GEN-2006-021

Impact Restudy for Generator Modification (Turbine Change)

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By Generator Interconnection

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
01/23/2018	Generator Interconnection		Initial issue of the report
1/31/2018	Generator Interconnection	Correction for transmission owner and a typographical error	

EXECUTIVE SUMMARY

The GEN-2006-021 Interconnection Customer has requested a modification to its Interconnection Request. SPP has performed this system impact restudy to determine the effects of replacing half (20) of the wind turbine generators from the previously studied Clipper Liberty 2.5MW wind turbine generators with twenty (20) Vestas 2.2MW wind turbine generators. The other half (20) of the wind turbine generators will remain as Clipper Liberty 2.5MW. The total nameplate changes from 100MW to 94MW.

The point of interconnection (POI) for GEN-2006-021 is on the ITC Flat Ridge Tap 138kV. The Interconnection Customer has provided documentation that shows the Vestas 2.2MW wind turbine generators have a reactive capability of 0.9870 lagging (providing VARS) and 0.99 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-2016-001-01 were used that analyzed the timeframes of 2016 winter, 2017 summer, and 2025 summer models.

The restudy showed that the stability analysis has determined with all previously assigned Network Upgrades in service, generators in the monitored areas remained stable and within the pre-contingency, voltage recovery, and post fault voltage recovery criterion of 0.7pu to 1.2pu for the entire modeled disturbances. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A. The requested modification is not considered Material.

A power factor analysis was performed for this modification request. The facility will be required to maintain a 95% lagging (providing VARs) to 95% leading (absorbing VARs) power factor at the POI.

With the assumptions outlined in this report and with all the required network upgrades from the DISIS-2016-001-01 in place, GEN-2006-021 with the Vestas 2.2MW and Clipper Liberty 2.5MW 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 and manufacturer. 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.

CONTENTS

SECTION 1: INTRODUCTION

GEN-2006-021 Impact Restudy is a generation interconnection study performed to study the impacts of interconnecting the project shown in Table 1-1. This restudy evaluates the requested modification to replace half (20) of the wind turbine generators from the previously studied Clipper Liberty 2.5MW wind turbine generators with twenty (20) Vestas 2.2MW wind turbine generators. The other half (20) of the wind turbine generators will remain as Clipper Liberty 2.5MW. The total nameplate changes from 100MW to 94MW.

TABLE 1-1: INTERCONNECTION REQUEST

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2006-021	94	20 Clipper Liberty 2.5MW & 20 Vestas 2.2MW generators	At Flat Ridge Tap(539638) 138kV

The prior-queued, equally-queued and lower queued requests shown in Table 1-2 were included in this study and the wind farms were dispatched to 100% of rated capacity.

TABLE 1-2: PRIOR AND LATER QUEUED INTERCONNECTION REQUESTS

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2001-039A	104.0	GE 1.6MW	Shooting Star 115 kV (539763)
GEN-2002-025A	150.0	GE 1.5 MW	Spearville 230 kV (539695)
GEN-2004-014	154.5	GE 1.5 MW	Spearville 230 kV (539695)
GEN-2005-012	250.7	Siemens 2.3MW	Ironwood 345 kV (539803)
GEN-2007-040	200.1	Siemens 2.3MW	Buckner 345 kV (531501)
GEN-2008-018	250.0	GE 1.85 MW	Finney 345 kV (523853)
GEN-2008-079	98.9	Siemens 2.3MW	CRKCK 115 kV line (539783)
GEN-2008-124	200.1	Siemens 2.3MW	Ironwood 345 kV (539803)
GEN-2010-009	165.6	Siemens 2.3MW	Buckner 345 kV (531501)
GEN-2010-045	197.8	Siemens 2.3MW	Buckner 345 kV (531501)
GEN-2011-008	600.0	Vestas 2.0MW	Clark County 345 kV (539800)
GEN-2011-016	200.1	Siemens 2.3MW	Spearville 345 kV (531469)
GEN-2012-007	96.0 Summer 120.0 Winter	GENSAL	Rubart 115 kV (531200)
ASGI-2012-006	20.74 Summer 21.21 Winter	GENSAL	ABBK 69 kV (531494)

