Limited Operational Impact Study for Generation Interconnection Request

GEN-2011-048

May, 2012
Generation Interconnection

Southwest Power Pool

Executive Summary

<OMITTED TEXT> (Customer) has requested an Limited Operation Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 165 MW of combustion turbine generation within the balancing authority of Southwestern Public Service (SPS) in Yoakum County, Texas. Customer has requested this Limited Operation Impact Study (LOIS) to determine the impacts of interconnecting its generating facility to the transmission system before such time that SPP can complete the required interconnection studies. Limited Operation Studies are conducted under GIA Section 5.9.

This study assumed that only the higher queued projects identified in Table 3 of this study might go into service before the completion of all Network Upgrades identified in DISIS-2011-002. If any additional generation projects not identified in Table 3 but with queue priority equal to or over GEN-2011-048, those projects listed in Table 4, request to go into commercial operation before all Network Upgrades identified through the DISIS-2011-002 study process as required, then this study must be conducted again to determine whether sufficient limited interconnection service exists to interconnect the GEN-2011-048 interconnection request in addition to all higher priority requests in operation or pending operation.

A power flow analysis shows that the Customer's combustion turbine facility can interconnect a maximum of 154 MW of interconnection capacity. Powerflow analysis was based on both summer and winter peak conditions and light loading cases. This interconnection request was studied for Energy Resource Interconnection Service (ERIS) only in this LOIS.

The construction lead time to construct the substation additions to Mustang substation will be determined by the Transmission Owner during the Facility Study. Any proposed in service date will be contingent upon the completion of the substation additions to Mustang substation.

The combustion turbine generation facility was studied as a 165 MW combustion turbine generator. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the SPS transmission system for the system condition as it will be on December 31, 2012. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were modified 2012 summer peak and 2012 winter peak cases that were adjusted to reflect system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Twenty-nine (29) contingencies were identified for use in this study. The combustion turbine was modeled using information provided by the Customer. Stability Analysis indicates that with the addition of stabilizers on certain generating units in the SPS balancing authority, the transmission system will remain stable for the studied contingencies for the added generation. The cost of the addition of stabilizers will be determined in the Facility Study.

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.

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Introduction

<OMITTED TEXT> (Customer) has requested a Limited Operation Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 165 MW of combustion turbine generation within the balancing authority of Southwestern Public Service (SPS) in Yoakum County, Texas. Customer has requested this Limited Operation Impact Study (LOIS) to determine the impacts of interconnecting its generating facility to the transmission system before such time that SPP can complete the required interconnection studies. Limited Operation Studies are conducted under GIA Section 5.9.

This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the SPS transmission system for the system condition as it will be on December 31, 2012. The combustion turbine generation facility was studied as a 165 MW request. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were modified versions of the 2012 summer peak and 2012 winter peak to reflect the system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Twenty-nine (29) contingencies were identified for this study.

Purpose

The purpose of this Limited Operation Impact Study (LOIS) is to evaluate the impact of the proposed interconnection on the reliability of the Transmission System. The LOIS considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the LOIS is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have a pending higher queued Interconnection Request to interconnect to the Transmission System listed in Table 3; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions, for example, one or more of the previously queued projects not included in this study signing an interconnection agreement, may require a re-study of this request 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.

Facilities

Generating Facility

The project was modeled with the plant comprised as a single combustion turbine generator with 165 MW output. The high side of the GSU is connected to a 230kV substation at the POI.

Interconnection Facility

The Point of Interconnection will be at the Mustang 230kV switching station. Figure 1 shows a one-line illustration of the facility and the POI. Figure 2 shows a one-line bus interconnection of the Point of Interconnection.

Cost to interconnect on a limited basis is estimated at $4,000,000.

Additional Facilities – Costs to install stabilizers needed on certain generating units in the SPS balancing authority will be determined in the Facility Study.

