GEN-2008-022 Impact Restudy for Generator Modification (Turbine Change)

September 2014
Generator Interconnection

Southwest Power Pool

Executive Summary

This report summarizes a restudy of the study performed for a modification request to the GEN-2008-022 Interconnection Request. The original study of the modification request was performed and posted in July 2014. The July 2014 study indicated the need for dynamic reactive compensation as a result of the modification to change from G.E. wind generators to Vestas generators. This restudy has been performed to study the effects of the withdrawal of GEN-2013-013 (248.8MW) from the Southwest Power Pool (SPP) Generation Interconnection Queue. GEN-2013-013 was interconnected to the transmission system at the same point of interconnection (POI) as GEN-2008-022. The POI is the new Southwestern Public Service Company (SPS) 345kV switching station on the Tolk to Eddy County 345kV transmission line.

In this restudy the project uses one hundred fifty (150) Vestas V100 VCSS 2.0MW wind turbine generators for an aggregate power of 300.0MW. The interconnection customer has provided documentation that shows the Vestas V100 VCSS 2.0MW wind turbine generators have a reactive capability of 0.98 lagging (providing VARS) and 0.96 leading (absorbing VARS) power factor.

This restudy showed that the voltage recovery issues observed in the July 2014 study[1] of this project are no longer present with the withdrawal of GEN-2013-013. The transmission network remained stable for all studied contingencies and voltages recovered adequately. The +/- 4Mvar SVC required in the July 2014 study is no longer required for Interconnection Service. 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 power factor analysis and the low-wind/no-wind condition analysis were not performed for this restudy. The results from the July 2014 study are still applicable. GEN-2008-022 will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the POI. Since the Vestas V100 VCSS 2.0MW wind turbine has limited reactive capability, the generation facility will need external capacitor banks or other reactive equipment to meet the power factor requirement at the POI. Additionally, the project will be required to install approximately 28Mvar of reactor shunts in its facility. 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 GEN-2008-022 GIA in place, GEN-2008-022 with the Vestas V100 VCSS 2.0MW wind turbine generators should be able to interconnect reliably to the SPP transmission grid.

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[1] See GEN-2008-022 Impact Restudy for Generator Modification (Turbine Change), July 2014

It should be noted that although this study analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, 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.

I. Introduction

This restudy for GEN-2008-022 modification request was performed to determine the effects of the withdrawal of GEN-2013-013 (248.8MW) from the SPP Generation Interconnection Queue since the time of the completion of the July 2014 study. Both GEN-2008-022 and GEN-2013-013 were interconnected to the transmission system at the same POI, a new SPS 345kV switching station on the Tolk to Eddy County 345kV transmission line. Table I-1 shows the interconnection request. The in-service date assumed for the generation addition is November 15, 2015.

Table I-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2008-022	300	Vestas V100 VCSS 2.0MW	Tap Tolk (525549) – Eddy County (527802) 345kV (560007)

The prior-queued and equally-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 Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2001-033	180	Mitsubishi 1000	San Juan Mesa 230kV (524885)
GEN-2001-036	80	Mitsubishi 1000	Norton 115kV (524502)
GEN-2006-018	170	GENSAL	Tuco 230kV (525830)
GEN-2006-026	502	GENROU (527901, 527902, 527903)	Hobbs 115kV(527891) Hobbs 230kV (527894)
GEN-2010-006	180 Summer 205 Winter	GENROU	Jones_bus2 230kV(526337)
ASGI-2010-010	42	GENSAL	Lovington 115kV (528334)
ASGI-2010-020	30	Nordex 2.5MW	Tap LE-Tatum to LE-Crsroads 69kV (AS10-020-POI, 560360)
ASGI-2010-021	15	Mitsubishi MPS-1000A 1.0MW	Tap LE-Saundrtp to LE-Anderson 69kV (ASGI-021-POI, 560364)
GEN-2010-046	56	GENSAL	Tuco 230kV (525830)
ASGI-2011-003	10	Sany 2.0MW	Hendricks 69kV (525943)
ASGI-2011-001	27.3	Suzlon 2.1MW	Lovington 115kV (528334)

Table I-2: Prior Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2011-025	79.5	Alstom ECO 110 3.0MW (4 machines for 12MW) Alstom ECO 122 2.7MW (25 machines for 67.5MW)	Tap on Floyd County - Crosby County 115kV line (G11-025-POI, 562004)
GEN-2011-045	180 Summer 205 Winter	GENROU	Jones_bus2 230kV (526337)
GEN-2011-046	23 Summer 27 Winter	GENROU	Quay County 115kV (524472)
GEN-2011-048	165 Summer 175 Winter	GENROU	Mustang 230kV (527151)
ASGI-2011-004	19.8	Sany 1.8MW	Crosby 69kV (525915)
GEN-2012-001	61.2	CCWE 3.6MW (WT4)	Tap Grassland to Borden 230kV (526679)
GEN-2012-009	15 MW increase (Pgen=165MW)	GENROU	Mustang 230kV (527151)
GEN-2012-010	15 MW increase (Pgen=165MW)	GENROU	Mustang 230kV (527151)
GEN-2012-020	478	GE 1.68MW	Tuco 230kV (525830)
GEN-2012-034	7 MW increase (Pgen=172MW)	GENROU	Mustang 230kV (527151)
GEN-2012-035	7 MW increase (Pgen=172MW)	GENROU	Mustang 230kV (527151)
GEN-2012-036	7 MW increase (Pgen=172MW Summer/185MW Winter)	GENROU	Mustang 230kV (527151)
GEN-2012-037	196 Summer 203 Winter	GENROU	Tuco 345kV (525832)
ASGI-2012-002	18	Vestas 1.65MW V82	Clovis 115kV (524808)
~~GEN-2013-013~~ **See note at the end of the table**	~~248.4~~	~~Siemens 2.3MW (583633, 583636)~~	~~Tap Tolk (525549) – Eddy County (527802) 345kV (560007)~~
GEN-2013-016	191 Summer 203 Winter	GENROU (583456)	Tuco 345kV (525832)
GEN-2013-022	25.0	Solaron 500kW (583313)	Caprock 115kV (524486)
ASGI-2013-002	18.4	Siemens 2.3MW VS (583613)	Tucumcari 115kV (524509)

Table I-2: Prior Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
ASGI-2013-003	18.4	Siemens 2.3MW VS (583623)	Clovis 115kV (524808)
ASGI-2013-005	19.8	Vestas V82 1.65MW (583283)	FE-Clovis 115kV (524808)
ASGI-2013-006	2.0	Gamesa G114 2MW (583813)	Erskine 115kV (526109)

NOTE: GEN-2013-013 withdrew from SPP's Generation Interconnection Queue after the previous study for GEN-2008-022 was completed in July 2014

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 power factor analysis and a low-wind/no-wind analysis were performed on this project since it is a wind farm. The analyses were performed on three seasonal models, the modified versions of the 2014 winter peak, the 2015 summer peak, and the 2024 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.

