GEN-2011-040 & GEN-2012-004 Impact Restudy for Generator Modification (Turbine Change)

SPP Generator Interconnection Studies

GEN-2011-040 & GEN-2012-004

August 2013

Executive Summary

This document reports on the findings of a restudy for the GEN-2011-040 & GEN-2012-004 interconnection requests which are both owned by the same interconnection customer. The two projects are collocated and share the same 34.5/345kV substation transformer and transmission line to the Point of Interconnection (POI). The interconnection customer has requested this restudy to determine the effects of changing wind turbine generators from the previously studied Siemens VS 2.3MW wind turbine generators to the Vestas V100 VCSS 2.0MW wind turbine generators.

In this restudy the combined project uses seventy-five (75) Vestas 2.0MW wind turbine generators for an aggregate power of 150.0MW and is located in Murray County, Oklahoma. The interconnection request shows that the Vestas 2.0MW wind turbine generators will have +0.98/-0.96 power factor capabilities installed.

The restudy showed that no stability problems were found during the summer or the winter peak conditions as a result of changing to the Vestas 2.0MW wind turbine generators. 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.

A power factor analysis was not performed during this study. The power factor analysis from DISIS-2011-002 and DISIS-2012-001 each remain valid for this project. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the point of interconnection. The Interconnection Customer will be required to install capacitor banks to meet this requirement.

It should be noted that although this study analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator[s] may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, it is likely that the **Customer[s] may be required to reduce their generation output to 0 MW under certain system conditions** to allow system operators to maintain the reliability of the transmission network.

With the assumptions outlined in this report and with all the required network upgrades from the GEN-2011-040 & GEN-2012-004 Generator Interconnection Agreement (GIA) in place, GEN-2011-040 & GEN-2012-004 should be able to reliably interconnect to the SPP transmission grid.

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

1.0 Introduction

The interconnection customer has requested this restudy to determine the effects of changing wind turbine generators from the previously studied Siemens VS 2.3MW wind turbine generators to the Vestas V100 VCSS 2.0MW wind turbine generators.

In this study SPP monitored the generators and transmission lines in Areas 520, 524, 525, 526, 531, 534, and 536.

2.0 Purpose

The purpose of this impact restudy is to evaluate the effects of using Vestas 2.0MW wind turbine generators on the reliability of the Transmission System.

3.0 Facilities

3.1 Customer Facility

The customer's facility was studied with a total of seventy-five (75) Vestas 2.0MW wind turbine generators; the project has a maximum power output of 150.0MW. Figure 1 shows the equivalent facility one-line drawing.

3.2 Interconnection Facility

The point of interconnection (POI) is at a new 138kV substation along the Pooleville – Ratliff 138kV transmission line located in Murray County, Oklahoma. Figure 1 shows the POI system topology one-line drawing.

