GEN-2015-096
Impact Restudy for Generator Modification (Turbine Change)

November 2016
Generator Interconnection

Southwest Power Pool

Revision History

Date	Author	Change Description
11/15/2016	SPP	GEN-2015-096 Impact Restudy for Generator Modification (Turbine Change) issued.

Executive Summary

The GEN-2015-096 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 GE 2.0MW wind turbine generators (75 machines total) to GE 2.1MW wind turbine generators (65 machines total) and GE 1.79MW wind turbine generators (7 machines total).

In this restudy the project uses sixty-five (65) GE 2.1MW and seven (7) GE 1.79MW wind turbine generators for an aggregate power of 149.03MW. The point of interconnection (POI) for GEN-2015-096 is tapping the Basin Electric Power Cooperative (BEPC) owned Belfield – Rhame 230kV transmission line on the planned Daglum 230kV substation. The Interconnection Customer has provided documentation that shows the GE 2.1MW and GE 1.79MW wind turbine generators have a reactive capability of 0.9 lagging (providing VARS) and 0.9 leading (absorbing VARS) power factor.

This study was performed to determine whether the request for modification is considered Material. To determine this, study models that included Interconnection Requests through DISIS-2015-002 were used that analyzed the timeframes of 2016 winter, 2017 summer, and 2025 summer models.

The restudy (which includes GEN 2015-091) showed that there were instability issues for FLT_05 and the prior outage FLT_19. Both faults will require the previously assigned Daglum – Dickson 230kV line. For limited operation amounts prior to Daglum – Dickson 230kV line being built, refer to the Limited Operation Impact Study posted on 09/14/16. 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 and a low-wind/no-wind condition analysis were performed for this modification request. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the POI. Additionally, the project will be required to install approximately 13 Mvar of reactor shunts on its substation 34.5kV bus(es). 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.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS 2015-002 in place, GEN-2015-096 with the GE 2.1MW and GE 1.79MW 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. 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 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.

Table of Contents

I. Introduction

GEN-2015-096 Impact Restudy is a generation interconnection study performed to study the impacts of interconnecting the project shown in Table I-1. This restudy evaluates the requested modification to change from seventy-five (75) GE 2.0MW wind turbine generators to sixty-five (65) GE 2.1MW and seven (7) GE 1.79MW wind turbine generators.

Table I-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-096	150	GE 2.1MW [sixty-five (65) generators] (20001) and GE 1.79MW [seven (7) generators] (20002)	Daglum 230kV

The prior-queued, equally-queued and lower queued requests shown in Table I-2 were included in this study and the wind farms were dispatched to 100% of rated capacity.

Table I-2: Prior and Later Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2005-008IS	50	WT3 generic wind (659294)	Edgeley 115kV (Pomona 115kV)
GEN-2006-015IS	50	WT3 generic wind (659273)	Marshall 115kV
GEN-2007-015IS	100	WT3 generic wind (659366)	Hilken 230kV
GEN-2007-027IS	99	WT3 generic wind (659010)	Bismarck-Garrison 230kV #1
GEN-2009-026IS	110	GENROU (659403)	Dickinson-Heskett 230kV
GEN-2010-007IS	172.5	GENROU (659407)	Antelope Valley 345kV
GEN-2012-006IS	125.01	GENROU (659162/659163/ 659192)	Williston-Charlie Creek 230kV
GEN-2014-004IS	384.2	GE 1.7MW (659125)	Charlie Creek 345kV
GEN-2014-006IS	125	GENSAL (659431, ‘A1’-‘A6’/659432, ‘B1’-‘B6’)	Williston 115kV
GEN-2014-010IS	150	Vestas V110 2.0MW (659141)	Neset 115kV
GEN-2014-014IS	149.6	GE 1.715MW (10001) and GE 1.79MW (10002)	Belfield-Rhame 230kV
GEN-2015-046	300	Vestas V110 2.0MW (584873)	Tande 345kV
GEN-2015-091	101.2	GE 2.3MW (585263)	Daglum 230kV
GEN-2015-098	98.9	GE 2.3MW (652616)	Mingusville 230kV

Table I-3: Prior and Later Queued MISO Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
G380	150	Suzlon S88 2.1MW (620115)	Rugby 115kV
G408	12	WT1 generic wind (600059)	Tap McHenry-Souris 115kV
G502	50.6	W4GUR (608603)	Milton Young 230kV
G645	50	GENROU (615015, '1')	Ladish 115kV
G723	10	GENSAL (661046)	Heskett 115kV
G752	150	WT3 generic wind (661989)	Tap Bison-Hettinger 230kV
G788	49	GENROU (615015, '1')	Ladish 115kV
G830	99	Vestas V100 1.8MW (10648)	GRE-McHenry 115kV
J003	20	WT3 generic wind (661317)	Baker 115kV
J249	180	WT3 generic wind (661999)	MDU Tatanka 230kV
J262	100	Vestas V100 2.0MW (11104)	Jamestown 345kV
J263	100	Vestas V100 2.0MW (11108)	Jamestown 345kV
J316	150	GE 1.7MW (11115)	MDU Ellendale-Tatanka 230kV line
J405	40	Wartsila Combustion Engine (11160)	Lewis and Clark 115kV

The study included a stability analysis of the interconnection request. Contingencies that resulted in a prior-queued project tripping off-line, if any, were re-run with the prior-queued project's voltage and frequency tripping relays disabled. Also a low-wind/no-wind analysis was performed on this project since it is a wind farm. The analyses were performed on three seasonal models, the modified versions of the 2016 winter peak, the 2017 summer peak, and the 2025 summer peak cases.

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

Power factor analysis results are in Appendix B

The low-wind/no-wind analysis determines the capacitive effect at the POI caused by the project's collector system and transmission line capacitance. A shunt reactor size was determined to offset the capacitive effect and to maintain zero Mvar flow at the POI when the plant generators and capacitors are off-line such as might be seen in low-wind or no-wind conditions.

II. Facilities

A one-line drawing for the GEN-2015-096 generation interconnection request is shown in Figure II-1. The POI is the BEPC Daglum 230kV substation.