The power factor analysis determines the power factor at the POI for the wind interconnection project for pre-contingency and post-contingency conditions. The contingencies used in the power factor analysis were a subset of the stability analysis contingencies shown in Table III-1.

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.

It should be noted that although this study analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, 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.

II. Facilities

A one-line drawing for the GEN-2008-022 generation interconnection request is shown in Figure II-1. The POI is the new SPS 345kV switching station on the Tolk to Eddy County 345kV transmission line.

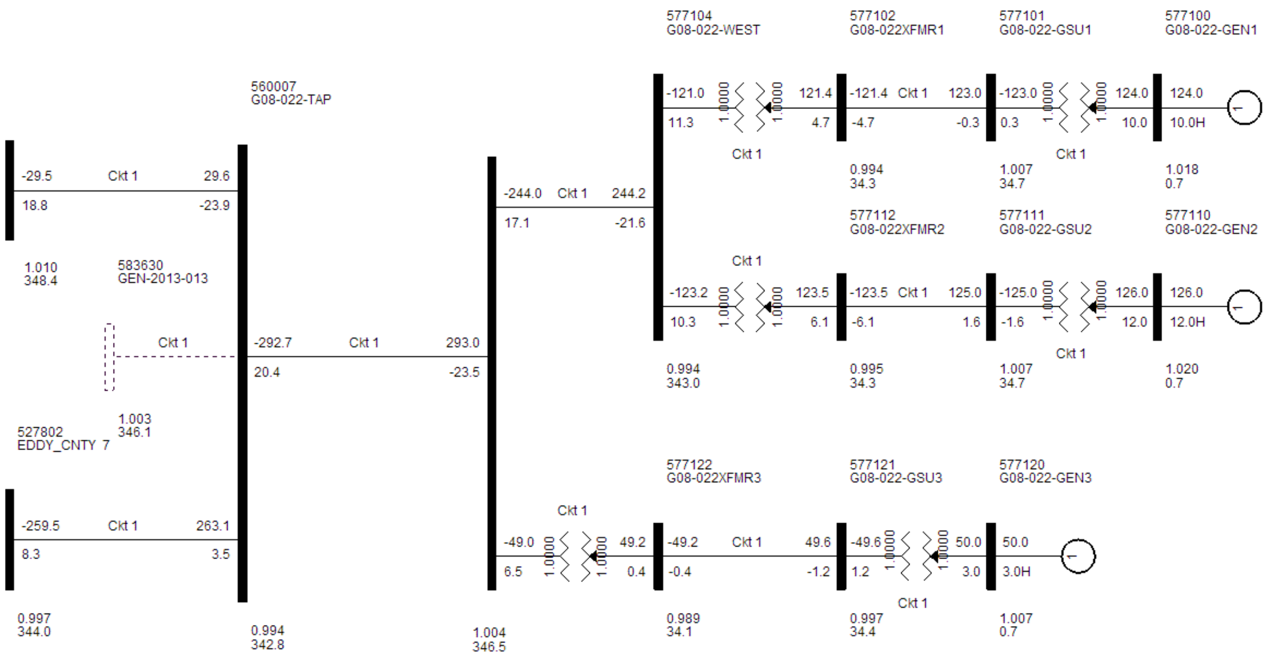

Figure II-1: GEN-2008-022 one-line diagram with GEN-2013-013 (dashed line) removed from POI

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 2013 series of Model Development Working Group (MDWG) dynamic study models including the 2014 winter peak, the 2015 summer peak, and the 2024 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

Sixty-six (66) 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 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 control areas monitored are 524, 525, 526, 531, 534, and 536.

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
1	FLT_01_G08022TAP_TOLK_345kV_3PH	3 phase fault on the G08-022 Tap (560007) to Tolk (525549) 345kV line, near G08-022 Tap. a. Apply fault at the G08-022 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.
2	FLT_02_G08022TAP_TOLK_345kV_1PH	*Single phase fault and sequence like previous*
3	FLT_03_G08022TAP_EDDYCOUNTY_345kV_3PH	3 phase fault on the G08-022 Tap (560007) to Eddy County (527802) 345kV line, near G08-022 Tap. a. Apply fault at the G08-022 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.
4	FLT_04_G08022TAP_EDDYCOUNTY_345kV_1PH	*Single phase fault and sequence like previous*
5	FLT_05_EDDYNORTH_CHAVESCOUNTY_230kV_3PH	3 phase fault on the Eddy North (527799) to Chaves (527483) 230kV line, near Eddy North. a. Apply fault at the Eddy North 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT_06_EDDYNORTH_CHAVESCOUNTY_230kV_1PH	*Single phase fault and sequence like previous*
7	FLT_07_EDDYNORTH_EDDYSOUTH_230kV_3PH	3 phase fault on the Eddy North (527799) to Eddy South (527800) 230kV line, near Eddy North. a. Apply fault at the Eddy North 230kV 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_EDDYNORTH_EDDYSOUTH_230kV_1PH	*Single phase fault and sequence like previous*
9	FLT_09_EDDYSOUTH_CUNNINGHAM_230kV_3PH	3 phase fault on the Eddy South (527800) to Cunningham (527865) 230kV line, near Eddy South. a. Apply fault at the Eddy South 230kV 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_EDDYSOUTH_CUNNINGHAM_230kV_1PH	*Single phase fault and sequence like previous*

