Southwest Power Pool

Impact Study For Generation Interconnection Request GEN-2006-031

SPP Tariff Studies

(#GEN-2006-031)

April, 2007

Summary

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Pterra Consulting Inc. (Pterra) performed the following Impact Study to satisfy the Impact Study Agreement executed by the requesting Customer and SPP for SPP Generation Interconnection request #GEN-2006-031.

Interconnection Facilities

The estimated Interconnection Facility and Network Upgrade Costs were given in the Feasibility Study. These costs have been revised and are given below in Table 1 and Table 2. These costs will be estimated in detail by the Transmission Owner during a Facility Study, if the Customer wishes to execute a Facility Study Agreement for this generation interconnection request.

Table 1. Customer Interconnection Facilities

Facility	ESTIMATED COST (2007 DOLLARS)
Customer – 115kV-GSU voltage Substation facilities.	*
Customer – 115kV facilities between Customer facilities and Midwest Knoll 115kV switching station	*
Customer - Right-of-Way for Customer facilities.	*
Total	*****

Table 2. Network Upgrades

Facility	ESTIMATED COST (2006 DOLLARS)
MIDW – Add 115kV terminal into the Knoll 115kV substation bus including one (1) 115kV circuit breaker and associated equipment.	$242,970
Total	**$242,970**