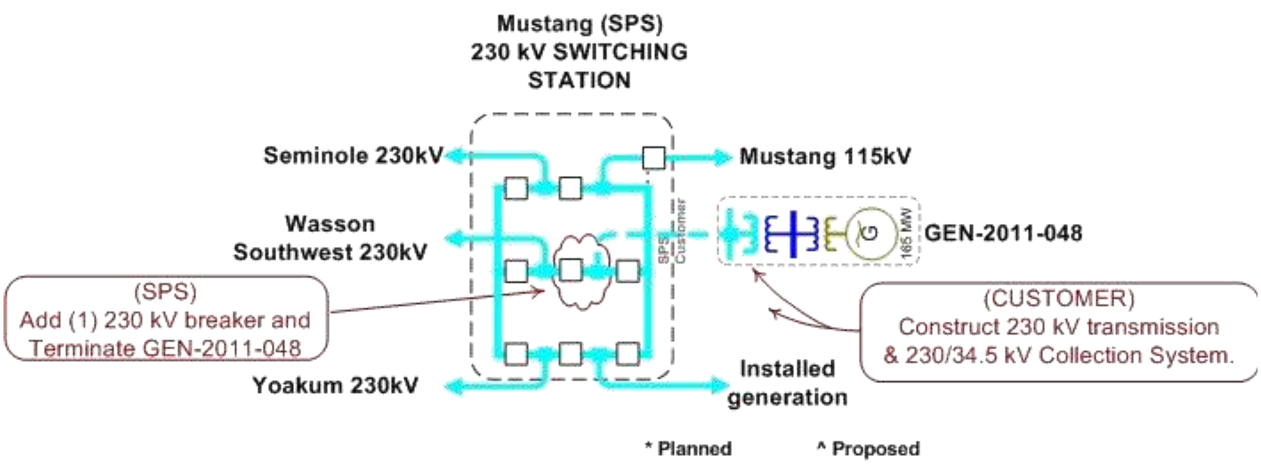

Figure 1: *GEN-2011-048 Facility and Proposed Interconnection Configuration*

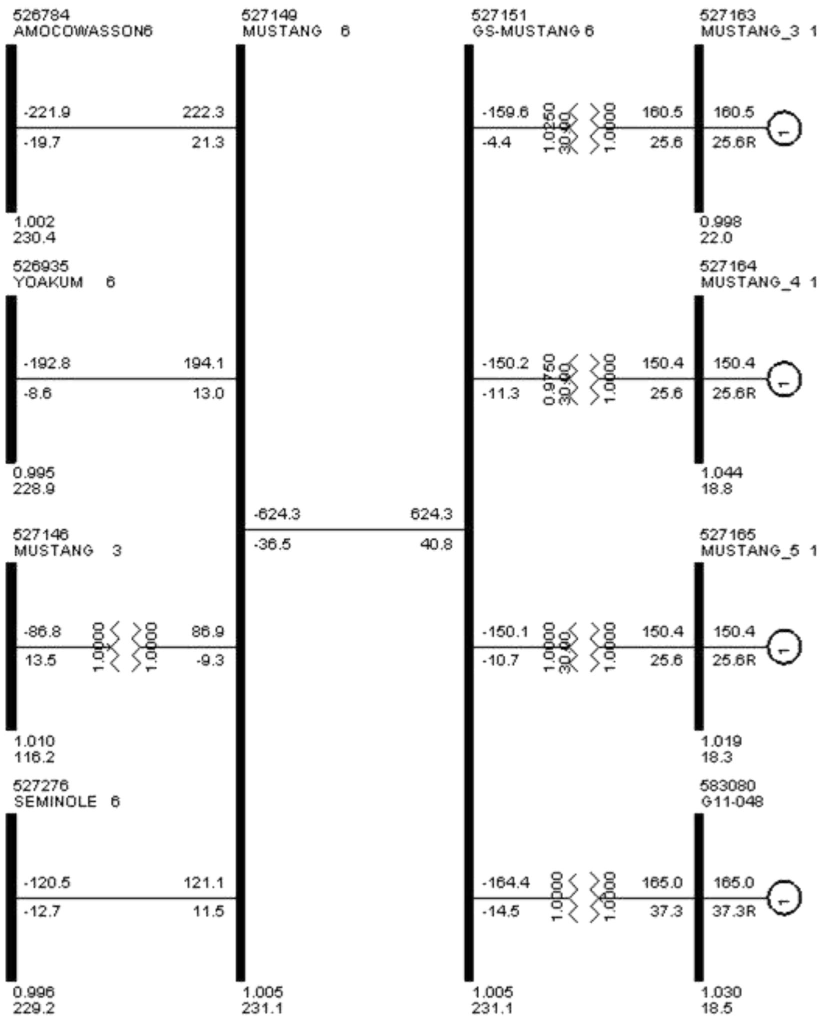

Figure 2: *GEN-2011-048 Bus Interconnection*

Powerflow Analysis

A powerflow analysis was conducted for the Interconnection Customer's facility using a modified version of the 2012 spring, 2012 summer, and 2012 winter seasonal models. The output of the Interconnection Customer's facility was offset in the model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. This analysis was conducted assuming that previous queued requests listed in Table 3 were in-service.

The Southwest Power Pool (SPP) Criteria states that:

> "The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable NERC Reliability Standards for transmission planning. All MDWG power flow models shall be tested to verify compliance with the System Performance Standards from NERC Table 1 – Category A."

The ACCC function of PSS/E was used to simulate single contingencies in portions of or all of the control area of SPS and other control areas within SPP and the resulting data analyzed. This satisfies the "more probable" contingency testing criteria mandated by NERC and the SPP criteria.

Higher queued projects listed in Table 4 were not modeled as in service. If any of these come in service, this study will need to be performed again to determine if any limited interconnection service is available.

The ACCC analysis indicates that the Customer's project can interconnect 154 MW of generation into the SPS transmission system. This interconnection request was studied for Energy Resource Interconnection Service (ERIS) only in this LOIS.

***Table 1**: ACCC Analysis for GEN-2011-048*

SEASON	SOURCE	DIRECTION	MONTCOMMONNAME	RATEA	RATEB	TDF	TC%LOADING	MW Available	CONTNAME