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
11	FLT_11_EDDYSOUTH_7RIVERS_230kV_3PH	3 phase fault on the Eddy South (527800) to 7Rivers (528095) 230kV line, near Eddy South. a. Apply fault at the Eddy South 230kV 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_EDDYSOUTH_7RIVERS_230kV_1PH	*Single phase fault and sequence like previous*
13	FLT_13_TOLKTAP_TOLKEAST_230kV_3PH	3 phase fault on the Tolk Tap (525543) to Tolk East (525524) 230kV line, near Tolk Tap. a. Apply fault at the Tolk Tap 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
14	FLT_14_TOLKTAP_TOLKEAST_230kV_1PH	*Single phase fault and sequence like previous*
15	FLT_15_TOLKTAP_TOLKWEST_230kV_3PH	3 phase fault on the Tolk Tap (525543) to Tolk West (525531) 230kV line, near Tolk Tap. a. Apply fault at the Tolk Tap 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
16	FLT_16_TOLKTAP_TOLKWEST_230kV_1PH	*Single phase fault and sequence like previous*
17	FLT_17_TOLKWEST_ROSSEVELTNORTH_230kV_3PH	3 phase fault on the Tolk West (525531) to Roosevelt North (524909) 230kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
18	FLT_18_TOLKWEST_ROSSEVELTNORTH_230kV_1PH	*Single phase fault and sequence like previous*
19	FLT_19_TOLKWEST_PLANTX_230kV_3PH	3 phase fault on the Tolk West (525531) to Plant X (525481) 230kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
20	FLT_20_TOLKWEST_PLANTX_230kV_1PH	*Single phase fault and sequence like previous*
21	FLT_21_TOLKWEST_LAMBCOUNTY_230kV_3PH	3 phase fault on the Tolk West (525531) to Lamb County (525637) 230kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
22	FLT_22_TOLKWEST_LAMBCOUNTY_230kV_1PH	*Single phase fault and sequence like previous*
23	FLT_23_TOLKWEST_YOAKUM_230kV_3PH	3 phase fault on the Tolk West (525531) to Yoakum (525935) 230kV line, near Tolk West. a. Apply fault at the Tolk West 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
24	FLT_24_TOLKWEST_YOAKUM_230kV_1PH	*Single phase fault and sequence like previous*

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
25	FLT_25_ROOSEVELTNORTH_PLEASANTHILL_230kV_3PH	3 phase fault on the Roosevelt North (524909) to Pleasant Hill (524770) 230kV line, near Roosevelt North. a. Apply fault at the near Roosevelt North 230kV 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.
26	FLT_26_ROOSEVELTNORTH_PLEASANTHILL_230kV_1PH	*Single phase fault and sequence like previous*
27	FLT_27_ROOSEVELTNORTH_SW4K33_230kV_3PH	3 phase fault on the Roosevelt North (524909) to SW4K33 (524915) 230kV line, near Roosevelt North. a. Apply fault at the near Roosevelt North 230kV 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.
28	FLT_28_ROOSEVELTNORTH_SW4K33_230kV_1PH	*Single phase fault and sequence like previous*
29	FLT_29_SW4K33_OASIS_230kV_3PH	3 phase fault on the SW4K33 (524915) to Oasis (524875) 230kV line, near SW4K33. a. Apply fault at the near SW4K33 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
30	FLT_30_SW4K33_OASIS_230kV_1PH	*Single phase fault and sequence like previous*
31	FLT_31_SW4K33_ROSSEVELTSOUTH_230kV_3PH	3 phase fault on the SW4K33 (524915) to Roosevelt South (524911) 230kV line, near SW4K33. a. Apply fault at the near SW4K33 230kV 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.
32	FLT_32_SW4K33_ROSSEVELTSOUTH_230kV_1PH	*Single phase fault and sequence like previous*
33	FLT_33_OASIS_PLEASANTHILL_230kV_3PH	3 phase fault on the Oasis (524875) to Pleasant Hill (524700) 230kV line, near Oasis. a. Apply fault at the near Oasis 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
34	FLT_34_OASIS_PLEASANTHILL_230kV_1PH	*Single phase fault and sequence like previous*

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
35	FLT_35_OASIS_SANJUAN_230kV_3PH	3 phase fault on the Oasis (524875) to San Juan (524885) 230kV line, near Oasis. a. Apply fault at the near Oasis 230kV 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.
36	FLT_36_OASIS_SANJUAN_230kV_1PH	*Single phase fault and sequence like previous*
37	FLT_37_SANJUAN_CHAVESCOUNTY_230kV_3PH	3 phase fault on the San Juan (524885) to Chaves County (527483) 230kV line, near San Juan. a. Apply fault at the near San Juan 230kV 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.
38	FLT_38_SANJUAN_CHAVESCOUNTY_230kV_1PH	*Single phase fault and sequence like previous*
39	FLT_39_YOAKUM_AMOCO_230kV_3PH	3 phase fault on the Yoakum (526935) to Amocco (526460) 230kV line, near Yoakum. a. Apply fault at the near Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
40	FLT_40_YOAKUM_AMOCO_230kV_1PH	*Single phase fault and sequence like previous*
41	FLT_41_YOAKUM_OXYBRUTAP_230kV_3PH	3 phase fault on the Yoakum (526935) to Oxybrutap (527010) 230kV line, near Yoakum. a. Apply fault at the near Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
42	FLT_42_YOAKUM_OXYBRUTAP_230kV_1PH	*Single phase fault and sequence like previous*
43	FLT_43_YOAKUM_HOBBS_230kV_3PH	3 phase fault on the Yoakum (526935) to Hobbs (527894) 230kV line, near Yoakum. a. Apply fault at the near Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
44	FLT_44_YOAKUM_HOBBS_230kV_1PH	*Single phase fault and sequence like previous*

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
45	FLT_45_YOAKUM_MUSTANG_230kV _3PH	3 phase fault on the Yoakum (526935) to Mustang (527149) 230kV line, near Yoakum. a. Apply fault at the near Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
46	FLT_46_YOAKUM_MUSTANG_230kV _1PH	*Single phase fault and sequence like previous*
47	FLT_47_PLANTX_DEAFSMITH_230kV _3PH	3 phase fault on the Plant X (525481) to Deaf Smith (524623) 230kV line, near Plant X. a. Apply fault at the near Plant X 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
48	FLT_48_PLANTX_DEAFSMITH_230kV _1PH	*Single phase fault and sequence like previous*
49	FLT_49_PLANTX_NEWHART_230kV_ 3PH (See note below)	3 phase fault on the Plant X (525481) to Newhart (524461) 230kV line, near Plant X. a. Apply fault at the near Plant X 230kV 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.
50	FLT_50_PLANTX_NEWHART_230kV_ 1PH (See note below)	*Single phase fault and sequence like previous*
51	FLT_51_PLANTX_TOLKEAST_230kV_ 3PH	3 phase fault on the Plant X (525481) to Tolk East (525542) 230kV line, near Plant X. a. Apply fault at the near Plant X 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
52	FLT_52_PLANTX_TOLKEAST_230kV_ 1PH	*Single phase fault and sequence like previous*
53	FLT_53_PLANTX_SUNDOWN_230kV _3PH	3 phase fault on the Plant X (525481) to Sundown (526435) 230kV line, near Plant X. a. Apply fault at the near Plant X 230kV 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.
54	FLT_54_PLANTX_SUNDOWN_230kV _1PH	*Single phase fault and sequence like previous*