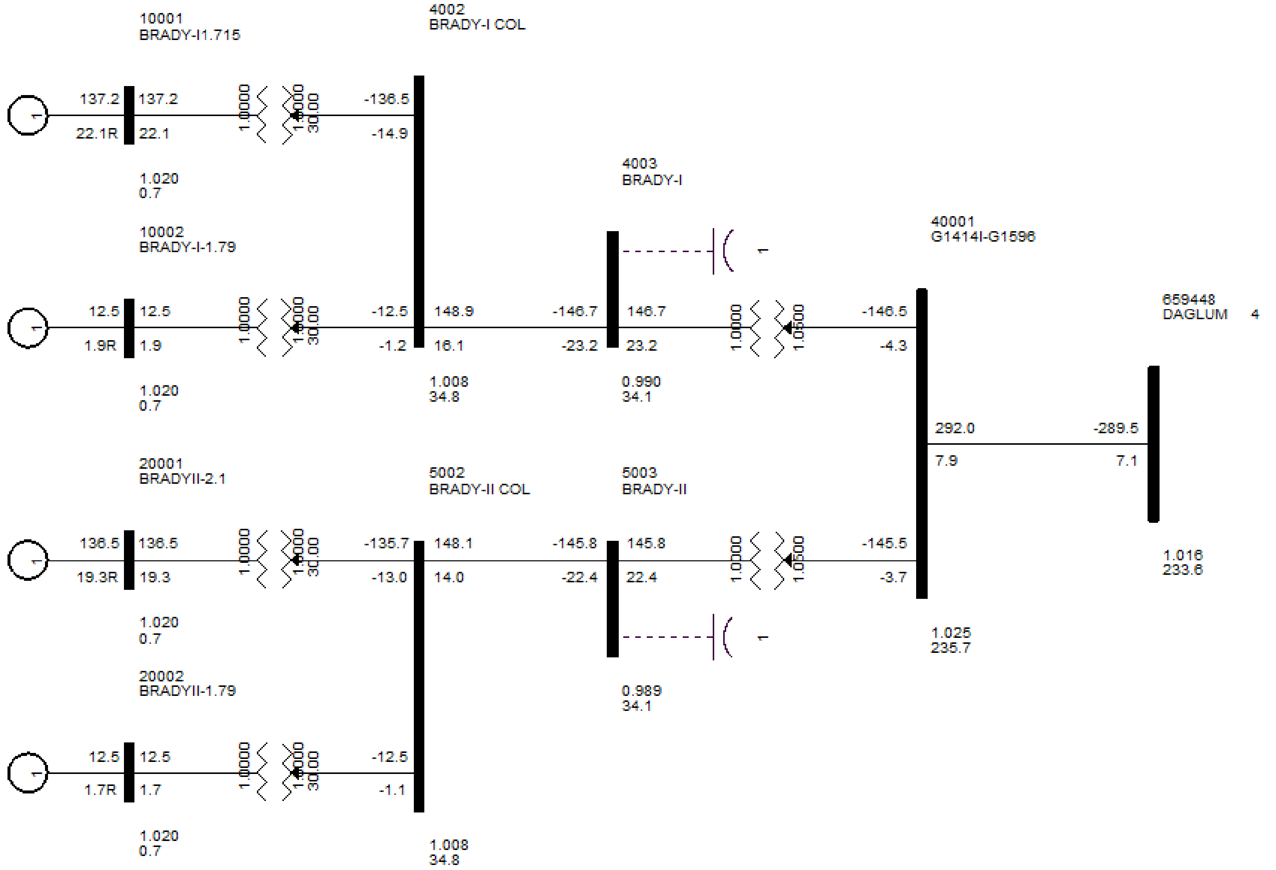

Figure II-1: GEN-2015-096. One-line Diagram

III. 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, the 2017 summer peak, and the 2025 summer peak seasonal models. The cases are then loaded with prior queued interconnection requests and network upgrades assigned to those interconnection requests. Finally 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-five (25) contingencies were identified for use in this study and are listed in Table III-1. These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. 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 a single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for six (6) cycles, clear the fault by tripping the faulted facility
3. run for an additional twenty (20) cycles

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 six (6) cycles
2. clear the fault by tripping the affected transformer facility (unless otherwise noted there will be no re-closing into a transformer fault)

Table III-1: Contingencies Evaluated

Contingency Number and Name		Description
1	FLT_01_KUMMERRIDGE3_ROUNDUP3_345kV_3PH	3 phase fault on the Kummer Ridge (659387) to Round Up (659384) 345kV line, near Kummer Ridge. a. Apply fault at the Kummer Ridge 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.

Table III-1: Contingencies Evaluated

Contingency Number and Name		Description
2	FLT_02_CHARCK3_ROUNDUP3_345kV_3PH	3 phase fault on the Charlie Creek (659183) to Round Up (659384) 345kV line, near Charlie Creek. a. Apply fault at the Charlie Creek 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
3	FLT_03_CHARCK3_ANTELOP3_345kV_3PH	3 phase fault on the Charlie Creek (659183) to Antelope (659101) 345kV line, near Charlie Creek. a. Apply fault at the Charlie Creek 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
4	FLT_04_CHARCK3_BELFELD3_345kV_3PH	3 phase fault on the Charlie Creek (659183) to Belfield (652424) 345kV line, near Charlie Creek. a. Apply fault at the Charlie Creek 345kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
5	FLT_05_DAGLUM4_BELFELD4_230kV_3PH	3 phase fault on the Daglum (659448) to Belfield (652425) 230kV line, near Daglum. a. Apply fault at the Daglum 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
6	FLT_06_DAGLUM4_RHAME4_230kV_3PH	3 phase fault on the Daglum (659448) to Rhame (659266) 230kV line, near Daglum. a. Apply fault at the Daglum 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
7	FLT_07_BELFELD4_DICKNSN4_230kV_3PH	3 phase fault on the Belfield (652425) to Dickinson (652417) 230kV line, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
8	FLT_08_BELFELD4_MEDORA4_230kV_3PH	3 phase fault on the Belfield (652425) to Medora (652413) 230kV line, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
9	FLT_09_RHAME4_BOWMAN4_230kV_3PH	3 phase fault on the Rhame (659266) to Bowman (661010) 230kV line, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
10	FLT_10_RHAME4_LTLMISS4_230kV_3PH	3 phase fault on the Rhame (659266) to Little Missouri (659265) 230kV line, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
11	FLT_11_BAKER4_MICTYE4_230kV_3PH	3 phase fault on the Baker (661004) to Miles City (652411) 230kV line, near Baker. a. Apply fault at the Baker 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
12	FLT_12_BOWMAN4_HETINGR4_230kV_3PH	3 phase fault on the Bowman (661010) to Hettinger (661047) 230kV line, near Bowman. a. Apply fault at the Bowman 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
13	FLT_13_HEBRON4_MANDAN4_230kV_3PH	3 phase fault on the Hebron (652468) to Mandan (661053) 230kV line, near Hebron. a. Apply fault at the Hebron 230kV bus. b. Clear fault after 6 cycles by tripping the faulted line.
14	FLT_14_CHARCK3SB_ROUNDUP3SB_345kV_1PH	**Single phase fault with stuck breaker** on the Charlie Creek (659183) to Round Up (659384) 345kV line, near Patentgate. a. Apply fault at the Charlie Creek 345kV bus. b. Clear fault after 16 cycles by tripping the faulted line.
15	FLT_15_BELFELD4SB_MEDORA4SB_230kV_1PH	**Single phase fault with stuck breaker** on the Belfield (652425) to Medora (652413) 230kV line, near Belfield. a. Apply fault at the Belfield 230kV bus. b. Clear fault after 16 cycles by tripping the faulted line.
16	FLT_16_RHAME4SB_LTLMISS4SB_230kV_1PH	**Single phase fault with stuck breaker** on the Rhame (659266) to Little Missouri (659265) 230kV line, near Rhame. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 16 cycles by tripping the faulted line.
17	FLT_17_SQBUTTE4SB_GRESTANTON4SB_230kV_1PH	**Single phase fault with stuck breaker** on the Square Butte (657756) to Stanton (615901) 230kV line, near Square Butte. a. Apply fault at the Square Butte 230kV bus. b. Clear fault after 16 cycles by tripping the faulted line.