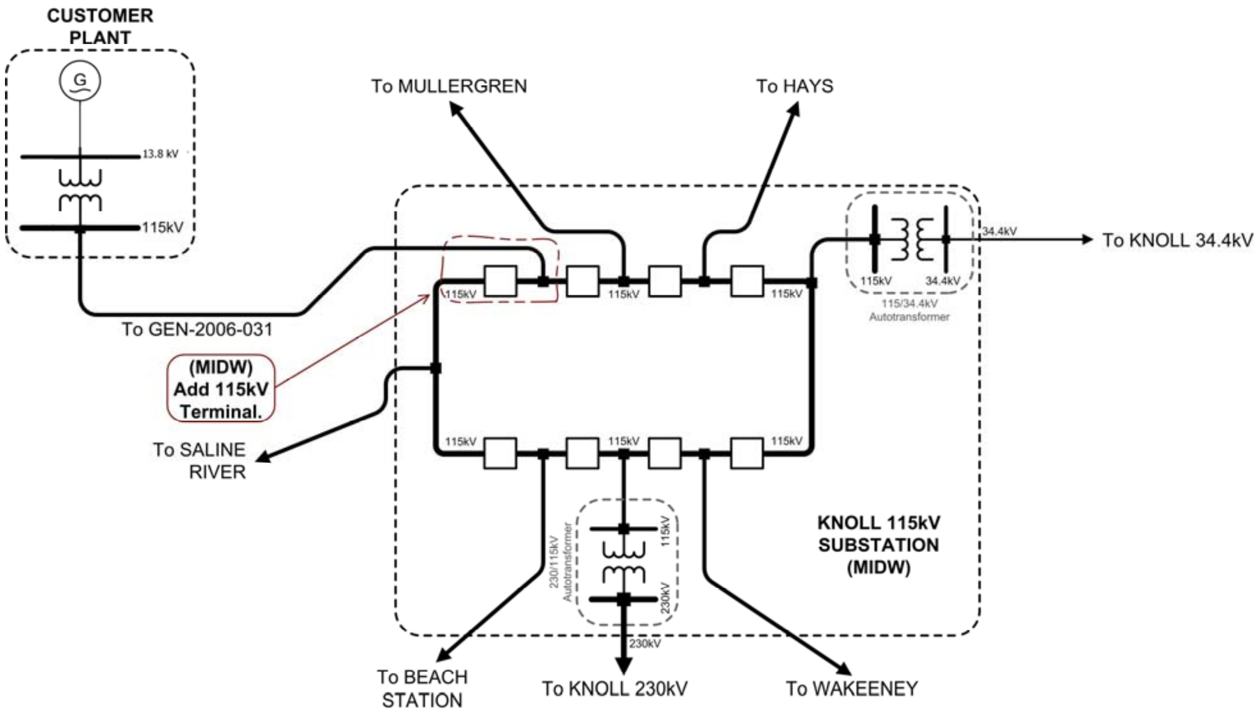

Figure 1: Proposed Interconnection
(Final substation design to be determined

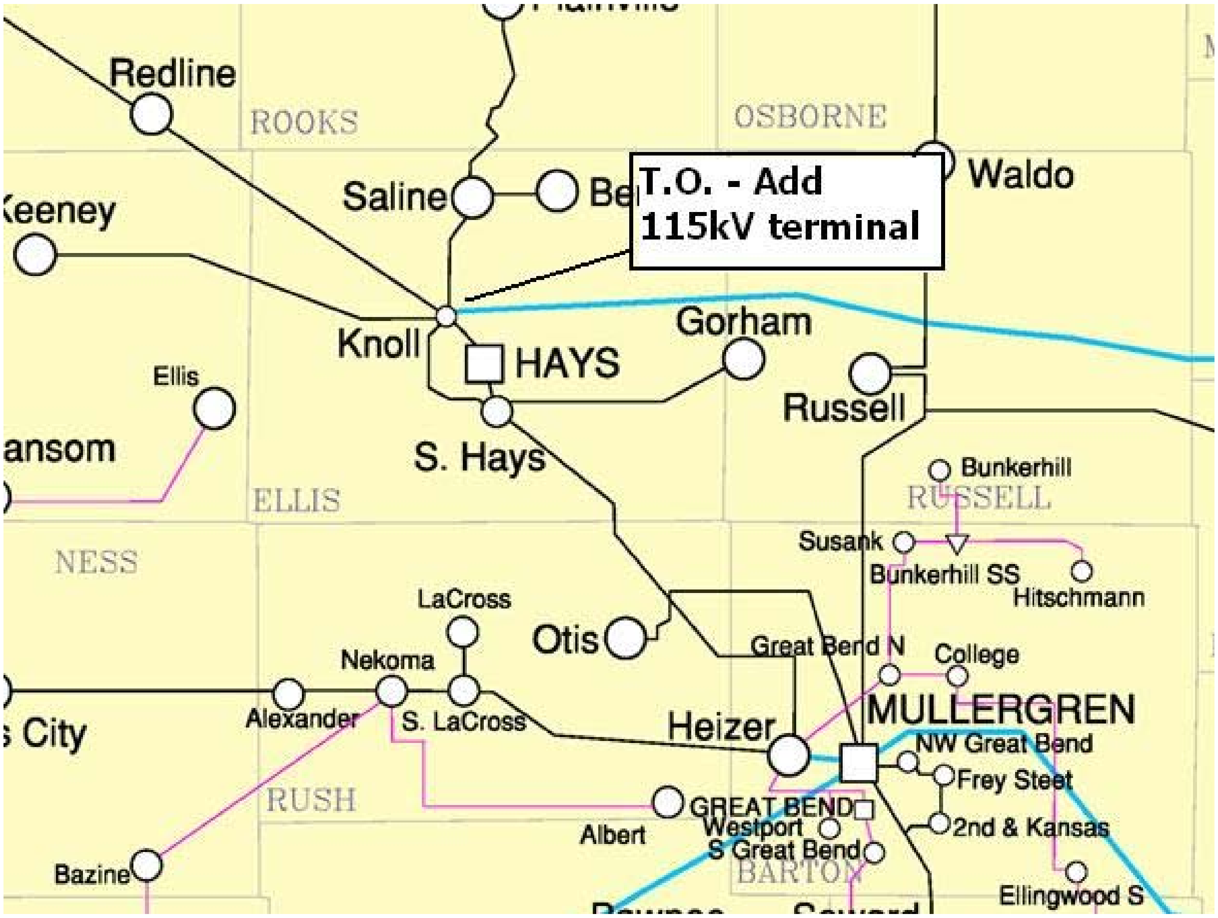

FIGURE 2. MAP OF THE LOCAL AREA

Pterra Consulting

Report No. R111-07

"Impact Study for Generation Interconnection Request GEN-2006-031"

Submitted to

The Southwest Power Pool

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Report No. R111-07

"Impact Study for Generation Interconnection Request GEN-2006-031"

1. Executive Summary

This report presents the stability simulation findings of the impact study of a proposed interconnection (Gen-2006-031). The analysis was conducted through the Southwest Power Pool Tariff for a proposed nine 8.4 MW combustion turbines with a full output of 75.6 MW project located in Ellis County, Kansas. This project would be interconnected to a new position in the existing Knoll 115 kV ring bus at the Knoll 230/115 kV substation. The Knoll substation is owned by Midwest Energy Inc. (MIDW). The customer has asked for a study case of 100% MW.

Two base cases each comprising of a power flow and corresponding dynamics database for 2011 summer and 2007 winter were provided by SPP. Transient stability simulations were conducted with the proposed combustion turbine in service with a full output of 75.6 MW. In order to integrate the proposed 75.6 MW combustion turbine in SPP system, the existing generation in the SPP footprint was re-dispatched.

Twenty five (25) disturbances 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. 1-phase faults were simulated by applying a fault impedance to the positive sequence network at the fault location, representing 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.