12SP	G11_048	FROM->TO	MUSTANG STATION - YOAKUM COUNTY INTERCHANGE 230KV CKT 1	319	351	0.658	101.9	154	'AMOCO WASSON SWITCHING STATION - MUSTANG STATION 230KV CKT 1'

Stability Analysis

Contingencies Simulated

Twenty-nine (29) contingencies were considered for the transient stability simulations. 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 below.

***Table 2**: Contingencies Evaluated*

Cont. No.	Cont. Name	Description
1.	FLT_01_CRVEALMOOR4_BORDEN6_138_230kV_3PH	3 phase fault on the Cap Rock Vealmoor 138kV (522896) to Borden Co. (526830) 230kV transformer, near Vealmoor. a. Apply fault at Vealmoor 138kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
2.	FLT_02_G11058TAP_BORDEN6_230kV_3PH	3 phase fault on the GEN-2011-058 Tap (562089) to Borden (526830) 230kV line, near GEN-2011-058 Tap. a. Apply fault at GEN-2011-058 Tap 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.
3.	FLT_03_G11058TAP_BORDEN6_230kV_1PH	*Single phase fault and sequence like previous*
4.	FLT_04_G11058TAP_GRASSLAND6_230kV_3PH	3 phase fault on the GEN-2011-058 Tap (562089) to Grassland (526677) 230kV line, near GEN-2011-058 Tap. a. Apply fault at GEN-2011-058 Tap 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.
5.	FLT_05_G11058TAP_GRASSLAND6_230kV_1PH	*Single phase fault and sequence like previous*
6.	FLT_06_GRASSLAND6_JONESBUS26_230kV_3PH	3 phase fault on the Grassland (526677) to Jones Bus 2 (526338) 230kV line, near Grassland. a. Apply fault at Grassland 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.
7.	FLT_07_GRASSLAND6_JONESBUS26_230kV_1PH	*Single phase fault and sequence like previous*
8.	FLT_08_GRASSLAND6_GRASSLAND6_115_230kV_3PH	3 phase fault on the Grassland (526676) 115kV to Grassland (526677) 230kV transformer, near Grassland 115kV. a. Apply fault at Grassland 115kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.

