Impact Study of Limited Operation for Generator Interconnection

GEN-2011-049

May 2013
Generation Interconnection

Southwest Power Pool

Executive Summary

<OMITTED TEXT> (Customer; GEN-2011-049) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 250.7 MW of wind generation to be interconnected as an Energy Resource (ER) into the Transmission System of Oklahoma Gas and Electric (OKGE) in Beckham County, Oklahoma. GEN-2011-049, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-002 (or most recent iteration) Impact Study can be placed into service.

This LOIS addresses the effects of interconnecting the plant to the rest of the transmission system for the system topology and conditions as expected in June 2014. GEN-2011-049 is requesting the interconnection of one hundred nine (109) Siemens SWT 2.3 MW wind turbine generators and associated facilities at the Border 345kV substation on the Woodward (OKGE) – Tuco (SPS) 345kV transmission line. For the typical LOIS, both a power flow and transient stability analysis are conducted. The LOIS assumes that only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within Table 2 of this report. If additional generation projects, listed within Table 3, with queue priority equal to or higher than the study project request rights to go into commercial operation before all Network Upgrades identified within Table 2 of this report are completed, this LOIS will need to be restudied to ensure that interconnection service remains for the GEN-2011-049 request.

Power flow analysis from this LOIS has determined that the GEN-2011-049 request can interconnect a limited amount of generation as an Energy Resource/Network Resource prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 156 MW of Limited Operation Interconnection Service available due to interconnection constraints on the FPL Switch - Woodward 138KV transmission line. Should any other projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available. It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator 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 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.

Transient stability analysis for this LOIS has determined that with additional reactive equipment the transmission system will remain stable for the ninety-four (94) selected faults for the limited operation interconnection of GEN-2011-049 and will meet Low Voltage Ride Through (LVRT) requirements of FERC Order #661A. The LOIS study determined that a minimum of 30MVars of capacitors are required on the 34.5kV bus for voltage recovery from certain simulated fault conditions.

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 must be requested on Southwest Power Pool's OASIS by the Customer.

Table of Contents

Purpose

<OMITTED TEXT> (Interconnection Customer) has requested a Limited Operation System Impact Study (LOIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for an interconnection request into the Transmission System of Oklahoma Gas and Electric (OKGE).

The purpose of this study is to reevaluate the impacts of interconnecting GEN-2011-049 request of 250.7 MW comprised of one hundred nine (109) Siemens SWT 2.3 MW wind turbine generators and associated facilities interconnecting at the Border 345kV substation on the Woodward (OKGE) – Tuco (SPS) 345kV transmission line in Beckham County, Oklahoma. The Customer has requested this amount to be studied as an Energy Resource (ER) with Limited Operation Interconnection Service to commence on or around June of 2014.

Both power flow and transient stability analysis were conducted for this Limited Operation Interconnection Service. Limited Operation Studies are conducted under GIA Section 5.9.

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 1; 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 requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this LOIS at the expense of the Customer.

Nothing within this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service rights. Should the Customer require transmission service, those rights should be requested through SPP's Open Access Same-Time Information System (OASIS).

This LOIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested 6/2014 in-service of GEN-2011-049 for this LOIS. Also listed in Table 1 are both the amount of MWs of interconnection service expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

Table 1: Generation Requests Included within LOIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2001-014	96.0	96.0	Wind	Ft Supply 138kV	Commercial Operation
GEN-2001-037	120.0	120.0	Wind	FPL Moreland Tap 138kV	Commercial Operation
GEN-2005-008	120.0	120.0	Wind	Woodward 138kV	Commercial Operation
GEN-2006-024S	18.9	18.9	Wind	Buffalo Bear Tap 69kV	Commercial Operation
GEN-2006-046	130.0	130.0	Wind	Dewey 138kV	Commercial Operation
GEN-2007-025	300.0	300.0	Wind	Viola 345kV	Commercial Operation
GEN-2007-043	200.0	200.0	Wind	Minco 345kV	Commercial Operation
GEN-2007-050	170.0	170.0	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2008-003	101.0	101.0	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2008-013	300.0	300.0	Wind	Tap Wichita - Woodring (Hunter) 345kV	Commercial Operation
GEN-2008-023	150.0	150.0	Wind	Hobart Junction 138kV	Commercial Operation
GEN-2008-044	197.8	197.8	Wind	Tatonga 345kV	Commercial Operation
GEN-2010-011	11.5	11.5	Wind	Tatonga 345kV	Commercial Operation
GEN-2010-040	298.2	298.2	Wind	Cimarron 345kV	Commercial Operation
GEN-2011-007	250.0	250.0	Wind	Tap Cimarron - Woodring (Matthewson) 345kV	IA Executed/On Schedule
GEN-2011-010	100.8	100.8	Wind	Minco 345kV	IA Executed/On Schedule
GEN-2011-054	300.0	300.0	Wind	Cimarron 345kV	IA Executed/On Schedule
GEN-2011-049	250.7	250.7	Wind	Border 345kV	IA Pending

