SPP Southwest Power Pool

Impact Study For Generation Interconnection Request GEN-2006-028

SPP Tariff Studies

(#GEN-2006-028)

April, 2007

Summary

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Black & Veatch performed the following Impact Study to satisfy the Impact Study Agreement executed by the requesting Customer and SPP for SPP Generation Interconnection request #GEN-2006-028.

Interconnection Facilities

The estimated Interconnection Facility and Network Upgrade Costs were given in the Feasibility Study. These costs are re-stated below in Table 1 and Table 2 and Table 3. These costs do not include the results of short circuit analysis. Detailed facility costs and a short circuit analysis will be conducted 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 – 345kV-GSU voltage Substation facilities.	*
Customer – 345kV facilities between Customer facilities and Westar 345kV switching station	*
Customer - Right-of-Way for Customer facilities.	*
Total	*****

Table 2. Network Upgrades

Facility	ESTIMATED COST (2007 DOLLARS)
Westar – Add two 345kV generator terminals to the 345kV switching station proposed to be built for G.I. request GEN-2006-027.	$3,347,399
Total	**$3,347,399**

Table 3: Required Interconnection Network Upgrade Facilities (if GEN-2006-027 withdraws)

Facility	ESTIMATED COST (2007 DOLLARS)
Westar – Build 345kV switching station in a breaker-and-a-half configuration. Initial layout of the station to have six 345kV circuit breakers, associated switches, steel, relaying and associated equipment. Station to include terminals to the three generators and line terminals to Lang and Morris County substations	$20,798,275
Westar – 345kV transmission work – Cutting in the Lang-Morris County 345kV line into the new switching station.	$500,000
Total	**$21,298,275**

