GEN-2015-063 Impact Restudy for Generator Modification (Turbine Change)

June 2017
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
6/23/2017	SPP	GEN-2015-063 Impact Restudy for Generator Modification Report Issued

Executive Summary

The GEN-2015-063 Interconnection Customer has requested a modification to its Generator Interconnection Request to change turbines. The previously studied project configuration consisted of One hundred fifty (150) Vestes V110 2.0 MW wind turbines for a total nameplate capacity of 300.0 MW. The proposed revised project configuration consists of ninety-five (95) Acciona 3.15 MW wind turbines for a total nameplate capacity of 299.25 MW. The point of interconnection (POI) is a new substation that taps the line between the Oklahoma Gas & Electric (OKGE) Woodring and Mathewson 345kV substations.

The study models used were the 2016 winter, 2017 summer, and 2025 summer models that included Interconnection Requests and assigned network upgrades through DISIS-2015-002-1.

Stability analysis has determined with all assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. Additionally, the project 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.

Power factor analysis for each generation project was performed on the current study 2016 winter peak, 2017 summer peak, and 2025 summer peak cases with identified system upgrades. As reactive power is required for GEN-2015-063, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

An analysis was conducted to determine the capacitive effects on the transmission system caused by the generator lead and collector system during periods of reduced generation. The generating facility is required to provide reactive compensation of approximately 15.2 Mvar of inductive reactance during periods of reduced generation. Such compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

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

With the assumptions outlined in this report and with all the required network upgrades from the DISIS-2015-002-1 in place, GEN-2015-063 with the Acciona 3.15 MW wind turbines should be able to interconnect reliably to the SPP transmission grid. This proposed change in wind turbines is not a Material Modification.

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

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

Table of Contents

1. Introduction

The GEN-2015-063 Interconnection Customer has requested a modification to its Generator Interconnection Request to change PV solar inverters from Vestas V110 2.0 MW wind turbines to Acciona 3.15 MW wind turbines.

The requested change is shown in **Table 1-1**.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-063	299.25	Acciona 3.15 MW wind turbines	Tap on Woodring (514715) to Matthewson (515497) 345 kV (560055)

The POI is a new substation that taps the line between the Oklahoma Gas & Electric (OKGE) Woodring and Mathewson 345kV substations. Other queued generation projects in the model are listed in **Table 1-2**.

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

Request	Capacity (MW)	Generator Model	Point of Interconnection
ASGI-2010-006	150	GE 1.5MW	Remington 138kV (301369)
ASGI-2014-014	54.3 Summer 56.4 Winter	GENSAL	Ferguson 69kV (512664)
ASGI-2015-004	54.3 Summer 56.364 Winter	GENSAL	Coffeyville Municipal Light & Power Northern Industrial Park Substation 69kV (512735)
GEN-2002-004	199.5	GE 1.5MW	Lathams 345kV (532800)
GEN-2005-013	199.8	Vestas V90 1.8MW	Caney River 345kV (532780)
GEN-2007-025	299.2	GE 1.6MW	Viola 345kV (532798)
GEN-2008-013	300	GE 1.68MW, and GE 2.4MW	Hunter 345kV (515476)
GEN-2008-021	1261 Summer 1283 Winter	GENROU	Wolf Creek 345kV (532797)
GEN-2008-098	100.3	Gamesa 2.0MW, and Gamesa 2.1MW	Waverly 345kV (532799)
GEN-2009-025	59.8	Siemens 2.3MW	Nardins 69kV (515528)
GEN-2010-003 (Phase II to GEN-2008-098)	98.7	Gamesa 2.1MW	Waverly 345kV (532799)
GEN-2010-005	299.2	GE 1.6MW, and Vestas V110 2.0MW	Viola 345kV (532798)
GEN-2010-055	4.8	GENROU	Wekiwa 138kV (509757)
GEN-2011-057	150	Vestas V110 2.0MW	Creswell 138kV (532981)
GEN-2012-032	299	Siemens 2.3MW	Open Sky 345kV (515621)
GEN-2012-033	98.055	GE 1.715MW, and GE 1.79MW	Breckenridge 138kV (514815)
GEN-2012-041	85.3 Summer 121.5 Winter	GENROU	Ranch Road 345kV (515576)
GEN-2013-012 (Uprate to Redbud station)	68 Summer 147 Winter (uprate) (4 x 168 Summer 4 x 215 Winter)	GENROU (514910) (514911) (514912) (514942)	Redbud 345kV (514909)

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

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2013-028	516.4 Summer 559.5 Winter	GENROU (583743, 583746)	Tap on Tulsa N to GRDA1 345kV (512865)
GEN-2013-029	299	Siemens 2.3MW	Renfrow 345kV (515543)
GEN-2014-001	199.5	Gamesa 2.1MW	Tap Wichita to Emporia Energy Center 345kV (562476)
GEN-2014-028 (Uprate to GEN-2004-017)	35 (uprate) (256 summer 259 winter)	GENROU	Riverton 161kV (547469)
GEN-2014-064	248.4	GE 2.3MW	Otter 138kV (514708)
GEN-2015-001	199.8	Vestas V126 3.3MW, and Vestas V126 3.0MW	Ranch Road 345kV (515576)
GEN-2015-015	154.56	Siemens 2.415MW	Tap Medford Tap to Coyote 138kV (560031)
GEN-2015-016	200.0	Vestas V110 2.0MW	Tap Centerville to Marmaton 161kV (560029)
GEN-2015-024	217.8	GE 1.8MW	Tap Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-025	215.95	GE 1.8MW, and GE 1.79MW	Tap Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-030	200.1	GE 2.3MW	Sooner 345kV (514803)
GEN-2015-034	200	Vestas V110 2.0MW	Ranch Road 345kV (515576)
GEN-2015-052	300	Vestas V110 2.0MW	Tap Open Sky to Rose Hill 345 kV (560053)
GEN-2015-062 (Uprate to GEN-2012-033)	4.505	GE 1.8MW (uprated 53 GE 1.715MW)	Breckenridge 138kV (514815)
GEN-2015-066	248.4	GE 2.3MW	Tap Cleveland to Sooner 345 kV (560056)
GEN-2015-067	150	Power Electronics – 1.667MW PV inverter	Sooner 138kV (514802)
GEN-2015-069	300	Vestas V110 2.0MW	Union Ridge 230kV (532874)
GEN-2015-073	200.1	Siemens 2.3MW	Emporia 345kV (532768)
GEN-2015-083	124.2	GE 2.3MW	Belle Plain 138kV (533063)
GEN-2015-090	220	GE 2.0MW	Tap Wichita to Thistle 345kV at GEN-2015-024 (584660) 345kV

A stability analysis was performed for the change in wind turbines. The analysis was performed on three (3) seasonal models including 2016 winter peak (16WP), the 2017 summer peak (17SP), and the 2025 summer peak (25SP) cases. These cases are modified versions of the 2015 model series of Model Development Working Group (MDWG) dynamic study models that included upgrades and Interconnection Requests through DISIS-2015-002-1.