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2012-024	180.0	Vestas V112-3.0MW	Clark County 345 kV (539800)
GEN-2013-010	99.0	Siemens 3.0MW (583603)	GEN-2013-010 Tap 345 kV (562334) (Tap on Spearville to Post Rock 345 kV line)
GEN-2015-021	20.0	AE 1000NX 1MW PV Inverter (584633)	Johnson Corner 115 kV (531424)
ASGI-2015-001	4.27 Summer 6.13 Winter	GENSAL (584713)	Ninnescah 115 kV (539648)
GEN-2016-005	150.0	Vestas V110 2.0MW wind	GEN-2016-005-TAP 345 kV (Tap on Clark County – Thistle 345 kV line)
GEN-2016-016	78.2	GE 2.3MW wind	North Kinsley 115 kV
GEN-2016-046	299.0	GE 2.3MW wind	GEN-2016-046-TAP 345 kV (Tap on Clark County – Ironwood 345 kV line)
GEN-2016-049	310.2	Vestas V117 GS 3.3MW wind	GEN-2016-049-TAP 345 kV (Tap on GEN-2013-010 Tap/Post Rock – Spearville 345 kV line)

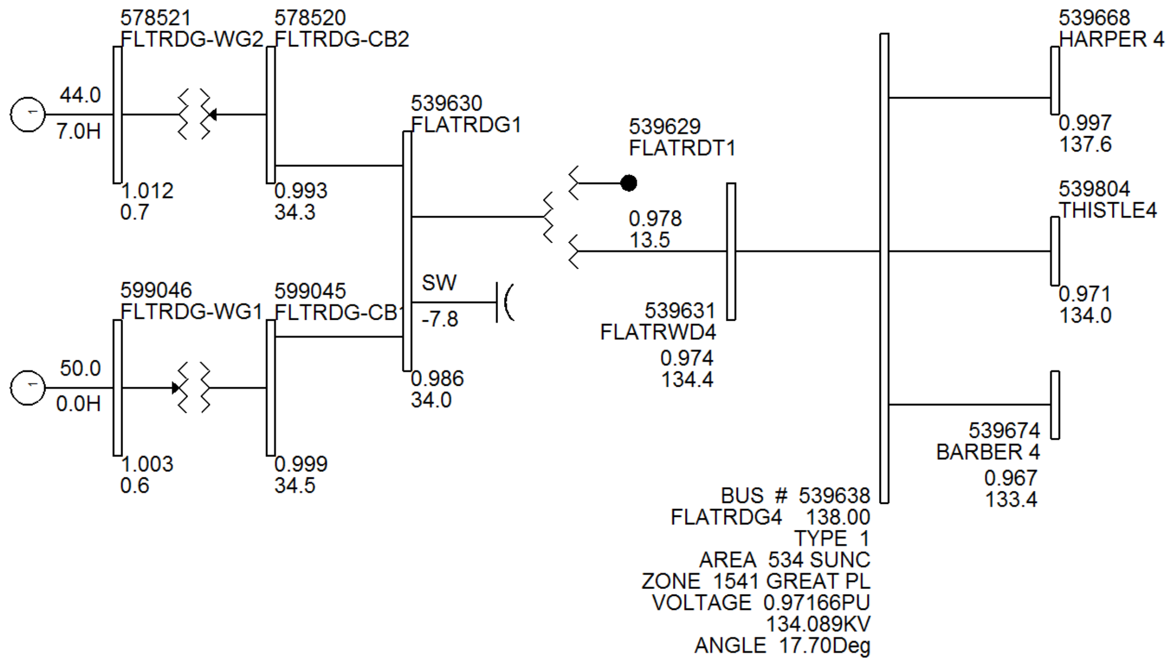
The study included a stability analysis of the interconnection request. Contingencies that resulted in a prior-queued project tripping off-line, if any, were re-run with the prior-queued project's voltage and frequency tripping relays disabled. The analyses were performed on three seasonal models, the 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 3-1 were used in the stability analysis.

A low-wind/no-wind analysis was not performed on this project since it is already in commercial operation. A power factor analysis was performed on the 2016 winter peak, the 2017 summer peak and the 2025 summer peak cases for the three phase faults listed in Table 3-1.

SECTION 2: FACILITIES

A one-line drawing for the GEN-2006-021 generation interconnection request is shown in Figure 2-1. The POI is the existing Flat Ridge Tap 138kV substation on the Harper to Barber 138kV line.

FIGURE 2-1: GEN-2006-021 ONE-LINE DIAGRAM



SECTION 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, 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. These are the DISIS-2016-001-01 Group 3 models. 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

Thirty-two (32) contingencies were identified for use in this study and are listed in Table 3-1. 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 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)

Prior Outages use the same sequences described above after the “prior outage” line is taken out of service.