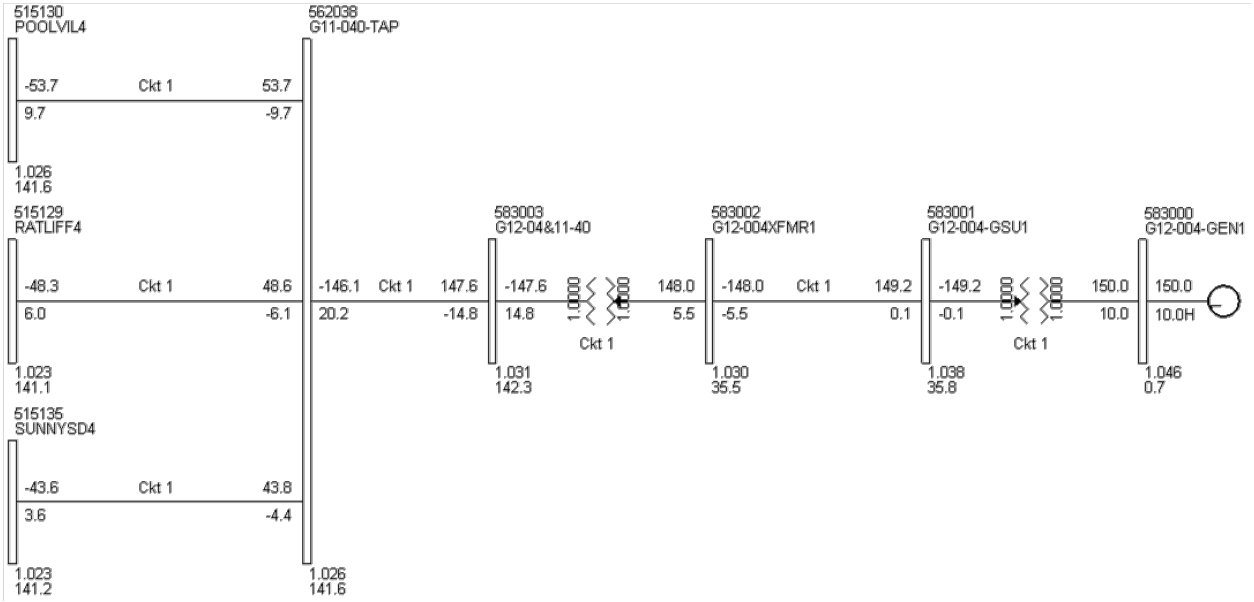

Figure 1: GEN-2011-040 & GEN-2012-004 Facility One-line Diagram

4.0 Stability Study Criteria

FERC Order 661A Low Voltage Ride-Through Provisions (LVRT), which went into effect January 1, 2006, requires that wind generating plants remain in-service during 3-phase faults at the point of interconnection. This order may require a Static VAR Compensator (SVC) or STATCOM device be specified at the Customer facility to keep the wind generator on-line for the fault. Dynamic Stability studies performed as part of the System Impact Study will provide additional guidance as to whether the reactive compensation can be static or a portion must be dynamic (such as a SVC or STATCOM).

5.0 Model Development

Transient stability analysis was performed using modified versions of the 2012 series of Model Development Working Group (MDWG) dynamic study models representing the South Central Oklahoma (Group 14) geographical study area or group within the SPP footprint.

This group contains the 2014 (summer and winter) and 2023 (summer) seasonal models or cases. The cases are then adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally the prior queued and study generation is 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.

Siemens PSS/E Version 32.1 was the software tool used to perform the impact restudy. For simulation purposes, the Customer's facility was simplified by using the equivalent model of the wind farm as shown in Figure 1. The data used to develop the equivalent wind farm model were supplied by the Customer.

The Customer also supplied the PSS/E Version 32.1 stability models for the Vestas 2.0MW wind turbine generators. The Vestas generator provided showed a reactive power capability of +0.98/-0.96 power factor range.

Equal and lower queued requests were included in the saved cases. The South Central Oklahoma (Group 14) requests are shown in Table 1.

Table 1: South Central Oklahoma GI Queued Projects

Request	Size (MW)	Generator Model	Point of Interconnection
GEN-2011-050	109.8	Vestas V90 VCSS 1.8MW	Tap Rush Springs – Marlow 138kV line (562081)
GEN-2011-040 & GEN-2012-004	150.0	Vestas V100 VCSS 2.0MW	Tap Pooleville – Ratliff 138kV line (562038)
GEN-2013-007	100.0	Vestas V100 VCSS 2.0MW	Tap Prices Fall – Carter 138kV line (560719)

6.0 Stability Study Analysis

Forty-eight (48) contingencies were considered for the transient stability simulations in this scenario. These contingencies included three phase faults and single phase line faults at locations defined by SPP.

Single-phase line faults were simulated by applying a 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.

The faults that were defined and simulated are listed in Table 2. The faults were simulated on both the summer peak and the winter peak models.

Table 2: Contingency List

Cont. No.	Cont. Name	Description
1	FLT_01_SUNNYSD7_LES7_345kV_3PH	3 phase fault on the Lawton East Side (511468) to Sunnyside (515136) 345kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 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_SUNNYSD7_LES7_345kV_1PH	*Single phase fault and sequence like previous*
3	FLT_03_SUNNYSD7_JOHNCO7_345kV_3PH	3 phase fault on the Johnson Co. (514809) to Sunnyside (515136) 345kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 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_SUNNYSD7_JOHNCO7_345kV_1PH	*Single phase fault and sequence like previous*
5	FLT_05_SUNNYSD7_HUGO7_345kV_3PH	3 phase fault on the Hugo (521157) to Sunnyside (515136) 345kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 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_SUNNYSD7_HUGO7_345kV_1PH	*Single phase fault and sequence like previous*
7	FLT_07_G11040TAP_RATLIFF4_138kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Ratliff (515129) 138kV CKT 1, near GEN-2011-040 Tap. a. Apply fault at the GEN-2011-040 Tap 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Table 2: Contingency List