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

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

Reduced Generation Analysis was performed to determine reactor inductive amounts to compensate for the capacitive effects on the transmission system caused by the interconnecting project's generator lead transmission line and collector systems during low or reduced generation conditions. The results of the analysis are illustrated in **Figure 5-2**.

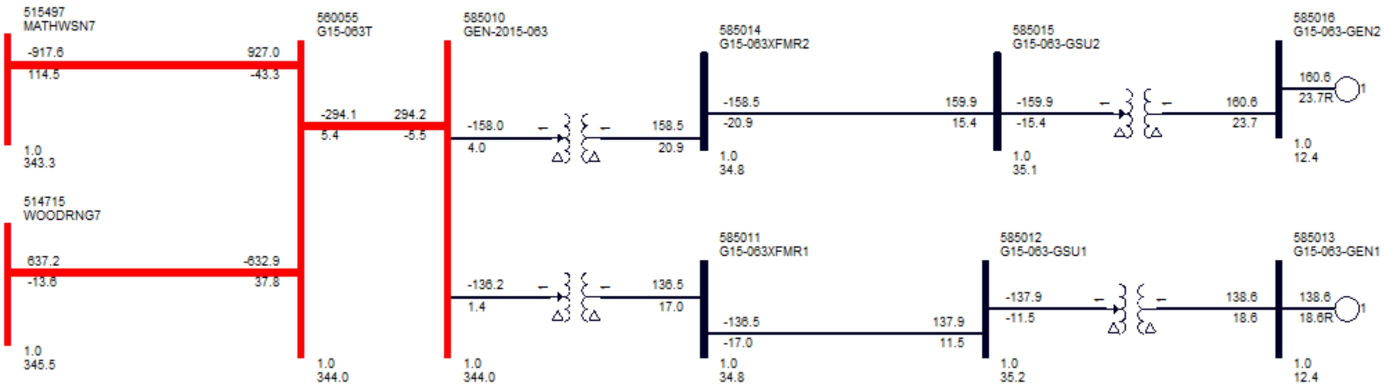
Short Circuit Analysis was conducted using the current study upgrade 2017 summer peak and 2025 summer peak cases. The results from the Short circuit analysis are shown in **Appendix E**.

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

2. Facilities

A one-line PSS/E slider drawing from the 16WP case is shown in **Figure 2-1** for GEN-2015-063. The POI is a tap on the OKGE Woodring – Mathewson 345kV transmission line.

Figure 2-1: GEN-2015-063 One-line Diagram



3. Stability Analysis

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

Model Preparation

Transient stability analysis was performed using modified versions of the 2015 series of Model Development Working Group (MDWG) dynamic study models including the 2016 winter peak, 2017 summer peak, and the 2025 summer peak seasonal models. The cases are then loaded with prior queued interconnection requests and network upgrades assigned to those interconnection requests through DISIS-2015-002-1. Finally the prior queued and study generation are dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

Disturbances

Twenty-four (24) contingencies were identified for use in this study and are listed in **Table 3-1**. These contingencies are faults at locations defined by SPP Generation Interconnection Staff. These contingencies include three-phase and single-phase N-1. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

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

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

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

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

The SPP areas monitored during the stability analysis were:

- 520: American Electric Power (AEPW)
- 523: Grand River Dam Authority (GRDA)
- 524: Oklahoma Gas and Electric Company (OKGE)
- 525: Western Farmers Electric Cooperative (WFEC)
- 527: Oklahoma Municipal Power Authority (OMPA)

- 534: Sunflower Electric Power Corp. (SUNC)
- 536: Westar Energy, Inc. (WERE)

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
0	FLT_000_NOFAULT	No Fault Conditions
1	FLT_01_SOONER7_G16061TAP_345kV_3PH	3 phase fault on the Sooner (5514803) to GEN-2016-061-TAP (560084) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT_02_G16061TAP_WOODRNG7_345kV_3PH	3 phase fault on the GEN-2016-061-TAP (560084) to Woodring (514715) 345kV line, near GEN-2016-061-TAP. a. Apply fault at the GEN-2016-061-TAP 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
3	FLT_03_WOODRNG7_G15063T_345kV_3PH	3 phase fault on the Woodring (514715) to GEN-2015-063-TAP (560055) 345kV line, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT_04_WOODRNG7_HUNTERS7_345kV_3PH	3 phase fault on the Woodring (514715) to Hunters (515476) 345kV line, near Woodring. a. Apply fault at the Woodring 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
5	FLT_05_G15063T_MATHWSN7_345kV_3PH	3 phase fault on the GEN-2015-063-TAP (560055) to Matthewson (515497) 345kV line, near GEN-2015-063T. a. Apply fault at the GEN-2015-063T 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
6	FLT_06_G15063T_WOODRNG7_345kV_3PH	3 phase fault on the GEN-2015-063-TAP (560055) to Woodring (514715) 345kV line, near GEN-2015-063-TAP. a. Apply fault at the GEN-2015-063-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.
7	FLT_07_MATHWSN7_CIMARON7_345kV_3PH	3 phase fault on the Mathewson (515497) to Cimarron (514901) 3455kV 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.
8	FLT_08_G15052T_ROSEHIL7_345kV_3PH	3 phase fault on the GEN-2015-052-TAP (560053) to Rosehill (532794) 345kV line, near GEN-2015-052-TAP. a. Apply fault at the GEN-2015-052-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.
9	FLT_09_VIOLA7_WICHITA7_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.
10	FLT_10_SOONER7_SPRNGCK7_345kV_3PH	3 phase fault on the Sooner (5514803) to Spring Creek (5514881) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
11	FLT_11_MINCO7_GRACMNT7_345kV_3PH	3 phase fault on the Minco (514801) to Gracemont (515800) 345kV line, near Minco. a. Apply fault at the Minco 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT_12_G15081TAP_WWRDEHV7_345kV_3PH	3 phase fault on the G15-081-Tap (562075) to Woodward EHV (515375) 345kV line, near G15-081-Tap. a. Apply fault at the G15-081-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.