Table III-1: Contingencies Evaluated

Contingency Number and Name		Description
18	FLT_18_BELFELD4PO_MEDORA4PO_230kV_3PH	**Prior outage** on the Belfield (652425) to Dickinson (652417) 230kV line: 3 phase fault on the Belfield (652425) to Medora (652413) 230kV line, near Belfield 230kV. a. Prior Outage Belfield to Dickinson 230kV. b. Apply fault at the Belfield 230kV bus. c. Clear fault after 6 cycles by tripping the faulted line.
19	FLT_19_RHAME4PO_BOWMAN4PO_230kV_3PH	**Prior outage** on the Belfield (652425) to Daglum (659448) 230kV line: 3 phase fault on the Rhame (659266) to Bowman (661010) 230kV line, near Rhame 230kV. a. Prior Outage Belfield to Daglum 230kV. b. Apply fault at the Rhame 230kV bus. c. Clear fault after 6 cycles by tripping the faulted line.
20	FLT_20_BELFELD4PO_MEDORA4PO_230kV_3PH	**Prior outage** on the Rhame (659266) to Daglum (659448) 230kV line: 3 phase fault on the Belfield (652425) to Medora (652413) 230kV line, near Belfield 230kV. a. Prior Outage Rhame to Daglum 230kV. b. Apply fault at the Belfield 230kV bus. c. Clear fault after 6 cycles by tripping the faulted line.
21	FLT_21_CHARCK3_CHARCK4_345_230kV_3PH	3 phase fault on the Charlie Creek 345kV (659183) / 230kV (659302) / 13.8kV (659319) transformer, near Charlie Creek 345kV ckt 2. a. Apply fault at Charlie Creek 345kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
22	FLT_22_BELFELD3_BELFELD4_345_230kV_3PH	3 phase fault on the Belfield 345kV (652424) / 230kV (652425) / 13.8kV (652221) transformer, near Belfield 345kV ckt 1. a. Apply fault at the Belfield 345kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
23	FLT_23_RHAME4_RHAME7_230_115kV_3PH	3 phase fault on the Rhame 230kV (659266) / 115kV (659267) transformer, near Rhame 230kV ckt 1. a. Apply fault at the Rhame 230kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
24	FLT_24_BAKER4_BAKER7_230_115kV_3PH	3 phase fault on the Baker 230kV (661004) / 115kV (661005) / 13.8kV (661901) transformer, near Baker 230kV ckt 1. a. Apply fault at the Baker 230kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.
25	FLT_25_BOWMAN4_BOWMAN7_230_115kV_3PH	3 phase fault on the Bowman 230kV (661010) / 115kV (659340) transformer, near Bowman 230kV ckt 1. a. Apply fault at the Bowman 230kV bus. b. Clear fault after 6 cycles by tripping the faulted transformer.

Results

The stability analysis was performed and the results are summarized in Table III-2. Based on the stability results and with all network upgrades in service, the Daglum – Dickson 230kV line will be required for the system to remain stable for the two unstable faults. For limited operation amounts prior to Daglum – Dickson 230kV line being built, refer to the Limited Operation Impact Study posted on 09/14/16.

Complete sets of plots for the stability analysis are available on request.

Table III-2: Stability Analysis Results

Contingency Number and Name		2016WP	2017SP	2025SP
1	FLT_01_KUMMERRIDGE3_ROUNDUP3_345kV_3PH	Stable	Stable	Stable
2	FLT_02_CHARCK3_ROUNDUP3_345kV_3PH	Stable	Stable	Stable
3	FLT_03_CHARCK3_ANTELOP3_345kV_3PH	Stable	Stable	Stable
4	FLT_04_CHARCK3_BELFELD3_345kV_3PH	Stable	Stable	Stable
5	FLT_05_DAGLUM4_BELFELD4_230kV_3PH	Stable	Unstable	Stable
6	FLT_06_DAGLUM4_RHAME4_230kV_3PH	Stable	Stable	Stable
7	FLT_07_BELFELD4_DICKNSN4_230kV_3PH	Stable	Stable	Stable
8	FLT_08_BELFELD4_MEDORA4_230kV_3PH	Stable	Stable	Stable
9	FLT_09_RHAME4_BOWMAN4_230kV_3PH	Stable	Stable	Stable
10	FLT_10_RHAME4_LTLMISS4_230kV_3PH	Stable	Stable	Stable
11	FLT_11_BAKER4_MICTYE4_230kV_3PH	Stable	Stable	Stable
12	FLT_12_BOWMAN4_HETINGR4_230kV_3PH	Stable	Stable	Stable
13	FLT_13_HEBRON4_MANDAN4_230kV_3PH	Stable	Stable	Stable
14	FLT_14_CHARCK3_ROUNDUP3SB_345kV_1PH	Stable	Stable	Stable
15	FLT_15_BELFELD4_MEDORA4SB_230kV_1PH	Stable	Stable	Stable
16	FLT_16_RHAME4_LTLMISS4SB_230kV_1PH	Stable	Stable	Stable
17	FLT_17_SQBUTTE4_GRESTANTON4SB_230kV_1PH	Stable	Stable	Stable
18	FLT_18_BELFELD4_MEDORA4PO_230kV_3PH	Stable	Stable	Stable
19	FLT_19_RHAME4_BOWMAN4PO_230kV_3PH	Unstable	Unstable	Unstable
20	FLT_20_BELFELD4_MEDORA4PO_230kV_3PH	Stable	Stable	Stable
21	FLT_21_CHARCK3_CHARCK4_345_230kV_3PH	Stable	Stable	Stable
22	FLT_22_BELFELD3_BELFELD4_345_230kV_3PH	Stable	Stable	Stable
23	FLT_23_RHAME4_RHAME7_230_115kV_3PH	Stable	Stable	Stable
24	FLT_24_BAKER4_BAKER7_230_115kV_3PH	Stable	Stable	Stable
25	FLT_25_BOWMAN4_BOWMAN7_230_115kV_3PH	Stable	Stable	Stable

NOTE: “- NA -“means the contingency is not applicable

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.

Contingencies 5 and 6 in Table III-2 simulated the LVRT contingencies. GEN-2015-096 met the LVRT requirements by staying on line and the transmission system remaining stable.

IV. Power Factor Analysis

A subset of the stability faults was used as power flow contingencies to determine the power factor requirements for the wind farm to maintain scheduled voltage at the POI. The voltage schedule was set equal to the voltages at the POI before the project is added, with a minimum of 1.0 per unit. A fictitious reactive power source replaced the study project to maintain scheduled voltage during all studied contingencies. The MW and Mvar injections from the study project at the POI were recorded and the resulting power factors were calculated for all contingencies for summer peak and winter peak cases. The most leading and most lagging power factors determine the minimum power factor range capability that the study project must install before commercial operation.

Per FERC and SPP Tariff requirements, if the power factor needed to maintain scheduled voltage is less than 0.95 lagging, then the requirement is limited to 0.95 lagging. The lower limit for leading power factor requirement is also 0.95. If a project never operated leading under any contingency, then the leading requirement is set to 1.0. The same applies on the lagging side.

The power factor analysis showed a need for reactive capability by the study project at the POI. The final power factor requirement in the Generator Interconnection Agreement (GIA) will be the pro-forma 0.95 lagging to 0.95 leading at the POI, and this requirement is shown in Table IV-1. The detailed power factor analysis tables are in Appendix B. Since the GE 2.1MW and 1.79MW wind turbines, as studied, have a reactive capability of 0.9 lagging and 0.9 leading, the generation facility may require external capacitor banks or other reactive equipment to meet the power factor requirement at the POI. The results are shown in **Appendix B: Power Factor Analysis**.

