable	Stable	Stable
FLT_46	3PH at Morris, Trip Morris 3-WND XFMR #1	Stable	Stable	Stable
FLT_47	3PH at Swissvale, Trip Swissvale to Douglas 345kV	N/A	N/A	Stable
FLT_47	3PH at Swissvale, Trip Swissvale to Wgardner 345kV	Stable	Stable	N/A
FLT_48	3PH at Swissvale, Trip Swissvale 3-WND XFMR #1	Stable	Stable	Stable
FLT_49	3PH at Wgardner, Trip Wgardner to Stillwell 345kV	Stable	Stable	Stable
FLT_50	3PH at Wgardner, Trip Wgardner to Craig 345kV	Stable	Stable	Stable
FLT_51	3PH at Wgardner, Trip Wgardner to Lacygne 345kV	Stable	Stable	Stable
FLT_52	3PH at Wgardner, Trip Wgardner 3-WND XFMR #11	Stable	Stable	Stable
FLT_53	3PH at Stillwell, Trip Stillwell to Peculiar 345kV	Stable	Stable	Stable
FLT_54	3PH at Stillwell, Trip Stillwell to Lacygne 345kV	Stable	Stable	Stable
FLT_55	3PH at Stillwell, Trip Stillwell 3-WND XFMR #11	Stable	Stable	Stable
FLT_56	3PH at Craig, Trip Craig to 87th 345kV	Stable	Stable	Stable
FLT_57	3PH at Craig, Trip Craig 3-WND XFMR #33	Stable	Stable	Stable
FLT_58	3PH at Lacygne, Trip Lacygne to Neosho 345kV	Stable	Stable	Stable
FLT_59	3PH at Lacygne, Trip Lacygne to Waverly 345kV	Unstable[4]	Unstable[4]	Unstable[4]
FLT_60	3PH at Neosho, Trip Neosho to Blackberry 345kV	Stable	Stable	Stable
FLT_61	3PH at Neosho, Trip Neosho to Delaware 345kV	Stable	Stable	Stable
FLT_62	3PH at Neosho, Trip Neosho to CaneyCreek 345kV	Stable	Stable	Stable
FLT_63	1PH at Viola, Trip Viola to Renfrow 345kV	Stable	Stable	Stable
FLT_64	1PH at Viola, Trip Viola to Wichita 345kV	Stable	Stable	Stable
FLT_65	1PH at Renfrow, Trip Renfrow to Hunter 345kV	Stable	Stable	Stable
FLT_66	1PH at Hunter, Trip Hunter to Woodring 345kV	Stable	Stable	Stable
FLT_67	1PH at Woodring, Trip Woodring to G14-061 Tap 345kV	Stable	Stable	Stable
FLT_68	1PH at Woodring, Trip Woodring to G15063Tap 345kV	Stable	Stable	Stable
FLT_69	1PH at Sooner, Trip Sooner to SpringCreek 345kV	Stable	Stable	Stable
FLT_70	1PH at Sooner, Trip Sooner to G15066T 345kV	Stable	Stable	Stable
FLT_71	1PH at RanchRoad, Trip RanchRoad to Sooner 345kV	Stable	Stable	Stable
FLT_72	1PH at RanchRoad, Trip RanchRoad to OpenSky 345kV	Stable	Stable	Stable
FLT_73	1PH at Rosehill, Trip Rosehill to Benton 345kV	Stable	Stable	Stable
FLT_74	1PH at Rosehill, Trip Rosehill to WolfCreek 345kV	Stable	Stable	Stable
FLT_75	1PH at Rosehill, Trip Rosehill to Latham 345kV	Stable	Stable	Stable
FLT_76	1PH at Rosehill, Trip Rosehill to G15052T 345kV	Stable	Stable	Stable
FLT_77	1PH at Wichita, Trip Wichita to Reno 345kV	Stable	Stable	Stable

[4] Undamped oscillations due to prior queued generators. GEN-2015-073 is not responsible for these oscillations.

		Stability Status		
Fault	**Fault Description**	**16WP**	**17SP**	**25SP**
FLT_78	1PH at Wichita, Trip Wichita to Benton 345kV	Stable	Stable	Stable
FLT_79	1PH at Wichita, Trip Wichita to G1524/1525 Tap 345kV	Stable	Stable	Stable
FLT_80	1PH at EMPEC, Trip EMPEC to Lang 345kV	Stable	Stable	Stable
FLT_81	1PH at EMPEC, Trip EMPEC to Morris 345kV	Stable	Stable	Stable
FLT_82	1PH at EMPEC, Trip EMPEC to Swissvale 345kV	Stable	Stable	Stable
FLT_83	1PH at EMPEC, Trip EMPEC to G14001Tap 345kV	Stable	Stable	Stable
FLT_84	1PH at Morris, Trip Morris to JECN 345kV	Stable	Stable	Stable
FLT_85	1PH at Wgardner, Trip Wgardner to Stillwell 345kV	Stable	Stable	Stable
FLT_86	1PH at Wgardner, Trip Wgardner to Craig 345kV	Stable	Stable	Stable
FLT_87	1PH at Wgardner, Trip Wgardner to Lacygne 345kV	Stable	Stable	Stable
FLT_88	3PH at Wgardner, Trip Wgardner to Douglas 345kV	N/A	N/A	Stable
FLT_89	3PH at Wgardner, Trip Wgardner to Swissvale 345kV	Stable	Stable	N/A
FLT_90	3PH at Douglas, Trip Douglas 3-WND XFMR #1	N/A	N/A	Stable
FLT_91	3PH at G14-001 Tap, Trip G14-001 Tap to Wichita 345kV	Stable	Stable	Stable
FLT_92	1PH at G14-001 Tap, Trip G14-001 Tap to Wichita 345kV	Stable	Stable	Stable
FLT_93	3PH at JEC N, Trip JEC N to Blustem 345kV	N/A	Stable	Stable
FLT_94	3PH at Rosehill, Trip Rosehill 3-WND XFMR #3	Stable	Stable	Stable
FLT_95	3PH at Rosehill, Trip Rosehill 3-WND XFMR #5	Stable	Stable	Stable
FLT_96	3PH at Northwest, Trip Northwest 3-WND XFMR #3	Stable	Stable	Stable
FLT_97	3PH at Northwest, Trip Northwest 3-WND XFMR #4	Stable	Stable	Stable
FLT_98	3PH at Benton, Trip Benton 3-WND XFMR #1	Stable	Stable	Stable
FLT_99	3PH at Wichita, Trip Wichita 3-WND XFMR #12	Stable	Stable	Stable
FLT_100	3PH at Reno, Trip Reno 3-WND XFMR #1	Stable	Stable	Stable
FLT_101	3PH at Summit, Trip Summit to JECN 345kV	Stable	N/A	N/A
FLT_102	3PH at Swissvale, Trip Swissvale 3-WND XFMR #2	Stable	Stable	Stable
FLT_103	3PH at Stillwell, Trip Stillwell 3-WND XFMR #22	Stable	Stable	Stable
FLT_104	3PH at Craig, Trip Craig 3-WND XFMR #11	Stable	Stable	Stable
FLT_105	3PH at Craig, Trip Craig 3-WND XFMR #22	Stable	Stable	Stable
FLT_106	1PH at Wgardner, Trip Wgardner to Swissvale 345kV	Stable	Stable	N/A
FLT_107	1PH at Wgardner, Trip Wgardner to Douglas 345kV	N/A	N/A	Stable

Low Voltage Ride Through (LVRT)

LVRT is demonstrated by plotting the real power output of the wind turbine generators and the corresponding voltage at the POI. Plots for the faults defined in are provided in Appendix B and include the real power response and the per unit voltage at the POI. These plots demonstrate that project GEN-2015-073 remains "in-service" during the fault as required in FERC Order 661A.