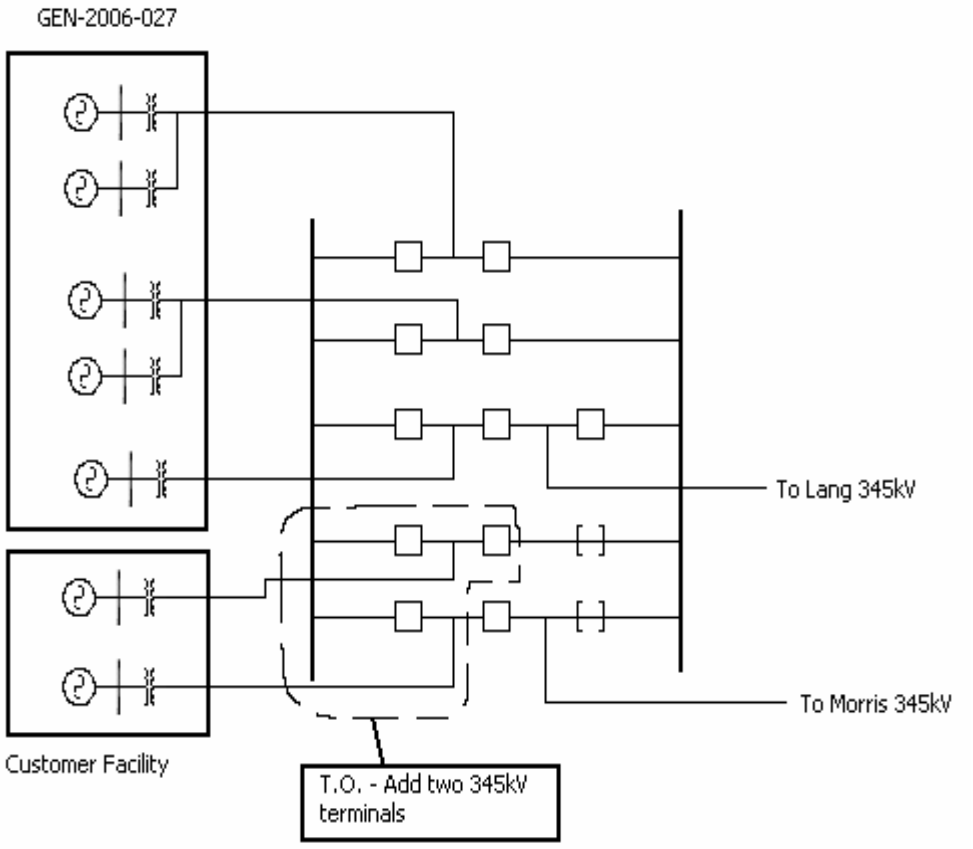

Figure 1: Proposed Interconnection (Final substation design to be determined

Figure 2. Map of the Local Area

IMPACT STUDY FOR SPP GENERATION

QUEUE POSITION GEN-2006-028

SOUTHWEST POWER POOL (SPP)

April 13, 2007

Final Report

By

BLACK & VEATCH

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EXECUTIVE SUMMARY

A transient stability study has been performed for Southwest Power Pool (SPP) Interconnection Queue Position Gen-2006-028 as part of the System Impact Study. The Interconnection Queue Position Gen-2006-028 consists of two combustion turbines with total capacity of 300 MW(Summer)/360 MW(Winter) located in Lyon County, Kansas within the service territory of Kansas Gas and Electric Company (Westar). The generation facility will be interconnected to the Lang 345kV substation on the Westar transmission system.

The 2011 summer peak and 2007 winter peak load flow cases together with the SPP MDWG 2004 stability model were used as the base case for the transient stability analysis. The study was performed using PTI's PSS/E program, which is an industry-wide accepted power system simulation program.

Transient Stability studies were conducted with the 100% total capacity of 300MW in the summer and 360 MW in the winter. Twenty two (22) contingencies were considered for each of the scenarios.

The study has not indicated any angular or voltage instability problem for the contingencies analyzed in both the scenarios after the addition of Gen-2006-028. However, the study has indicated a pre-existing stability issue in winter peak load scenario for a three phase fault closer to JEC. Tripping one of the JEC units prevents system instability for this contingency.

If any previously queued projects that were included in this study drop out then this System Impact Study may have to be revised to determine the impacts of this Interconnection Customer's project on SPS transmission facilities.

1. INTRODUCTION

This report discusses the results of a transient stability study performed for Southwest Power Pool (SPP) Interconnection Queue Position Gen-2006-028.

The Interconnection Queue Position Gen-2006-028 is a generating facility with two combustion turbines of combined capacity of 300 MW (Summer) /360 MW (Winter). The generating facility will be located in Lyon County, Kansas within the service territory of Kansas Gas and Electric Company (Westar) and will be interconnected to Lang 345kV substation. The system one line diagram of the area near the Queue Position Gen-2006-028 is shown below.

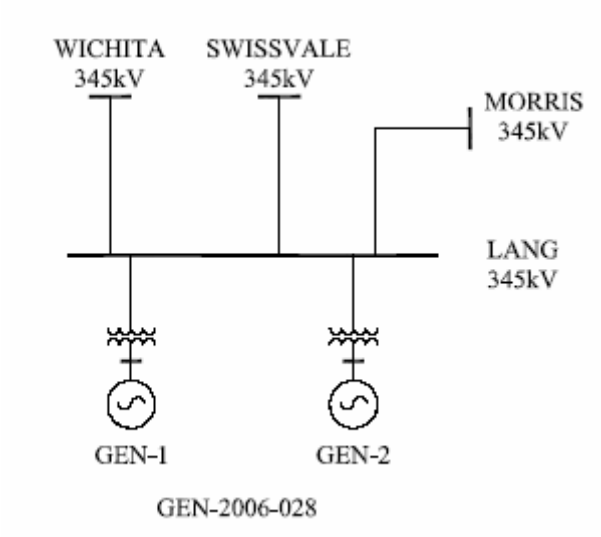

Figure 1 : System One Line Diagram near GEN-2006-028

Transient Stability studies were conducted with the 100% combined capacity, i.e., 300 MW in summer case and 360 MW in winter case. Gen-2006-028 was considered to contain "GE7FA" combustion turbines and the parameters were provided by the Customer for the study.