Table IV-1: Power Factor Requirements [a]

Request	Size (MW)	Generator Model	Point of Interconnection	Final PF Requirement at POI	
				Lagging [b]	Leading [c]
GEN-2015-096	150	GE 2.1MW [sixty-five (65) generators] (20001) and GE 1.79MW [seven (7) generators] (20002)	Daglum 230kV	0.95[d]	0.95[e]

Notes:

a. The table shows the minimum required power factor capability at the point of interconnection that must be designed and installed with the plant. The power factor capability at the POI includes the net effect of the generators, transformers, line impedances, and any reactive compensation devices installed on the plant side of the meter. Installing more capability than the minimum requirement is acceptable.

b. Lagging is when the generating plant is supplying reactive power to the transmission grid, like a shunt capacitor. In this situation, the alternating current sinusoid “lags” behind the alternating voltage sinusoid, meaning that the current peaks shortly after the voltage.

c. Leading is when the generating plant is taking reactive power from the transmission grid, like a shunt reactor. In this situation, the alternating current sinusoid “leads” the alternating voltage sinusoid, meaning that the current peaks shortly before the voltage.

d. Electrical need is lower, but PF requirement limited to 0.95 by FERC order.

e. The most leading power factor determined through analysis was 1.00.

V. Low Wind Analysis

Interconnection requests for wind generation projects that interconnect on the SPP system are analyzed for the capacitive charging effects during reduced generation conditions (unsuitable wind speeds, curtailment, etc.) at the generation site.

Model Preparation

The project generators and capacitors (if any), and all other wind projects that share the same POI, were turned off in the base case. The resulting reactive power injection into the transmission network comes from the capacitance of the project's transmission lines and collector cables. This reactive power injection is measured at the POI. Shunt reactors were added at the study project substation low voltage bus to bring the Mvar flow into the POI down to approximately zero.

Results

A final shunt reactor requirement for each of the studied interconnection requests is shown in **Table V-1**. One line drawings used in the analysis are shown in **Appendix D: Low Wind Compensation Analysis**.

Table V-1: Summary of Shunt Reactor Requirements

Request	Capacity	POI	Approximate Shunt Reactor Required
GEN-2015-096	150MW	Daglum 230kV	13 Mvar

The results shown are for the 2025 summer case. The other two cases (2016 winter and 2017 summer) were almost identical since the generation plant design is the same in all cases.

VI. Short Circuit Analysis

Results

The short circuit analysis was performed on the 2025 Summer Peak power flow case 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. The following pages list the results of the analysis. The results are shown in **Appendix E: Short Circuit Analysis**.

VII. Conclusion

The SPP GEN-2015-096 Impact Restudy evaluated the impact of interconnecting the project shown below in Table VII-1.

Table VII-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-096	150	GE 2.1MW [sixty-five (65) generators] (20001) and GE 1.79MW [seven (7) generators] (20002)	Daglum 230kV

With all Base Case Network Upgrades in service, previously assigned Network Upgrades in service, the GEN-2015-096 project was found to remain on line, but the transmission system was found to become unstable for two conditions studied. The requested modification is not considered material for the GE 2.0MW to GE 2.1MW and GE 1.79MW change.

A low-wind/no-wind condition analysis was performed for this modification request. The project will be required to install a total of approximately 13 Mvar of reactor shunts on its substation 34.5kV buses. This is necessary to offset the capacitive effect on the transmission network cause by the project's transmission line and collector system during low-wind or no-wind conditions.

Low Voltage Ride Through (LVRT) analysis showed the study generators did not trip offline due to low voltage when all Network Upgrades are in service.

All generators in the monitored areas remained stable for all of the modeled disturbances with the Daglum – Dickson 230kV transmission line in service.

Any changes to the assumptions made in this study, for example, one or more of the previously queued requests withdraw, may require a re-study at the expense of the Customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.

APPENDIX A

PLOTS

Available on request

APPENDIX B

POWER FACTOR ANALYSIS

GEN 2015-096 Turbine Restudy POI – DAGLUM 4230.00 236.682067871 (659448)		2016 Winter Voltage = 1.02905 pu				2017 Summer Voltage = 1.02493 pu				2025 Summer Voltage = 1.01771 pu			
Cont. No.	Contingency Name	Power at POI	VARS at POI	Power Factor		Power at POI	VARS at POI	Power Factor		Power at POI	VARS at POI	Power Factor	
0	FLT_00_NoFault	149.03	-2.58535	0.99985	LEAD	149.03	-0.01727	1	LEAD	149.03	-4.57388	0.999529	LEAD
1	FLT_01_KUMMERRIDGE3_ROUNDUP3_345kV	149.03	-1.62502	0.999941	LEAD	149.03	2.41073	0.999869	LAG	149.03	-2.35086	0.999876	LEAD
2	FLT_02_CHARCK3_ROUNDUP3_345kV	149.03	0.12289	1	LAG	149.03	6.04403	0.999179	LAG	149.03	-3.73584	0.999686	LEAD
3	FLT_03_CHARCK3_ANTELOP3_345kV	149.03	-0.9744	0.999979	LEAD	149.03	4.81155	0.999479	LAG	149.03	-1.97193	0.999912	LEAD
4	FLT_04_CHARCK3_BELFELD3_345kV	149.03	4.04481	0.999632	LAG	149.03	9.86148	0.997818	LAG	149.03	0.688935	0.999989	LAG
5	FLT_05_DAGLUM4_BELFELD4_230kV	149.03	23.2517	0.988047	LAG	149.03	23.1385	0.988161	LAG	149.03	14.0605	0.995579	LAG
6	FLT_06_DAGLUM4_RHAME4_230kV	149.03	11.1416	0.997217	LAG	149.03	3.67077	0.999697	LAG	149.03	6.644745	0.999007	LAG
7	FLT_07_BELFELD4_DICKNSN4_230kV	149.03	-3.29703	0.999755	LEAD	149.03	2.12950	0.999898	LAG	149.03	-6.91855	0.998924	LEAD
8	FLT_08_BELFELD4_MEDORA4_230kV	149.03	-0.866	0.999983	LEAD	149.03	0.24288	0.999999	LAG	149.03	0.236982	0.999999	LAG
9	FLT_09_RHAME4_BOWMAN4_230kV	149.03	-7.63545	0.99869	LEAD	149.03	-10.3988	0.997574	LEAD	149.03	-11.627	0.99697	LEAD
10	FLT_10_RHAME4_LTLMISS4_230kV	149.03	7.10567	0.998865	LAG	149.03	9.62748	0.99792	LAG	149.03	0.48221	0.999995	LAG
11	FLT_11_BAKER4_MICTYE4_230kV	149.03	2.52554	0.999856	LAG	149.03	11.0386	0.997268	LAG	149.03	-0.75738	0.999987	LEAD
12	FLT_12_BOWMAN4_HETINGR4_230kV	149.03	-10.1944	0.997669	LEAD	149.03	-14.3152	0.995418	LEAD	149.03	-8.77938	0.998269	LEAD
13	FLT_13_HEBRON4_MANDAN4_230kV	149.03	3.59656	0.999709	LAG	149.03	7.73504	0.998656	LAG	149.03	0.275295	0.999998	LAG
14	FLT_14_CHARCK3_ROUNDUP3SB_345kV	149.03	0.12289	1	LAG	149.03	6.04403	0.999179	LAG	149.03	-3.73584	0.999686	LEAD
15	FLT_15_BELFELD4_MEDORA4SB_230kV	149.03	-0.866	0.999983	LEAD	149.03	0.24288	0.999999	LAG	149.03	0.236982	0.999999	LAG
16	FLT_16_RHAME4_LTLMISS4SB_230kV	149.03	7.10567	0.998865	LAG	149.03	9.62748	0.99792	LAG	149.03	0.48221	0.999995	LAG
17	FLT_17_SQBUTTE4_GRESTANTON4SB_230kV	149.03	-1.6283	0.99994	LEAD	149.03	0.30185	0.999998	LAG	149.03	-4.39994	0.999564	LEAD
18	FLT_18_BELFELD4_MEDORA4PO_230kV	149.03	-0.866	0.999983	LEAD	149.03	0.24288	0.999999	LAG	149.03	0.236982	0.999999	LAG
19	FLT_19_RHAME4_BOWMAN4PO_230kV	149.03	-7.63545	0.99869	LEAD	149.03	-10.3988	0.997574	LEAD	149.03	-11.627	0.99697	LEAD
20	FLT_20_BELFELD4_MEDORA4PO_230kV	149.03	-0.866	0.999983	LEAD	149.03	0.24288	0.999999	LAG	149.03	0.236982	0.999999	LAG
21	FLT_21_CHARCK3_CHARCK4_345_230kV	149.03	-2.35575	0.999875	LEAD	149.03	0.11958	1	LAG	149.03	-4.4365	0.999557	LEAD
22	FLT_22_BELFELD3_BELFELD4_345_230kV	149.03	-1.66602	0.999938	LEAD	149.03	1.50648	0.999949	LAG	149.03	-3.62907	0.999704	LEAD
23	FLT_23_RHAME4_RHAME7_230_115kV	149.03	-2.58535	0.99985	LEAD	149.03	-0.01727	1	LEAD	149.03	-4.57388	0.999529	LEAD
24	FLT_24_BAKER4_BAKER7_230_115kV	149.03	-9.82076	0.99784	LEAD	149.03	-7.58098	0.998709	LEAD	149.03	-13.7125	0.995794	LEAD