Table 0-5: LVRT Faults

File Name	Description
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.

File Name	Description
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.
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.
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.

Reduced Wind Generation

A low wind analysis was performed for GEN-2015-073 to determine the capacitive reactive power injected at the POI from the project's gen-tie transmission line and collector systems. GEN-2015-073 will be required to install a reactor or an equivalent means of compensation for the capacitive reactive power injected at the POI.

In order to make this determination, the study generator was turned off in the 25SP case. In this state, approximately 17.0Mvar is observed at the POI from the GEN-2015-073 collector systems and transmission line (see **Figure 0-2**). To offset this capacitive injection, a reactor totaling 16.7Mvar was installed on the low side of the project's 345/34.5kV main station transformer (see **Figure 0-3**). With this reactor installed, the capacitive reactive power injected at the POI is zero.

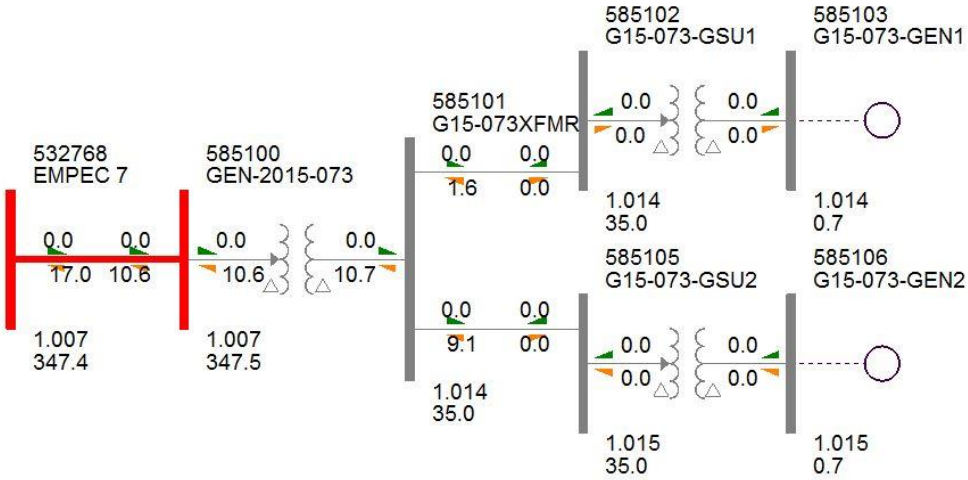

Figure 0-2: GEN-2015-073 Offline

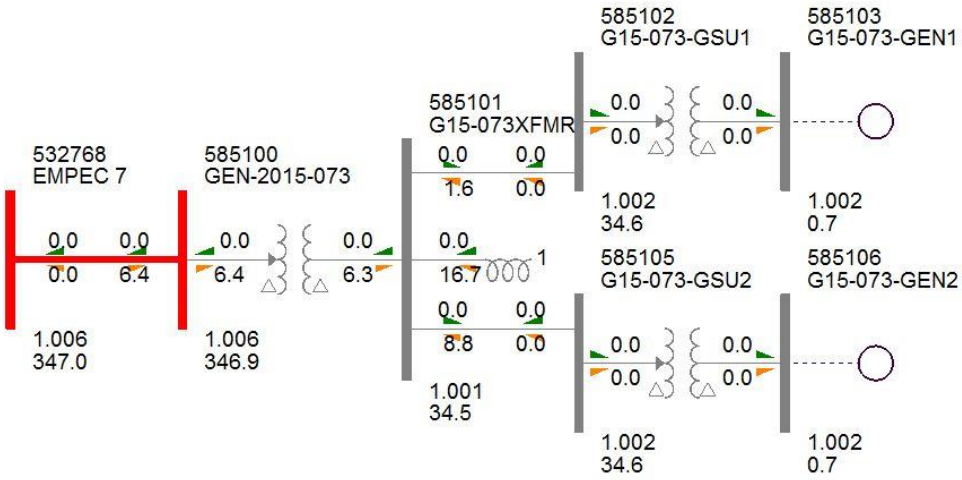

Figure 0-3: GEN-2015-073 Offline With Reactor

Short Circuit Analysis

The short circuit analysis was performed on the 16WP, 17SP, and 25SP power flow cases using the PSS/E Automatic Sequencing (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 POI and other buses up to and including buses five levels away from the POI.

The short circuit analysis was conducting using flat conditions with the following PSS/E ASCC 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

The maximum fault current calculated for GEN-2015-073 is 42.8kA in 25SP, up from a maximum of 42.1kA with the Vestas V126 wind turbines. The complete results of the short circuit analysis are shown in Appendix A for 16WP, 17SP, and 25SP.

Stability Plots

Stability plots are available upon request.

All disturbances studied achieved satisfactory performance without significant differences being observed when the Gamesa G132 and Siemens SWT2.3 wind turbines are substituted for the Vestas V126 wind turbines. The dynamic first swing voltage dips experienced during the specified faults are provided in Appendix B to demonstrate the system performance.

In Appendix B, multiple plots are provided for each fault with multiple traces.

For each fault, the first plot compares the real power output of GEN-2015-073. The magenta trace represents the aggregate Siemens SWT2.3 wind turbines and the red trace represents the aggregate Gamesa G132 wind turbines. The blue and black traces represent the real power response of project GEN-2015-073 with the previously studied Vestas V126 wind turbines.

The second plot compares the reactive power response of project GEN-2015-073 on a -2 to 2 per unit scale and from 0 to 20 seconds. The magenta trace represents the aggregate Siemens SWT2.3 wind turbines and the red trace represents the aggregate Gamesa G132 wind turbines. The blue and black traces represent the previously studied Vestas V126 wind turbines.

The third plot compares the terminal voltage (ETRM) of project GEN-2015-073 on a 0.5 to 1.5 per unit scale and from 0 to 20 seconds. The magenta trace represents the aggregate Siemens SWT2.3 wind turbines and the red trace represents the aggregate Gamesa G132 wind turbines. The blue and black traces represent the previously studied Vestas V126 wind turbines.