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
13	FLT_13_MATHWSN7_NORTWST7_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.
14	FLT_14_NORTWST7_ARCADIA7_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.
15	FLT_15_CIMARON7_DRAPER7_345kV_3PH	3 phase fault on the Cimarron (514901) to Draper (514934) 345kV line, near Cimarron. a. Apply fault at the Cimarron 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
16	FLT_16_SOONER7_G16061TAPSB_345kV_1PH	**Single phase fault with stuck breaker** on the Sooner (514803) to GEN-2016-061-TAP (560084) 345kV line, near Sooner. a. Apply fault at the Sooner 345kV bus. b. Clear fault after 16 cycles by tripping the faulted line as well as the line from Sooner (514803) to Ranch Road (515576).
17	FLT_17_WOODRNG7_G16061TAPSB_345kV_1PH	**Single phase fault with stuck breaker** on Woodring (514715) to GEN-2016-061-TAP (560084) 345kV line, near GEN-2016-061-TAP. a. Apply fault at the Woodring 345 kV bus. b. Clear fault after 16 cycles by tripping the faulted line as well as the line from Woodring (514715) to Hunter (515476).
18	FLT_18_WOODRNG7_WOODRNG4_345_138kV_3PH	3 phase fault on the Woodring 345kV (514715) to 138 kV (514714) to 13.8 kV (515770) XFMR CKT 1, near Woodring 345 kV bus. a. Apply fault at the Woodring 345 kV bus. b. Clear fault after 5 cycles by tripping the transformer
19	FLT_19_NORTWST7_NORTWST4_345_138kV_3PH	3 phase fault on the Northwest 345kV (514880) to 138 kV (514879) to 13.8 kV (514885) XFMR CKT 1, near Northwest 345 kV bus. a. Apply fault at the Northwest 345 kV bus. b. Clear fault after 5 cycles by tripping the transformer
20	FLT_20_CIMARON7_CIMARON4_345_138kV_3PH	3 phase fault on the Cimarron 345kV (514901) to 138 kV (514898) to 13.8 kV (515715) XFMR CKT 1, near Cimarron 345 kV bus. a. Apply fault at the Cimarron 345 kV bus. b. Clear fault after 5 cycles by tripping the transformer

Table 3-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
21	FLT_21_MATHWSN7_CIMARON7PO_345kV_3PH	**<u>Prior outage</u>** on the Mathewson (515497) to Northwest (514880) 345kV line: 3 phase fault on the Mathewson (515497) to Cimarron (514901) 345kV line, near Mathewson 345kV. a. Prior Outage Mathewson to Northwest 345kV. b. Apply fault at the Mathewson 345kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (b) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
22	FLT_22_WOODRNG7_G16061TAPPO_345kV_3PH	**<u>Prior outage</u>** on the G15-063T (560055) to Mathewson (515497) 345kV line: 3 phase fault on the Woodring (514715) to G16-061-Tap (560084) 345kV line, near Woodring 345kV. a. Prior Outage G15-063T to Mathewson 345kV. b. Apply fault at the Woodring 345kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (b) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
23	FLT_23_WOODRNG7_HUNTERS7PO_345kV_3PH	**<u>Prior outage</u>** on the G15-063T (560055) to Mathewson (515497) 345kV line: 3 phase fault on the Woodring (514715) to Hunters (515476) 345kV line, near Woodring 345kV. a. Prior Outage G15-063T to Mathewson 345kV. b. Apply fault at the Woodring 345kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (b) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
24	FLT_24_MATHWSN7_CIMARON7PO_345kV_3PH	**<u>Prior outage</u>** on the G15-063T (560055) to Woodring (514715) 345kV line: 3 phase fault on the Mathewson (515497) to Cimarron (514901) 345kV line, near Mathewson 345kV. a. Prior Outage G15-063T to Woodring 345kV. b. Apply fault at the Mathewson 345kV bus. c. Clear fault after 5 cycles by tripping the faulted line. d. Wait 20 cycles, and then re-close the line in (b) back into the fault. e. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Results

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

Table 3-2: Contingency Results

Contingency Number and Name		Three Phase		
		2016WP	2017SP	2025SP
0	FLT_000_NOFAULT	STABLE	STABLE	STABLE
1	FLT_01_SOONER7_G16061TAP_345kV	STABLE	STABLE	STABLE
2	FLT_02_G16061TAP_WOODRNG7_345kV	STABLE	STABLE	STABLE
3	FLT_03_WOODRNG7_G15063T_345kV	STABLE	STABLE	STABLE
4	FLT_04_WOODRNG7_HUNTERS7_345kV	STABLE	STABLE	STABLE
5	FLT_05_G15063T_MATHWSN7_345kV	STABLE	STABLE	STABLE
6	FLT_06_G15063T_WOODRNG7_345kV	STABLE	STABLE	STABLE
7	FLT_07_MATHWSN7_CIMARON7_345kV	STABLE	STABLE	STABLE
8	FLT_08_G15052T_ROSEHIL7_345kV	STABLE	STABLE	STABLE
9	FLT_09_VIOLA7_WICHITA7_345kV	STABLE	STABLE	STABLE
10	FLT_10_SOONER7_SPRNGCK7_345kV	STABLE	STABLE	STABLE
11	FLT_11_MINCO7_GRACMNT7_345kV	STABLE	STABLE	STABLE
12	FLT_12_G15081TAP_WWRDEHV7_345kV	STABLE	STABLE	STABLE
13	FLT_13_MATHWSN7_NORTWST7_345kV	STABLE	STABLE	STABLE
14	FLT_14_NORTWST7_ARCADIA7_345kV	STABLE	STABLE	STABLE
15	FLT_15_CIMARON7_DRAPER7_345kV	STABLE	STABLE	STABLE
16	FLT_16_SOONER7_G16061TAPSB_345kV**	STABLE	STABLE	STABLE
17	FLT_17_WOODRNG7_G16061TAPSB_345kV **	STABLE	STABLE	STABLE
18	FLT_18_WOODRNG7_WOODRNG4_345_138kV	STABLE	STABLE	STABLE
19	FLT_19_NORTWST7_NORTWST4_345_138kV	STABLE	STABLE	STABLE
20	FLT_20_CIMARON7_CIMARON4_345_138kV	STABLE	STABLE	STABLE
21	FLT_21_MATHWSN7_CIMARON7PO_345kV	STABLE	STABLE	STABLE
22	FLT_22_WOODRNG7_G16061TAPPO_345kV	STABLE	STABLE	STABLE
23	FLT_23_WOODRNG7_HUNTERS7PO_345kV	STABLE	STABLE	STABLE
24	FLT_24_MATHWSN7_CIMARON7PO_345kV	STABLE	STABLE	STABLE