GEN 2015-096 Turbine Restudy POI – DAGLUM 4230.00 236.682067871 (659448)		2016 Winter Voltage = 1.02905 pu				2017 Summer Voltage = 1.02493 pu				2025 Summer Voltage = 1.01771 pu			
Cont. No.	Contingency Name	Power at POI	VARS at POI	Power Factor		Power at POI	VARS at POI	Power Factor		Power at POI	VARS at POI	Power Factor	
25	FLT_25_BOWMAN4_BOWMAN7_230_115kV	149.03	-2.58535	0.99985	LEAD	149.03	-0.01727	1	LEAD	149.03	-4.57388	0.999529	LEAD

APPENDIX C

PROJECT MODELS

GEN-2015-096 (GE 2.1MW & GE 1.79MW)

```
RDCH
1
 4002,'BRADY-I COL ',  34.5000,1, 300,   1,   1,1.00798,  68.5902
 4003,'BRADY-I     ',  34.5000,1, 300,   1,   1,0.99011,  67.1674
 5002,'BRADY-II COL',  34.5000,1, 300,   1,   1,0.97869,  59.8240
 5003,'BRADY-II    ',  34.5000,1, 300,   1,   1,0.97736,  59.8635
10001,'BRADY-I1.715',   0.6900,2,  70,   1,   1,1.02000,  41.5294
10002,'BRADY-I-1.79',   0.6900,2,  70,   1,   1,1.02000,  41.6607
20001,'BRADYII-2.1 ',   0.6900,2,  70,   1,   1,0.97869,  29.8240
20002,'BRADYII-1.79',   0.6900,2,  70,   1,   1,0.97869,  29.8240
40001,'G1414I-G1596', 230.0000,1, 300,   1,   1,1.02622,  59.8637
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA
 4003,'1 ',0,     0.000,    30.000
 5003,'1 ',0,     0.000,    30.000
0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA
 10001,'1 ',   137.200,    21.113,    66.480,   -64.480,1.02000,     0,   152.480, 0.00000E+0, 8.00000E-1, 0.00000E+0,
0.00000E+0,1.00000,1,  100.0,   137.200,     0.000,   1,0.5000,   1,0.5000
 10002,'1 ',    12.530,     1.822,     6.069,    -6.069,1.02000,     0,    13.923, 0.00000E+0, 8.00000E-1, 0.00000E+0, 0.00000E+0,1.00000,1,
100.0,    12.530,     0.000,   1,0.5000,   1,0.5000
 20001,'1 ',   136.500,    19.268,    66.105,   -66.105,1.02000,     0,   151.450, 0.00000E+0, 8.00000E-1, 0.00000E+0,
0.00000E+0,1.00000,1,  100.0,   136.500,     0.000,   1,0.5000,   1,0.5000
 20002,'1 ',    12.530,     1.744,     6.069,    -6.069,1.02000,     0,    13.923, 0.00000E+0, 8.00000E-1, 0.00000E+0, 0.00000E+0,1.00000,1,
100.0,    12.530,     0.000,   1,0.5000,   1,0.5000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
  4002,  4003,'1 ', 9.80000E-3, 1.80000E-2,   0.11160,   25.70,    0.00,    0.00,  0.00000,  0.00000,  0.00000,  0.00000,1,2,   0.00,
1,1.0000
  5002,  5003,'1 ', 1.06000E-2, 2.10000E-2,   0.13000,   28.00,    0.00,    0.00,  0.00000,  0.00000,  0.00000,  0.00000,1,2,   0.00,
1,1.0000
 40001,659448,'1 ', 3.08100E-3, 2.56140E-2,   0.05544, 1165.00, 1165.00, 1165.00,  0.00000,  0.00000,  0.00000,  0.00000,1,2,  15.60,
65,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
  4002, 10001,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 5.64000E-3, 5.62000E-2,   144.00
1.00000,   0.000,  30.000,   144.00,   144.00,   144.00, 0,      0, 1.00000, 1.00000, 1.00000, 1.00000,   2, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000
  4002, 10002,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 5.64000E-3, 5.62000E-2,    12.60
1.00000,   0.000,  30.000,    12.60,    12.60,    12.60, 0,      0, 1.00000, 1.00000, 1.00000, 1.00000,   2, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000
 40001,  4003,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 1.30000E-3, 8.57000E-2,   102.00
1.05000, 230.000,   0.000,   170.00,   170.00,   170.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,   5, 0, 0.00000, 0.00000,  0.000
1.00000,  34.500
  5002, 20001,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 7.67000E-3, 5.75000E-2,   166.40
1.00000,   0.000,  30.000,   166.40,   166.40,   166.40, 0,      0, 1.05000, 0.95000, 1.50000, 0.50000,   5, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000
  5002, 20002,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 5.64000E-3, 5.62000E-2,    12.60
1.00000,   0.000,  30.000,    12.60,    12.60,    12.60, 0,      0, 1.00000, 1.00000, 1.00000, 1.00000,   2, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000
 40001,  5003,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000
 1.30000E-3, 8.57000E-2,   102.00
1.05000, 230.000,   0.000,   170.00,   170.00,   170.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,   5, 0, 0.00000, 0.00000,  0.000
1.00000,  34.500
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
```

```
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA, BEGIN SWITCHED SHUNT DATA
0 / END OF SWITCHED SHUNT DATA, BEGIN GNE DATA
0 / END OF GNE DATA
Q

/
/ dynamics data for machine at bus 20001
20001  'USRMDL'  1  'GEWTG2'  1 1 4 18 3 5
           0          65          0          0
       2.1000E+00  0.8000      0.5000      0.9000      1.2200      1.2000
       2.0000      0.4000      0.8000      10.000      0.2000E-01  0.0000
       0.0000      0.5000      0.1670      0.9000      0.9250      0.0000    /
20001  'USRMDL'  1  'GEWTE2'  4 0 12 67 18 9
       20001          0          0          1          0          0
          0          0          0          1          0          0
       0.1500      2.000      1.0000      0.0000      0.0000      0.5000E-01  3.0000
       0.6000      1.1200      0.4000E-01  0.4360     -0.4360      1.1000      0.2000E-01
       0.4500     -0.4500      60.00      0.1000      0.9000
       1.1000      40.00      0.5000      1.450      0.5000E-01
       0.5000E-01   1.000      0.1500      0.9600      0.9960
       1.0040      1.040      1.000      1.0000      1.0000
       0.4000      1.000      0.2000      1.000      0.2500