The fourth plot compares the speed deviation of project GEN-2015-073 on a -1000 to 34000 per unit scale and from 0 to 20 seconds. The magenta trace represents the aggregate Siemens SWT2.3 wind turbines and the red trace represents the aggregate Gamesa G132 wind turbines. The blue and black traces represent the previously studied Vestas V126 wind turbines.

The fifth plot compares the voltage response at the Emporia 345kV bus on a 0.7 to 1.2 per unit scale and from 0 to 20 seconds. The blue trace represents the response with the aggregate Siemens SWT2.3 and Gamesa G132 wind turbines while the black trace represents the previously studied Vestas V126 wind turbines.

The sixth plot compares the rotor angle response of the Emporia Unit 5 on a -180 to 180 degrees scale and from 0 to 20 seconds. The blue trace represents the response with the aggregate Siemens SWT2.3 and Gamesa G132 wind turbines while the black trace represents the previously studied Vestas V126 wind turbines.

Page seven of each set of plots trace the rotor angle response during the applicable fault for each of the thermal units' requested by SPP (see **Table 0-1**). These responses are for the case including the aggregate Siemens SWT2.3 and Gamesa G132 wind turbines only.

Page eight begins the non-thermal responses during the applicable fault for each of the non-thermal units' requested by SPP (see **Table 0-2**). The magenta trace represents the terminal voltage response (ETRM), the red trace represents the reactive power response, the blue trace represents the speed deviation, and the black trace represents the real power response. These responses are for the case including the aggregate Siemens SWT2.3 and Gamesa G132 wind turbines only.

The voltage response at the requested buses begin on page 20 for each fault and are traced on a 0.7 to 1.2 per unit scale and from 0 to 20 seconds.

These plots demonstrate that the response of the aggregate Siemens SWT2.3 and Gamesa G132 is similar or superior to the Vestas V126 wind machine previously studied. Thus, system performance is not degraded as a result of this turbine substitution; it should not be considered to be a material change.

Additional plots demonstrating the requested non-thermal units (listed in **Table 0-2**) responses prior to the turbine modification are provided in Appendix C.

Conclusion

Reading Wind Energy, LLC (GEN-2015-073) has requested a modification to its Generator Interconnection Request (GIR) to change wind turbine generators. Previously, the GEN-2015-073 GIR consisted of 58 Vestas V126 3.45MW wind turbines. The requested change is to 48 Gamesa G132 3.465MW wind turbines, 13 Siemens SWT2.3 2.415MW wind turbines, and 1 Siemens SWT2.3 2.385MW wind turbine totaling 200.1MW. The POI remains at the Westar Energy (WERE) Emporia 345kV Substation.

The stability analysis has determined that, with the exception of fault 59[5], the generators in the monitored areas remain stable and within the pre-fault and post-fault voltage recovery criterion of 0.7 per unit to 1.2 per unit during each of the modeled disturbances. Additionally, the project wind farm was found to remain "in-service" during the faults that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A power factor analysis was performed during the previous generator modification study, and was not required to be repeated during this generator modification study. The final reactive power requirement in the GEN-2015-073 GIA will be the pro-forma 95% lagging to 95% leading at the POI.

A reduced wind generation analysis was conducted to determine the inductive support required to compensate for the capacitive effects on the bulk transmission system caused by the GEN-2015-073 gen-tie transmission line and collector systems during low or reduced wind conditions. GEN-2015-073 is required to install a reactor or equivalent compensation that can inject approximately 16.7Mvar.

A short circuit analysis was also conducted using the 16WP, 17SP, and 25SP cases. The maximum fault current calculated for GEN-2015-073 is 42.8kA in 25SP, up from a maximum of 42.1kA with the Vestas V126 wind turbines. The results from the short circuit analysis are shown in Appendix A.

Under the assumptions outlined in this report, GEN-2015-073 with 48 Gamesa G132 3.465MW wind turbines, 13 Siemens SWT2.3 2.415MW wind turbines, and 1 Siemens SWT2.3 2.385MW wind turbine should be able to reliably interconnect to the SPP transmission grid. The change in wind turbine generators does not represent a Material Modification.

This study was completed as a requested modification to change generator technology, manufacturer, and layout; additional power flow analysis beyond that required for this purpose was not performed. This study analyzed many of the most probable stability faults, but it did not utilize an all-inclusive list, and thus did not account for every operational situation.

This study does not guarantee delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be submitted on Southwest Power Pool's OASIS by the Customer.

[5] Fault 59 results in undamped oscillations due to prior queued generators. GEN-2015-073 is not responsible for these oscillations.

Appendix A – Short Circuit Results

2016WP GEN-2015-073 Short Circuit Analysis Results

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PSS(R)E-32.2.4 ASCC SHORT CIRCUIT CURRENTS           TUE, AUG 28 2018  16:56
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2016W WITH MMWG 2015W, MRO & SERC 2016 WINTER

OPTIONS USED: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
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X---------- BUS ----------X	THREE PHASE FAULT /I+/	AN(I+)
300739 [7BLACKBERRY 345.00] AMP	12162.8	-84.38
510380 [DELWARE7 345.00] AMP	11384.3	-84.89
515375 [WWRDEHV7 345.00] AMP	16499.2	-85.98
515476 [HUNTERS7 345.00] AMP	12665.2	-84.69
515543 [RENFROW7 345.00] AMP	11477	-84.59
515544 [RENFROW4 138.00] AMP	13610.6	-84.76
530592 [SMOKYHL6 230.00] AMP	6880.6	-84.28
532765 [HOYT 7 345.00] AMP	14935.6	-85.76
532766 [JEC N 7 345.00] AMP	22791.3	-87.54
532768 [EMPEC 7 345.00] AMP	17299.4	-86.16
532769 [LANG 7 345.00] AMP	17087.1	-86.15
532770 [MORRIS 7 345.00] AMP	12606	-85.5
532771 [RENO 7 345.00] AMP	10478.6	-85.45
532772 [STRANGR7 345.00] AMP	21088.1	-85.93
532773 [SUMMIT 7 345.00] AMP	9955.7	-85.68
532774 [SWISVAL7 345.00] AMP	15592.7	-85.19
532775 [87TH 7 345.00] AMP	18493.4	-85.56
532780 [CANEYRV7 345.00] AMP	9761.2	-85.48
532791 [BENTON 7 345.00] AMP	17901.8	-85.47
532792 [FR2EAST7 345.00] AMP	6205.6	-85.55
532793 [NEOSHO 7 345.00] AMP	16097.4	-84.53
532794 [ROSEHIL7 345.00] AMP	17912.1	-85.64
532795 [FR2WEST7 345.00] AMP	5199.4	-85.62
532796 [WICHITA7 345.00] AMP	22249.4	-85.59
532797 [WOLFCRK7 345.00] AMP	15814	-86.81
532798 [VIOLA 7 345.00] AMP	11372.2	-85
532799 [WAVERLY7 345.00] AMP	14582.8	-86.51
532800 [LATHAMS7 345.00] AMP	10294.6	-85.53
532802 [WAVERTX7 345.00] AMP	12463.3	-86.05
532851 [AUBURN 6 230.00] AMP	12843.5	-83.57
532852 [JEC 6 230.00] AMP	24037.8	-87.77
532853 [LAWHILL6 230.00] AMP	12277.7	-84.83
532854 [LEC U5 6 230.00] AMP	12178.2	-84.75