This LOIS was required because the Customer is requesting interconnection prior to the completion of all of their required upgrades listed within the latest iteration of their Definitive Interconnection System Impact Study (DISIS). Table 2 below lists the required upgrade projects for which this request has cost responsibility. GEN-2011-049 was included within the DISIS-2011-002 that was studied in fall 2011 and posted January 31, 2012. The cluster has been restudied since the original posting. These reports can be located here at the following GI Study URL: http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2011_Impact_Studies.

Table 2: Upgrade Projects not included but Required for Full Interconnection Service

Upgrade Project	Type	Description	Status
Chisholm – Maize 138kV CKT 1 (NRIS only upgrade, Replace terminal equipment at Chisholm)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-002 Customers	Not authorized to begin construction
Evans Energy Center – Maize 138kV CKT 1 (NRIS only upgrade, Replace terminal equipment at Evans Energy Center)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-002 Customers	Not authorized to begin construction
FPL Switch – Mooreland 138kV CKT 1, Rebuild approximately 0.2 miles of 138kV transmission line	Most recent iteration of DISIS 2011-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
FPL Switch – Woodward 138kV CKT 1 , Rebuild approximately 12 miles of 138kV transmission line	Most recent iteration of DISIS 2011-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
Matthewson – Cimarron 345kV CKT 2 (Build second 345kV circuit)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
Tatonga – Matthewson 345kV CKT 2 (Build a second 345kV circuit)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
Thistle – Wichita 345kV Dbl CKT	Most recent iteration of ICS 2008-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Thistle – Woodward 345kV Dbl CKT	Most recent iteration of ICS 2008-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	Build Priority Project	Current Estimated In-Service date of 12/31/2014

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this LOIS at the expense of the Customer. The higher or equally queued projects that were not included in this study are listed in Table 3. While this list is not all inclusive it is a list of the most probable and affecting prior queued requests that were not included within this LOIS, either because no request for an LOIS has been made or the request is on suspension, etc.

Table 3: Higher or Equally Queued GI Requests not included within LOIS

Project	Remainder MW	Total MW	Fuel	POI	Status
GEN-2007-021	201.0	201.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2007-044	300.0	300.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2007-062	765.0	765.0	Wind	Woodward EHV 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-019	300.0	300.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-029	250.5	250.5	Wind	Woodward EHV 138kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-046	200.0	200.0	Wind	Sunnyside 345kV	IA FULLY EXECUTED/ON SUSPENSION
GEN-2008-071	76.8	76.8	Wind	Newkirk 138kV	IA FULLY EXECUTED/ON SUSPENSION
GEN-2009-016	100.8	100.8	Wind	Falcon Road 138kV	IA FULLY EXECUTED/ON SUSPENSION
GEN-2011-019	299.0	299.0	Wind	Woodward 345kV	IA PENDING
GEN-2011-020	299.0	299.0	Wind	Woodward 345kV	IA PENDING
GEN-2011-024	299.0	299.0	Wind	Tatonga 345kV	IA PENDING

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

Sensitivities for Limited Operation beyond 2015

A sensitivity analysis was run for transmission conditions beyond January 1, 2015 until the time that all required network upgrades can be placed into service.

The first sensitivity included additional prior queued generation interconnection requests as listed in Table 4 and additional network upgrades as listed in Table 5. Those listed within Table 4 are the additional generation interconnection requests that are assumed to have rights to either full or partial interconnection service after the completion of the Priority Project that go into service in January 2015.