       -1.000      14.00      25.00      3.000     -0.9000
       8.0000      0.2000      10.00      1.000      1.700
       1.2200      1.250      5.000      0.000      0.000
       0.0000      0.2500E-02   1.000      5.500      0.1000
      -1.0000      0.1000      0.000      0.1000     -0.1000
       0.7000      0.1200     -0.1200    /
20001  'USRMDL'  1  'GEWTT1'       5    0    1    5    4    3   0
       3.5200      0.0000      0.0000      1.8800      1.5000    /
0 'USRMDL'  0 'GEWGC1' 8    0    3    6    0    4
       20001   '1'    0
       9999.0      5.0000      30.000      9999.0      9999.0
       30.000    /
0 'USRMDL'  0 'GEWTA1'       8    0    3    9    1    4
       20001   '1'    0
       20.000      0.0000      27.000     -4.0000      0.0000      1.2250
       50.000      93.900      1200.0    /
0 'USRMDL'  0 'GEWTP1'       8    0    3    10    3    3
       20001   '1'    0
       0.3000      150.00      25.000      3.0000      30.000
      -4.0000      27.000     -10.000      10.000      1.0000    /
0   'USRMDL'  0 'GEWPLT' 8  0  2  0  0  17    20001   '1'    /
0   'USRMDL'   0   'FRQTPA'   0   2   6   4   0   1
       20001   20001   '1'   0   0   0   56.5   62.5   1   0.08/
0   'USRMDL'   0   'VTGTPA'   0   2   6   4   0   1
       20001   20001   '1'   0   0   0   0.10  5.000  0.500  0.08 /
0   'USRMDL'   0   'VTGTPA'   0   2   6   4   0   1
       20001   20001   '1'   0   0   0   0.20  5.000  0.625  0.08 /
0   'USRMDL'   0   'VTGTPA'   0   2   6   4   0   1
       20001   20001   '1'   0   0   0   0.40  5.000  1.000  0.08 /
0   'USRMDL'   0   'VTGTPA'   0   2   6   4   0   1
       20001   20001   '1'   0   0   0   0.60  5.000  1.700  0.08 /
```

```
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.75  5.000  2.200  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.85  5.000  10.00  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.90  5.000  600.0  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.00  1.101  1.000  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.00  1.150  0.500  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.00  1.175  0.200  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.00  1.200  0.100  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20001  20001  '1'  0  0  0  0.00  1.300  0.010  0.08 /
/
/ dynamics data for machine at bus 20002
20002  'USRMDL'  1  'GEWTG2'  1 1 4 18 3 5
         0        7        0        0
      1.7900E+00  0.8000     0.5000     0.9000     1.2200     1.2000
      2.0000     0.4000     0.8000     10.000     0.2000E-01  0.0000
      0.0000     0.5000     0.1670     0.9000     0.9250     0.0000    /
20002  'USRMDL'  1  'GEWTE2'  4 0 12 67 18 9
      20002        0        0        1        0        0
         0        0        0        1        0        0
      0.1500     2.000     1.0000     0.0000     0.0000     0.5000E-01  3.0000
      0.6000     1.1200     0.4000E-01  0.4360    -0.4360     1.1000     0.2000E-01
      0.4500    -0.4500     60.00     0.1000     0.9000
      1.1000     40.00     0.5000     1.450     0.5000E-01
      0.5000E-01   1.000     0.1500     0.9600     0.9960
      1.0040     1.040     1.000     1.0000     1.0000
      0.4000     1.000     0.2000     1.000     0.2500
      -1.000     14.00     25.00     3.000    -0.9000
      8.0000     0.2000     10.00     1.000     1.700
      1.2200     1.250     5.000     0.000     0.000
      0.0000     0.2500E-02   1.000     5.500     0.1000
     -1.0000     0.1000     0.000     0.1000    -0.1000
      0.7000     0.1200    -0.1200    /
20002  'USRMDL'  1  'GEWTT1'      5    0    1    5    4    3    0
      4.1341     0.0000     0.0000     1.8800     1.5000    /
0 'USRMDL'  0 'GEWGC1' 8    0    3    6    0    4
      20002   '1'    0
      9999.0     5.0000     30.000     9999.0     9999.0
      30.000    /
0 'USRMDL'  0 'GEWTA1'      8    0    3    9    1    4
      20002   '1'    0
      20.000     0.0000     27.000    -4.0000     0.0000     1.2250
      50.000     93.900     1200.0    /
0 'USRMDL'  0 'GEWTP1'      8    0    3    10    3    3
      20002   '1'    0
      0.3000     150.00     25.000     3.0000     30.000
     -4.0000     27.000    -10.000     10.000     1.0000    /
0  'USRMDL'  0 'GEWPLT' 8  0  2  0  0  17   20002   '1'    /
0  'USRMDL'  0  'FRQTPA'  0  2  6  4  0  1
      20002   20002   '1'  0  0  0  56.5   62.5   1   0.08/
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20002   20002   '1'  0  0  0  0.10  5.000  0.500  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
      20002   20002   '1'  0  0  0  0.20  5.000  0.625  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
```

```
    20002  20002  '1'  0  0  0  0.40  5.000  1.000  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.60  5.000  1.700  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.75  5.000  2.200  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.85  5.000  10.00  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.90  5.000  600.0  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.00  1.101  1.000  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.00  1.150  0.500  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.00  1.175  0.200  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.00  1.200  0.100  0.08 /
0  'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1
    20002  20002  '1'  0  0  0  0.00  1.300  0.010  0.08 /
/
/
```