			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
532855 [MIDLAND6	230.00]	AMP	11012.4	-84.48
532856 [SWISVAL6	230.00]	AMP	20189.7	-85.23
532857 [TECHILL6	230.00]	AMP	10443.9	-83.74
532861 [EMANHAT6	230.00]	AMP	8269.3	-84.37
532862 [MCDOWEL6	230.00]	AMP	6275.1	-83.96
532863 [MORRIS 6	230.00]	AMP	13418.9	-85.25
532865 [NMANHT6	230.00]	AMP	7743.4	-84.18
532872 [EMCPHER6	230.00]	AMP	7691.4	-83.37
532873 [SUMMIT 6	230.00]	AMP	12784.4	-85.12
532874 [UNIONRG6	230.00]	AMP	8709.1	-83.66
532920 [TECHILL5	161.00]	AMP	5539	-84.33
532937 [NEOSHO 5	161.00]	AMP	21900.4	-84.3
532986 [BENTON 4	138.00]	AMP	26042.4	-85.76
532990 [MIDIAN 4	138.00]	AMP	9811.8	-80.53
533015 [BENTLEY4	138.00]	AMP	8996.3	-85.03
533021 [NEOSHO 4	138.00]	AMP	22976.7	-84.49
533024 [29TH 4	138.00]	AMP	18427.2	-85.09
533035 [CHISHLM4	138.00]	AMP	19512.3	-84.69
533037 [COMOTAR4	138.00]	AMP	17491.6	-84.62
533040 [EVANS N4	138.00]	AMP	26657.4	-86.28
533041 [EVANS S4	138.00]	AMP	26657.4	-86.28
533053 [LAKERDG4	138.00]	AMP	15243.7	-85.21
533054 [MAIZE 4	138.00]	AMP	18778.6	-84.97
533062 [ROSEHIL4	138.00]	AMP	29024.7	-86.07
533065 [SG12COL4	138.00]	AMP	16711.4	-85.47
533074 [45TH ST4	138.00]	AMP	20435.2	-85.26
533151 [AUBURN 3	115.00]	AMP	20265.6	-83.58
533153 [COLINE 3	115.00]	AMP	20323.2	-80.8
533154 [OLDAUBU3	115.00]	AMP	19619.3	-83.54
533155 [CROOKED3	115.00]	AMP	19204	-83.57
533163 [HOYT 3	115.00]	AMP	21972.4	-85.64
533166 [INDIANH3	115.00]	AMP	16491.3	-82.07
533169 [NTHLAND3	115.00]	AMP	14253.1	-82.62
533170 [OSAGE 3	115.00]	AMP	4344.3	-71.76
533171 [OSAGE J3	115.00]	AMP	5096.2	-72.89
533176 [SHAWNEE3	115.00]	AMP	11301.6	-81.73
533177 [6 GOLDN3	115.00]	AMP	14807.4	-81.48
533180 [TEC E 3	115.00]	AMP	23964.4	-81.78
533182 [TECHILE3	115.00]	AMP	24517.7	-81.86
533187 [27CROCO3	115.00]	AMP	17926.8	-82.28
533194 [SHERWOD3	115.00]	AMP	18516.2	-83.34
533197 [HARTLND3	115.00]	AMP	4558.8	-75.01
533198 [HOYTJS 3	115.00]	AMP	19178.3	-84.84
533199 [HOYTJN 3	115.00]	AMP	18327.2	-84.63
533232 [BALDCRK3	115.00]	AMP	12643.3	-82.93
533248 [LEC U3 3	115.00]	AMP	20698.6	-82.94
533249 [LEC U4 3	115.00]	AMP	20015.7	-82.81
533250 [LWRNCHL3	115.00]	AMP	21501.6	-82.99
533252 [MIDLAND3	115.00]	AMP	22309.1	-83.11
533253 [MOCKBRD3	115.00]	AMP	15193	-78.63
533264 [6TH ST 3	115.00]	AMP	15921.9	-81.38
533268 [STRANGR3	115.00]	AMP	30679.4	-86.81
533270 [STULL T3	115.00]	AMP	11135.6	-73.1
533280 [WREN 3	115.00]	AMP	11887.3	-80.66
533283 [87TH 3	115.00]	AMP	24897.1	-85.94