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
55	FLT_55_TOLKEAST_TUCOINT_230kV_3PH	3 phase fault on the Tolk East (525524) to Tuco Int (525830) 230kV line, near Tolk East. a. Apply fault at the Tolk East 230kV bus. b. Clear fault after 5 cycles and trip the faulted line.
56	FLT_56_TOLKEAST_TUCOINT_230kV_1PH	*Single phase fault and sequence like previous*
57	FLT_57_TOLKTAP_TOLK_230_345kV_3PH	3 phase fault on the Tolk Tap (525543) 230kV to Tolk (525549) 345kV/(525537) 13.2kV transformer, near Tolk Tap 230kV. a. Apply fault at the Tolk Tap 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
58	FLT_58_EDDYCOUNTY_EDDYCOUNTY_230_345kV_3PH	3 phase fault on the Eddy North (527799) 230kV to Eddy County (527802) 345kV/(527796) 13.2kV transformer, near Eddy North 230kV. a. Apply fault at the Eddy North 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
59	FLT_59_EDDYNORTH_EDDYSOUTH_230_115kV_3PH	3 phase fault on the Eddy North (527799) 230kV to Eddy South (527793) 115kV/(527795) 13.2kV ckt 2 transformer, near Eddy North 230kV. a. Apply fault at the Eddy North 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
60	FLT_60_EDDYSOUTH_EDDYNORTH_230_115kV_3PH	3 phase fault on the Eddy South (527800) 230kV to Eddy North (527798) 115kV/(527797) 13.2kV ckt 1 transformer, near Eddy South 230kV. a. Apply fault at the Eddy South 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
61	FLT_61_ROOSEVELTNORTH_ROOSEVELT_230_115kV_3PH	3 phase fault on the Roosevelt North (524909) 230kV to Roosevelt North (524908) 115kV/(524907) 13.2kV transformer, near Roosevelt North 230kV. a. Apply fault at the Roosevelt North 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
62	FLT_62_OASIS_OASIS_230_115kV_3PH	3 phase fault on the Oasis (524875) 230kV to Oasis (524874) 115kV/(524872) 13.2kV transformer, near Oasis 230kV. a. Apply fault at the Oasis 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
63	FLT_63_PLEASANTHILL_PLEASANTHILL_230_115kV_3PH	3 phase fault on the Pleasant Hill (524770) 230kV to Pleasant Hill (524768) 115kV/(524767) 13.2kV transformer, near Pleasant Hill 230kV. a. Apply fault at the Pleasant Hill 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
64	FLT_64_LAMBCOUNTY_LAMBCOUNTY_230_115kV_3PH	3 phase fault on the Lamb County (525637) 230kV to Lamb County (525636) 115kV/(525633) 13.2kV transformer, near Lamb County 230kV. a. Apply fault at the Lamb County 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
65	FLT_65_YOAKUM_YOAKUM_230_115kV_3PH	3 phase fault on the Yoakum (526935) 230kV to Yoakum (526934) 115kV/(526932) 13.2kV ckt 2 transformer, near Yoakum 230kV. a. Apply fault at the Yoakum 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Table III-1: Contingencies Evaluated

Cont. No.	Contingency Name	Description
66	FLT_66_PLANTX_PLANTX_230_115kV_3PH	3 phase fault on the Plant X (525481) 230kV to Plant X (525480) 115kV/(525479) 13.2kV transformer, near Plant X 230kV. a. Apply fault at the Plant X 230kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

NOTE: Contingencies 49 and 50 not applicable to 2014 winter.

Results

The stability analysis was performed and the results are summarized in Table III-2. Based on the stability analysis with all network upgrades in service GEN-2008-022 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.

In the July 2014 study for GEN-2008-022, voltage recovery issues were observed during the summer and the winter peak conditions as a result of changing to the Vestas V100 VCSS 2.0MW wind turbine generators. The July 2014 study showed that a +/- 4Mvar SVC was required in the customer's facility for adequate voltage recovery after fault clearing. However, in this study no voltage recovery issues were found. The +/- 4Mvar SVC requirement from the July 2014 study is no longer required based on the results of this study. For a fault at the POI Figure III-1 shows the voltage response at the POI and a few nearby busses.