APPENDIX D

LOW WIND COMPENSATION ANALYSIS

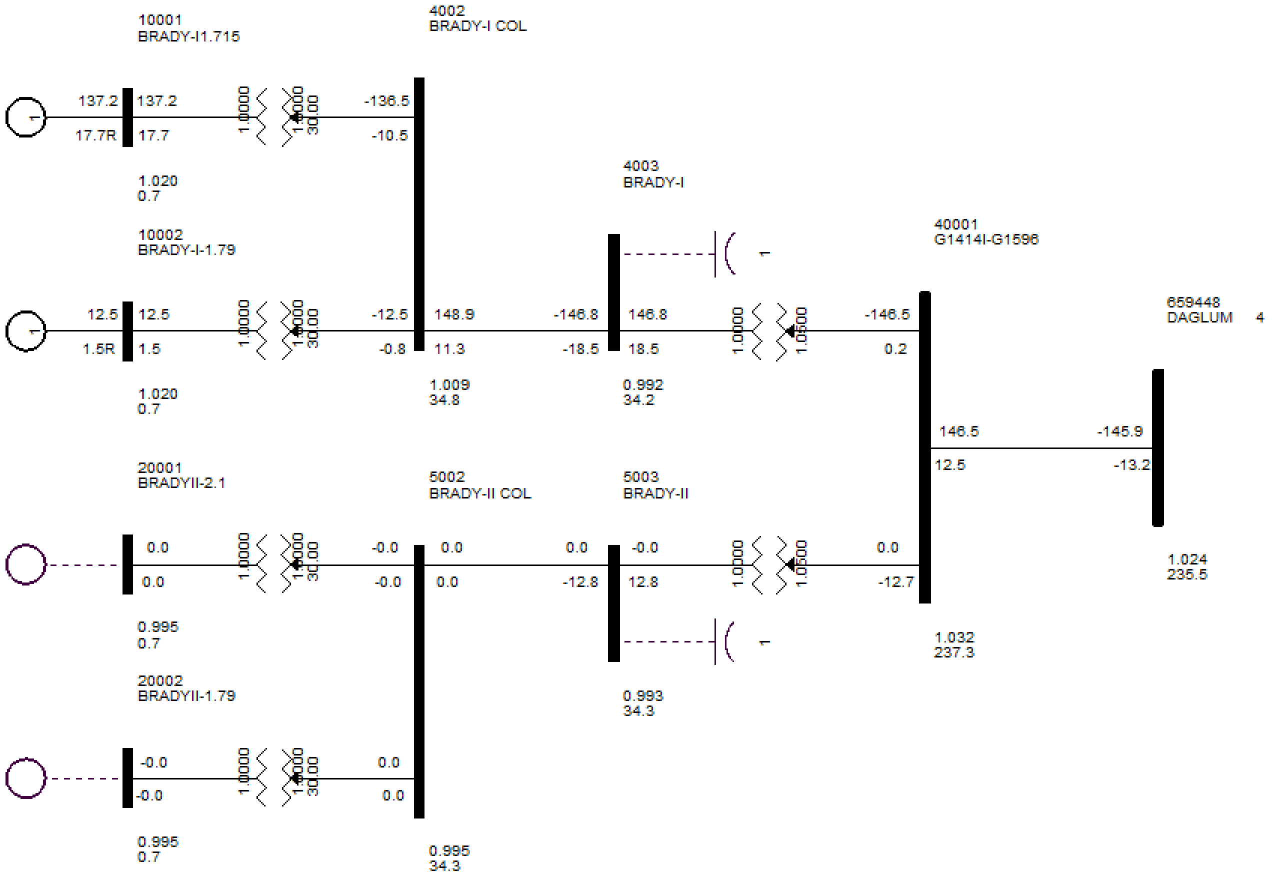

Figure E-1: GEN-2015-096 with generators off and no shunt reactors

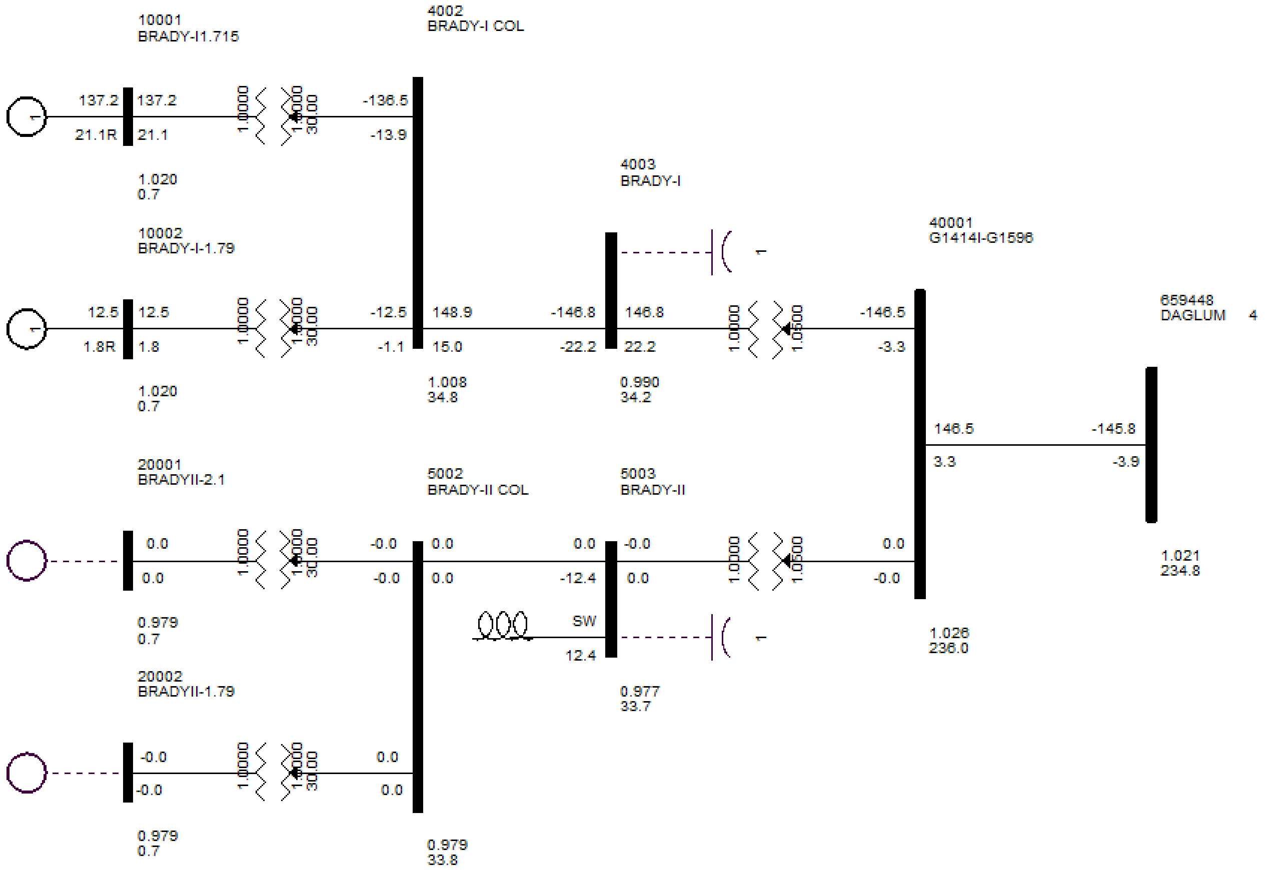

Figure E-2: GEN-2015-096 with generator turned off and shunt reactor added to the low side of the substation 230/34.5kV transformer