			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
533301	[EAST ST3	115.00] AMP	9171.1	-82.12
533304	[LANG 3	115.00] AMP	14370.4	-85.2
533305	[MORRIS 3	115.00] AMP	12277.8	-86.27
533306	[READING3	115.00] AMP	6345.8	-73.76
533307	[PRAIRIE3	115.00] AMP	9216.3	-82.5
533308	[VAUGHN 3	115.00] AMP	2808.3	-71.31
533309	[WEMPORI3	115.00] AMP	9731.6	-81.65
533311	[WMBROSJ3	115.00] AMP	6743	-76.37
533326	[EMANHAT3	115.00] AMP	11742.4	-84.87
533328	[FT JCT 3	115.00] AMP	8927.3	-84.38
533335	[MCDOWEL3	115.00] AMP	13168	-83.81
533341	[STAGGHL3	115.00] AMP	8546.1	-83.44
533350	[SMAN_W_3	115.00] AMP	10471.8	-79.31
533359	[UNIONRG3	115.00] AMP	3779.1	-87.74
533360	[TCHOPE 3	115.00] AMP	3360.3	-87.25
533381	[SUMMIT 3	115.00] AMP	16587.3	-86.23
533390	[MAIZEW 4	138.00] AMP	20932.6	-85.23
533392	[SCRNTJS3	115.00] AMP	5003.9	-74.23
533413	[CIRCLE 3	115.00] AMP	18019	-84.88
533415	[DAVIS 3	115.00] AMP	8084.7	-82.35
533416	[RENO 3	115.00] AMP	21372.7	-85.43
533429	[MOUNDRG3	115.00] AMP	6952.5	-83
533438	[WMCPHER3	115.00] AMP	10802.9	-84.1
539639	[ELMCREK6	230.00] AMP	7031.7	-84.79
539801	[THISTLE7	345.00] AMP	15647.4	-85.79
539804	[THISTLE4	138.00] AMP	16275	-86.47
539805	[ELMCREEK7	345.00] AMP	5119.8	-85.34
541198	[PECULR 7	345.00] AMP	18515.6	-85.38
541200	[PHILL 7	345.00] AMP	17033.3	-85.52
541231	[STRANGR5	161.00] AMP	14939.8	-87.56
541341	[S.HARP 5	161.00] AMP	19393.9	-84.26
541342	[PECULR 5	161.00] AMP	21086.8	-85.1
542965	[W.GRDNR7	345.00] AMP	22750.4	-85.46
542966	[WGARDNR5	161.00] AMP	20943.6	-86.28
542968	[STILWEL7	345.00] AMP	22141.4	-85.62
542969	[STILWEL5	161.00] AMP	35142.1	-85.68
542977	[CRAIG 7	345.00] AMP	19714.8	-85.52
542978	[CRAIG 5	161.00] AMP	35556.4	-85.6
542979	[PFLUMM 5	161.00] AMP	25073.1	-85.02
542981	[LACYGNE7	345.00] AMP	24234.5	-86.85
542982	[IATAN 7	345.00] AMP	24907	-86.72
542994	[HICKMAN5	161.00] AMP	17590.1	-83.94
542995	[MONTROS5	161.00] AMP	17070.5	-84.1
543031	[SHWNMSN5	161.00] AMP	28636.1	-84.73
543038	[LENEXAS5	161.00] AMP	24466.8	-85.02
543039	[LENEXAN5	161.00] AMP	25356.8	-84.73
543044	[MOONLT 5	161.00] AMP	14322.7	-84.8
543048	[COLLEGE5	161.00] AMP	25707.2	-84.68
543049	[CEDRCRK5	161.00] AMP	25298.9	-84.9
543050	[ANTIOCH5	161.00] AMP	20606.7	-84.42
543053	[REDEL 5	161.00] AMP	22360.9	-84.2
543054	[CEDARNL5	161.00] AMP	8385.6	-84.35
543055	[SEOTTWA5	161.00] AMP	6278.5	-81.2
543057	[BUCYRUS5	161.00] AMP	17880.1	-84.17
543077	[PLSTVAL5	161.00] AMP	8898.9	-83.34

			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
543105	[BULLCRK5 161.00]	AMP	18750.8	-86.37
543126	[LACKMAN5 161.00]	AMP	12610.5	-83.87
543132	[BNSF 5 161.00]	AMP	16854	-85.42
560033	[G1524&G1525T345.00]	AMP	19226.1	-85.96
560053	[G15-052T 345.00]	AMP	12986	-86.38
560072	[G16-005-TAP 345.00]	AMP	13283	-85.16
562476	[G14-001-TAP 345.00]	AMP	10800.2	-84.95
583750	[GEN-2013-029345.00]	AMP	10199.7	-84.56
583850	[GEN-2014-001345.00]	AMP	7440.8	-84.71
584659	[G15024G15025345.00]	AMP	6752.6	-86.43
584660	[GEN-2015-024345.00]	AMP	5619.3	-86.48
584670	[GEN-2015-025345.00]	AMP	6752.6	-86.43
585070	[GEN-2015-069230.00]	AMP	6546.5	-84.47
585100	[GEN-2015-073345.00]	AMP	13227.4	-85.54
587500	[GEN-2016-073345.00]	AMP	14868.3	-85.69

2017SP GEN-2015-073 Short Circuit Analysis Results

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PSS(R)E-32.2.4 ASCC SHORT CIRCUIT CURRENTS            TUE, AUG 28 2018  16:32
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+)
 300739 [7BLACKBERRY 345.00] AMP      12259.5  -84.36
 510380 [DELWARE7    345.00] AMP      11402.7  -84.83
 515375 [WWRDEHV7    345.00] AMP      16618.7  -85.98
 515476 [HUNTERS7    345.00] AMP      12714.3  -84.67
 515543 [RENFROW7    345.00] AMP      11581.9   -84.6
 515544 [RENFROW4    138.00] AMP      13652.7  -84.77
 530592 [SMOKYHL6    230.00] AMP       6936.3  -84.28
 532765 [HOYT   7    345.00] AMP      15369.8  -85.75
 532766 [JEC N  7    345.00] AMP      23350.9  -87.49
 532767 [BLUSTEM7    345.00] AMP         9635  -86.21
 532768 [EMPEC 7     345.00] AMP      17708.8  -86.15
 532769 [LANG   7    345.00] AMP      17487.1  -86.14
 532770 [MORRIS 7    345.00] AMP      12835.6  -85.51
 532771 [RENO   7    345.00] AMP      10829.3  -85.55
 532772 [STRANGR7    345.00] AMP      22141.5  -85.93
 532773 [SUMMIT 7    345.00] AMP      10296.1   -85.7
 532774 [SWISVAL7    345.00] AMP      16448.7  -85.34
 532775 [87TH 7      345.00] AMP      19933.3  -85.68
 532780 [CANEYRV7    345.00] AMP       9929.8  -85.49
 532791 [BENTON 7    345.00] AMP      19487.9  -85.69
 532792 [FR2EAST7    345.00] AMP       6269.3  -85.57
 532793 [NEOSHO 7    345.00] AMP      16225.5  -84.48
 532794 [ROSEHIL7    345.00] AMP        19150  -85.79
 532795 [FR2WEST7    345.00] AMP       5240.5  -85.64
 532796 [WICHITA7    345.00] AMP      25114.1  -86.09
 532797 [WOLFCRK7    345.00] AMP      16014.7  -86.81
 532798 [VIOLA   7   345.00] AMP        11653  -85.06
 532799 [WAVERLY7    345.00] AMP      14744.8   -86.5
 532800 [LATHAMS7    345.00] AMP      10516.1  -85.55
 532802 [WAVERTX7    345.00] AMP      12579.1  -86.04
 532851 [AUBURN 6    230.00] AMP      13445.7  -83.78
 532852 [JEC    6    230.00] AMP      24551.1  -87.75
 532853 [LAWHILL6    230.00] AMP      13544.3  -85.36
 532854 [LEC U5 6    230.00] AMP      13414.4  -85.26
 532855 [MIDLAND6    230.00] AMP      12077.8  -84.96
 532856 [SWISVAL6    230.00] AMP      21650.2  -85.42
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			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
532857	[TECHILL6 230.00]	AMP	11268.6	-84.31
532861	[EMANHAT6 230.00]	AMP	9573.9	-85.6
532862	[MCDOWEL6 230.00]	AMP	6902.3	-84.86
532863	[MORRIS 6 230.00]	AMP	13832	-85.32
532865	[NMANHT6 230.00]	AMP	8778.2	-85.16
532872	[EMCPHER6 230.00]	AMP	7761.6	-83.37
532873	[SUMMIT 6 230.00]	AMP	12983.5	-85.15
532874	[UNIONRG6 230.00]	AMP	8782.1	-83.65
532920	[TECHILL5 161.00]	AMP	5772.4	-84.76
532937	[NEOSHO 5 161.00]	AMP	22027	-84.25
532986	[BENTON 4 138.00]	AMP	28292.4	-85.84
532988	[BELAIRE4 138.00]	AMP	18810.3	-84.77
532990	[MIDIAN 4 138.00]	AMP	10108.7	-80.47
533015	[BENTLEY4 138.00]	AMP	9874.2	-85.09
533021	[NEOSHO 4 138.00]	AMP	23066.5	-84.45
533024	[29TH 4 138.00]	AMP	19587	-85.1
533035	[CHISHLM4 138.00]	AMP	22019.7	-84.79
533040	[EVANS N4 138.00]	AMP	37737.1	-87.19
533041	[EVANS S4 138.00]	AMP	37737.1	-87.19
533053	[LAKERDG4 138.00]	AMP	18149.9	-85.59
533054	[MAIZE 4 138.00]	AMP	22443.5	-85.16
533062	[ROSEHIL4 138.00]	AMP	31428.9	-86.15
533065	[SG12COL4 138.00]	AMP	20346.3	-85.75
533074	[45TH ST4 138.00]	AMP	26278.3	-85.67
533151	[AUBURN 3 115.00]	AMP	21721.4	-84.04
533153	[COLINE 3 115.00]	AMP	23249.7	-81.04
533155	[CROOKED3 115.00]	AMP	20506.6	-84
533163	[HOYT 3 115.00]	AMP	22837.6	-85.67
533166	[INDIANH3 115.00]	AMP	17644	-82.25
533167	[KEENE 3 115.00]	AMP	10055.9	-84.37
533169	[NTHLAND3 115.00]	AMP	15028.9	-82.69
533170	[OSAGE 3 115.00]	AMP	4387.9	-71.7
533171	[OSAGE J3 115.00]	AMP	5156.4	-72.84
533176	[SHAWNEE3 115.00]	AMP	12211.4	-82.2
533177	[6 GOLDN3 115.00]	AMP	16265.1	-81.89
533180	[TEC E 3 115.00]	AMP	29626.3	-82.95
533182	[TECHILE3 115.00]	AMP	30040.9	-82.92
533187	[27CROCO3 115.00]	AMP	20257.1	-83.02
533194	[SHERWOD3 115.00]	AMP	19840.7	-83.73
533197	[HARTLND3 115.00]	AMP	4720.7	-74.94
533198	[HOYTJS 3 115.00]	AMP	19915.7	-84.88
533199	[HOYTJN 3 115.00]	AMP	18922.5	-84.62
533232	[BALDCRK3 115.00]	AMP	14031.3	-83.3
533248	[LEC U3 3 115.00]	AMP	25213.5	-83.74
533249	[LEC U4 3 115.00]	AMP	24754.7	-83.73
533250	[LWRNCHL3 115.00]	AMP	26422.7	-83.82
533252	[MIDLAND3 115.00]	AMP	25669	-83.42
533253	[MOCKBRD3 115.00]	AMP	16981.8	-78.43
533264	[6TH ST 3 115.00]	AMP	18128.6	-81.65
533268	[STRANGR3 115.00]	AMP	31876.2	-86.81
533270	[STULL T3 115.00]	AMP	11955.5	-72.52
533280	[WREN 3 115.00]	AMP	13255.1	-80.82
533283	[87TH 3 115.00]	AMP	25992.4	-85.96
533301	[EAST ST3 115.00]	AMP	9229.5	-82.08
533304	[LANG 3 115.00]	AMP	14513.1	-85.16