2. STABILITY STUDY CRITERIA

The 2011 summer peak and 2007 winter peak load flow cases together with the SPP MDWG 2004 stability model were used as the base case for the transient stability analysis. These models were provided by SPP.

Using Planning Standards approved by NERC, the following stability definition was applied in the Transient Stability Analysis:

"Power system stability is defined as that condition in which the difference of the angular positions of synchronous machine rotor becomes constant following an aperiodic system disturbance."

Disturbances such as three phase and single phase line faults were simulated for a specified duration and the synchronous machine rotor angles were monitored for their synchronism following the fault removal.

The ability of the wind generators to stay connected to the grid during the disturbances and during the fault recovery was also monitored.

3. SIMULATION CASES

Transient Stability studies were conducted with the Gen-2006-028 output at 100% for two scenarios, i.e., (i) 2011 summer peak load and (ii) 2007 winter peak load.

Table 1 indicates the contingencies which were studied for each of the two cases.

Fault Number	Fault Definition
FLT13PH	Three phase fault on the Lang – Swissvale 345 kV line, near Lang, with one shot reclosing after 20 cycles.
FLT21PH	Single phase fault on the Lang - Swissvale 345 kV line, near Lang, with one shot reclosing after 20 cycles.
FLT33PH	Three phase fault on the Lang – Morris County 345 kV line, near Lang with one shot reclosing after 20 cycles.
FLT41PH	Single phase fault on the Lang - Morris County 345 kV line, near Lang with one shot reclosing after 20 cycles.
FLT53PH	Three phase fault on the Lang - Wichita 345 kV line, near Lang with one shot reclosing after 20 cycles.
FLT61PH	Single phase fault on the Lang – Wichita 345 kV line, near Lang with one shot reclosing after 20 cycles.
FLT73PH	Three phase fault on the Swissvale – Stilwell 345 kV, near Swissvale with one shot reclosing after 20 cycles.
FLT81PH	Single phase fault on the Swissvale – Stilwell 345

	kV, near Swissvale with one shot reclosing after 20 cycles.
FLT93PH	Three phase fault on the JEC N- Hoyt 345 kV, near JEC N with one shot reclosing after 20 cycles.
FLT101PH	Single phase fault on the JEC N- Hoyt 345 kV, near JEC N with one shot reclosing after 20 cycles
FLT113PH	Three phase fault on the Benton - Wolfcreek 345 kV line, near Benton, with one shot reclosing after 20 cycles
FLT121PH	Single phase fault on the Benton - Wolfcreek 345 kV line, near Benton, with one shot reclosing after 20 cycles
FLT133PH	Three phase fault on the Morris county – Swissvale 230 kV line, near Lang with one shot reclosing after 20 cycles
FLT141PH	Single phase fault on the Morris county – Swissvale 230 kV line, near Lang with one shot reclosing after 20 cycles
FLT153PH	Three phase fault on the Lang – East Street 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT161PH	Single phase fault on the Lang – East Street 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT173PH	Three phase fault on the Lang - Reading 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT181PH	Single phase fault on the Lang - Reading 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT193PH	Three phase fault on the Lang - Prairie 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT201PH	Single phase fault on the Lang - Prairie 115 kV line, near Lang with one shot reclosing after 20 cycles
FLT213PH	Three phase fault on the Lang auto transformer – 345 kV bus.
FLT221PH	Single phase fault on the Lang auto transformer – 345 kV bus.

Table 1: Study Cases

In all of the simulations, the fault duration was considered to be 5 cycles. A single shot re-close was considered in all of the above cases with a wait time of 20 cycles, except for the auto transformer circuit.

4. SIMULATION MODEL

The customer requested to use GE7FA turbine generators for the System Impact Study. The following are the main parameters of the each combustion turbine generator unit and Table 3 shows the electrical parameters of the generators.

Rated Power : 188.7 MW
Voltage : 18,000 V
Rated Power Factor : 0.850

The Customer also provided the following Generator Step-up Transformers impedance:

Transformer Impedance : 10 % on 129 MVA

Each generating unit was considered to be connected with the Lang substation using 2 x 795 kcmil overhead conductors of 0.5 miles.

The models of the generating station equipment such as generators, transformers and overhead transmission lines were added to the base case for the purpose of this study.

Prior queued projects Gen-2002-026 of 121 MW, Gen-2003-019 of 250 MW, Gen-2004-016 of 150 MW and Gen-2006-027 of 310 MW were also included in the study model.

Description	Value
Open Circuit Transient Time Constant, T'D0	5.94
Open Circuit Subtransient Time Constant, T"D0	0.035
Open Circuit Quadrature axis Time Constant, T'Q0	0.57
Open Circuit Quadrature axis Subtransient Time Constant,T"Q0	0.07
Inertia Constant, H	5.01
Synchronous reactance, XD	2
Quadrature axis reactance, XQ	1.89
Transient Reactance, X'D	0.25

Quadrature axis Transient Reactance, X'Q	0.25
Sub transient Reactance, X"D	0.185
Leakage reactance, XL	0.14

Table 3 : Generator Parameters

5. STUDY ASSUMPTIONS

The following assumptions were made in the Study:

1. The wind speed over the entire wind farm (in prior queued projects) was assumed to be uniform and constant during the study period.
2. The generations in the SPP control area were scaled down to accommodate the new generation as indicated in Table 4.

Scenario	**Generation within SPP**	
	Summer	**Winter**
With the Gen-2006-028	39,310 MW	28,770 MW
Without the Gen-2006-028	36,010 MW	28,410 MW

Table 4: SPP Dispatches

6. SIMULATION RESULTS

Initial simulation was carried out for 20 seconds without any disturbance to verify the numerical stability of the model and was confirmed to be stable.

Table 5 provides the summary of the stability studies for Gen-2006-028.

Fault Number	**Summer Peak**	**Winter Peak**
FLT1_3PH	- -	PQ
FLT2_1PH	- -	- -
FLT3_3PH	- -	- -
FLT4_1PH	- -	- -
FLT5_3PH	- -	PQ
FLT6_1PH	- -	- -
FLT7_3PH	- -	- -
FLT8_1PH	- -	- -
FLT9_3PH	- -	S

FLT10_1PH	- -	- -
FLT11_3PH	- -	- -
FLT12_1PH	- -	- -
FLT13_3PH	- -	- -
FLT14_1PH	- -	- -
FLT15_3PH	- -	- -
FLT16_1PH	- -	- -
FLT17_3PH	- -	- -
FLT18_1PH	- -	- -
FLT19_3PH	- -	- -
FLT20_1PH	- -	- -
FLT21_3PH	- -	--
FLT22_1PH	- -	- -

UV : Tripped due to low voltage
OV : Tripped due to high voltage
UF : Tripped due to low frequency
OF : Tripped due to high frequency
S : Stability issues encountered
- - : Combusion Turbine did not trip
PQ : Prior queued project Gen-2002-026 tripped.

Table 5 : Stability Study Results Summary

Gen-2006-028 and the rest of the system were found to be stable for all the contingencies that were studied with the summer peak load. However, system instability was encountered in the winter peak load scenario for a three phase fault on JEC – Hoyt 345 kv line, closer to JEC. It was also found that this instability existed even prior to Gen-2006-028 was interconnected and hence the instability was not caused by Gen-2006-028. Tripping one of the JEC generating units for this contingency prevents the system going unstable.

The prior queued project Gen-2002-026 was found to be tripped for FLT1_3PH and FLT5_3PH.

Figure 2 shows the system response for FLT1_3PH in winter peak load case.