**indicates a single phase contingency

FERC LVRT Compliance

FERC Order 661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu. The faults listed below in **Table *3-3*** were tested to meet Order 661A LVRT provisions. GEN-2015-063 was found to be in compliance with FERC Order 661A

Table 3-3 LVRT Contingencies

Contingency Name	Description
FLT_05_G15063T_MATHWSN_345kV	Fault on the GEN-2015-063-TAP (560055) to Mathewson (515497) 345kV line, near GEN-2015-063-TAP. a. Apply fault at the GEN-2015-063-TAP 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close 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_ G15063T_ WOODRNG7_ 345kV	Fault on the GEN-2015-063-TAP (560055) to Woodring (514715) 345kV line, near G15-063T. a. Apply fault at the GEN-2015-063-TAP 345kV bus b. Clear fault after 5 cycles by tripping the faulted line and islanded generation. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

4. Power Factor Analysis

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

Model Preparation

For each project included in this study, as well as previous queued projects modeled at the same POI, the projects were turned off for the power factor analysis. The projects were replaced by an equivalent generator located at the POI producing the total MW of the projects at that POI and 0.0 Mvar capability.

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

Disturbances

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

Results

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

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

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

Request	Capacity (MW)	Point of Interconnection (POI)	Fuel	Generator	Lagging (providing Mvars)	Leading (absorbing Mvars)
GEN-2015-063	299.25	Tap on Woodring (514715) to Matthewson (515497) 345 kV (560055)	Wind	Acciona 3.15 MW wind turbines	0.95	0.95

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

5. Reduced Generation Analysis

A low generation analysis was performed for GEN-2015-063 to determine the capacitive charging current injected at the POI from the generation facility.

The project inverters and capacitors (if any) were turned off in the study case. **Figure 5-1** shows the resulting reactive power injection (approximately 15.2 Mvar) at the POI that is due to the capacitance of the projects' 34.5 kV collector system transmission lines and of the transmission lead that connects the 345/34.5 kV transformer to the POI.

A shunt reactor was added at the GEN-2015-063 project substation 34.5 kV bus to bring the Mvar flow into the POI down to approximately zero as shown in **Figure 5-2**. A reactor of approximately 7.6 (15.2 total) Mvar installed on the low side of both 345/34.5 kV transformers will negate the capacitive effect of the project at the POI.

Figure 5-1*:* GEN-2015-063 with inverters turned off

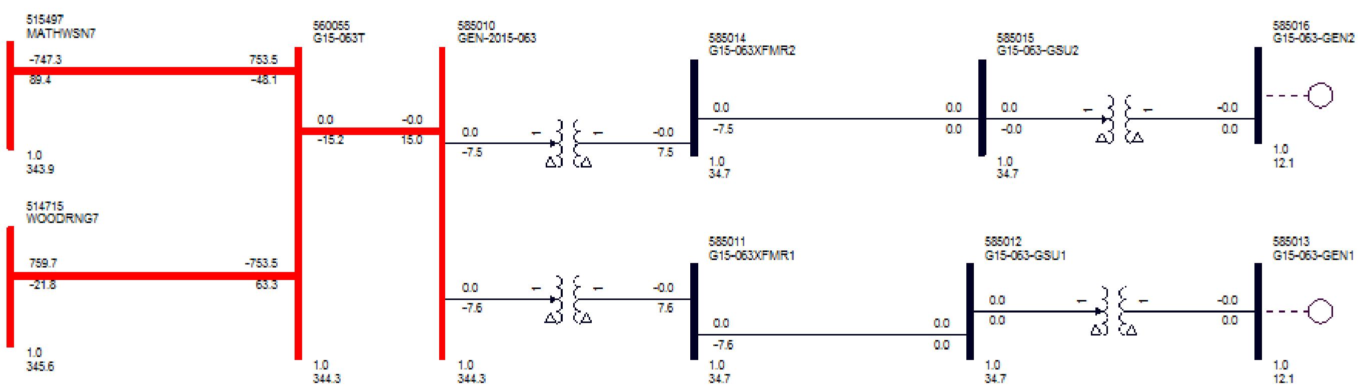
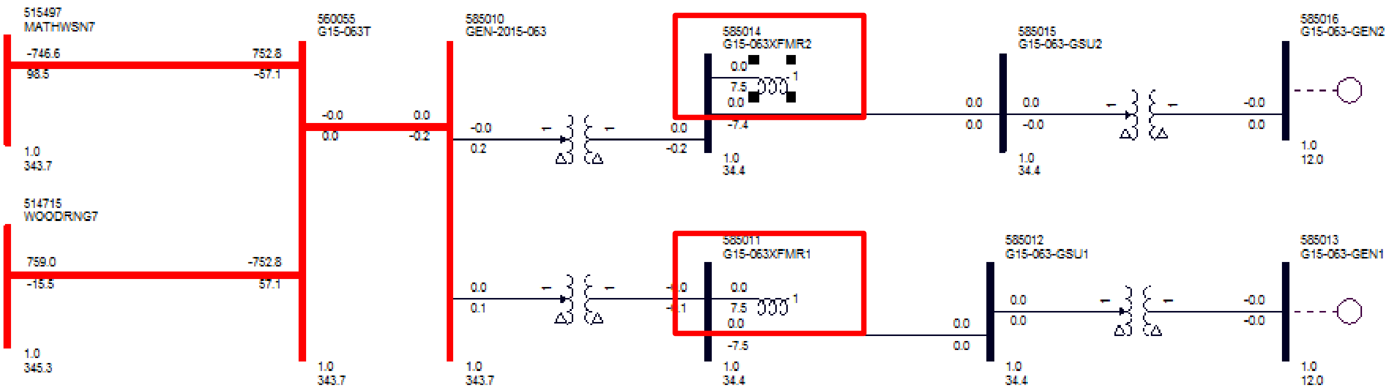


Figure 5-2: GEN-2015-063 with inverters turned off and 15.2Mvar reactor at 34.5kV buses



6. Short Circuit Analysis

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

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

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

Results

The results of the short circuit analysis are shown in **Appendix E**; 2017 summer peak results in **Table *E-1*** and 2025 summer peak results in **Table *E-2***.