For both peak summer and winter loading conditions, the simulations conducted in the study showed stable response for the studied disturbances. All oscillations were well damped. The study finds that the proposed 75.6 MW combustion turbine project shows stable performance of SPP system for the contingencies tested on the supplied base cases.

2. Introduction

2.1 Project Overview

The proposed 75.6 MW project will be connected to a new position on the Knoll 115 kV ring bus. A new 115 kV line will be built by the developer to connect the proposed 75.6 MW project to the Knoll 115 kV substation. Figure 1 shows the interconnection diagram of the proposed GEN-2006-031 project to the 115 kV transmission system.

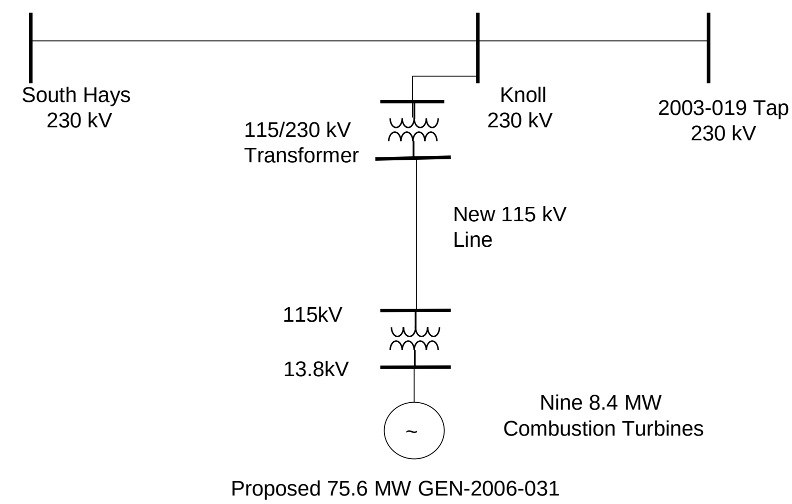

Figure 1. Interconnection Plan for GEN 2006-031 to the 115 kV System

In order to integrate the proposed 75.6 MW project in SPP system, the SPP footprint is re-dispatched.

Table 1 shows the total reactive capability of the proposed 75.6 MW project.

Table. 1 Generator Reactive Capability

Project Output Limit	P_{GEN}	Min. Reactive Power	Max. Reactive Power
Gen 2006-031	75.6 MW	-20 MVAR	20 MVAR

Two base cases each comprising of a power flow and corresponding dynamics database for 2011 summer and 2007 winter were provided by SPP. The base cases contain three (3) prior queued projects in the base case. The projects are as follows:

a. GEN-2003-019; 250MW wind farm on the Summitt-Knoll 230 kV line

b. GEN-2004-014 154MW wind farm on the Mullergren-Spearville 230 kV line

c. GEN-2004-016 150MW wind farm on the Summitt-E McPherson 230 kV line

2.2 Objective

The objective of the study is to determine the impact on system stability of connecting the proposed 75.6 MW project to SPP's transmission system.

3. Stability Analysis

3.1 Modeling of the 75.6 MW Combustion Turbine

The proposed 75.6 MW project and its step-up (GSU) transformer in the load flow case were modeled.

3.2 Assumptions

The following assumptions were adopted for the study:

1) Simulation models for proposed combustion turbine:
   a) Generator excitation system - ESAC8B
   b) Turbine speed governor - GGOV1
   c) Power system stabilizer, IEEE Dual-Input Stabilizer - PSS2A
   d) Machine model, round rotor generator model with quadratic saturation - GENROU
2) SPP provided the generator data and the parameters used for other dynamic models.
3) Generation units in areas 536, 531, 539, 534, and 541 in addition to the prior queued projects were monitored during the stability simulations.

3.3 Disturbances Simulated

Twenty five (25) disturbances 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.

Table 2. List of Contingencies

Fault #	Fault Description
FLT_1_3PH	Fault on the South Hays (56599) to Mullergren (58779) 230 kV line, near South Hays a. Apply Fault at the South Hays bus (56599). b. Clear Fault after 5 cycles by removing the line from South Hays to Mullergen 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.
FLT_2_1PH	Same as FLT13PH above
FLT_3_3PH	Fault on the South Hays (56599) to Knoll (56558) 230 kV line, near South Hays a. Apply Fault at the S Hays (565599).