Table 4: Additional Generation Requests included only for January 2015 sensitivity

Project	Total MW	Fuel	POI	Status
GEN-2002-008	120.0	Wind	Hitchland 345kV	Commercial Operation
GEN-2002-009	80.0	Wind	Hansford 115kV	Commercial Operation
GEN-2003-020	160.0	Wind	Martin 115kV	Commercial Operation
GEN-2006-044	80.0	Wind	Hitchland 345kV	Commercial Operation
GEN-2008-018	250.0	Wind	Finney 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-051	161.0	Wind	Potter County 345kV	IA FULLY EXECUTED/ON SCHEDULE

Table 5: Upgrade Projects included only for 2015 sensitivity

Upgrade Project	Type	Description	Status
Thistle – Wichita 345kV Dbl CKT	Most recent iteration of ICS 2008-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Thistle – Woodward 345kV Dbl CKT	Most recent iteration of ICS 2008-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Spearville – Clark County 345kV Dbl CKT	Most recent iteration of ICS 2008-001.	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Thistle – Clark County 345kV Dbl CKT	Most recent iteration of ICS 2008-001.	Build Priority Project	Current Estimated In-Service date of 12/31/2014

The second sensitivity included additional prior queued generation interconnection requests as listed in Tables 4, 6 and additional network upgrades as listed in Table 5. These interconnection requests are scheduled to be in service by the end of December 2015 and have no additional upgrades required beyond those already included the earlier sensitivities. These generators represent all interconnection requests studied up through DISIS-2010-002.

Table 6: Additional Generation Requests included only for December 2015 sensitivity

Project	Total MW	Fuel	POI	Status
GEN-2007-021	201.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2007-044	300.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2007-062	765.0	Wind	Woodward EHV 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-019	300.0	Wind	Tatonga 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-029	250.5	Wind	Woodward EHV 138kV	IA FULLY EXECUTED/ON SCHEDULE
All Interconnection requests up through DISIS-2010-002 in areas outside of the northwest Oklahoma region (Woodward Group). Wind requests dispatched at lower nameplate (20% nameplate).				

Facilities

Generating Facility

GEN-2011-049 Interconnection Customer's request to interconnect a total of 250.7 MW is comprised of one hundred nine (109) Siemens SWT 2.3 MW wind turbine generators and associated interconnection facilities.

Interconnection Facilities

The POI for GEN-2011-049 Interconnection Customer is through a tap on the Woodward (OKGE) – Tuco (SPS) 345kV transmission line in Beckham County, Oklahoma. Figure 1 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.

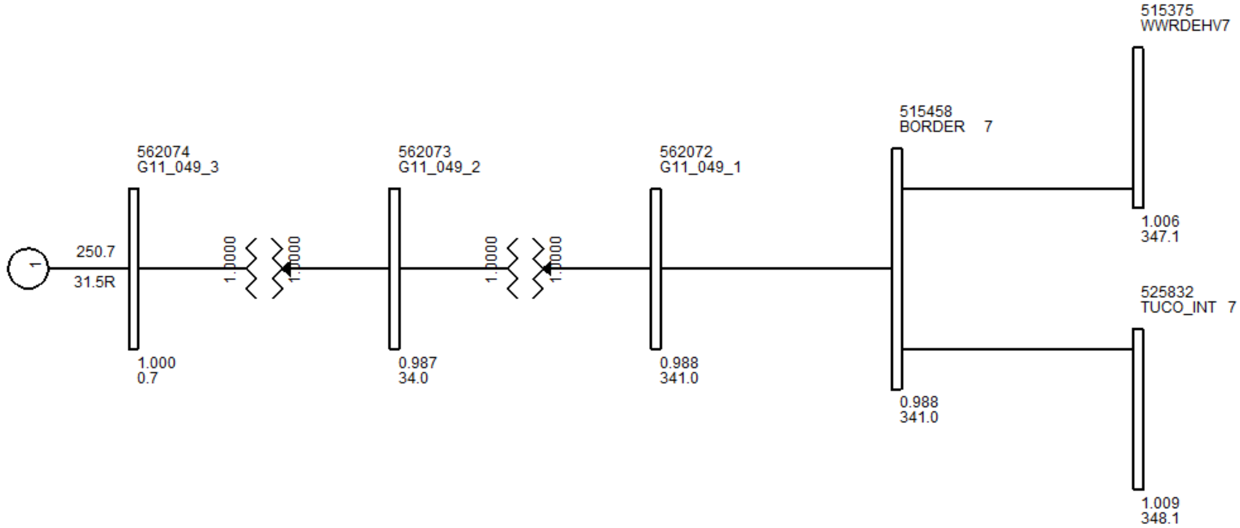

Figure 1: Proposed POI Configuration and Request Power Flow Model

Base Case Network Upgrades

The Network Upgrades included within the cases used for this LOIS study are those facilities that are a part of the SPP Transmission Expansion Plan or the Balanced Portfolio projects that have in-service dates prior to the GEN-2011-049 LOIS requested in-service date of June 2014. These facilities have an approved Notice to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other upgrades were included for this LOIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer.