7. Conclusion

The GEN-2015-063 Interconnection Customer has requested a modification to its Generator Interconnection Request to change turbines. The proposed revised project configuration consists of ninety-five (95) Acciona 3.15 MW wind turbine generators for a total nameplate capacity of 299.25 MW. The point of interconnection (POI) is a new substation that taps the line between the Oklahoma Gas & Electric (OKGE) Woodring and Mathewson 345kV substations.

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

A power factor analysis was performed for the modification request. As reactive power is required for GEN-2015-063, the final requirement in the GIA will be the pro-forma 95% lagging to 95% leading at the POI.

An analysis was conducted to determine the capacitive effects on the transmission system caused by the generator lead and collector system during periods of reduced generation. The generating facility is required to provide reactive compensation of approximately 15.2 Mvar of inductive reactance during periods of reduced generation. Such compensation can be provided either by discrete reactive devices or by the generator itself if it possesses that capability.

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

With the assumptions outlined in this report and with all the required network upgrades from the DISIS 2015-002 in place, GEN-2015-063 with the Acciona 3.15 MW wind turbines should be able to interconnect reliably to the SPP transmission grid. This proposed change in wind turbines is not a Material Modification.

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

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

Appendix A – 2016 Winter Peak Stability Plots

(Available on request)

Appendix B – 2017 Summer Peak Stability Plots

(Available on request)

Appendix C – 2025 Summer Peak Stability Plots

(Available on request)

Appendix D – Power Factor Analysis Results

Table D-1: GEN-2015-063 Power Factor Analysis Results

Leading power factor is absorbing vars; Lagging power factor is providing vars										
GEN-2015-063 POI: G15-063T 345 kV (560055) Power at POI (MW): 299.25		2016 Winter Peak POI Voltage = 1.000 pu			2017 Summer Peak POI Voltage = 1.002 pu			2025 Summer Peak POI Voltage = 1.002 pu		
	Contingency Name	Mvars at POI	Power Factor		Mvars at POI	Power Factor		Mvars at POI	Power Factor	
0	FLT_000_NOFAULT	24.65058	0.996624	LAG	-21.3034	0.997476	LEAD	-21.5676	0.997413	LEAD
1	FLT_01_SOONER7_G16061TAP_345kV	-1.21222	0.999992	LEAD	-39.6338	0.991343	LEAD	-43.9444	0.989389	LEAD
2	FLT_02_G16061TAP_WOODRNG7_345kV	8.843079	0.999564	LAG	-29.53	0.995166	LEAD	-33.9099	0.993641	LEAD
3	FLT_03_WOODRNG7_G15063T_345kV	-6.19546	0.999786	LEAD	-38.1622	0.991966	LEAD	-44.8162	0.988971	LEAD
4	FLT_04_WOODRNG7_HUNTERS7_345kV	12.01102	0.999195	LAG	-30.0961	0.994981	LEAD	-26.7472	0.996029	LEAD
5	FLT_05_G15063T_MATHWSN7_345kV	-24.0919	0.996775	LEAD	-34.2286	0.993522	LEAD	-30.1345	0.994968	LEAD
6	FLT_06_G15063T_WOODRNG7_345kV	-6.19546	0.999786	LEAD	-38.1622	0.991966	LEAD	-44.8162	0.988971	LEAD
7	FLT_07_MATHWSN7_CIMARON7_345kV	28.29643	0.995559	LAG	-16.8721	0.998414	LEAD	-19.6661	0.997848	LEAD
8	FLT_08_G15052T_ROSEHIL7_345kV	100.2358	0.94822	LAG	54.82665	0.983627	LAG	60.47233	0.980187	LAG
9	FLT_09_VIOLA7_WICHITA7_345kV	135.4263	0.911049	LAG	84.8182	0.962101	LAG	9.950927	0.999448	LAG
11	FLT_10_SOONER7_SPRNGCK7_345kV	118.8594	0.929374	LAG	56.10362	0.982876	LAG	53.71619	0.984269	LAG
12	FLT_11_MINCO7_GRACMNT7_345kV	38.09072	0.991996	LAG	-13.3133	0.999012	LEAD	-14.8271	0.998775	LEAD
13	FLT_12_G15081TAP_WWRDEHV7_345kV	26.04634	0.996234	LAG	-27.6207	0.995767	LEAD	-22.5972	0.997161	LEAD
14	FLT_13_MATHWSN7_NORTWST7_345kV	-6.94569	0.999731	LEAD	-45.397	0.988688	LEAD	-46.2635	0.98826	LEAD
15	FLT_14_NORTWST7_ARCADIA7_345kV	42.7047	0.98997	LAG	-10.7437	0.999356	LEAD	-10.5081	0.999384	LEAD
16	FLT_15_CIMARON7_DRAPER7_345kV	17.54405	0.998286	LAG	-18.9716	0.997996	LEAD	-23.4079	0.996955	LEAD
17	FLT_16_SOONER7_G16061TAPSB_345kV	-1.21222	0.999992	LEAD	-39.6338	0.991343	LEAD	-43.9444	0.989389	LEAD
18	FLT_17_WOODRNG7_G16061TAPSB_345kV **	8.843079	0.999564	LAG	-29.53	0.995166	LEAD	-33.9099	0.993641	LEAD
19	FLT_17_G16061TAP_WOODRNG7SB_345kV**	38.2422	0.991933	LAG	-13.5052	0.998983	LEAD	-17.974	0.998201	LEAD
20	FLT_18_WOODRNG7_WOODRNG4_345_138kV	15.10444	0.998729	LAG	-27.6619	0.995755	LEAD	-27.2484	0.99588	LEAD
21	FLT_19_NORTWST7_NORTWST4_345_138kV	4.263728	0.999899	LAG	-36.3156	0.992717	LEAD	-35.3281	0.993103	LEAD
22	FLT_21_MATHWSN7_CIMARON7PO_345kV	28.29643	0.995559	LAG	-16.8721	0.998414	LEAD	-19.6661	0.997848	LEAD
23	FLT_22_WOODRNG7_G16061TAPPO_345kV	8.843079	0.999564	LAG	-29.53	0.995166	LEAD	-33.9099	0.993641	LEAD
24	FLT_23_WOODRNG7_HUNTERS7PO_345kV	12.01102	0.999195	LAG	-30.0961	0.994981	LEAD	-26.7472	0.996029	LEAD
25	FLT_24_MATHWSN7_CIMARON7PO_345kV	28.29643	0.995559	LAG	-16.8721	0.998414	LEAD	-19.6661	0.997848	LEAD