7. SUMMARY

A transient stability analysis was conducted for the SPP Interconnection Generation Queue Position Gen-2006-028 with the maximum output of 300 MW in summer and 360 MW in winter. The study was conducted for two different power flow scenarios, i.e., one for 2011 summer peak load and the other for 2007 winter peak load. The study has indicated instability for a three phase fault closer to JEC in the winter peak load scenario. However this instability was not caused by Gen-2006-028. Tripping one of the JEC units for this contingency prevents the system instability.

Disclaimer

If any previously queued projects that were included in this study drop out, then this System Impact Study may have to be revised to determine the impacts of this Interconnection Customer's project on SPS transmission facilities. Since this is also a preliminary System Impact Study, not all previously queued projects were assumed to be in service in this System Impact Study. If any of those projects are constructed, then this System Impact Study may have to be revised to determine the impacts of this Interconnection Customer's project on SPS transmission facilities. In accordance with FERC and SPP procedures, the study cost for restudy shall be borne by the Interconnection Customer.

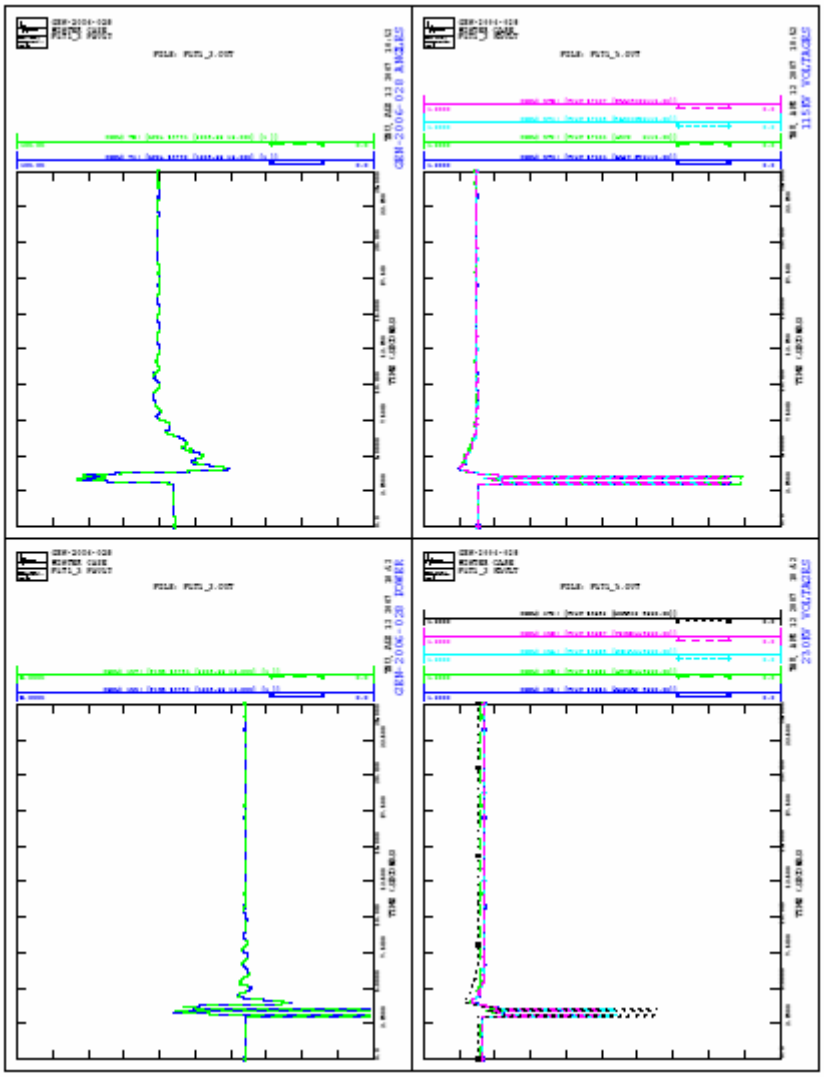

Figure 2 : System Responses with 100% output of Gen-2006-028

Figure 2 : System Responses with 100% output of Gen-2006-028 (Cont'd)