Fault #	Fault Description
	b. Clear Fault after 5 cycles by removing the line from South Hays - Knoll 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.
FLT_4_1PH	Same as FLT33PH above
FLT_5_3PH	Fault on the Wind Farm Gen-2003-019 Switching Station (99950) to Knoll (56558) 230 kV line, near the Knoll. a. Apply fault at the Knoll bus (56558). b. Clear fault after 5 cycles by removing the line from the Gen-2003-019 Switching Station (99950) to Knoll (56558). c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_6_1PH	Same as FLT53PH above
FLT_7_3PH	Fault on the Circle (56871) to Mullergren (58799) 230 kV line, near Circle. a. Apply Fault at the Circle bus (56871). b. Clear fault after 5 cycles by removing the line from Circle (56871) to Mullergren (58799). c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_8_1PH	Same as FLT73PH above
FLT_9_3PH	Fault on the Spearville (58795) to GEN-2004-014 tap (90) 230 kV line, near GEN-2004-014 tap. a. Apply Fault at the GEN-2004-014 Tap bus (90). b. Clear fault after 5 cycles by removing the line 04-14 tap - Spearville. c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_10_1PH	Same as FLT93PH above
FLT_11_3PH	Fault on the Manhattan (56861) to Concordia (58758) 230 kV line, near Manhattan. a. Apply fault at the Manhattan bus (56861). b. Clear fault after 5 cycles by tripping the line from Manhattan (56861) to Concordia (58758). 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.
FLT_12_1PH	Same as FLT113PH above
FLT_13_3PH	Fault on the Jefferies Energy Center (56766) to Summit (56773) 345 kV line, near Summit. a. Apply fault at the Summit bus (56773). b. Clear fault after 5 cycles by tripping the line from Jefferies Energy Center (56766) to Summit (56773). c. Wait 30 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.
FLT_14_1PH	Same as FLT133PH above

Fault #	Fault Description
FLT_15_3PH	Fault on the Morris (56863) to Summit (56873) 230 kV line, near Summit. a. Apply fault at the Summit bus (56873). b. Clear fault after 5 cycles by tripping the line Morris (56863) to Summit (56873). c. Wait 20 cycles, and then re-close line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_16_1PH	Same as FLT153PH above
FLT_17_3PH	Fault on the Knoll (56561) to Redline (56605) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Knoll (56561) to Redline (56605). c. Wait 15 cycles, and then re-close line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_18_1PH	Same as FLT173PH above
FLT_19_3PH	Fault on the Knoll (56561) to Vine (56591) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Hays (56562) to Vine (56591). c. Wait 15 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.
FLT_20_1PH	Same as FLT193PH above
FLT_21_3PH	Fault on the Knoll (56561) to Saline (56551) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Knoll (56561) to Saline (56551). c. Wait 15 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.
FLT_22_1PH	Same as FLT213PH above
FLT_23_3PH	Fault on the Knoll 230/115kV autotransformer. a. Apply fault at the Knoll bus (56558). b. Clear fault after 5 cycles by tripping the auto
FLT_24_1PH	Same as FLT233PH above
FLT_25_3PH	Fault on the Wind Farm Gen-2003-019 Switching Station (99950) to Summit 230 kV line, near the 03-19 bus. a. Apply fault at the G03-19 bus (99950). b. Clear fault after 5 cycles by removing the line from the Gen-2003-019 Switching Station (99950) to Summit (56558). c. Reclose after 20cycles. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

3.4 Simulation Results

Simulations were performed with a 0.1-second steady-state run followed by the appropriate disturbance as described in Table 2. Simulations were run for a minimum 10-second duration to confirm proper machine damping. Based on the obtained simulation results, the system remained stable for all the simulated faults with the proposed 75.6 MW project in service. All oscillations were well damped. The study finds that the proposed 75.6 MW project, on the basis of base cases, modeling assumptions described within this report, and for the tested contingencies (on the supplied base cases) show stable performance of SPP system.

A complete set of the transient stability plots for rotor angle, speed, frequency, and voltages for the monitored buses in SPP for the simulated (25) disturbances with the proposed 75.6 MW combustion turbine in service, are in an electronic format on the accompanying CD.

For both peak summer and winter loading conditions, the simulations conducted in the study showed stable response for the studied disturbances. All oscillations were well damped. The study finds that the proposed 75.6 MW project shows stable performance of SPP system for the contingencies tested on the supplied base cases.

4. Conclusion

The stability simulation findings of the impact study of a proposed interconnection (Gen-2006-031) were presented in this report. The analysis was conducted through the Southwest Power Pool Tariff for a 115 kV interconnection of nine8.4 MW combustion turbines with a full output of 75.6 MW in Greene County, Missouri.

Transient stability simulations were conducted with the proposed project in service with a full output of 75.6 MW for the provided power flow cases for 2011 summer and 2007 winter peak loading conditions.

Twenty five (25) disturbances 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.

For both summer and winter peak loading conditions, the simulations conducted in the study showed stable response for the studied disturbances. All oscillations were well damped. The study finds that the proposed 75.6 MW combustion turbine project shows stable performance of SPP system for the contingencies tested on the supplied base cases.