APPENDIX E

SHORT CIRCUIT ANALYSIS

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                        PSS®E-32.2.0 ASCC SHORT CIRCUIT CURRENTS         MON, NOV 14 2016   8:13
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

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

                            THREE PHASE FAULT
X---------- BUS ----------X         /I+/    AN(I+)
659448 [DAGLUM     4230.00] AMP     6446.3   -85.30
 40001 [G1414I-G1596230.00] AMP     4402.5   -85.06
585260 [GEN-2015-091230.00] AMP     6412.9   -85.30
652425 [BELFELD4    230.00] AMP     9171.6   -85.45
659266 [RHAME  4    230.00] AMP     4034.0   -84.03
  4003 [BRADY-I     34.500] AMP    14534.9   -87.52
  5003 [BRADY-II    34.500] AMP    14523.5   -87.49
585261 [G15-091-XFMR34.500] AMP    11052.7   -87.90
652220 [BELFELD29   13.800] AMP    24574.3   -87.37
652221 [BELFELD9    13.800] AMP    22691.8   -89.27
652413 [MEDORA 4    230.00] AMP     5061.8   -84.07
652417 [DICKNSN4    230.00] AMP     6643.5   -83.99
652424 [BELFELD3    345.00] AMP     6576.2   -85.61
659265 [LTLMISS4    230.00] AMP     3298.6   -83.61
659267 [RHAME  7    115.00] AMP     3086.9   -86.83
659309 [S HEART    4230.00] AMP     9171.6   -85.45
661010 [BOWMAN 4    230.00] AMP     3553.7   -83.78
  4002 [BRADY-I COL 34.500] AMP    13345.3   -85.47
  5002 [BRADY-II COL34.500] AMP    13166.9   -85.35
585262 [G15-091-GSU134.500] AMP    10721.1   -86.79
652418 [DKSN-ND7    115.00] AMP     5890.2   -83.18
652468 [HEBRON 4    230.00] AMP     5119.6   -83.75
652616 [BEAVERHILL4 230.00] AMP     3918.3   -83.66
659183 [CHAR.CK3    345.00] AMP    10636.6   -86.12
659197 [DICKNSON   913.800] AMP    15051.9   -85.76
659263 [LTLMISS7    115.00] AMP     1812.7   -87.20
659306 [S HEART    7115.00] AMP     2198.1   -88.19
659340 [BOWMAN 7    115.00] AMP     3301.4   -81.05
661004 [BAKER  4    230.00] AMP     3135.6   -83.47
661047 [HETINGR4    230.00] AMP     3440.2   -83.62
585340 [GEN-2015-098230.00] AMP     3836.5   -83.37
652403 [DAWSONC4    230.00] AMP     4237.9   -83.37
652411 [MI CTYE4    230.00] AMP     2776.0   -83.36
652470 [BISON  4    230.00] AMP     2757.0   -83.11
652617 [BEAVERHILL8 57.000] AMP     2150.7   -87.41
659101 [ANTELOP3    345.00] AMP    16412.6   -87.41
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659124 [G14_004IS_1 34.500] AMP    45475.6   -88.65
659182 [CHAR.CK7    115.00] AMP    14079.9   -85.80
659211 [CHARCREEK 1913.800] AMP    23843.0   -87.99
659302 [CHAR.CK4    230.00] AMP    11367.3   -85.97
659318 [CHARCREEK 2913.800] AMP    23053.6   -88.41
659319 [CHARCREEK 3913.800] AMP    30590.9   -88.77
659341 [NBURR   7   115.00] AMP     1722.0   -76.87
659384 [ROUNDUP    3345.00] AMP     8830.7   -86.02
659390 [PATENTGATE 3345.00] AMP     6302.9   -86.89
659400 [NDSUNFLWR  4230.00] AMP     4605.0   -83.88
661005 [BAKER  7    115.00] AMP     3571.3   -83.04
661019 [MATHSON7    115.00] AMP     5520.4   -82.11
661024 [WDICKSN7    115.00] AMP     4886.8   -82.64
661048 [HETINGR7    115.00] AMP     3216.7   -83.56
661053 [MANDAN 4    230.00] AMP    14205.7   -84.12
661070 [N ENGLN7    115.00] AMP     3234.8   -78.99
661901 [BAKER  9    13.800] AMP    11801.7   -86.02
661902 [HETINGR9    13.800] AMP    10974.3   -86.24
661987 [G752CLC4    230.00] AMP     3002.3   -82.90
585341 [G15-098-XFMR34.500] AMP    11929.8   -86.23
652111 [COALHILL4   230.00] AMP     2335.0   -84.24
652211 [DAWSONC9    13.200] AMP    31764.3   -85.37
652216 [WATFORD4    230.00] AMP     6688.6   -83.89
652217 [MI CTYE9    13.800] AMP    13646.6   -86.01
652258 [BISON  8    69.000] AMP     2070.6   -87.13
652296 [WARD   4    230.00] AMP    11668.5   -83.62
652404 [DAWSONC7    115.00] AMP     7724.1   -82.12
652412 [MI CTYE7    115.00] AMP     3888.6   -83.85
652419 [KILDEER7    115.00] AMP     7833.2   -77.54
652497 [MAURINE4    230.00] AMP     2744.8   -82.79
657751 [CENTER 4    230.00] AMP    19976.0   -85.63
659103 [ANTEL31G    23.000] AMP   145944.9   -88.70
659105 [LELANDO3    345.00] AMP    16064.5   -86.88
659107 [ANTEL32G    23.000] AMP   145944.9   -88.70
659184 [R.RIDER7    115.00] AMP     4306.1   -75.94
659185 [FOUREYES   7115.00] AMP     3597.2   -78.35
659212 [DGC        3345.00] AMP    15643.1   -87.29
659218 [COTEAU     3345.00] AMP    16412.6   -87.41
659333 [JUDSON     3345.00] AMP     5864.6   -86.89
659342 [KPS15-BOW7  115.00] AMP     1149.1   -76.55
659350 [BISON  7    115.00] AMP     1402.0   -85.53
659385 [ROUNDUP    7115.00] AMP    12599.5   -85.99
659386 [ROUNDUP    913.800] AMP    23290.0   -88.02
659387 [KUMMERRIDGE3345.00] AMP     5046.3   -85.77
659391 [PATENTGATE 7115.00] AMP    11913.4   -87.91
659392 [PATENTGATE 913.800] AMP    22834.6   -88.29
659401 [NDSUNFLWR  934.500] AMP    17023.0   -86.95
659404 [ANTELPHILLS3345.00] AMP    11159.7   -87.20
659420 [ANTELOP-LNX3345.00] AMP    16412.6   -87.41
659653 [GRSYBUTTAP 7115.00] AMP    13097.1   -85.43
661020 [DIXGREENRVR7115.00] AMP     5054.3   -80.86
661022 [DICKNTH7    115.00] AMP     4704.6   -82.27
661034 [KPS14-BAK7  115.00] AMP     3227.2   -80.68
661042 [HESKETT4    230.00] AMP    13471.3   -84.02
661050 [GASCOYN7    115.00] AMP     1769.5   -79.30
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661054 [MANDAN 7    115.00] AMP    19817.3   -85.39
661300 [BAKER  8    60.000] AMP     3092.7   -83.96
661908 [MANDAN 9    13.800] AMP    34764.9   -87.78
661988 [G752CLC9    34.500] AMP    14977.7   -86.13
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