Cont. No.	Cont. Name	Description
9.	FLT_09_JONESBUS26_LUBBCKSTH6_230kV_3PH	3 phase fault on the Jones Bus 2 (526338) to Lubbock South (526269) 230kV line, near Jones Bus 2. a. Apply fault at Jones Bus 2 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
10.	FLT_10_JONESBUS26_LUBBCKSTH6_230kV_1PH	*Single phase fault and sequence like previous*
11.	FLT_11_JONESBUS16_JONESBUS26_230kV_3PH	3 phase fault on the Jones Bus 1 (526337) to Jones Bus 2 (526338) 230kV line, near Jones Bus 1. a. Apply fault at Jones Bus 1 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
12.	FLT_12_JONESBUS16_JONESBUS26_230kV_1PH	*Single phase fault and sequence like previous*
13.	FLT_13_TUCOINT6_JONESBUS16_230kV_3PH	3 phase fault on the Tuco (525830) to Jones Bus 1 (526337) 230kV line, near Tuco. a. Apply fault at Tuco 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
14.	FLT_14_TUCOINT6_JONESBUS16_230kV_1PH	*Single phase fault and sequence like previous*
15.	FLT_15_TUCOINT7_TUCOINT6_345_230kV_3PH	3 phase fault on the Tuco 345kV (525832) to Tuco 230kV (525830) transformer, near Tuco 345kV. a. Apply fault at Tuco 345kV bus. b. Clear fault after 5 cycles by tripping the faulted transformer.
16.	FLT_16_TOLKEAST6_TUCOINT6_230kV_3PH	3 phase fault on the Tolk East (525524) to Tuco (525830) 230kV line, near Tolk East. a. Apply fault at Tolk East 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
17.	FLT_17_TOLKEAST6_TUCOINT6_230kV_1PH	*Single phase fault and sequence like previous*
18.	FLT_18_MUSTANG6_SEAGRAVES3_230kV_3PH	3 phase fault on the Mustang (527149) to Seagraves (527276) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
19.	FLT_19_MUSTANG6_SEAGRAVES3_230kV_1PH	*Single phase fault and sequence like previous*
20.	FLT_20_MUSTANG6_AMOCOWASSON6_230kV_3PH	3 phase fault on the Mustang (527149) to AMOCO Wasson (526784) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
21.	FLT_21_MUSTANG6_AMOCOWASSON6_230kV_1PH	*Single phase fault and sequence like previous*
22.	FLT_22_MUSTANG6_YOAKUM6_230kV_3PH	3 phase fault on the Mustang (527149) to Yoakum (526935) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
23.	FLT_23_MUSTANG6_YOAKUM6_230kV_1PH	*Single phase fault and sequence like previous*
24.	FLT_24_SEMINOLE3_DENVERS3_115kV_3PH	3 phase fault on the Seminole (527275) to Denver South (527136) 115kV line, near Seminole. a. Apply fault at Seminole 115kV 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.
25.	FLT_25_SEMINOLE3_DENVERS3_115kV_1PH	*Single phase fault and sequence like previous*

Cont. No.	Cont. Name	Description
26.	FLT_26_YOAKUM6_TOLKWEST6_230kV_3PH	3 phase fault on the Yoakum (526935) to Tolk West (525531) 230kV line, near Yoakum. a. Apply fault at 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.
27.	FLT_27_YOAKUM6_TOLKWEST6_230kV_1PH	*Single phase fault and sequence like previous*
28.	FLT_28_TUCOINT7_OKU7_345kV_3PH	3 phase fault on the Tuco (525832) to Oklaunion (511456) 345kV line, near Tuco. a. Apply fault at Tuco 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
29.	FLT_29_TUCOINT7_OKU7_345kV_1PH	*Single phase fault and sequence like previous*

Further Model Preparation

The base cases contain prior queued projects as shown in Table 3.

The combustion turbine generation from the study customer and the previously queued customers were dispatched into the SPP footprint.

Initial simulations were carried out on both base cases and cases with the added generation for a no-disturbance run of 20 seconds to verify the numerical stability of the model. All cases were confirmed to be stable.