Stuck Breaker faults are typically modeled as single-phase faults, unless otherwise noted. The sequence of events for a stuck breaker fault is as follows:

1. apply fault for sixteen (16) cycles

2. clear the fault by tripping the affected facility and adjacent facilities that would be tripped during a stuck breaker event (unless otherwise noted there will be no re-closing into a stuck breaker fault)

TABLE 3-1: CONTINGENCIES EVALUATED

Contingency Number and Name	Faulted Bus		Tripped Branch
FLT_01_FLATRDG4_BARBER4_138kV_3PH	FLATRDG4	539638	Trip FLATRDG4 (539638) to BARBER 4 (539674) 138kV Ckt 1
FLT_02_FLATRDG4_HARPER4_138kV_3PH	FLATRDG4	539638	Trip FLATRDG4 (539638) to HARPER 4 (539668) 138kV Ckt 1
FLT_03_FLATRDG4_THISTLE4_138kV_3PH	FLATRDG4	539638	Trip FLATRDG4 (539638) to THISTLE4 (539804) 138kV Ckt 1
FLT_04_BARBER4_BARBER3_138_115kV_3PH	BARBER 4	539674	Trip BARBER 4 (539674) to BARBER 3 (539760) 138/115kV Ckt 1
FLT_05_BARBER3_MEDLDG3_115kV_3PH	BARBER 3	539760	Trip BARBER 3 (539760) to MED-LDG3 (539673) 115kV Ckt 1
FLT_06_MEDLDG3_SUNCITY3_115kV_3PH	MED-LDG3	539673	Trip MED-LDG3 (539673) to SUNCITY3 (539697) 115kV Ckt 1
FLT_07_SUNCITY3_GRNBURG3_115kV_3PH	SUNCITY3	539697	Trip SUNCITY3 (539697) to GRNBURG3 (539664) 115kV Ckt 1
FLT_08_GRNBURG3_SSTARTP3_115kV_3PH	GRNBURG3	539664	Trip GRNBURG3 (539664) to SSTARTP3 (539763) 115kV Ckt 1
FLT_09_BARBER3_SAWYER3_115kV_3PH	BARBER 3	539760	Trip BARBER 3 (539760) to SAWYER 3 (539649) 115kV Ckt 1
FLT_10_SAWYER3_RVROAD_115kV_3PH	SAWYER 3	539649	Trip SAWYER 3 (539649) to RVROAD (539651) 115kV Ckt 1
FLT_11_RVROAD_NINNESC3_115kV_3PH	RVROAD	539651	Trip RVROAD (539651) to NINNESC3 (539648) 115kV Ckt 1
FLT_12_HARPER4_MILANTP4_138kV_3PH	HARPER 4	539668	Trip HARPER 4 (539668) to MILANTP4 (539675) 138kV Ckt 1
FLT_13_MILANTP4_CLEARWT4_138kV_3PH	MILANTP4	539675	Trip MILANTP4 (539675) to CLEARWT4 (533036) 138kV Ckt 1
FLT_14_CLEARWT4_GILLW4_138kV_3PH	CLEARWT4	533036	Trip CLEARWT4 (533036) to GILL W 4 (533045) 138kV Ckt 1
FLT_15_THISTLE4_THISTLE7_138_345kV_3PH	THISTLE4	539804	Trip THISTLE4 (539804) to THISTLE7 (539801) 345/138kV Ckt 1
FLT_16_THISTLE7_G16005TAP_345kV_3PH	THISTLE7	539801	Trip THISTLE7 (539801) to G16-005-TAP (560072) 345kV Ckt 1
FLT_17_G16005TAP_CLARKCOUNTY7_345kV_3PH	G16-005-TAP	560072	Trip G16-005-TAP (560072) to CLARKCOUNTY7 (539800) 345kV Ckt 1