Cont. No.	Cont. Name	Description
8	FLT_08_G11040TAP_RATLIFF4_138 kV_1PH	*Single phase fault and sequence like previous*
9	FLT_09_G11040TAP_POOLVIL4_13 8kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Pooleville (515130) 138kV CKT 1, near GEN-2011-040 Tap. a. Apply fault at the GEN-2011-040 Tap 138kV 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_G11040TAP_POOLVIL4_13 8kV_1PH	*Single phase fault and sequence like previous*
11	FLT_11_ARBUCKL4_JOLLYVL4_138k V_3PH	3 phase fault on the Arbuckle (515117) to Jollyville (515118) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV 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_ARBUCKL4_JOLLYVL4_138k V_1PH	*Single phase fault and sequence like previous*
13	FLT_13_ARBUCKL4_MILLCKT4_138 kV_3PH	3 phase fault on the Arbuckle (515117) to Mill Creek Tap (515121) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
14	FLT_14_ARBUCKL4_MILLCKT4_138 kV_1PH	*Single phase fault and sequence like previous*
15	FLT_15_ARBUCKL4_OAKLAW4_138 kV_3PH	3 phase fault on the Arbuckle (515117) to Oaklawn (515123) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
16	FLT_16_ARBUCKL4_OAKLAW4_138 kV_1PH	*Single phase fault and sequence like previous*
17	FLT_17_ARBUCKL4_BLUERIV4_138 kV_3PH	3 phase fault on the Arbuckle (515117) to Blue River (515133) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV 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.
18	FLT_18_ARBUCKL4_BLUERIV4_138 kV_1PH	*Single phase fault and sequence like previous*

Table 2: Contingency List

Cont. No.	Cont. Name	Description
19	FLT_19_ARBUCKL4_BERWYN4_138 kV_3PH	3 phase fault on the Arbuckle (515117) to Berwyn (515173) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV 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.
20	FLT_20_ARBUCKL4_BERWYN4_138 kV_1PH	*Single phase fault and sequence like previous*
21	FLT_21_ARBUCKL4_VANOSS4_138 kV_3PH	3 phase fault on the Arbuckle (515117) to Vanoss Sub (515174) 138kV CKT 1, near Arbuckle. a. Apply fault at the Arbuckle 138kV 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.
22	FLT_22_ARBUCKL4_VANOSS4_138 kV_1PH	*Single phase fault and sequence like previous*
23	FLT_23_CARTER4_CHIKSAW4_138k V_3PH	3 phase fault on the Carter Tap (515138) to Chickasaw (515171) 138kV CKT 1, near Carter Tap. a. Apply fault at the Carter Tap 138kV 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.
24	FLT_24_CARTER4_CHIKSAW4_138k V_1PH	*Single phase fault and sequence like previous*
25	FLT_25_CARTER4_ARDWEST4_138 kV_3PH	3 phase fault on the Ardmore West (515372) to Carter Tap (515138) 138kV CKT 1, near Carter Tap. a. Apply fault at the Carter Tap 138kV 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_CARTER4_ARDWEST4_138 kV_1PH	*Single phase fault and sequence like previous*
27	FLT_27_G13007TAP_CARTER4_138 kV_3PH	3 phase fault on the Carter Tap (515138) to GEN-2013-007 Tap (560719) 138kV CKT 1, near GEN-2013-007 Tap. a. Apply fault at the GEN-2013-007 Tap 138kV 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_G13007TAP_CARTER4_138 kV_1PH	*Single phase fault and sequence like previous*
29	FLT_29_CHIKSAW4_FNDTION4_13 8kV_3PH	3 phase fault on the Chickasaw (515171) to Foundation (515162) 138kV CKT 1, near Chickasaw. a. Apply fault at the Chickasaw 138kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Table 2: Contingency List