***Table 3**: Prior Queued Projects Included*

Project	MW
ASGI-2010-010	42
ASGI-2010-021	15
ASGI-2011-001	27.3
GEN-2001-033	120
GEN-2001-036	80
GEN-2006-018	170
GEN-2006-026	502
GEN-2010-006	205
ASGI-2011-004	20

The projects listed in Table 4 are higher or equally queued projects that are not included in this analysis. If any of these projects come into service, this study will need to be re-performed to determine if any limited service is available.

***Table 4**: Prior Queued Projects Not Included*

Project	MW
ASGI-2010-020	50
ASGI-2011-002	10
ASGI-2011-003	10
GEN-2001-033	60
GEN-2008-008	60
GEN-2008-009	60
GEN-2008-014	150
GEN-2008-016	248
GEN-2008-022	300
GEN-2009-067S	20
GEN-2010-020	20
GEN-2010-046	56
GEN-2010-058	20
GEN-2011-025	82.3
GEN-2011-045	205
GEN-2011-046	27

Results

Results of the stability analysis are summarized in Table 5. These results are valid for GEN-2011-048 interconnecting with a generation amount up to 165 MW. The results indicate that with the addition of stabilizers on certain generating units in the SPS balancing authority, the transmission system remains stable for all contingencies studied.

***Table 5**: Contingencies Evaluated*

Cont. No.	Cont. Name	Description	2011 Summer	2011 Winter
1.	FLT_01_CRVEALMOOR4_BORDEN6_138_230kV_3PH	3 phase fault on the Cap Rock Vealmoor 138kV (522896) to Borden Co. (526830) 230kV transformer, near Vealmoor.	Stable	Stable
2.	FLT_02_G11058TAP_BORDEN6_230kV_3PH	3 phase fault on the GEN-2011-058 Tap (562089) to Borden (526830) 230kV line, near GEN-2011-058 Tap.	Stable	Stable
3.	FLT_03_G11058TAP_BORDEN6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
4.	FLT_04_G11058TAP_GRASSLAND6_230kV_3PH	3 phase fault on the GEN-2011-058 Tap (562089) to Grassland (526677) 230kV line, near GEN-2011-058 Tap.	Stable	Stable
5.	FLT_05_G11058TAP_GRASSLAND6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
6.	FLT_06_GRASSLAND6_JONESBUS26_230kV_3PH	3 phase fault on the Grassland (526677) to Jones Bus 2 (526338) 230kV line, near Grassland.	Stable	Stable
7.	FLT_07_GRASSLAND6_JONESBUS26_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
8.	FLT_08_GRASSLAND6_GRASSLAND6_115_230kV_3PH	3 phase fault on the Grassland (526676) 115kV to Grassland (526677) 230kV transformer, near Grassland 115kV.	Stable	Stable