Power Flow Analysis

Power flow analysis is used to determine if the transmission system can accommodate the injection from the request without violating thermal or voltage transmission planning criteria.

Model Preparation

Power flow analysis was performed using modified versions of the 2012 series of transmission service request study models including the 2013 (spring, summer, and winter) seasonal models. To incorporate the Interconnection Customer's request, a re-dispatch of existing generation within SPP was performed with respect to the amount of the Customer's injection and the interconnecting Balancing Authority. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. For this LOIS, only the previous queued requests listed in Table 1 were assumed to be in-service.

Study Methodology and Criteria

The ACCC function of PSS/E is used to simulate contingencies, including single and multiple facility (i.e. breaker-to-breaker, etc.) outages, within all of the control areas of SPP and other control areas external to SPP and the resulting data analyzed. This satisfies the "more probable" contingency testing criteria mandated by NERC and the SPP criteria.

The contingency set includes all SPP control area branches and ties 69kV and above, first tier Non-SPP control area branches and ties 115 kV and above, any defined contingencies for these control areas, and generation unit outages for the SPP control areas with SPP reserve share program redispatch.

The monitor elements include all SPP control area branches, ties, and buses 69 kV and above, and all first tier Non-SPP control area branches and ties 69 kV and above. NERC Power Transfer Distribution Flowgates for SPP and first tier Non-SPP control area are monitored. Additional NERC Flowgates are monitored in second tier or greater Non-SPP control areas. Voltage monitoring was performed for SPP control area buses 69 kV and above.

Results

The LOIS ACCC analysis indicates that the Customer can interconnect a limited amount of generation into the OKGE transmission system before all required upgrades listed within the DISIS-2011-002 study can be placed into service. A maximum amount of 156.0 MW of generation can be placed into service at the interconnect date of June 2014 due to the interconnection constraints on the FPL Switch - Woodward 138KV transmission line. Should any other GI projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available.

ACCC results for the LOIS can be found in Table 7 and Table 8 below. Generator Interconnection Energy Resource analysis doesn't mitigate for those issues in which the affecting GI request has less than a 20% OTDF, Table 8 is provided for informational purposes only so that the Customer understands there may be operational conditions when they may be required to reduce their output to maintain system reliability.

Limited Operation and System Reliability

In no way does this study guarantee limited operation for all periods of time. It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, it is likely that the Customer 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.

Table 7: Interconnection Constraints for Mitigation of GEN-2011-049 LOIS @ 250.7MW

Season	Dispatch Group	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max MW Available	Contingency
Spring	01G11_049	TO->FROM	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.266	116.5	156.0	NORTHWEST - TATONGA7 345.00 345KV CKT 1
Spring	1	TO->FROM	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.266	107.1	210.1	NORTHWEST - TATONGA7 345.00 345KV CKT 1

Table 8: Additional Constraints of GEN-2011-049 LOIS @ 250.7MW

Season	Dispatch Group	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max Available	Contingency
Spring	01G11_049	TO->FROM	WOODWARD - WOODWARD 69KV CKT 1	53.0	65.0	0.060	101.2	236	FPL SWITCH - MOORELAND 138KV CKT 1

Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

Model Preparation

Transient stability analysis was performed using modified versions of the 2012 series of Model Development Working Group (MDWG) dynamic study models including the 2014 summer and 2013 winter peak dynamic cases. The cases were adapted to resemble the power flow study cases with regards to prior queued generation requests and topology as expected in June 2014. A sensitivity was also conducted for the topology and additional interconnection requests expected for in-service by end of December 2015. Finally the prior queued and study generation was 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.

Disturbances

The ninety-four (94) contingencies were identified for the Limited Operation scenario for use in this study. These faults are listed within Table 9. These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying 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.

With exception to transformers, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically only performed for three-phase faults, unless otherwise noted. Additionally the sequence of events for a transformer is to 1) apply a three-phase fault for five (5) cycles and 2) clear the fault by tripping the affected transformer facility. Unless otherwise noted there will be no re-closing into a transformer fault.