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

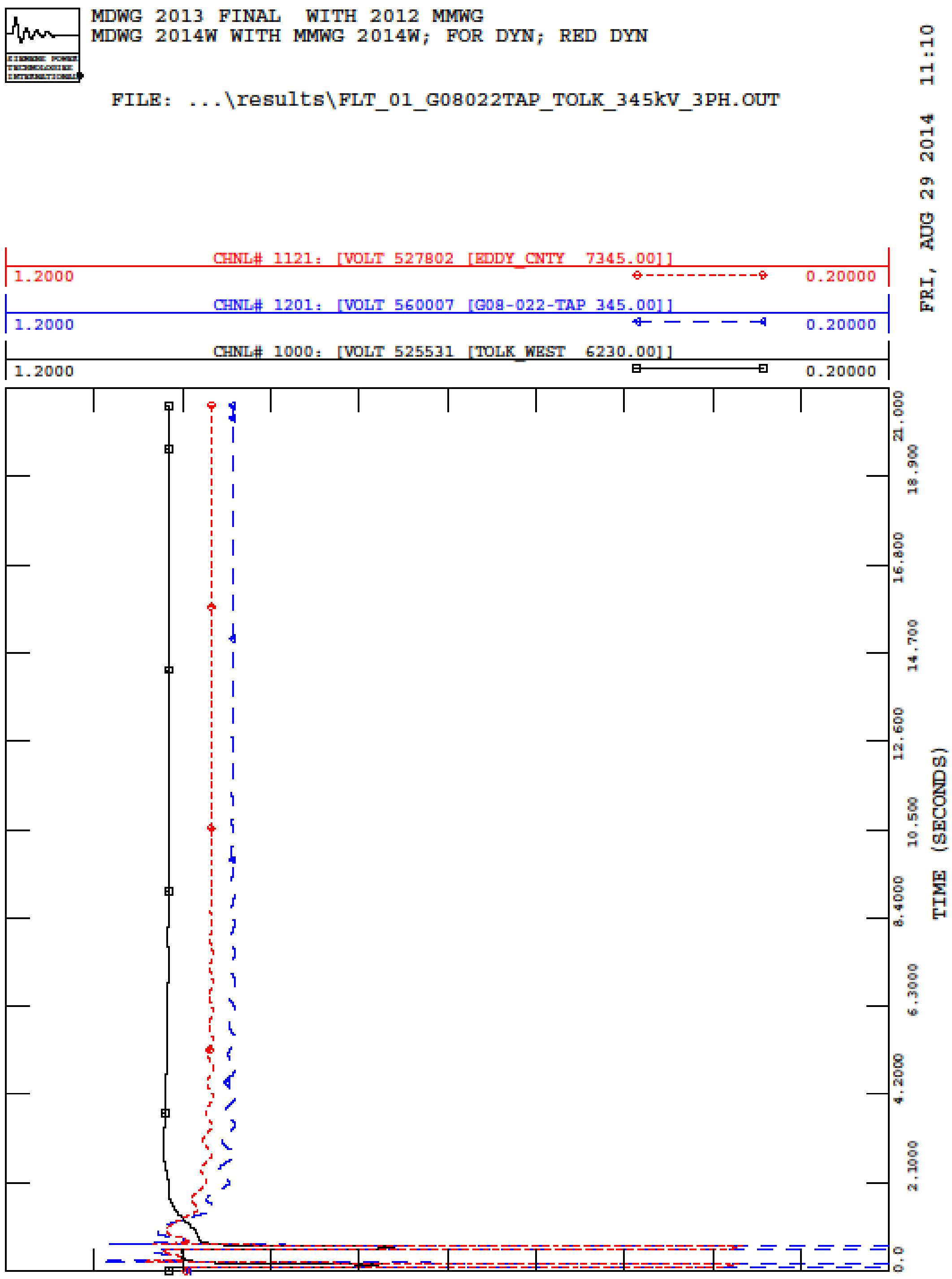

Figure III-1: Voltage plot for POI to Tolk 345kV contingency (fault at the POI)
Vestas V100 2.0MW – 2014 Winter Peak

Table III-2: Stability Analysis Results

	Contingency Number and Name	2014WP	2015SP	2024SP
1	FLT_01_G08022TAP_TOLK_345kV_3PH	Stable	Stable	Stable
2	FLT_02_G08022TAP_TOLK_345kV_1PH	Stable	Stable	Stable
3	FLT_03_G08022TAP_EDDYCOUNTY_345kV_3PH	Stable	Stable	Stable
4	FLT_04_G08022TAP_EDDYCOUNTY_345kV_1PH	Stable	Stable	Stable
5	FLT_05_EDDYNORTH_CHAVESCOUNTY_230kV_3PH	Stable	Stable	Stable
6	FLT_06_EDDYNORTH_CHAVESCOUNTY_230kV_1PH	Stable	Stable	Stable
7	FLT_07_EDDYNORTH_EDDYSOUTH_230kV_3PH	Stable	Stable	Stable
8	FLT_08_EDDYNORTH_EDDYSOUTH_230kV_1PH	Stable	Stable	Stable
9	FLT_09_EDDYSOUTH_CUNNINGHAM_230kV_3PH	Stable	Stable	Stable
10	FLT_10_EDDYSOUTH_CUNNINGHAM_230kV_1PH	Stable	Stable	Stable
11	FLT_11_EDDYSOUTH_7RIVERS_230kV_3PH	Stable	Stable	Stable
12	FLT_12_EDDYSOUTH_7RIVERS_230kV_1PH	Stable	Stable	Stable
13	FLT_13_TOLKTAP_TOLKEAST_230kV_3PH	Stable	Stable	Stable
14	FLT_14_TOLKTAP_TOLKEAST_230kV_1PH	Stable	Stable	Stable
15	FLT_15_TOLKTAP_TOLKWEST_230kV_3PH	Stable	Stable	Stable
16	FLT_16_TOLKTAP_TOLKWEST_230kV_1PH	Stable	Stable	Stable
17	FLT_17_TOLKWEST_ROSSEVELTNORTH_230kV_3PH	Stable	Stable	Stable
18	FLT_18_TOLKWEST_ROSSEVELTNORTH_230kV_1PH	Stable	Stable	Stable
19	FLT_19_TOLKWEST_PLANTX_230kV_3PH	Stable	Stable	Stable
20	FLT_20_TOLKWEST_PLANTX_230kV_1PH	Stable	Stable	Stable
21	FLT_21_TOLKWEST_LAMBCOUNTY_230kV_3PH	Stable	Stable	Stable
22	FLT_22_TOLKWEST_LAMBCOUNTY_230kV_1PH	Stable	Stable	Stable
23	FLT_23_TOLKWEST_YOAKUM_230kV_3PH	Stable	Stable	Stable
24	FLT_24_TOLKWEST_YOAKUM_230kV_1PH	Stable	Stable	Stable
25	FLT_25_ROOSEVELTNORTH_PLEASANTHILL_230kV_3PH	Stable	Stable	Stable
26	FLT_26_ROOSEVELTNORTH_PLEASANTHILL_230kV_1PH	Stable	Stable	Stable
27	FLT_27_ROOSEVELTNORTH_SW4K33_230kV_3PH	Stable	Stable	Stable
28	FLT_28_ROOSEVELTNORTH_SW4K33_230kV_1PH	Stable	Stable	Stable
29	FLT_29_SW4K33_OASIS_230kV_3PH	Stable	Stable	Stable
30	FLT_30_SW4K33_OASIS_230kV_1PH	Stable	Stable	Stable
31	FLT_31_SW4K33_ROSSEVELTSOUTH_230kV_3PH	Stable	Stable	Stable