Appendix E – Short Circuit Analysis Results

Table E-1: GEN-2015-063 Short Circuit Analysis Results (2017SP)

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                           PSS®E-32.2.0 ASCC SHORT CIRCUIT CURRENTS          THU, MAY 25 2017  13:54
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+)
560055 [G15-063T    345.00] AMP    16758.2   -84.89
514715 [WOODRNG7    345.00] AMP    16949.4   -84.81
515497 [MATHWSN7    345.00] AMP    27519.6   -85.77
585010 [GEN-2015-063345.00] AMP    16486.1   -84.83
514714 [WOODRNG4    138.00] AMP    18631.1   -83.29
514880 [NORTWST7    345.00] AMP    29354.9   -86.04
514901 [CIMARON7    345.00] AMP    29712.3   -85.76
515407 [TATONGA7    345.00] AMP    10482.6   -86.78
515476 [HUNTERS7    345.00] AMP    12083.1   -84.69
560084 [G16-061-TAP 345.00] AMP    14720.8   -84.89
514708 [OTTER  4    138.00] AMP     9520.9   -82.41
514709 [FRMNTAP4    138.00] AMP    17455.7   -82.87
514711 [WAUKOTP4    138.00] AMP    14931.0   -81.71
514733 [MARSHL 4    138.00] AMP     7784.1   -80.53
514801 [MINCO  7    345.00] AMP    16166.3   -85.15
514803 [SOONER 7    345.00] AMP    24626.9   -86.49
514879 [NORTWST4    138.00] AMP    42442.3   -85.92
514881 [SPRNGCK7    345.00] AMP    21411.9   -85.53
514898 [CIMARON4    138.00] AMP    42021.6   -84.99
514908 [ARCADIA7    345.00] AMP    24884.0   -86.46
514934 [DRAPER 7    345.00] AMP    20389.5   -85.14
515448 [CRSRDSW7    345.00] AMP     8151.6   -85.99
515477 [CHSHLMV7    345.00] AMP    12067.1   -84.69
515543 [RENFROW7    345.00] AMP    11221.8   -84.65
515582 [SLNGWND7    345.00] AMP     7041.9   -85.75
515585 [MAMTHPW7    345.00] AMP     9281.9   -86.61
515610 [FSHRTAP7    345.00] AMP    15917.9   -85.09
562075 [G15-081-TAP 345.00] AMP    11376.1   -86.55
584700 [GEN-2015-029345.00] AMP     7355.3   -85.26
511425 [TUTCONT4    138.00] AMP    10456.4   -80.80
514710 [WAUKOMI4    138.00] AMP     9516.1   -80.46
514712 [FAIRMON4    138.00] AMP    13634.3   -82.23
514713 [WRVALLY4    138.00] AMP     8658.7   -82.14
514731 [SO4TH  4    138.00] AMP    14807.1   -81.22
514802 [SOONER 4    138.00] AMP    31412.8   -86.77
514819 [EL-RENO4    138.00] AMP    15218.5   -80.01
514820 [JENSENT4    138.00] AMP    14995.6   -79.44
514828 [KETCHTP4    138.00] AMP    26013.7   -84.55
514854 [BRADEN 4    138.00] AMP    30755.1   -85.14
514863 [HAYMAKR4    138.00] AMP    26007.1   -82.45
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514873 [LNEOAK 4    138.00] AMP    26423.8   -84.56
514894 [CZECHAL4    138.00] AMP    28013.6   -82.98
514895 [SARA   4    138.00] AMP    18582.2   -84.09
514907 [ARCADIA4    138.00] AMP    40842.7   -85.63
514909 [REDBUD 7    345.00] AMP    23853.8   -86.78
514933 [DRAPER 4    138.00] AMP    38576.3   -85.17
515045 [SEMINOL7    345.00] AMP    25941.6   -86.18
515375 [WWRDEHV7    345.00] AMP    16733.1   -86.05
515444 [MCNOWND7    345.00] AMP    16121.3   -85.14
515471 [NW164TH4    138.00] AMP    34845.1   -85.66
515544 [RENFROW4    138.00] AMP    13396.0   -84.84
515549 [MNCWND37    345.00] AMP    11273.6   -84.89
515576 [RANCHRD7    345.00] AMP    13873.8   -86.68
515600 [KNGFSHR7    345.00] AMP    11007.2   -84.89
515605 [CANADN7     345.00] AMP    11348.6   -84.82
515800 [GRACMNT7    345.00] AMP    14766.5   -85.23
521006 [MARSHAL4    138.00] AMP     7747.8   -80.47
532798 [VIOLA   7   345.00] AMP    11410.8   -85.09
560056 [G15-066T    345.00] AMP    17997.7   -86.55
560077 [G16-032-TAP 345.00] AMP     3367.1   -79.62