Table 9: Contingencies Evaluated for Limited Operation

Contingency Number and Name		Description
1	FLT_01_BORDER7_WWRDEHV7_345kV_3PH	*3-Phase fault on the Border – Woodward 345kV line near the Woodward 345kV bus.*
2	FLT_02_BORDER7_WWRDEHV7_345kV_1PH	*Single-phase fault similar to previous fault.*
3	FLT_03_BORDER7_TUCOINT7_345kV_3PH	*3-Phase fault on the Border – Tuco 345kV line near the Woodward 345kV bus.*
4	FLT_04_BORDER7_TUCOINT7_345kV_1PH	*Single-phase fault similar to previous fault.*
5	FLT_05_WWRDEHV7_TATONGA7_345kV_3PH	*3-Phase fault on the Woodward – Tatonga 345kV line near the Woodward 345kV bus.*
6	FLT_06_WWRDEHV7_TATONGA7_345kV_1PH	*Single-phase fault similar to previous fault.*
7	* FLT_07_WWRDEHV7_HITCHLAND7_345kV_3PH	** 3-Phase fault on the Woodward – Hitchland 345kV line near the Woodward 345kV bus.*
8	* FLT_08_WWRDEHV7_HITCHLAND7_345kV_1PH	** Single-phase fault similar to previous fault.*
9	FLT_09_TATONGA7_NORTWST7_345kV_3PH	*3-Phase fault on the Tatonga – Northwest 345kV line near the Tatonga 345kV bus.*
10	FLT_10_TATONGA7_NORTWST7_345kV_1PH	*Single-phase fault similar to previous fault.*
11	FLT_11_NORTWST7_SPRNGCK7_345kV_3PH	*3-Phase fault on the Northwest – Spring Creek 345kV line near the Northwest 345kV bus.*
12	FLT_12_NORTWST7_SPRNGCK7_345kV_1PH	*Single-phase fault similar to previous fault.*
13	FLT_13_NORTWST7_CIMARON7_345kV_3PH	*3-Phase fault on the Northwest – Cimarron 345kV line near the Northwest 345kV bus.*
14	FLT_14_NORTWST7_CIMARON7_345kV_1PH	*Single-phase fault similar to previous fault.*
15	FLT_15_NORTWST7_ARCADIA7_345kV_3PH	*3-Phase fault on the Northwest – Arcadia 345kV line near the Northwest 345kV bus.*
16	FLT_16_NORTWST7_ARCADIA7_345kV_1PH	*Single-phase fault similar to previous fault.*
17	FLT_17_HITCHLAND7_FINNEY7_345kV_3PH	*3-Phase fault on the Hitchland – Finney 345kV line near the Hitchland 345kV bus.*
18	FLT_18_HITCHLAND7_FINNEY7_345kV_1PH	*Single-phase fault similar to previous fault.*
19	FLT_19_HITCHLAND7_POTTERCO7_345kV_3PH	*3-Phase fault on the Hitchland – Potter County 345kV line near the Hitchland 345kV bus.*
20	FLT_20_HITCHLAND7_POTTERCO7_345kV_1PH	*Single-phase fault similar to previous fault.*
21	FLT_21_FINNEY7_HOLCOMB7_345kV_3PH	*3-Phase fault on the Finney – Holcomb 345kV line near the Finney 345kV bus.*
22	FLT_22_FINNEY7_HOLCOMB7_345kV_1PH	*Single-phase fault similar to previous fault.*
23	FLT_23_HOLCOMB7_SETAB7_345kV_3PH	*3-Phase fault on the Holcomb – Setab 345kV line near the Holcomb 345kV bus.*
24	FLT_24_HOLCOMB7_SETAB7_345kV_1PH	*Single-phase fault similar to previous fault.*
25	FLT_25_HOLCOMB7_SPERVIL7_345kV_3PH	*3-Phase fault on the Holcomb – Spearville 345kV line near the Holcomb 345kV bus.*
26	FLT_26_HOLCOMB7_SPERVIL7_345kV_1PH	*Single-phase fault similar to previous fault.*
27	FLT_27_TUCOINT7_OKU7_345kV_3PH	*3-Phase fault on the Tuco – Oklaunion 345kV line near the Tuco 345kV bus.*
28	FLT_28_TUCOINT7_OKU7_345kV_1PH	*Single-phase fault similar to previous fault.*
29	FLT_29_OKU7_LES7_345kV_3PH	*3-Phase fault on the Oklaunion – Lawton East Side 345kV line near the Oklaunion 345kV bus.*
30	FLT_30_OKU7_LES7_345kV_1PH	*Single-phase fault similar to previous fault.*
31	FLT_31_LES7_SUNNYSD7_345kV_3PH	*3-Phase fault on the Lawton East Side – Sunnyside 345kV line near the Lawton East Side 345kV bus.*
32	FLT_32_LES7_SUNNYSD7_345kV_1PH	*Single-phase fault similar to previous fault.*
33	FLT_33_LES7_GRACMNT7_345kV_3PH	*3-Phase fault on the Lawton East Side – Gracemont 345kV line near the Lawton East Side 345kV bus.*
34	FLT_34_LES7_GRACMNT7_345kV_1PH	*Single-phase fault similar to previous fault.*
35	FLT_35_WWRDEHV4_WOODWRD4_138kV_3PH	*3-Phase fault on the Woodward EHV– Woodward 138kV line near the Woodward EHV 138kV bus.*
36	FLT_36_WWRDEHV4_WOODWRD4_138kV_1PH	*Single-phase fault similar to previous fault.*
37	FLT_37_WWRDEHV4_IODINE4_138kV_3PH	*3-Phase fault on the Woodward EHV – Iodine 138kV line near the Woodward EHV 138kV bus.*