FLT_18_CLARKCOUNTY7_IRONWOOD7_345kV_3PH	CLARKCOUNTY7	539800	Trip CLARKCOUNTY7 (539800) to IRONWOOD7 (560002) 345kV Ckt 1
FLT_19_CLARKCOUNTY7_G16046TAP_345kV_3PH	CLARKCOUNTY7	539800	Trip CLARKCOUNTY7 (539800) to G16-046-TAP (560080) 345kV Ckt 1
FLT_20_G16046TAP_IRONWOOD7_345kV_3PH	G16-046-TAP	560080	Trip G16-046-TAP (560080) to IRONWOOD7 (539803) 345kV Ckt 1
FLT_21_IRONWOOD7_SPERVIL7_345kV_3PH	IRONWOOD7	539803	Trip IRONWOOD7 (539803) to SPERVIL7 (531469) 345kV Ckt 1
FLT_22_THISTLE7_WWRDEHV7_345kV_3PH	THISTLE7	539801	Trip THISTLE7 (539801) to WWRDEHV7 (515375) 345kV Ckt 1
FLT_23_THISTLE7_G1524&G1525T_345kV_3PH	THISTLE7	539801	Trip THISTLE7 (539801) to G1524&G1525T (560033) 345kV Ckt 1
FLT_24_G1524&G1525T_WICHITA7_345kV_3PH	G1524&G1525T	560033	Trip G1524&G1525T (560033) to WICHITA7 (532796) 345kV Ckt 1
Prior Outages			
FLT_25_BARBER3_SAWYER3PO_115kV_3PH **Prior Outage of G1524&G1525T (560033) to WICHITA7 (532796) 345kV Ckt 1**	BARBER 3	539760	Trip BARBER 3 (539760) to SAWYER 3_PO (539649) 115kV Ckt 1
FLT_26_THISTLE7_WWRDEHV7PO_345kV_3PH **Prior Outage of G1524&G1525T (560033) to WICHITA7 (532796) 345kV Ckt 1**	THISTLE7	539801	Trip THISTLE7 (539801) to WWRDEHV7_PO (515375) 345kV Ckt 1
FLT_27_FLATRDG4_BARBER4PO_138kV_3PH **Prior Outage of FLATRDG4 (539638) to THISTLE4 (539804) 138kV Ckt 1**	FLATRDG4	539638	Trip FLATRDG4 (539638) to BARBER 4_PO (539674) 138kV Ckt 1
FLT_28_FLATRDG4_HARPER4PO_138kV_3PH **Prior Outage of FLATRDG4 (539638) to THISTLE4 (539804) 138kV Ckt 1**	FLATRDG4	539638	Trip FLATRDG4 (539638) to HARPER 4_PO (539668) 138kV Ckt 1
FLT_29_FLATRDG4_BARBER4PO_138kV_3PH **Prior Outage of FLATRDG4 (539638) to HARPER 4 (539668) 138kV Ckt 1**	FLATRDG4	539638	Trip FLATRDG4 (539638) to BARBER 4_PO (539674) 138kV Ckt 1
Stuck Breakers			
FLT_30_FLATRDG4_BARBER4SB_138kV_1PH	FLATRDG4	539638	Trip FLATRDG4 (539638) to BARBER 4_SB (539674) 138kV Ckt 1
			Trip FLATRDG4 (539638) to THISTLE4 (539804) 138kV Ckt 1
FLT_31_MEDLDG3_BARBER3SB_115kV_1PH	MED-LDG3	539673	Trip MED-LDG3 (539673) to BARBER 3_SB (539760) 115kV Ckt 1
			Trip MED-LDG3 (539673) to SUNCITY3 (539697) 115kV Ckt 1
			Trip MED-LDG3 (539673) to MED-LDG1 (539717) 34.5kV Ckt 1
FLT_32_HARPER4_FLATRDG4SB_138kV_1PH	HARPER 4	539668	Trip HARPER 4 (539668) to FLATRDG4_SB (539638) 138kV Ckt 1
			Disconnect bus HARPER 4 (539668)

RESULTS

The stability analysis was performed and the results are summarized in Table 3-2. Based on the stability results and with all network upgrades in service, GEN-2006-021 did not cause any stability problems and remained stable for all faults studied. No generators tripped or went unstable, and voltages recovered to acceptable levels.

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

TABLE 3-2: STABILITY ANALYSIS RESULTS

Contingency Number and Name		2016WP	2017SP	2025SP
1	FLT_01_FLATRDG4_BARBER4_138kV_3PH	Stable	Stable	Stable
2	FLT_02_FLATRDG4_HARPER4_138kV_3PH	Stable	Stable	Stable
3	FLT_03_FLATRDG4_THISTLE4_138kV_3PH	Stable	Stable	Stable
4	FLT_04_BARBER4_BARBER3_138_115kV_3PH	Stable	Stable	Stable
5	FLT_05_BARBER3_MEDLDG3_115kV_3PH	Stable	Stable	Stable
6	FLT_06_MEDLDG3_SUNCITY3_115kV_3PH	Stable	Stable	Stable
7	FLT_07_SUNCITY3_GRNBURG3_115kV_3PH	Stable	Stable	Stable
8	FLT_08_GRNBURG3_SSTARTP3_115kV_3PH	Stable	Stable	Stable
9	FLT_09_BARBER3_SAWYER3_115kV_3PH	Stable	Stable	Stable
10	FLT_10_SAWYER3_RVROAD_115kV_3PH	Stable	Stable	Stable
11	FLT_11_RVROAD_NINNESC3_115kV_3PH	Stable	Stable	Stable
12	FLT_12_HARPER4_MILANTP4_138kV_3PH	Stable	Stable	Stable
13	FLT_13_MILANTP4_CLEARWT4_138kV_3PH	Stable	Stable	Stable
14	FLT_14_CLEARWT4_GILLW4_138kV_3PH	Stable	Stable	Stable
15	FLT_15_THISTLE4_THISTLE7_138_345kV_3PH	Stable	Stable	Stable
16	FLT_16_THISTLE7_G16005TAP_345kV_3PH	Stable	Stable	Stable
17	FLT_17_G16005TAP_CLARKCOUNTY7_345kV_3PH	Stable	Stable	Stable
18	FLT_18_CLARKCOUNTY7_IRONWOOD7_345kV_3PH	Stable	Stable	Stable
19	FLT_19_CLARKCOUNTY7_G16046TAP_345kV_3PH	Stable	Stable	Stable
20	FLT_20_G16046TAP_IRONWOOD7_345kV_3PH	Stable	Stable	Stable
21	FLT_21_IRONWOOD7_SPERVIL7_345kV_3PH	Stable	Stable	Stable
22	FLT_22_THISTLE7_WWRDEHV7_345kV_3PH	Stable	Stable	Stable
23	FLT_23_THISTLE7_G1524&G1525T_345kV_3PH	Stable	Stable	Stable
24	FLT_24_G1524&G1525T_WICHITA7_345kV_3PH	Stable	Stable	Stable
25	FLT_25_BARBER3_SAWYER3PO_115kV_3PH	Stable	Stable	Stable
26	FLT_26_THISTLE7_WWRDEHV7PO_345kV_3PH	Stable	Stable	Stable
27	FLT_27_FLATRDG4_BARBER4PO_138kV_3PH	Stable	Stable	Stable
28	FLT_28_FLATRDG4_HARPER4PO_138kV_3PH	Stable	Stable	Stable
29	FLT_29_FLATRDG4_BARBER4PO_138kV_3PH	Stable	Stable	Stable
30	FLT_30_FLATRDG4_BARBER4SB_138kV_1PH	Stable	Stable	Stable
31	FLT_31_MEDLDG3_BARBER3SB_115kV_1PH	Stable	Stable	Stable
32	FLT_32_HARPER4_FLATRDG4SB_138kV_1PH	Stable	Stable	Stable

FERC LVRT COMPLIANCE

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu. Contingencies 1, 2, and 3 in Table 3-1 simulated the LVRT contingencies. GEN-2006-021 met the LVRT requirements by staying on line and the transmission system remaining stable.

SECTION 4: 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.

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 4-1. The detailed power factor analysis tables are in Appendix B. The generation facility may require external capacitor banks or other reactive equipment to meet the power factor requirement at the POI.

TABLE 4-1: STABILITY ANALYSIS RESULTS

Request	Size (MW)	Generator Model	Point of Interconnection	Final PF Requirement at POI	
				Lagging [b]	Leading [c]
GEN-2006-021	94	20 Clipper Liberty 2.5MW & 20 Vestas 2.2MW generators	At Flat Ridge (539638) on the Harper to Barber 138kV line	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.

SECTION 5: REDUCED GENERATION 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. However, since this facility is already in commercial operation, a low-wind/no-wind condition analysis was not performed.

SECTION 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 C.

SECTION 7: CONCLUSION

The SPP GEN-2006-021 Impact Restudy evaluated the impact of interconnecting the project shown below in Table 7-1.

TABLE 7-1: INTERCONNECTION REQUEST

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2006-021	94	20 Clipper Liberty 2.5MW & 20 Vestas 2.2MW generators	At Flat Ridge Tap (539638) 138kV

With all Base Case Network Upgrades in service, previously assigned Network Upgrades in service, and required capacitor banks in service, the GEN-2006-021 project was found to remain on line, and the transmission system was found to remain stable for all conditions studied. The requested modification is not considered Material.

A low-wind/no-wind condition analysis was not performed for this modification request.

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.