Cont. No.	Cont. Name	Description	2011 Summer	2011 Winter
9.	FLT_09_JONESBUS26_LUBBCKSTH6_230kV_3PH	3 phase fault on the Jones Bus 2 (526338) to Lubbock South (526269) 230kV line, near Jones Bus 2.	Stable	Stable
10.	FLT_10_JONESBUS26_LUBBCKSTH6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
11.	FLT_11_JONESBUS16_JONESBUS26_230kV_3PH	3 phase fault on the Jones Bus 1 (526337) to Jones Bus 2 (526338) 230kV line, near Jones Bus 1.	Stable	Stable
12.	FLT_12_JONESBUS16_JONESBUS26_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
13.	FLT_13_TUCOINT6_JONESBUS16_230kV_3PH	3 phase fault on the Tuco (525830) to Jones Bus 1 (526337) 230kV line, near Tuco.	Stable	Stable
14.	FLT_14_TUCOINT6_JONESBUS16_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
15.	FLT_15_TUCOINT7_TUCOINT6_345_230kV_3PH	3 phase fault on the Tuco 345kV (525832) to Tuco 230kV (525830) transformer, near Tuco 345kV.	Stable	Stable
16.	FLT_16_TOLKEAST6_TUCOINT6_230kV_3PH	3 phase fault on the Tolk East (525524) to Tuco (525830) 230kV line, near Tolk East.	Stable	Stable
17.	FLT_17_TOLKEAST6_TUCOINT6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
18.	FLT_18_MUSTANG6_SEAGRAVES3_230kV_3PH	3 phase fault on the Mustang (527149) to Seagraves (527276) 230kV line, near Mustang.	Stable	Stable
19.	FLT_19_MUSTANG6_SEAGRAVES3_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
20.	FLT_20_MUSTANG6_AMOCOWASSON6_230kV_3PH	3 phase fault on the Mustang (527149) to AMOCO Wasson (526784) 230kV line, near Mustang.	Stable	Stable
21.	FLT_21_MUSTANG6_AMOCOWASSON6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
22.	FLT_22_MUSTANG6_YOAKUM6_230kV_3PH	3 phase fault on the Mustang (527149) to Yoakum (526935) 230kV line, near Mustang.	Stable	Stable
23.	FLT_23_MUSTANG6_YOAKUM6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
24.	FLT_24_SEMINOLE3_DENVERS3_115kV_3PH	3 phase fault on the Seminole (527275) to Denver South (527136) 115kV line, near Seminole.	Stable	Stable
25.	FLT_25_SEMINOLE3_DENVERS3_115kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
26.	FLT_26_YOAKUM6_TOLKWEST6_230kV_3PH	3 phase fault on the Yoakum (526935) to Tolk West (525531) 230kV line, near Yoakum.	Stable	Stable
27.	FLT_27_YOAKUM6_TOLKWEST6_230kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable
28.	FLT_28_TUCOINT7_OKU7_345kV_3PH	3 phase fault on the Tuco (525832) to Oklaunion (511456) 345kV line, near Tuco.	Stable	Stable
29.	FLT_29_TUCOINT7_OKU7_345kV_1PH	*Single phase fault and sequence like previous*	Stable	Stable

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.

Fault contingencies were developed to verify that wind farms remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table 6.

***Table 6**: Contingencies Evaluated*

Cont. Name	Description
FLT_18_MUSTANG6_SEAGRAVES3_230kV_3PH	3 phase fault on the Mustang (527149) to Seagraves (527276) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT_20_MUSTANG6_AMOCOWASSON6_230kV_3PH	3 phase fault on the Mustang (527149) to AMOCO Wasson (526784) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.
FLT_22_MUSTANG6_YOAKUM6_230kV_3PH	3 phase fault on the Mustang (527149) to Yoakum (526935) 230kV line, near Mustang. a. Apply fault at Mustang 230kV bus. b. Clear fault after 5 cycles by tripping the faulted line.

The prior queued project wind farms remained online for the fault contingencies described in this section and for all the fault contingencies described in the Contingencies Simulated section. GEN-2011-048 is found to be in compliance with FERC Order #661A.

Conclusion

<OMITTED TEXT> (Customer) has requested a Limited Operation Impact Study for limited interconnection service of 165 MW of combustion turbine generation within the balancing authority of Southwestern Public Service (SPS) in Yoakum County, Texas, in accordance with section 5.9 of the Standard Generation Interconnection Procedures Agreement (GIA) in the SPP OATT.

Power flow analysis showed that the Customer's combustion turbine facility can interconnect 154 MW of combustion turbine generation. This interconnection request was studied for Energy Resource Interconnection Service (ERIS) only in this LOIS.

The construction lead time to construct the substation additions to Mustang substation will be determined by the Transmission Owner during the Facility Study. Any proposed in service date will be contingent upon the completion of the substation additions to Mustang substation.

The stability analysis results of this study show that with the addition of stabilizers on certain generating units in the SPS balancing authority, the combustion turbine generation facility and the transmission system will remain stable for the studied contingencies. The cost of the addition of stabilizers will be determined in the Facility Study. Also, GEN-2011-048 is found to be in compliance with FERC Order #661A.

The projects listed in Table 4 are higher or equally queued projects that are not included in this analysis. If any of these projects come into service, this study will need to be re-performed to determine if any limited interconnection service is available.

The estimates do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer requests transmission service through Southwest Power Pool's OASIS. It should be noted that the models used for simulation do not contain all SPP transmission service.