Table III-2: Stability Analysis Results

	Contingency Number and Name	2014WP	2015SP	2024SP
32	FLT_32_SW4K33_ROSSEVELTSOUTH_230kV_1PH	Stable	Stable	Stable
33	FLT_33_OASIS_PLEASANTHILL_230kV_3PH	Stable	Stable	Stable
34	FLT_34_OASIS_PLEASANTHILL_230kV_1PH	Stable	Stable	Stable
35	FLT_35_OASIS_SANJUAN_230kV_3PH	Stable	Stable	Stable
36	FLT_36_OASIS_SANJUAN_230kV_1PH	Stable	Stable	Stable
37	FLT_37_SANJUAN_CHAVESCOUNTY_230kV_3PH	Stable	Stable	Stable
38	FLT_38_SANJUAN_CHAVESCOUNTY_230kV_1PH	Stable	Stable	Stable
39	FLT_39_YOAKUM_AMOCO_230kV_3PH	Stable	Stable	Stable
40	FLT_40_YOAKUM_AMOCO_230kV_1PH	Stable	Stable	Stable
41	FLT_41_YOAKUM_OXYBRUTAP_230kV_3PH	Stable	Stable	Stable
42	FLT_42_YOAKUM_OXYBRUTAP_230kV_1PH	Stable	Stable	Stable
43	FLT_43_YOAKUM_HOBBS_230kV_3PH	Stable	Stable	Stable
44	FLT_44_YOAKUM_HOBBS_230kV_1PH	Stable	Stable	Stable
45	FLT_45_YOAKUM_MUSTANG_230kV_3PH	Stable	Stable	Stable
46	FLT_46_YOAKUM_MUSTANG_230kV_1PH	Stable	Stable	Stable
47	FLT_47_PLANTX_DEAFSMITH_230kV_3PH	Stable	Stable	Stable
48	FLT_48_PLANTX_DEAFSMITH_230kV_1PH	Stable	Stable	Stable
49	FLT_49_PLANTX_NEWHART_230kV_3PH	-NA-[1]	Stable	Stable
50	FLT_50_PLANTX_NEWHART_230kV_1PH	-NA-[1]	Stable	Stable
51	FLT_51_PLANTX_TOLKEAST_230kV_3PH	Stable	Stable	Stable
52	FLT_52_PLANTX_TOLKEAST_230kV_1PH	Stable	Stable	Stable
53	FLT_53_PLANTX_SUNDOWN_230kV_3PH	Stable	Stable	Stable
54	FLT_54_PLANTX_SUNDOWN_230kV_1PH	Stable	Stable	Stable
55	FLT_55_TOLKEAST_TUCOINT_230kV_3PH	Stable	Stable	Stable
56	FLT_56_TOLKEAST_TUCOINT_230kV_1PH	Stable	Stable	Stable
57	FLT_57_TOLKTAP_TOLK_230_345kV_3PH	Stable	Stable	Stable
58	FLT_58_EDDYCOUNTY_EDDYCOUNTY_230_345kV_3PH	Stable	Stable	Stable
59	FLT_59_EDDYNORTH_EDDYSOUTH_230_115kV_3PH	Stable	Stable	Stable
60	FLT_60_EDDYSOUTH_EDDYNORTH_230_115kV_3PH	Stable	Stable	Stable
61	FLT_61_ROOSEVELTNORTH_ROOSEVELT_230_115kV_3PH	Stable	Stable	Stable
62	FLT_62_OASIS_OASIS_230_115kV_3PH	Stable	Stable	Stable
63	FLT_63_PLEASANTHILL_PLEASANTHILL_230_115kV_3PH	Stable	Stable	Stable

Table III-2: Stability Analysis Results

Contingency Number and Name		2014WP	2015SP	2024SP
64	FLT_64_LAMBCOUNTY_LAMBCOUNTY_230_115kV_3PH	Stable	Stable	Stable
65	FLT_65_YOAKUM_YOAKUM_230_115kV_3PH	Stable	Stable	Stable
66	FLT_66_PLANTX_PLANTX_230_115kV_3PH	Stable	Stable	Stable

NOTES:
1. "- 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 1 and 3 in Table III-2 simulated the LVRT contingencies. GEN-2008-022 met the LVRT requirements by staying on line and the transmission system remaining stable.

IV. Power Factor Analysis[2]

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 Vestas V100 VCSS 2.0MW wind turbine has limited reactive capability (0.98 lagging and 0.96 leading), the generation facility will require external capacitor banks or other reactive equipment to meet the power factor requirement at the POI.

[2] The Power Factor Analysis from the previous study (see GEN-2008-022 Impact Restudy for Generator Modification (Turbine Change), July 2014) is reproduced here. The July 2014 Power Factor Analysis remains valid for this study.

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-2008-022	300	Vestas V100 VCSS 2.0MW	Tap Tolk (525549) – Eddy County (527802) 345kV (560007)	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. The most lagging power factor determined through analysis was 0.98.

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

In a separate test, the effect of low-wind/no-wind conditions at the wind farm is analyzed. The project generators and capacitors (if any) were turned off in the base case (Figure IV-1). 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 345 kV bus to bring the Mvar flow into the POI down to approximately zero. Final shunt reactor requirement for this project is approximately 28Mvars. The one-line diagram in Figure IV-2 shows actual Mvar output at the specific voltages in the base case. The results shown are for the 2014WP case. The other two cases (2015SP and 2024SP) were almost identical since the plant design is the same in all cases.