			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
533305	[MORRIS 3	115.00] AMP	12431.5	-86.3
533306	[READING3	115.00] AMP	6401.3	-73.69
533307	[PRAIRIE3	115.00] AMP	9275.4	-82.46
533308	[VAUGHN 3	115.00] AMP	2813.6	-71.28
533309	[WEMPORI3	115.00] AMP	9798.3	-81.6
533311	[WMBROSJ3	115.00] AMP	6774.3	-76.32
533326	[EMANHAT3	115.00] AMP	13097.3	-85.58
533328	[FT JCT 3	115.00] AMP	14523.7	-85.84
533335	[MCDOWEL3	115.00] AMP	17726.7	-85.3
533336	[BLUSTEM3	115.00] AMP	16990.5	-86.42
533341	[STAGGHL3	115.00] AMP	9510.5	-83.81
533350	[SMAN_W_3	115.00] AMP	12516.5	-79.34
533359	[UNIONRG3	115.00] AMP	3785.9	-87.74
533360	[TCHOPE 3	115.00] AMP	3365.7	-87.26
533362	[CHAPMAN3	115.00] AMP	10335.3	-85.52
533381	[SUMMIT 3	115.00] AMP	16873.7	-86.24
533390	[MAIZEW 4	138.00] AMP	26270.4	-85.51
533392	[SCRNTJS3	115.00] AMP	5086.4	-74.23
533413	[CIRCLE 3	115.00] AMP	18271	-84.93
533415	[DAVIS 3	115.00] AMP	8139.3	-82.35
533416	[RENO 3	115.00] AMP	21781.2	-85.5
533429	[MOUNDRG3	115.00] AMP	7030.2	-83.04
533438	[WMCPHER3	115.00] AMP	10877.1	-84.11
539801	[THISTLE7	345.00] AMP	16090.6	-85.87
539804	[THISTLE4	138.00] AMP	16622.8	-86.53
539805	[ELMCREEK7	345.00] AMP	5263	-85.36
541198	[PECULR 7	345.00] AMP	20129.2	-85.62
541200	[PHILL 7	345.00] AMP	18164.9	-85.64
541231	[STRANGR5	161.00] AMP	15156	-87.58
541341	[S.HARP 5	161.00] AMP	25064.4	-85.17
541342	[PECULR 5	161.00] AMP	24428.7	-85.47
542965	[W.GRDNR7	345.00] AMP	25295.7	-85.82
542966	[WGARDNR5	161.00] AMP	27268.7	-86.91
542968	[STILWEL7	345.00] AMP	24293.6	-85.88
542969	[STILWEL5	161.00] AMP	39043.4	-85.84
542977	[CRAIG 7	345.00] AMP	21529.5	-85.69
542978	[CRAIG 5	161.00] AMP	39262.9	-85.68
542979	[PFLUMM 5	161.00] AMP	26872	-85.03
542981	[LACYGNE7	345.00] AMP	24973.9	-86.87
542982	[IATAN 7	345.00] AMP	25787.1	-86.7
542994	[HICKMAN5	161.00] AMP	18429.4	-83.89
542995	[MONTROS5	161.00] AMP	17464.8	-84.08
543031	[SHWNMSN5	161.00] AMP	31012.8	-84.73
543038	[LENEXAS5	161.00] AMP	26158.9	-85.03
543039	[LENEXAN5	161.00] AMP	27178.4	-84.72
543044	[MOONLT 5	161.00] AMP	16519.3	-85.04
543048	[COLLEGE5	161.00] AMP	27887.3	-84.69
543049	[CEDRCRK5	161.00] AMP	27491.7	-84.94
543050	[ANTIOCH5	161.00] AMP	21962.7	-84.41
543053	[REDEL 5	161.00] AMP	23854.1	-84.19
543054	[CEDARNL5	161.00] AMP	13627	-84.6
543055	[SEOTTWA5	161.00] AMP	6710.7	-81.09
543057	[BUCYRUS5	161.00] AMP	19175	-84.31
543077	[PLSTVAL5	161.00] AMP	9750.4	-83.34
543105	[BULLCRK5	161.00] AMP	24987.7	-87.09