Cont. No.	Cont. Name	Description
30	FLT_30_CHIKSAW4_FNDTION4_138kV_1PH	*Single phase fault and sequence like previous*
31	FLT_31_CHIKSAW4_TOTAL4_138kV_3PH	3 phase fault on the Chickasaw (515171) to Total Petr. (515165) 138kV CKT 1, near Chickasaw. a. Apply fault at the Chickasaw 138kV 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_CHIKSAW4_TOTAL4_138kV_1PH	*Single phase fault and sequence like previous*
33	FLT_33_G13007TAP_PRICESF4_138kV_3PH	3 phase fault on the GEN-2013-007 Tap (560719) to Prices Fall (514814) 138kV CKT 1, near GEN-2013-007 Tap. a. Apply fault at the GEN-2013-007 Tap 138kV 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_G13007TAP_PRICESF4_138kV_1PH	*Single phase fault and sequence like previous*
35	FLT_35_POOLVIL4_FOX4_138kV_3PH	3 phase fault on the Fox (515131) to Pooleville (515130) 138kV CKT 1, near Pooleville. a. Apply fault at the Pooleville 138kV 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_POOLVIL4_FOX4_138kV_1PH	*Single phase fault and sequence like previous*
37	FLT_37_G11040TAP_SUNNYSD4_138kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Sunnyside (515135) 138kV CKT 1, near GEN-2011-040 Tap. a. Apply fault at the GEN-2011-040 Tap 138kV 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_G11040TAP_SUNNYSD4_138kV_1PH	*Single phase fault and sequence like previous*
39	FLT_39_SUNNYSD4_UNIROY4_138kV_3PH	3 phase fault on the Sunnyside (515135) to Uniroyal (515137) 138kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 138kV 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_SUNNYSD4_UNIROY4_138kV_1PH	*Single phase fault and sequence like previous*

Table 2: Contingency List

Cont. No.	Cont. Name	Description
41	FLT_41_SUNNYSD4_LONEGRV4_138kV_3PH	3 phase fault on the Lone Grove (515144) to Sunnyside (515135) 138kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 138kV 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_SUNNYSD4_LONEGRV4_138kV_1PH	*Single phase fault and sequence like previous*
43	FLT_43_SUNNYSD4_ROCKYPT4_138kV_3PH	3 phase fault on the Sunnyside (515135) to Rocky Point (515164) 138kV CKT 1, near Sunnyside. a. Apply fault at the Sunnyside 138kV 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_SUNNYSD4_ROCKYPT4_138kV_1PH	*Single phase fault and sequence like previous*
45	FLT_45_RATLIFF4_PRARPNT4_138kV_3PH	3 phase fault on the Prairie Pt. (515134) to Ratliff (515129) 138kV CKT 1, near Ratliff. a. Apply fault at the Ratliff 138kV 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_RATLIFF4_PRARPNT4_138kV_1PH	*Single phase fault and sequence like previous*
47	FLT_47_SUNNYSD7_SUNNYSD4_345_138kV_3PH	3 phase fault on the Sunnyside 345kV (515136) to 138kV (515135) to 13.8kV (515405) CKT 1, near Sunnyside 345kV. a. Apply fault at the Sunnyside 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
48	FLT_48_RATLIFF4_RATLIFF2_138_69kV_3PH	3 phase fault on the Ratliff 138kV (515129) to 69kV (515128) to 13.2kV (515752) CKT 1, near Ratliff 138kV. a. Apply fault at the Ratliff 138kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
49	FLT_49_G11040TAP_RATLIFF4_138kV_3PH_PO_SS_POI	Prior Outage of the GEN-2011-040 Tap – Sunnyside 138kV CKT 1. 3 phase fault on the GEN-2011-040 Tap (562038) to Ratliff (515129) 138kV CKT 1, near GEN-2011-040 Tap. a. Apply fault at the GEN-2011-040 Tap 138kV 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_G11040TAP_RATLIFF4_138kV_1PH_PO_SS_POI	*Single phase fault and sequence like previous*

Table 2: Contingency List

Cont. No.	Cont. Name	Description
51	FLT_51_G11040TAP_POOLVIL4_138kV_3PH_PO_SS_POI	Prior Outage of the GEN-2011-040 Tap – Sunnyside 138kV CKT 1. 3 phase fault on the GEN-2011-040 Tap (562038) to Pooleville (515130) 138kV CKT 1, near GEN-2011-040 Tap. a. Apply fault at the GEN-2011-040 Tap 138kV 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_G11040TAP_POOLVIL4_138kV_1PH_PO_SS_POI	*Single phase fault and sequence like previous*

7.0 Simulation Results

All faults were run for both summer and winter cases, and no tripping occurred in this study. Table 3 summarizes the results for all faults. Complete sets of plots for summer and winter cases are available on request.