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-2006-021 Flat Ridge Turbine Restudy POI - FLATRDG4 138.00 138.075958252 (539638)		2016 Winter Voltage = 1.00055 pu				2017 Summer Voltage = 1.0 pu				2025 Summer Voltage = 1.0 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	94	0.04	1.000	LAG	94	113.60	0.638	LAG	94	99.52	0.687	LAG
1	FLT_01_FLATRDG4_BARBER4_138kV	94	-13.17	0.990	LEAD	94	91.30	0.717	LAG	94	76.44	0.776	LAG
2	FLT_02_FLATRDG4_HARPER4_138kV	94	23.87	0.969	LAG	94	140.77	0.555	LAG	94	125.01	0.601	LAG
3	FLT_03_FLATRDG4_THISTLE4_138kV	94	-1.67	1.000	LEAD	94	4.85	0.999	LAG	94	5.18	0.998	LAG
4	FLT_04_BARBER4_BARBER3_138_115kV	94	-14.20	0.989	LEAD	94	90.29	0.721	LAG	94	75.42	0.780	LAG
5	FLT_05_BARBER3_MEDLDG3_115kV	94	-14.43	0.988	LEAD	94	93.43	0.709	LAG	94	78.62	0.767	LAG
6	FLT_06_MEDLDG3_SUNCITY3_115kV	94	-16.87	0.984	LEAD	94	95.58	0.701	LAG	94	80.73	0.759	LAG
7	FLT_07_SUNCITY3_GRNBURG3_115kV	94	-15.85	0.986	LEAD	94	95.50	0.702	LAG	94	80.69	0.759	LAG
8	FLT_08_GRNBURG3_SSTARTP3_115kV	94	-10.50	0.994	LEAD	94	98.50	0.690	LAG	94	92.02	0.715	LAG
9	FLT_09_BARBER3_SAWYER3_115kV	94	17.85	0.982	LAG	94	121.61	0.612	LAG	94	105.83	0.664	LAG
10	FLT_10_SAWYER3_RVROAD_115kV	94	16.63	0.985	LAG	94	120.66	0.615	LAG	94	104.93	0.667	LAG
11	FLT_11_RVROAD_NINNESC3_115kV	94	-0.75	1.000	LEAD	94	107.13	0.660	LAG	94	95.94	0.700	LAG
12	FLT_12_HARPER4_MILANTP4_138kV	94	2.58	1.000	LAG	94	121.82	0.611	LAG	94	110.64	0.647	LAG
13	FLT_13_MILANTP4_CLEARWT4_138kV	94	1.64	1.000	LAG	94	113.23	0.639	LAG	94	105.79	0.664	LAG
14	FLT_14_CLEARWT4_GILLW4_138kV	94	-10.88	0.993	LEAD	94	102.53	0.676	LAG	94	98.76	0.689	LAG
15	FLT_15_THISTLE4_THISTLE7_138_345kV	94	-1.80	1.000	LEAD	94	4.71	0.999	LAG	94	5.03	0.999	LAG
16	FLT_16_THISTLE7_G16005TAP_345kV	94	51.89	0.875	LAG	94	148.98	0.534	LAG	94	133.94	0.574	LAG
17	FLT_17_G16005TAP_CLARKCOUNTY7_345kV	94	9.85	0.995	LAG	94	122.81	0.608	LAG	94	108.30	0.655	LAG
18	FLT_18_CLARKCOUNTY7_IRONWOOD7_345kV	94	12.32	0.992	LAG	94	128.49	0.590	LAG	94	113.84	0.637	LAG
19	FLT_19_CLARKCOUNTY7_G16046TAP_345kV	94	-2.93	1.000	LEAD	94	112.07	0.643	LAG	94	97.54	0.694	LAG
20	FLT_20_G16046TAP_IRONWOOD7_345kV	94	-0.33	1.000	LEAD	94	110.29	0.649	LAG	94	96.46	0.698	LAG
21	FLT_21_IRONWOOD7_SPERVIL7_345kV	94	29.73	0.953	LAG	94	139.57	0.559	LAG	94	125.58	0.599	LAG
22	FLT_22_THISTLE7_WWRDEHV7_345kV	94	43.55	0.907	LAG	94	130.32	0.585	LAG	94	116.74	0.627	LAG

GEN-2006-021 Flat Ridge Turbine Restudy POI - FLATRDG4 138.00 138.075958252 (539638)		2016 Winter Voltage = 1.00055 pu				2017 Summer Voltage = 1.0 pu				2025 Summer Voltage = 1.0 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	
23	FLT_23_THISTLE7_G1524&G1525T_345kV	94	17.10	0.984	LAG	94	148.96	0.534	LAG	94	129.76	0.587	LAG
24	FLT_24_G1524&G1525T_WICHITA7_345kV	94	10.90	0.993	LAG	94	124.91	0.601	LAG	94	108.85	0.654	LAG

APPENDIX C: SHORT CIRCUIT ANALYSIS

17SP

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                             PSS®E ASCC SHORT CIRCUIT CURRENTS          MON, JAN 15 2018  12:14
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+)
539638 [FLATRDG4    138.00] AMP    15393.7   -85.90
539631 [FLATRWD4    138.00] AMP    10308.4   -84.11
539668 [HARPER 4    138.00] AMP     5722.0   -80.22
539674 [BARBER 4    138.00] AMP     8210.1   -83.91
539804 [THISTLE4    138.00] AMP    17089.6   -86.54
539001 [ANTHONY4    138.00] AMP     3488.6   -81.61
539675 [MILANTP4    138.00] AMP     6074.5   -76.97
539760 [BARBER 3    115.00] AMP     8067.1   -83.60
539801 [THISTLE7    345.00] AMP    16237.3   -85.90
515375 [WWRDEHV7    345.00] AMP    16638.5   -85.99
533036 [CLEARWT4    138.00] AMP    11296.7   -84.11
539002 [BLF-CTY4    138.00] AMP     3096.8   -81.16
539649 [SAWYER 3    115.00] AMP     4660.7   -81.77
539673 [MED-LDG3    115.00] AMP     7890.8   -83.11
539676 [MILAN 4     138.00] AMP     3881.1   -74.89
560033 [G1524&G1525T345.00] AMP    20847.5   -86.29
560072 [G16-005-TAP 345.00] AMP    13479.9   -85.18
515376 [WWRDEHV4    138.00] AMP    21454.8   -85.94
515407 [TATONGA7    345.00] AMP    10300.6   -86.72
515458 [BORDER     7345.00] AMP     4948.7   -86.21
515599 [G07621119-20345.00] AMP    11872.5   -85.58
532796 [WICHITA7    345.00] AMP    25135.6   -86.09
533045 [GILL W 4    138.00] AMP    22147.2   -84.51
539003 [CLDWELL4    138.00] AMP     3094.3   -79.76
539004 [MAYFLD 4    138.00] AMP     3497.4   -77.01
539651 [RVROAD      115.00] AMP     4500.9   -80.87
539697 [SUNCITY3    115.00] AMP     3983.7   -77.29
539800 [CLARKCOUNTY7345.00] AMP    14645.4   -84.47
560071 [G16-003-TAP 345.00] AMP    13759.9   -86.23
584659 [G15024G15025345.00] AMP     6898.3   -86.51
587040 [GEN-2016-005345.00] AMP    10999.9   -85.04
587500 [GEN-2016-073345.00] AMP    15769.0   -85.91
514796 [IODINE-4    138.00] AMP     7115.7   -79.86
515394 [KEENAN 4    138.00] AMP     7825.1   -84.87
515398 [OUSPRT 4    138.00] AMP     8575.5   -82.16
515448 [CRSRDSW7    345.00] AMP     8041.0   -85.95
515497 [MATHWSN7    345.00] AMP    30500.7   -85.66
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515582 [SLNGWND7    345.00] AMP     6964.0   -85.73
515585 [MAMTHPW7    345.00] AMP     9140.3   -86.56
515997 [WWPAR4      138.00] AMP    16161.5   -84.07
525832 [TUCO_INT   7345.00] AMP     9897.2   -85.89
532771 [RENO   7    345.00] AMP    10829.2   -85.56
532791 [BENTON 7    345.00] AMP    19494.8   -85.69
532798 [VIOLA   7   345.00] AMP    11655.0   -85.06
533040 [EVANS N4    138.00] AMP    37753.0   -87.19
533044 [GILL E 4    138.00] AMP    22147.2   -84.51
533046 [GILL S 4    138.00] AMP    22147.2   -84.51
533072 [WACO   4    138.00] AMP    19372.9   -84.54
539648 [NINNESC3    115.00] AMP     4510.1   -80.29
539664 [GRNBURG3    115.00] AMP     3672.0   -77.13
539687 [PRATT 3     115.00] AMP     4486.0   -80.81
560002 [IRONWOOD7   345.00] AMP    14729.9   -84.84
560070 [G16-001-TAP 345.00] AMP    12864.8   -86.31
560080 [G16-046-TAP 345.00] AMP    12942.2   -79.35
562476 [G14-001-TAP 345.00] AMP    11066.5   -85.01
582008 [GEN-2011-008345.00] AMP    11665.4   -84.07
583090 [G1149&G1504 345.00] AMP     4536.2   -86.07
583370 [GEN-2012-024345.00] AMP    12295.1   -84.41
584660 [GEN-2015-024345.00] AMP     5713.8   -86.55
584670 [GEN-2015-025345.00] AMP     6898.3   -86.51
584700 [GEN-2015-029345.00] AMP     7267.3   -85.24
585410 [GREAT_WESTRN345.00] AMP     9230.4   -85.31
585430 [PRSIMN_CRK1 345.00] AMP    10591.7   -85.46
587020 [GEN-2016-003345.00] AMP    13759.9   -86.23
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25SP

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                          PSS®E ASCC SHORT CIRCUIT CURRENTS          MON, JAN 15 2018  12:14
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

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

                                  THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
539638 [FLATRDG4    138.00] AMP    15596.2   -85.78
539631 [FLATRWD4    138.00] AMP    10395.1   -84.01
539668 [HARPER 4    138.00] AMP     6013.3   -79.20
539674 [BARBER 4    138.00] AMP     8259.8   -83.86
539804 [THISTLE4    138.00] AMP    17307.8   -86.45
539000 [RAGO   4    138.00] AMP     3625.3   -81.09
539001 [ANTHONY4    138.00] AMP     3635.9   -80.98
539675 [MILANTP4    138.00] AMP     7125.8   -75.22
539760 [BARBER 3    115.00] AMP     8104.1   -83.56
539801 [THISTLE7    345.00] AMP    16595.5   -85.92
515375 [WWRDEHV7    345.00] AMP    18959.4   -86.06
533036 [CLEARWT4    138.00] AMP    22014.5   -85.38
539002 [BLF-CTY4    138.00] AMP     3237.3   -80.56
539649 [SAWYER 3    115.00] AMP     4675.6   -81.75
539673 [MED-LDG3    115.00] AMP     7926.0   -83.07
539676 [MILAN 4     138.00] AMP     4221.8   -73.47
560033 [G1524&G1525T345.00] AMP    21376.5   -86.39
560072 [G16-005-TAP 345.00] AMP    13572.2   -85.18
515376 [WWRDEHV4    138.00] AMP    22481.2   -86.11
515407 [TATONGA7    345.00] AMP    15873.3   -86.51
515458 [BORDER     7345.00] AMP     5073.2   -86.22
515599 [G07621119-20345.00] AMP    12865.8   -85.55
532796 [WICHITA7    345.00] AMP    26099.4   -86.23
533045 [GILL W 4    138.00] AMP    28737.1   -85.40
533075 [VIOLA  4    138.00] AMP    22362.9   -86.02
533880 [GODDARD2    138.00] AMP    19104.4   -85.90
539003 [CLDWELL4    138.00] AMP     3264.2   -79.05
539004 [MAYFLD 4    138.00] AMP     3754.7   -75.94
539651 [RVROAD      115.00] AMP     4516.5   -80.84
539697 [SUNCITY3    115.00] AMP     3989.4   -77.27
539800 [CLARKCOUNTY7345.00] AMP    14723.3   -84.48
560071 [G16-003-TAP 345.00] AMP    14788.0   -86.28
584659 [G15024G15025345.00] AMP     6942.2   -86.53
587040 [GEN-2016-005345.00] AMP    11060.0   -85.04
587500 [GEN-2016-073345.00] AMP    16054.4   -85.96
514796 [IODINE-4    138.00] AMP     7176.3   -79.86
515394 [KEENAN 4    138.00] AMP     7957.8   -84.91
515398 [OUSPRT 4    138.00] AMP     8735.3   -82.16
515448 [CRSRDSW7    345.00] AMP    11075.7   -85.51
515497 [MATHWSN7    345.00] AMP    32587.8   -85.94
515582 [SLNGWND7    345.00] AMP     8966.8   -85.24
515585 [MAMTHPW7    345.00] AMP    13215.8   -86.30
515997 [WWPAR4      138.00] AMP    16635.3   -84.14
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525832 [TUCO_INT   7345.00] AMP    12080.6   -86.10
532771 [RENO   7    345.00] AMP    11600.7   -85.94
532791 [BENTON 7    345.00] AMP    19833.4   -85.72
532798 [VIOLA   7   345.00] AMP    13813.2   -85.42
532984 [SUMNER 4    138.00] AMP    10652.5   -83.10
533040 [EVANS N4    138.00] AMP    42844.9   -87.26
533041 [EVANS S4    138.00] AMP    42844.9   -87.26
533044 [GILL E 4    138.00] AMP    28737.1   -85.40
533046 [GILL S 4    138.00] AMP    28737.1   -85.40
533072 [WACO   4    138.00] AMP    23673.1   -85.27
539648 [NINNESC3    115.00] AMP     4526.9   -80.26
539664 [GRNBURG3    115.00] AMP     3674.2   -77.12
539687 [PRATT 3     115.00] AMP     4501.5   -80.78
560002 [IRONWOOD7   345.00] AMP    14787.9   -84.82
560070 [G16-001-TAP 345.00] AMP    13478.2   -86.35
560080 [G16-046-TAP 345.00] AMP    12991.0   -79.32
562476 [G14-001-TAP 345.00] AMP    11159.0   -85.03
582008 [GEN-2011-008345.00] AMP    11709.2   -84.07
583090 [G1149&G1504 345.00] AMP     4637.6   -86.07
583370 [GEN-2012-024345.00] AMP    12349.6   -84.41
584660 [GEN-2015-024345.00] AMP     5742.2   -86.56
584670 [GEN-2015-025345.00] AMP     6942.2   -86.53
584700 [GEN-2015-029345.00] AMP     9583.3   -84.58
585410 [GREAT_WESTRN345.00] AMP     9769.6   -85.26
585430 [PRSIMN_CRK1 345.00] AMP    11362.5   -85.42
587020 [GEN-2016-003345.00] AMP    14788.0   -86.28
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APPENDIX D: LOW WIND ANALYSIS

NOT USED