	Contingency Number and Name	Description
38	FLT_38_WWRDEHV4_IODINE4_138kV_1PH	*Single-phase fault similar to previous fault.*
39	FLT_39_WOODWRD4_WINDFRM4_138kV_3PH	*3-Phase fault on the Woodward – Windfarm Tap 138kV line near the Woodward 138kV bus.*
40	FLT_40_WOODWRD4_WINDFRM4_138kV_1PH	*Single-phase fault similar to previous fault.*
41	FLT_41_IODINE4_DEWEY4_138kV_3PH	*3-Phase fault on the Iodine – Dewey 138kV line near the Iodine 138kV bus.*
42	FLT_42_IODINE4_DEWEY4_138kV_1PH	*Single-phase fault similar to previous fault.*
43	FLT_43_HITCHLAND6_OCHILTREE6_230kV_3PH	*3-Phase fault on the Hitchland – Ochiltree 230kV line near the Hitchland 230kV bus.*
44	FLT_44_HITCHLAND6_OCHILTREE6_230kV_1PH	*Single-phase fault similar to previous fault.*
45	FLT_45_HITCHLAND6_MOORECNTY6_230kV_3PH	*3-Phase fault on the Hitchland – Moore County 230kV line near the Hitchland 230kV bus.*
46	FLT_46_HITCHLAND6_MOORECNTY6_230kV_1PH	*Single-phase fault similar to previous fault.*
47	FLT_47_TUCOINT6_SWISHER6_230kV_3PH	*3-Phase fault on the Tuco – Swisher 230kV line near the Tuco 230kV bus.*
48	FLT_48_TUCOINT6_SWISHER6_230kV_1PH	*Single-phase fault similar to previous fault.*
49	FLT_49_TUCOINT6_TOLKEAST_230kV_3PH	*3-Phase fault on the Tuco – Tolk East 230kV line near the Tuco 230kV bus.*
50	FLT_50_TUCOINT6_TOLKEAST_230kV_1PH	*Single-phase fault similar to previous fault.*
51	FLT_51_TUCOINT6_CARLISLE6_230kV_3PH	*3-Phase fault on the Tuco – Carlisle 230kV line near the Tuco 230kV bus.*
52	FLT_52_TUCOINT6_CARLISLE6_230kV_1PH	*Single-phase fault similar to previous fault.*
53	FLT_53_TUCOINT6_JONES6_230kV_3PH	*3-Phase fault on the Tuco – Jones 230kV line near the Tuco 230kV bus.*
54	FLT_54_TUCOINT6_JONES6_230kV_1PH	*Single-phase fault similar to previous fault.*
55	FLT_55_SWISHER6_AMASOUTH6_230kV_3PH	*3-Phase fault on the Swisher – Amarillo South 230kV line near the Swisher 230kV bus.*
56	FLT_56_SWISHER6_AMASOUTH6_230kV_1PH	*Single-phase fault similar to previous fault.*
57	FLT_57_TOLKEAST_ROSEVELTS6_230kV_3PH	*3-Phase fault on the Tolk East – