Southwest Power Pool

Impact Restudy Study for Generation Interconnection Request GEN–2007–043

SPP Tariff Studies
(#GEN-2007-043)

May 2010

Summary

At the request of the interconnection customer and under the direction of the Southwest Power Pool, Pterra Consulting performed the following impact study through Attachment V. of the Southwest Power Pool OATT. This report contains a restudy of the GEN-2007-043 interconnection request. The request was previously studied using GE 1.5MW wind turbines for 300MW. The customer has requested to change the turbine to G.E. 1.6 MW and lower the request to 200MW. The requested Point of Interconnection is a new 345kV substation on the Lawton Eastside – Cimarron 345kv line.

No angular or voltage stability problems were found for the studied faults. The requested change of wind turbine does not impact stability performance on the SPP transmission system.

Power factor requirements were determined in the impact study ICS-2008-001-1 restudy.

Pterra Consulting

Technical Report R131-10

Impact Study for Generation Interconnection Request GEN-2007-043

Submitted to

Southwest Power Pool

May 2010

This page intentionally left blank

Contents

This page intentionally left blank

Executive Summary

This report presents the stability simulation findings of the re-study of the generator interconnection study for GEN-2007-043 (the “Project”). The Project has a nominal 200 MW maximum rating and was previously studied using GE 1.5 MW Wind Turbine Generators (“WTGs”). In this re-study, the Project is studied using GE 1.6 MW WTGs. The Point of Interconnection (“POI”) is a new 345 kV substation on the existing Anadarko – Cimarron 345 kV transmission line in the Oklahoma Gas and Electric (OG&E) balancing authority. The analysis was conducted through the Southwest Power Pool (“SPP”) Tariff.

Two base cases for 2010 summer and winter conditions, each comprising of a power flow and corresponding dynamics database, were provided by SPP. In order to integrate the proposed 200 MW wind, the existing generation in the SPP footprint was re-dispatched as specified by SPP.

Eighteen (18) faults were considered for the transient stability simulations which included 3-phase faults, as well as, 1-phase to ground faults, at the locations defined by SPP. The results of the simulations showed no angular or voltage instability problems for the 18 faults. The study finds that the interconnection of the proposed 200 MW Project does not impact stability performance of the SPP system for the faults tested on the supplied base cases.

1.1. Project Overview

This report presents the stability simulation findings of the re-study comprising of stability simulation of the proposed interconnection GEN-2007-043 (the "Project"). The Project has a nominal 200 MW max rating studied using GE 1.6 MW wind turbine generators ("WTGs"). The Project's Point of Interconnection ("POI") is at a new 345 kV Substation on the existing Anadarko – Cimarron 345 kV transmission line in the Oklahoma Gas and Electric (OG&E) balancing authority.

Figure 1-1 shows a conceptual interconnection diagram of the Project to the 345 kV transmission network.

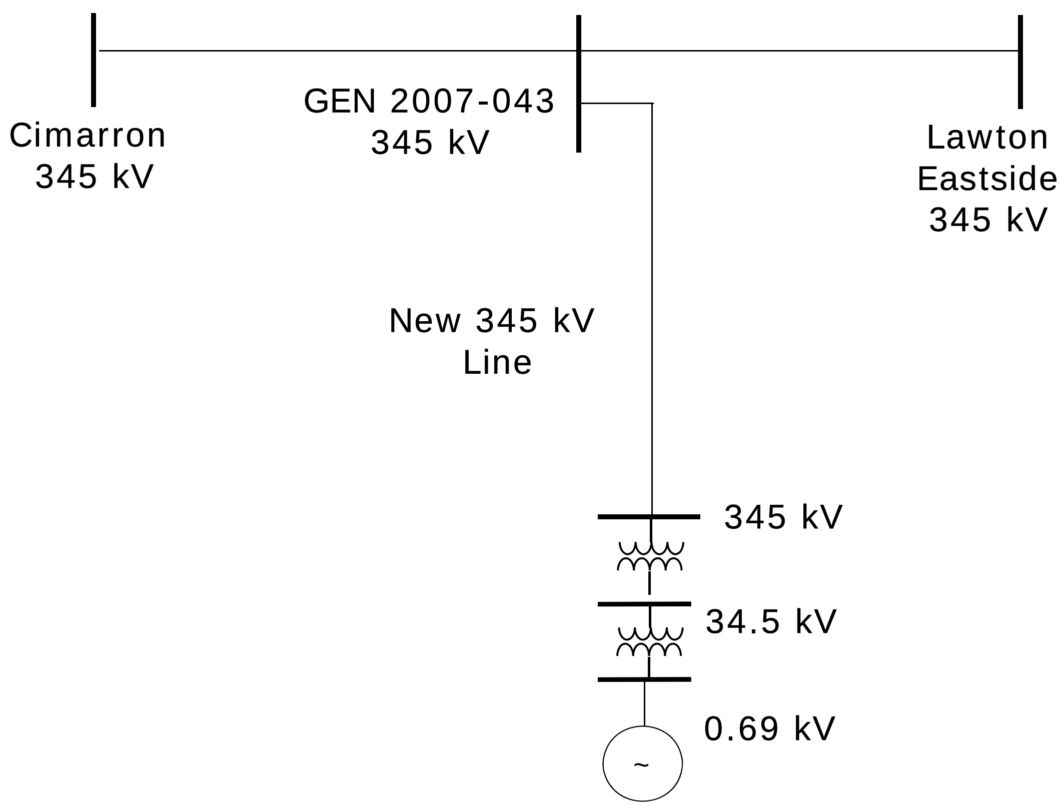

Figure 1-1 Interconnection Plan for the Project to SPP's 345 kV System

In order to integrate the proposed 200 MW wind farm in SPP system as an Energy Resource, existing generation in the SPP footprint was redispatched to maintain area interchange totals.

To simplify the model of the wind farm while capturing the effect of the different impedances of cables (due to change of the conductor size and length), the wind turbines connected to the same 34.5 kV feeder end points were aggregated into one equivalent unit. An equivalent impedance of that feeder was represented by taking the equivalent series impedances of the different feeders connecting the wind turbines. Using this approach, the proposed 200 MW wind farm was modeled with 54 equivalent units. SPP provided the following data:

1. The impedance values for 34.5 kV feeders.
2. The data for the 345 kV/34.5 kV transformers.
3. The line parameters of the new 345 kV line.

Table 1-1 shows a list of the prior queued projects that are included in the base case.

Table 1-1 List of Prior Queued Projects

Request	Size	Wind Turbine Model	Point of Interconnection
GEN-2007-032	150	Acciona 1.5MW	Clinton Jct. – Clinton 138kV (560939)
GEN-2007-052	150	Gas Turbine	Anadarko 138kV (520814)
Blue Canyon I	74	CIMTR	Washita 138kV (521089)
Blue Canyon II (GEN-2003-004)	151	Vestas V80	Washita 138kV (521089)
Weatherford	147	G.E. 1.5MW	Weatherford 138kV (511506)
GEN-2003-005	100	G.E. 1.5MW	Anadarko – Paradise 138kV (560916)
GEN-2006-002	150	Gamesa	Beckham County 345kV (560019)
GEN-2006-035	224	Gamesa	Beckham County 345kV (560019)
GEN-2006-043	99	G.E. 1.5MW	Beckham County 345kV (560019)

1.2. Objective

The objective of the study is to conduct stability analysis determine the impact on system stability of interconnecting a proposed 200 MW wind farm to SPP's 345 kV transmission system.

Section 2. Stability Analysis

2.1. Assumptions

The following assumptions were adopted for the dynamic simulations:

- Constant maximum and uniform wind speed for the entire period of study.
- Wind turbine control models with their default values.

2.2. Faults Simulated

Eighteen (18) faults were considered for the transient stability simulations which included three phase faults, as well as single-phase faults, at the locations defined by SPP. Single-phase 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. Prior queued projects shown in Table 1-1 and units in areas 520, 524, 525, 526, 531, 534, and 536 were monitored in the simulations. Table 2-1 shows the list of simulated faults. The table also shows the fault clearing time and the time delay before re-closing for all the study faults.

Table 2-1 List of the Simulated Faults

Fault No.	Fault Name	Description
1	FLT01-3PH	3 phase fault on the GEN-2007-043 (210431) to Cimarron (514901) 345kV line, near GEN-2007-043. a. Apply fault at the GEN-2007-043 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	FLT02-1PH	*Single phase fault and sequence like previous*
3	FLT03-3PH	3 phase fault on the GEN-2007-043 (210431) to Anadarko (521210) 345kV line, near GEN-2007-043. a. Apply fault at the GEN-2007-043 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	FLT04-1PH	*Single phase fault and sequence like previous*
5	FLT05-3PH	3 phase fault on the Cimarron (514901) to Draper (514934) 345kV line, near Cimarron. a. Apply fault at the Cimarron 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT06-1PH	*Single phase fault and sequence like previous*

Fault No.	Fault Name	Description
7	FLT07-3PH	3 phase fault on the Cimarron (514901) to Northwest (514880) 345kV line, near Cimarron. a. Apply fault at the Cimarron 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT08-1PH	*Single phase fault and sequence like previous*
9	FLT09-3PH	3 phase fault on the Cimarron (514901) to Woodring (514715) 345kV line, near Cimarron. a. Apply fault at the Cimarron 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
10	FLT10-1PH	*Single phase fault and sequence like previous*
11	FLT11-3PH	3 phase fault on the Northwest (514880) to Arcadia (514908) 345kV line, near Northwest. a. Apply fault at the Northwest 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT12-1PH	*Single phase fault and sequence like previous*
13	FLT13-3PH	3 phase fault on the Anadarko (521210) to Lawton Eastside (511468) 345kV line, near Anadarko. a. Apply fault at the Anadarko 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
14	FLT14-1PH	*Single phase fault and sequence like previous*
15	FLT15-3PH	3 phase fault on the Lawton Eastside (511468) to Sunnyside (515136) 345kV line, near Lawton Eastside. a. Apply fault at the Lawton Eastside 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
16	FLT16-1PH	*Single phase fault and sequence like previous*
17	FLT17-3PH	3 phase fault on the Lawton Eastside (511468) to Oklaunion (511456) 345kV line, near Lawton Eastside. a. Apply fault at the Lawton Eastside 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.
18	FLT18-1PH	*Single phase fault and sequence like previous*

Simulations were performed with a 0.1-second steady-state run followed by the appropriate fault as described in Table 2-1. Simulations were run for a minimum 10-second duration to confirm proper machine damping.

2.3. Simulation Results

The simulations conducted in the study using the GE 1.6 MW WTGs did not find any angular or voltage instability problems for the 18 faults. The study finds that the interconnection of the proposed 200 MW Project does not impact stability performance of the SPP system for the faults tested on the supplied base cases.

Section 3. Conclusions

The stability simulation results of the impact study for the proposed 200 MW Project using GE 1.6 MW WTGs, show no angular or voltage instability problems in the SPP system for the studied 18 faults. The study finds that the interconnection of the proposed 200 MW Project does not impact stability performance of the SPP system for the faults tested on the supplied base cases.