			THREE PHASE FAULT	
X---------- BUS ----------X			/I+/	AN(I+)
543126	[LACKMAN5 161.00]	AMP	13050	-83.85
543131	[CLARE 5 161.00]	AMP	13987.6	-84.48
543132	[BNSF 5 161.00]	AMP	19934.2	-85.73
560033	[G1524&G1525T345.00]	AMP	20808	-86.29
560053	[G15-052T 345.00]	AMP	13298.9	-86.44
560072	[G16-005-TAP 345.00]	AMP	13446.6	-85.17
562476	[G14-001-TAP 345.00]	AMP	11098.2	-85.01
583750	[GEN-2013-029345.00]	AMP	10281.3	-84.56
583850	[GEN-2014-001345.00]	AMP	7569.7	-84.74
584659	[G15024G15025345.00]	AMP	6894.9	-86.51
584660	[GEN-2015-024345.00]	AMP	5711.7	-86.54
584670	[GEN-2015-025345.00]	AMP	6894.9	-86.51
585070	[GEN-2015-069230.00]	AMP	6578.5	-84.47
585100	[GEN-2015-073345.00]	AMP	13458.3	-85.52
587500	[GEN-2016-073345.00]	AMP	15747.5	-85.9

2025SP GEN-2015-073 Short Circuit Analysis Results

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PSS(R)E-32.2.4 ASCC SHORT CIRCUIT CURRENTS          TUE, AUG 28 2018  16:14
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+)
 515375 [WWRDEHV7    345.00] AMP     18939.7      -86.06
 515476 [HUNTERS7    345.00] AMP     13062.9      -84.71
 515543 [RENFROW7    345.00] AMP     12219.1      -84.71
 515544 [RENFROW4    138.00] AMP       13864      -84.84
 530592 [SMOKYHL6    230.00] AMP      6989.9      -84.27
 532765 [HOYT   7    345.00] AMP     15643.4      -85.77
 532766 [JEC N  7    345.00] AMP       23560      -87.49
 532767 [BLUSTEM7    345.00] AMP      9758.4      -86.28
 532768 [EMPEC 7     345.00] AMP     17816.7      -86.15
 532769 [LANG   7    345.00] AMP     17592.3      -86.13
 532770 [MORRIS 7    345.00] AMP     12897.7       -85.5
 532771 [RENO   7    345.00] AMP     11600.8      -85.94
 532772 [STRANGR7    345.00] AMP     24246.3      -86.19
 532773 [SUMMIT 7    345.00] AMP     10654.1      -85.88
 532774 [SWISVAL7    345.00] AMP     16736.7      -85.33
 532775 [87TH 7      345.00] AMP       20396      -85.74
 532776 [DOUGLAS7    345.00] AMP     18225.5      -85.12
 532791 [BENTON 7    345.00] AMP     19827.2      -85.71
 532792 [FR2EAST7    345.00] AMP      6704.8      -85.71
 532793 [NEOSHO 7    345.00] AMP     16317.8      -84.48
 532794 [ROSEHIL7    345.00] AMP     19433.4       -85.8
 532795 [FR2WEST7    345.00] AMP        5516      -85.74
 532796 [WICHITA7    345.00] AMP     26077.2      -86.23
 532797 [WOLFCRK7    345.00] AMP     16079.3      -86.81
 532798 [VIOLA   7   345.00] AMP     13809.1      -85.42
 532799 [WAVERLY7    345.00] AMP     14793.6       -86.5
 532800 [LATHAMS7    345.00] AMP     10567.8      -85.55
 532851 [AUBURN 6    230.00] AMP     13510.2       -83.8
 532852 [JEC    6    230.00] AMP     24667.9      -87.75
 532853 [LAWHILL6    230.00] AMP     14094.3      -85.54
 532854 [LEC U5 6    230.00] AMP       13950      -85.42
 532855 [MIDLAND6    230.00] AMP     12564.7      -85.12
 532856 [SWISVAL6    230.00] AMP     21738.7      -85.43
 532857 [TECHILL6    230.00] AMP     11308.9       -84.3
 532861 [EMANHAT6    230.00] AMP      9606.5      -85.62
 532862 [MCDOWEL6    230.00] AMP      6920.7      -84.92
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X---------- BUS ----------X			THREE PHASE FAULT /I+/	AN(I+)
532863	[MORRIS 6	230.00] AMP	13905.6	-85.32
532865	[NMANHT6	230.00] AMP	8808.3	-85.18
532872	[EMCPHER6	230.00] AMP	8556.8	-83.85
532873	[SUMMIT 6	230.00] AMP	13542.1	-85.3
532874	[UNIONRG6	230.00] AMP	8871.7	-83.64
532920	[TECHILL5	161.00] AMP	5792	-84.76
532984	[SUMNER 4	138.00] AMP	10651.8	-83.1
532986	[BENTON 4	138.00] AMP	28816.6	-85.81
532988	[BELAIRE4	138.00] AMP	19065.6	-84.74
532990	[MIDIAN 4	138.00] AMP	10201.1	-80.4
533015	[BENTLEY4	138.00] AMP	10162.8	-85.05
533024	[29TH 4	138.00] AMP	19862.4	-85.07
533035	[CHISHLM4	138.00] AMP	22679.1	-84.74
533036	[CLEARWT4	138.00] AMP	21999.4	-85.39
533040	[EVANS N4	138.00] AMP	42826.6	-87.27
533041	[EVANS S4	138.00] AMP	42826.6	-87.27
533046	[GILL S 4	138.00] AMP	28725.5	-85.41
533053	[LAKERDG4	138.00] AMP	19117.5	-85.55
533054	[MAIZE 4	138.00] AMP	23618.4	-85.09
533062	[ROSEHIL4	138.00] AMP	32186.3	-86.12
533065	[SG12COL4	138.00] AMP	21699.7	-85.69
533074	[45TH ST4	138.00] AMP	29586.7	-86.41
533075	[VIOLA 4	138.00] AMP	22354.6	-86.02
533151	[AUBURN 3	115.00] AMP	21991.5	-84.08
533153	[COLINE 3	115.00] AMP	23446	-80.93
533155	[CROOKED3	115.00] AMP	20747.1	-84.03
533163	[HOYT 3	115.00] AMP	23031.4	-85.74
533166	[INDIANH3	115.00] AMP	17825.8	-82.21
533167	[KEENE 3	115.00] AMP	10035.6	-85.11
533169	[NTHLAND3	115.00] AMP	15101.5	-82.67
533170	[OSAGE 3	115.00] AMP	4390.7	-71.69
533171	[OSAGE J3	115.00] AMP	5160.3	-72.83
533176	[SHAWNEE3	115.00] AMP	12279	-82.15
533177	[6 GOLDN3	115.00] AMP	16344.1	-81.83
533180	[TEC E 3	115.00] AMP	30080.7	-82.78
533182	[TECHILE3	115.00] AMP	30521.9	-82.76
533187	[27CROCO3	115.00] AMP	20497.5	-82.88
533194	[SHERWOD3	115.00] AMP	20148.9	-83.71
533197	[HARTLND3	115.00] AMP	13021.6	-81.22
533198	[HOYTJS 3	115.00] AMP	20058.7	-84.93
533199	[HOYTJN 3	115.00] AMP	19069.6	-84.72
533232	[BALDCRK3	115.00] AMP	15660.9	-83.78
533234	[BISMARK3	115.00] AMP	21703.2	-80.89
533236	[FAIRGDS3	115.00] AMP	21666.7	-81.51
533240	[EUDORA 3	115.00] AMP	12038	-81.75
533248	[LEC U3 3	115.00] AMP	28182.1	-83.81
533249	[LEC U4 3	115.00] AMP	27618.3	-83.79
533250	[LWRNCHL3	115.00] AMP	29907.6	-83.95
533252	[MIDLAND3	115.00] AMP	28053.7	-83.32
533253	[MOCKBRD3	115.00] AMP	19829.5	-79.27
533256	[19THST 3	115.00] AMP	18589	-80.66
533257	[19THSTJ3	115.00] AMP	18997.4	-80.82
533264	[6TH ST 3	115.00] AMP	20348.5	-81.72
533268	[STRANGR3	115.00] AMP	33033.4	-86.94
533270	[STULL T3	115.00] AMP	12548.7	-72.29

X---------- BUS ----------X			THREE PHASE FAULT /I+/	AN(I+)
533271	[SWLWRNC3	115.00] AMP	21418.3	-81.66
533280	[WREN 3	115.00] AMP	14077.5	-80.69
533285	[DOUGLAS3	115.00] AMP	23744.5	-85.75
533301	[EAST ST3	115.00] AMP	9243.5	-82.06
533304	[LANG 3	115.00] AMP	14541.5	-85.15
533305	[MORRIS 3	115.00] AMP	12461.1	-86.3
533306	[READING3	115.00] AMP	6406.1	-73.67
533307	[PRAIRIE3	115.00] AMP	9290.2	-82.44
533308	[VAUGHN 3	115.00] AMP	2815.1	-71.26
533309	[WEMPORI3	115.00] AMP	9817.1	-81.59
533311	[WMBROSJ3	115.00] AMP	6786.3	-76.3
533326	[EMANHAT3	115.00] AMP	13130.7	-85.63
533328	[FT JCT 3	115.00] AMP	14600.7	-85.95
533335	[MCDOWEL3	115.00] AMP	17783.8	-85.56
533336	[BLUSTEM3	115.00] AMP	17100.3	-86.53
533340	[SMANHAT3	115.00] AMP	12005.1	-85.49
533341	[STAGGHL3	115.00] AMP	9528.9	-83.88
533359	[UNIONRG3	115.00] AMP	3794.2	-87.75
533360	[TCHOPE 3	115.00] AMP	3372.2	-87.26
533362	[CHAPMAN3	115.00] AMP	10390.8	-85.59
533381	[SUMMIT 3	115.00] AMP	17410.4	-86.38
533390	[MAIZEW 4	138.00] AMP	28200.8	-85.42
533392	[SCRNTJS3	115.00] AMP	5091.5	-74.22
533413	[CIRCLE 3	115.00] AMP	22913.7	-85.79
533415	[DAVIS 3	115.00] AMP	8768.9	-82.37
533416	[RENO 3	115.00] AMP	25275.4	-86.05
533429	[MOUNDRG3	115.00] AMP	7198.5	-83.12
533438	[WMCPHER3	115.00] AMP	12460.6	-84.75
533880	[GODDARD2	138.00] AMP	19097.8	-85.9
539801	[THISTLE7	345.00] AMP	16450.1	-85.89
539804	[THISTLE4	138.00] AMP	16842.2	-86.44
539805	[ELMCREEK7	345.00] AMP	5322.6	-85.42
541198	[PECULR 7	345.00] AMP	20165.3	-85.59
542965	[W.GRDNR7	345.00] AMP	25975.7	-85.82
542966	[WGARDNR5	161.00] AMP	27457.8	-86.93
542968	[STILWEL7	345.00] AMP	24425.6	-85.85
542969	[STILWEL5	161.00] AMP	38919.1	-85.82
542977	[CRAIG 7	345.00] AMP	21955	-85.74
542978	[CRAIG 5	161.00] AMP	39849.8	-85.72
542981	[LACYGNE7	345.00] AMP	25089.9	-86.86
542982	[IATAN 7	345.00] AMP	27003.6	-86.66
543049	[CEDRCRK5	161.00] AMP	27779.7	-84.96
543054	[CEDARNL5	161.00] AMP	13673.4	-84.6
543077	[PLSTVAL5	161.00] AMP	9773	-83.33
543105	[BULLCRK5	161.00] AMP	25137.4	-87.11
543132	[BNSF 5	161.00] AMP	20034.3	-85.74
560033	[G1524&G1525T	345.00] AMP	21337.2	-86.38
560053	[G15-052T	345.00] AMP	13363.5	-86.45
560072	[G16-005-TAP	345.00] AMP	13540.3	-85.17
562476	[G14-001-TAP	345.00] AMP	11190.4	-85.02
583750	[GEN-2013-029	345.00] AMP	10773.2	-84.66
583850	[GEN-2014-001	345.00] AMP	7609.1	-84.74
584659	[G15024G15025	345.00] AMP	6939	-86.53
584660	[GEN-2015-024	345.00] AMP	5740.1	-86.56
584670	[GEN-2015-025	345.00] AMP	6939	-86.53

		THREE PHASE FAULT	
X---------- BUS ----------X		/I+/	AN(I+)
585070 [GEN-2015-069230.00]	AMP	6617.4	-84.47
585100 [GEN-2015-073345.00]	AMP	13518.7	-85.51
587500 [GEN-2016-073345.00]	AMP	16033.3	-85.96

Appendix B – Stability Plots

Stability plots are available upon request.

Appendix C – GEN-2015-073 V126 Prior-Queue Project Response Stability Plots

Stability plots are available upon request.