579272 [G0744&1403HV345.00] AMP     7041.9   -85.75
583750 [GEN-2013-029345.00] AMP    10000.4   -84.60
584170 [GEN-2014-064138.00] AMP     9448.8   -82.38
584690 [GEN-2015-030345.00] AMP    18751.5   -85.92
584880 [GEN-2015-047345.00] AMP    11012.3   -83.66
585180 [GEN-2015-081345.00] AMP    10013.5   -86.19
509782 [R.S.S.-7    345.00] AMP    30823.8   -86.91
510907 [PITTSB-7    345.00] AMP    13067.7   -84.54
511424 [T-CONCO4    138.00] AMP     6824.2   -74.78
511468 [L.E.S.-7    345.00] AMP    12027.4   -84.69
511501 [TUTTLE4     138.00] AMP    10332.5   -80.76
512694 [CLEVLND7    345.00] AMP    14858.6   -86.35
514704 [MILLERT4    138.00] AMP    20178.7   -85.57
514706 [COWCRK 4    138.00] AMP    11245.7   -82.98
514707 [PERRY  4    138.00] AMP    10947.5   -83.28
514730 [SO4TH  2    69.000] AMP    13548.6   -82.36
514774 [HENESEY4    138.00] AMP     7312.3   -79.09
514790 [IMO    4    138.00] AMP    11621.4   -80.85
514798 [SNRPMPT4    138.00] AMP    20202.3   -85.53
514815 [BRECKNR4    138.00] AMP    13481.1   -80.99
514818 [ELRENO 2    69.000] AMP     7202.2   -78.40
514821 [JENSEN 4    138.00] AMP    10527.7   -79.40
514823 [ROMNOSE4    138.00] AMP     4121.1   -74.29
514827 [CTNWOOD4    138.00] AMP    16556.1   -80.43
514834 [KETCH  4    138.00] AMP    26479.3   -84.56
514851 [QUAILCK4    138.00] AMP    28916.7   -83.27
514852 [SLVRLAK4    138.00] AMP    32141.3   -83.89
514853 [DVISION4    138.00] AMP    35475.9   -83.30
514864 [PIEDMNT4    138.00] AMP    22045.6   -84.44
514893 [XEROX  4    138.00] AMP    29368.7   -82.99
514906 [JNSKAMO4    138.00] AMP    20536.4   -81.91
514946 [MIDWEST4    138.00] AMP    29740.6   -83.52
514949 [SOONRTP4    138.00] AMP    20104.9   -82.40
514961 [GM     4    138.00] AMP    19119.4   -84.12
515003 [BARNES 4    138.00] AMP    15819.7   -83.17
515044 [SEMINOL4    138.00] AMP    39196.8   -85.70
515224 [MUSKOGE7    345.00] AMP    28789.9   -86.76
515376 [WWRDEHV4    138.00] AMP    22229.8   -86.07
515447 [MORISNT4    138.00] AMP    13669.7   -82.93
515458 [BORDER     7345.00] AMP     4957.4   -86.22
515461 [RNDBARN4    138.00] AMP    38851.6   -85.56
515465 [LGARBER4    138.00] AMP    21023.9   -82.40
515466 [MITCHSB4    138.00] AMP    21067.2   -83.35
515481 [STHLAKE4    138.00] AMP    20609.0   -84.63
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515546 [GRANTCO4    138.00] AMP     6232.4   -81.17
515569 [MDFRDTP4    138.00] AMP    10856.1   -83.45
515599 [G07621119-20345.00] AMP    11915.1   -85.61
515621 [OPENSKY7    345.00] AMP    12829.7   -86.64
515641 [PLNSMEN4    138.00] AMP    13493.1   -82.03
515802 [GRACMNT4    138.00] AMP    25655.3   -84.71
520409 [RENFROW4    138.00] AMP     9943.6   -83.13
521100 [WARREN 4    138.00] AMP     8658.7   -82.14
529200 [OMCDLEC7    345.00] AMP    13848.0   -86.67
532792 [FR2EAST7    345.00] AMP     6214.4   -85.59
532796 [WICHITA7    345.00] AMP    23729.1   -86.11
539801 [THISTLE7    345.00] AMP    15230.0   -85.87
560071 [G16-003-TAP 345.00] AMP    13437.1   -86.21
560078 [G16-037-TAP 345.00] AMP     6658.5   -84.68
584060 [GEN-2014-056345.00] AMP     8330.2   -84.94
584450 [G1501-G1631 345.00] AMP    11137.5   -85.62
584770 [GEN-2015-034345.00] AMP    11813.2   -86.26
585040 [GEN-2015-066345.00] AMP    17832.5   -86.52
585050 [GEN-2015-067138.00] AMP    21836.6   -86.20
585270 [GEN-2015-093345.00] AMP     9040.0   -84.98
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Table E-2: GEN-2015-063 Short Circuit Analysis Results (2025SP)