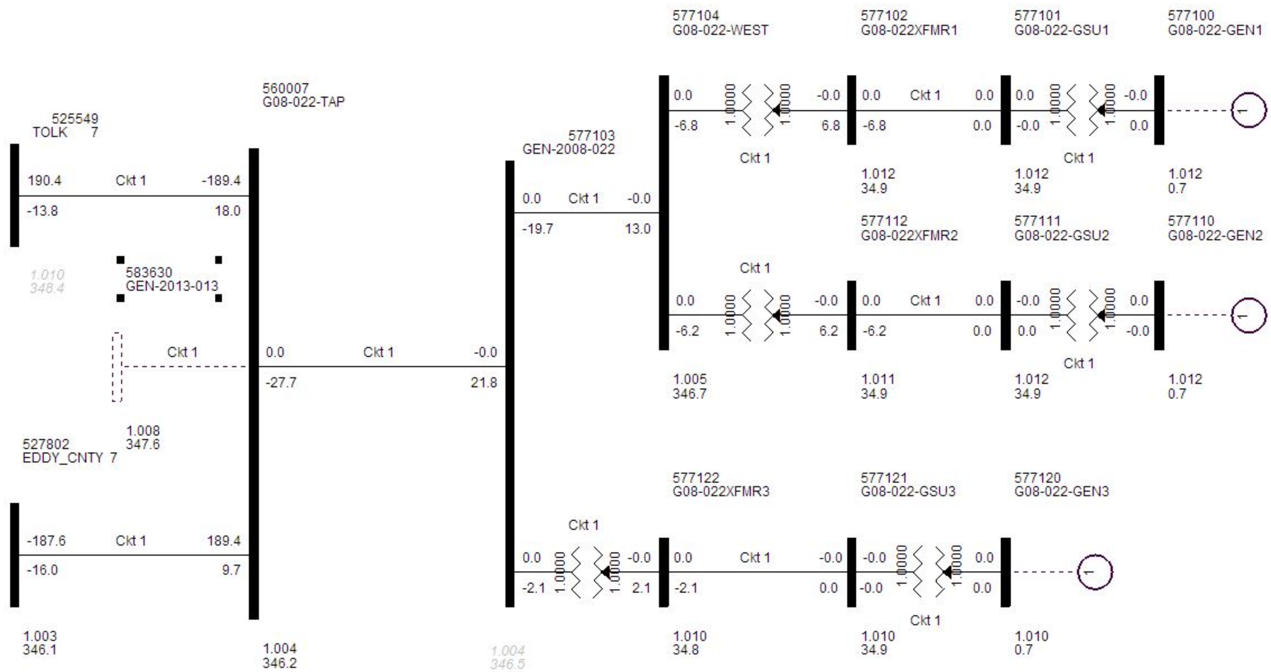

Figure IV-1: GEN-2008-022 with generators off and no shunt reactors

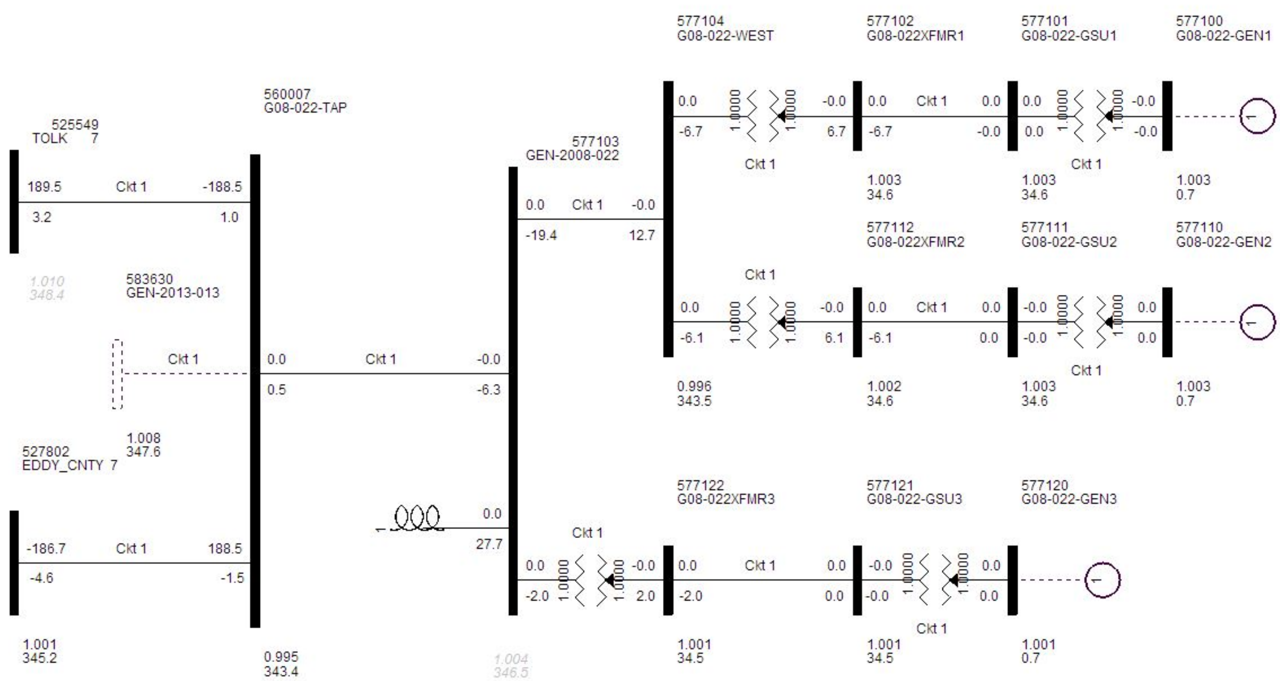

Figure IV-2: GEN-2008-022 with generators turned off and shunt reactors added to the high side of the substation 345/34.5kV transformers

V. Conclusion

The SPP GEN-2008-022 Impact Restudy evaluated the impact of the withdrawal of GEN-2013-13 (248.8MW) from SPP's Generation Interconnection Queue. The following table shows the interconnection request.

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2008-022	300	Vestas V100 VCSS 2.0MW	Tap Tolk (525549) – Eddy County (527802) 345kV (560007)

With all Base Case Network Upgrades in service and previously assigned Network Upgrades in service, the GEN-2008-022 project was found to remain on line, and the transmission system was found to remain stable for all conditions studied. All generators in the monitored areas remained stable for all of the modeled disturbances.

The power factor analysis and the low-wind/no-wind condition analysis conducted in the July 2014 study remain valid for this study. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the POI. Since the Vestas V100 VCSS 2.0MW wind turbine has limited reactive capability, the generation facility will require external capacitor banks or other reactive equipment to meet the power factor requirement at the POI.

Additionally, the project will be required to install approximately 28Mvar of reactor shunts. 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.

Any changes to the assumptions made in this study, for example, one or more of the previously queued requests withdraw, may require a restudy 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

(Plots available on request)

APPENDIX B

POWER FACTOR ANALYSIS[3]

[3] The following table is from the previous study (see GEN-2008-022 Impact Restudy for Generator Modification (Turbine Change), July 2014). The data remain valid for this study.

GEN-2008-022 Tap Tolk (525549) – Eddy County (527802) 345kV (560007) POI voltage for all seasons is 1.0PU	2014 Winter Peak				2015 Summer Peak				2024 Summer Peak			
	MW	Mvar	PF		MW	Mvar	PF		MW	Mvar	PF	
FLT_00_NoFault	300.0	6.25	1.00	LAG	300.0	10.27	1.00	LAG	300.0	23.93	1.00	LAG
FLT_01_G08022TAP_TOLK_345kV	300.0	44.96	0.99	LAG	300.0	49.04	0.99	LAG	300.0	59.96	0.98[1]	LAG
FLT_03_G08022TAP_EDDYCOUNTY_345kV	300.0	17.66	1.00	LAG	300.0	24.23	1.00	LAG	300.0	21.47	1.00	LAG
FLT_05_EDDYNORTH_CHAVESCOUNTY_230kV	300.0	6.23	1.00	LAG	300.0	9.71	1.00	LAG	300.0	26.10	1.00	LAG
FLT_07_EDDYNORTH_EDDYSOUTH_230kV	300.0	13.01	1.00	LAG	300.0	13.88	1.00	LAG	300.0	28.72	1.00	LAG
FLT_09_EDDYSOUTH_CUNNINGHAM_230kV	300.0	5.82	1.00	LAG	300.0	11.04	1.00	LAG	300.0	36.62	0.99	LAG
FLT_11_EDDYSOUTH_7RIVERS_230kV	300.0	5.38	1.00	LAG	300.0	9.93	1.00	LAG	300.0	15.18	1.00	LAG
FLT_13_TOLKTAP_TOLKEAST_230kV	300.0	6.19	1.00	LAG	300.0	10.30	1.00	LAG	300.0	23.32	1.00	LAG
FLT_15_TOLKTAP_TOLKWEST_230kV	300.0	7.17	1.00	LAG	300.0	10.78	1.00	LAG	300.0	26.23	1.00	LAG
FLT_17_TOLKWEST_ROSSEVELTNORTH_230kV	300.0	6.62	1.00	LAG	300.0	10.60	1.00	LAG	300.0	25.19	1.00	LAG
FLT_19_TOLKWEST_PLANTX_230kV	300.0	6.37	1.00	LAG	300.0	10.36	1.00	LAG	300.0	24.92	1.00	LAG
FLT_21_TOLKWEST_LAMBCOUNTY_230kV	300.0	6.62	1.00	LAG	300.0	10.53	1.00	LAG	300.0	25.85	1.00	LAG
FLT_23_TOLKWEST_YOAKUM_230kV	300.0	9.54	1.00	LAG	300.0	10.48	1.00	LAG	300.0	28.14	1.00	LAG
FLT_25_ROOSEVELTNORTH_PLEASANTHILL_230kV	300.0	6.27	1.00	LAG	300.0	10.29	1.00	LAG	300.0	24.47	1.00	LAG
FLT_27_ROOSEVELTNORTH_SW4K33_230kV	300.0	6.21	1.00	LAG	300.0	10.24	1.00	LAG	300.0	23.33	1.00	LAG
FLT_29_SW4K33_OASIS_230kV	300.0	6.49	1.00	LAG	300.0	10.41	1.00	LAG	300.0	27.20	1.00	LAG
FLT_31_SW4K33_ROSSEVELTSOUTH_230kV	300.0	6.69	1.00	LAG	300.0	10.62	1.00	LAG	300.0	37.20	0.99	LAG
FLT_33_OASIS_PLEASANTHILL_230kV	300.0	6.25	1.00	LAG	300.0	10.26	1.00	LAG	300.0	24.19	1.00	LAG
FLT_35_OASIS_SANJUAN_230kV	300.0	7.25	1.00	LAG	300.0	10.31	1.00	LAG	300.0	24.70	1.00	LAG
FLT_37_SANJUAN_CHAVESCOUNTY_230kV	300.0	13.88	1.00	LAG	300.0	14.49	1.00	LAG	300.0	50.06	0.99	LAG
FLT_39_YOAKUM_AMOCO_230kV	300.0	6.71	1.00	LAG	300.0	9.57	1.00	LAG	300.0	22.22	1.00	LAG
FLT_41_YOAKUM_OXYBRUTAP_230kV	300.0	6.34	1.00	LAG	300.0	10.21	1.00	LAG	300.0	23.77	1.00	LAG
FLT_43_YOAKUM_HOBBS_230kV	300.0	4.44	1.00	LAG	300.0	10.04	1.00	LAG	300.0	24.43	1.00	LAG
FLT_45_YOAKUM_MUSTANG_230kV	300.0	6.32	1.00	LAG	300.0	10.21	1.00	LAG	300.0	23.76	1.00	LAG
FLT_47_PLANTX_DEAFSMITH_230kV	300.0	6.42	1.00	LAG	300.0	10.45	1.00	LAG	300.0	27.26	1.00	LAG

GEN-2008-022 **Tap Tolk (525549) – Eddy County (527802) 345kV (560007)** **POI voltage for all seasons is 1.0PU**	**2014 Winter Peak**				**2015 Summer Peak**				**2024 Summer Peak**			
	MW	**Mvar**	**PF**		**MW**	**Mvar**	**PF**		**MW**	**Mvar**	**PF**	
FLT_49_PLANTX_NEWHART_230kV	NA[3]	NA[3]	NA[3]	NA[3]	300.0	10.53	1.00	LAG	300.0	27.94	1.00	LAG
FLT_51_PLANTX_TOLKEAST_230kV	300.0	6.36	1.00	LAG	300.0	10.35	1.00	LAG	300.0	24.87	1.00	LAG
FLT_53_PLANTX_SUNDOWN_230kV	300.0	8.81	1.00	LAG	300.0	10.86	1.00	LAG	300.0	29.70	1.00	LAG
FLT_55_TOLKEAST_TUCOINT_230kV	300.0	7.08	1.00	LAG	300.0	10.64	1.00	LAG	300.0	29.72	1.00	LAG
FLT_57_TOLKTAP_TOLK_230_345kV	300.0	41.93	0.99	LAG	300.0	46.01	0.99	LAG	300.0	56.93	0.98	LAG
FLT_58_EDDYCOUNTY_EDDYCOUNTY_230_345kV	300.0	3.57	1.00[2]	LAG	300.0	10.15	1.00	LAG	300.0	7.39	1.00	LAG
FLT_59_EDDYNORTH_EDDYSOUTH_230_115kV	300.0	5.98	1.00	LAG	300.0	10.14	1.00	LAG	300.0	25.08	1.00	LAG
FLT_60_EDDYSOUTH_EDDYNORTH_230_115kV	300.0	5.98	1.00	LAG	300.0	10.06	1.00	LAG	300.0	25.95	1.00	LAG
FLT_61_ROOSEVELTNORTH_ROOSEVELT_230_115kV	300.0	6.29	1.00	LAG	300.0	10.29	1.00	LAG	300.0	24.85	1.00	LAG
FLT_62_OASIS_OASIS_230_115kV	300.0	6.15	1.00	LAG	300.0	10.19	1.00	LAG	300.0	23.23	1.00	LAG
FLT_63_PLEASANTHILL_PLEASANTHILL_230_115kV	300.0	6.24	1.00	LAG	300.0	10.25	1.00	LAG	300.0	23.84	1.00	LAG
FLT_64_LAMBCOUNTY_LAMBCOUNTY_230_115kV	300.0	6.62	1.00	LAG	300.0	10.53	1.00	LAG	300.0	25.85	1.00	LAG
FLT_65_YOAKUM_YOAKUM_230_115kV	300.0	6.22	1.00	LAG	300.0	10.25	1.00	LAG	300.0	23.87	1.00	LAG
FLT_66_PLANTX_PLANTX_230_115kV	300.0	6.49	1.00	LAG	300.0	10.46	1.00	LAG	300.0	25.58	1.00	LAG

NOTE:

1. Lowest lagging (supplying vars) power factor requirement for all three seasons
2. For the contingencies simulated, the analysis found no leading (absorbing vars) power factor for any of the three seasons. The FERC requirement is 0.95 leading capability at the POI
3. Not applicable to this season

APPENDIX C

PROJECT MODELS

(Power flow and dynamic models available on request)