Based on the dynamic results and with all network upgrades in service, GEN-2011-040 and GEN-2012-004 did not cause any stability problems and remained stable for all faults studied. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and therefore, meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

Table 3: Contingency Simulation Results

Cont. No.	Cont. Name	Description	Summer 2014	Winter 2014	Summer 2023
1	FLT_01_SUNNYSD7_LES7_345kV_3PH	3 phase fault on the Lawton East Side (511468) to Sunnyside (515136) 345kV CKT 1, near Sunnyside.	Stable	Stable	Stable
2	FLT_02_SUNNYSD7_LES7_345kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
3	FLT_03_SUNNYSD7_JOHNCO7_345kV_3PH	3 phase fault on the Johnson Co. (514809) to Sunnyside (515136) 345kV CKT 1, near Sunnyside.	Stable	Stable	Stable
4	FLT_04_SUNNYSD7_JOHNCO7_345kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
5	FLT_05_SUNNYSD7_HUGO7_345kV_3PH	3 phase fault on the Hugo (521157) to Sunnyside (515136) 345kV CKT 1, near Sunnyside.	Stable	Stable	Stable
6	FLT_06_SUNNYSD7_HUGO7_345kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
7	FLT_07_G11040TAP_RATLIFF4_138kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Ratliff (515129) 138kV CKT 1, near GEN-2011-040 Tap.	Stable	Stable	Stable
8	FLT_08_G11040TAP_RATLIFF4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable

Table 3: Contingency Simulation Results

Cont. No.	Cont. Name	Description	Summer 2014	Winter 2014	Summer 2023
9	FLT_09_G11040TAP_POOLVIL4_138kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Pooleville (515130) 138kV CKT 1, near GEN-2011-040 Tap.	Stable	Stable	Stable
10	FLT_10_G11040TAP_POOLVIL4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
11	FLT_11_ARBUCKL4_JOLLYVL4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Jollyville (515118) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
12	FLT_12_ARBUCKL4_JOLLYVL4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
13	FLT_13_ARBUCKL4_MILLCKT4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Mill Creek Tap (515121) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
14	FLT_14_ARBUCKL4_MILLCKT4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
15	FLT_15_ARBUCKL4_OAKLAW4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Oaklawn (515123) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
16	FLT_16_ARBUCKL4_OAKLAW4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
17	FLT_17_ARBUCKL4_BLUERIV4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Blue River (515133) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
18	FLT_18_ARBUCKL4_BLUERIV4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
19	FLT_19_ARBUCKL4_BERWYN4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Berwyn (515173) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
20	FLT_20_ARBUCKL4_BERWYN4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
21	FLT_21_ARBUCKL4_VANOSS4_138kV_3PH	3 phase fault on the Arbuckle (515117) to Vanoss Sub (515174) 138kV CKT 1, near Arbuckle.	Stable	Stable	Stable
22	FLT_22_ARBUCKL4_VANOSS4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
23	FLT_23_CARTER4_CHIKSAW4_138kV_3PH	3 phase fault on the Carter Tap (515138) to Chickasaw (515171) 138kV CKT 1, near Carter Tap.	Stable	Stable	Stable
24	FLT_24_CARTER4_CHIKSAW4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
25	FLT_25_CARTER4_ARDWEST4_138kV_3PH	3 phase fault on the Ardmore West (515372) to Carter Tap (515138) 138kV CKT 1, near Carter Tap.	Stable	Stable	Stable
26	FLT_26_CARTER4_ARDWEST4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
27	FLT_27_G13007TAP_CARTER4_138kV_3PH	3 phase fault on the Carter Tap (515138) to GEN-2013-007 Tap (560719) 138kV CKT 1, near GEN-2013-007 Tap.	Stable	Stable	Stable
28	FLT_28_G13007TAP_CARTER4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
29	FLT_29_CHIKSAW4_FNDTION4_138kV_3PH	3 phase fault on the Chickasaw (515171) to Foundation (515162) 138kV CKT 1, near Chickasaw.	Stable	Stable	Stable
30	FLT_30_CHIKSAW4_FNDTION4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
31	FLT_31_CHIKSAW4_TOTAL4_138kV_3PH	3 phase fault on the Chickasaw (515171) to Total Petr. (515165) 138kV CKT 1, near Chickasaw.	Stable	Stable	Stable
32	FLT_32_CHIKSAW4_TOTAL4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable

Table 3: Contingency Simulation Results

Cont. No.	Cont. Name	Description	Summer 2014	Winter 2014	Summer 2023
33	FLT_33_G13007TAP_PRICESF4_138kV_3PH	3 phase fault on the GEN-2013-007 Tap (560719) to Prices Fall (514814) 138kV CKT 1, near GEN-2013-007 Tap.	Stable	Stable	Stable
34	FLT_34_G13007TAP_PRICESF4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
35	FLT_35_POOLVIL4_FOX4_138kV_3PH	3 phase fault on the Fox (515131) to Pooleville (515130) 138kV CKT 1, near Pooleville.	Stable	Stable	Stable
36	FLT_36_POOLVIL4_FOX4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
37	FLT_37_G11040TAP_SUNNYSD4_138kV_3PH	3 phase fault on the GEN-2011-040 Tap (562038) to Sunnyside (515135) 138kV CKT 1, near GEN-2011-040 Tap.	Stable	Stable	Stable
38	FLT_38_G11040TAP_SUNNYSD4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
39	FLT_39_SUNNYSD4_UNIROY4_138kV_3PH	3 phase fault on the Sunnyside (515135) to Uniroyal (515137) 138kV CKT 1, near Sunnyside.	Stable	Stable	Stable
40	FLT_40_SUNNYSD4_UNIROY4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
41	FLT_41_SUNNYSD4_LONEGRV4_138kV_3PH	3 phase fault on the Lone Grove (515144) to Sunnyside (515135) 138kV CKT 1, near Sunnyside.	Stable	Stable	Stable
42	FLT_42_SUNNYSD4_LONEGRV4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
43	FLT_43_SUNNYSD4_ROCKYPT4_138kV_3PH	3 phase fault on the Sunnyside (515135) to Rocky Point (515164) 138kV CKT 1, near Sunnyside.	Stable	Stable	Stable
44	FLT_44_SUNNYSD4_ROCKYPT4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
45	FLT_45_RATLIFF4_PRARPNT4_138kV_3PH	3 phase fault on the Prairie Pt. (515134) to Ratliff (515129) 138kV CKT 1, near Ratliff.	Stable	Stable	Stable
46	FLT_46_RATLIFF4_PRARPNT4_138kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable	Stable
47	FLT_47_SUNNYSD7_SUNNYSD4_345_138kV_3PH	3 phase fault on the Sunnyside 345kV (515136) to 138kV (515135) to 13.8kV (515405) CKT 1, near Sunnyside 345kV.	Stable	Stable	Stable
48	FLT_48_RATLIFF4_RATLIFF2_138_69kV_3PH	3 phase fault on the Ratliff 138kV (515129) to 69kV (515128) to 13.2kV (515752) CKT 1, near Ratliff 138kV.	Stable	Stable	Stable
49	FLT_49_G11040TAP_RATLIFF4_138kV_3PH_PO_SS_POI	Prior Outage of the GEN-2011-040 Tap – Sunnyside 138kV CKT 1. 3 phase fault on the GEN-2011-040 Tap (562038) to Ratliff (515129) 138kV CKT 1, near GEN-2011-040 Tap.	Stable	Stable	Stable
50	FLT_50_G11040TAP_RATLIFF4_138kV_1PH_PO_SS_POI	*Single phase fault and sequence like previous*	Stable	Stable	Stable
51	FLT_51_G11040TAP_POOLVIL4_138kV_3PH_PO_SS_POI	Prior Outage of the GEN-2011-040 Tap – Sunnyside 138kV CKT 1. 3 phase fault on the GEN-2011-040 Tap (562038) to Pooleville (515130) 138kV CKT 1, near GEN-2011-040 Tap.	Stable	Stable	Stable
52	FLT_52_G11040TAP_POOLVIL4_138kV_1PH_PO_SS_POI	*Single phase fault and sequence like previous*	Stable	Stable	Stable

8.0 Power Factor Analysis

A power factor analysis was not performed during this study. The power factor analysis from DISIS-2011-002 and DISIS-2012-001 each remain valid for this project. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the point of interconnection. The Interconnection Customer will be required to install capacitor banks to meet this requirement.

9.0 Conclusion

The restudy showed that no stability problems were found during the summer or the winter peak conditions as a result of changing to the Vestas 2.0MW wind turbine generators. 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.

A power factor analysis was not performed during this study. The power factor analysis from DISIS-2011-002 and DISIS-2012-001 each remain valid for this project. The facility will be required to maintain a 95% lagging (providing VARs) and 95% leading (absorbing VARs) power factor at the point of interconnection. The Interconnection Customer will be required to install capacitor banks to meet this requirement.

With the assumptions outlined in this report and with all the required network upgrades from the GEN-2011-040 & GEN-2012-004 GIA in place, GEN-2011-040 & GEN-2012-004 should be able to reliably interconnect to the SPP transmission grid.