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                                PSS®E-32.2.0 ASCC SHORT CIRCUIT CURRENTS          FRI, APR 21 2017  12:06
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+)
560055 [G15-063T    345.00] AMP    17187.6   -84.94
514715 [WOODRNG7    345.00] AMP    17263.9   -84.84
515497 [MATHWSN7    345.00] AMP    29649.5   -86.08
585010 [GEN-2015-063345.00] AMP    16900.9   -84.88
514714 [WOODRNG4    138.00] AMP    18740.5   -83.29
514880 [NORTWST7    345.00] AMP    30512.5   -86.09
514901 [CIMARON7    345.00] AMP    31107.0   -85.95
515407 [TATONGA7    345.00] AMP    15927.3   -86.55
515476 [HUNTERS7    345.00] AMP    12401.6   -84.74
560084 [G16-061-TAP 345.00] AMP    14848.7   -84.90
514708 [OTTER  4    138.00] AMP     9545.6   -82.40
514709 [FRMNTAP4    138.00] AMP    17552.6   -82.87
514711 [WAUKOTP4    138.00] AMP    15007.6   -81.72
514733 [MARSHL 4    138.00] AMP     7799.0   -80.53
514801 [MINCO  7    345.00] AMP    16528.1   -85.20
514803 [SOONER 7    345.00] AMP    24736.6   -86.50
514879 [NORTWST4    138.00] AMP    42918.6   -85.97
514881 [SPRNGCK7    345.00] AMP    21898.2   -85.53
514898 [CIMARON4    138.00] AMP    42418.1   -85.06
514908 [ARCADIA7    345.00] AMP    26061.8   -86.55
514934 [DRAPER 7    345.00] AMP    20528.4   -85.12
515448 [CRSRDSW7    345.00] AMP    11102.1   -85.54
515477 [CHSHLMV7    345.00] AMP    12384.7   -84.74
515582 [SLNGWND7    345.00] AMP     8983.0   -85.26
515585 [MAMTHPW7    345.00] AMP    13252.8   -86.34
515610 [FSHRTAP7    345.00] AMP    16265.2   -85.15
560086 [G16-072-TAP 345.00] AMP    11617.8   -84.72
562075 [G15-081-TAP 345.00] AMP    16228.5   -86.40
584700 [GEN-2015-029345.00] AMP     9602.6   -84.60
511425 [TUTCONT4    138.00] AMP    10672.1   -80.90
514710 [WAUKOMI4    138.00] AMP     9561.4   -80.48
514712 [FAIRMON4    138.00] AMP    13696.6   -82.22
514713 [WRVALLY4    138.00] AMP     8688.7   -82.12
514731 [SO4TH  4    138.00] AMP    14878.3   -81.21
514802 [SOONER 4    138.00] AMP    31801.4   -86.81
514819 [EL-RENO4    138.00] AMP    15286.4   -80.04
514820 [JENSENT4    138.00] AMP    15063.0   -79.45
514828 [KETCHTP4    138.00] AMP    26059.7   -84.56
514854 [BRADEN 4    138.00] AMP    30925.7   -85.16
514863 [HAYMAKR4    138.00] AMP    26068.5   -82.47
514873 [LNEOAK 4    138.00] AMP    26551.6   -84.59
514894 [CZECHAL4    138.00] AMP    27695.8   -83.00
514895 [SARA   4    138.00] AMP    18617.7   -84.10
514907 [ARCADIA4    138.00] AMP    41260.3   -85.71
514909 [REDBUD 7    345.00] AMP    25382.5   -86.83
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514933 [DRAPER 4    138.00] AMP    38601.5   -85.15
515045 [SEMINOL7    345.00] AMP    26073.8   -86.15
515375 [WWRDEHV7    345.00] AMP    19023.4   -86.12
515444 [MCNOWND7    345.00] AMP    16481.0   -85.19
515471 [NW164TH4    138.00] AMP    35149.5   -85.70
515543 [RENFROW7    345.00] AMP    11781.6   -84.77
515549 [MNCWND37    345.00] AMP    11439.7   -84.91
515576 [RANCHRD7    345.00] AMP    13769.1   -86.67
515600 [KNGFSHR7    345.00] AMP    11157.9   -84.92
515800 [GRACMNT7    345.00] AMP    15204.9   -85.32
521006 [MARSHAL4    138.00] AMP     7762.6   -80.47
560056 [G15-066T    345.00] AMP    18044.6   -86.54
560077 [G16-032-TAP 345.00] AMP     3372.5   -79.62
562790 [G15-038T    345.00] AMP    13470.7   -84.97
579272 [G0744&1403HV345.00] AMP     8983.0   -85.26
584170 [GEN-2014-064138.00] AMP     9473.0   -82.37
584690 [GEN-2015-030345.00] AMP    18814.4   -85.92
584880 [GEN-2015-047345.00] AMP    11522.4   -83.75
585180 [GEN-2015-081345.00] AMP    13489.7   -85.91
509782 [R.S.S.-7    345.00] AMP    31488.9   -86.99
510907 [PITTSB-7    345.00] AMP    13084.4   -84.54
511424 [T-CONCO4    138.00] AMP     6915.7   -74.76
511468 [L.E.S.-7    345.00] AMP    12316.5   -84.70
511501 [TUTTLE4     138.00] AMP    10566.7   -80.87
512694 [CLEVLND7    345.00] AMP    14881.4   -86.33
514704 [MILLERT4    138.00] AMP    20414.1   -85.61
514706 [COWCRK 4    138.00] AMP    11309.5   -82.96
514707 [PERRY  4    138.00] AMP    11005.8   -83.26
514730 [SO4TH  2    69.000] AMP    13578.1   -82.36
514774 [HENESEY4    138.00] AMP     7367.3   -79.16
514790 [IMO    4    138.00] AMP    11661.7   -80.84
514798 [SNRPMPT4    138.00] AMP    20461.4   -85.59
514815 [BRECKNR4    138.00] AMP    13544.6   -80.97
514818 [ELRENO 2    69.000] AMP     7312.9   -78.44
514821 [JENSEN 4    138.00] AMP    10568.5   -79.39
514823 [ROMNOSE4    138.00] AMP     4123.3   -74.29
514827 [CTNWOOD4    138.00] AMP    16601.6   -80.44
514834 [KETCH  4    138.00] AMP    26518.5   -84.57
514851 [QUAILCK4    138.00] AMP    28975.2   -83.27
514852 [SLVRLAK4    138.00] AMP    32241.8   -83.91
514853 [DVISION4    138.00] AMP    35481.9   -83.33
514864 [PIEDMNT4    138.00] AMP    22136.2   -84.46
514893 [XEROX  4    138.00] AMP    28892.3   -83.00
514906 [JNSKAMO4    138.00] AMP    20324.3   -81.88
514946 [MIDWEST4    138.00] AMP    29776.4   -83.49
514949 [SOONRTP4    138.00] AMP    20110.1   -82.38
514961 [GM     4    138.00] AMP    19051.2   -84.10
515003 [BARNES 4    138.00] AMP    15717.5   -83.16
515044 [SEMINOL4    138.00] AMP    39220.4   -85.67
515224 [MUSKOGE7    345.00] AMP    28887.3   -86.76
515376 [WWRDEHV4    138.00] AMP    23252.1   -86.23
515447 [MORISNT4    138.00] AMP    13863.2   -82.89
515458 [BORDER     7345.00] AMP     5079.0   -86.22
515461 [RNDBARN4    138.00] AMP    39221.0   -85.63
515465 [LGARBER4    138.00] AMP    20996.8   -82.39
515466 [MITCHSB4    138.00] AMP    21100.5   -83.35
515481 [STHLAKE4    138.00] AMP    20608.6   -84.62
515544 [RENFROW4    138.00] AMP    13592.8   -84.90
515599 [G07621119-20345.00] AMP    12892.0   -85.58
515605 [CANADN7     345.00] AMP    11519.3   -84.86
515621 [OPENSKY7    345.00] AMP    12781.3   -86.64
515641 [PLNSMEN4    138.00] AMP    13554.6   -82.02
515802 [GRACMNT4    138.00] AMP    27928.0   -84.83
521100 [WARREN 4    138.00] AMP     8688.7   -82.12
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529200 [OMCDLEC7    345.00] AMP    13743.6   -86.67
532798 [VIOLA   7   345.00] AMP    13264.1   -85.50
539801 [THISTLE7    345.00] AMP    15582.8   -85.89
560071 [G16-003-TAP 345.00] AMP    14429.0   -86.25
560078 [G16-037-TAP 345.00] AMP     6725.9   -84.70
583750 [GEN-2013-029345.00] AMP    10436.2   -84.71
584060 [GEN-2014-056345.00] AMP     8416.7   -84.95
584450 [G1501-G1631 345.00] AMP    11072.0   -85.63
584770 [GEN-2015-034345.00] AMP    11060.0   -85.68
585040 [GEN-2015-066345.00] AMP    17878.4   -86.52
585050 [GEN-2015-067138.00] AMP    22023.7   -86.22
585270 [GEN-2015-093345.00] AMP     9195.9   -85.02
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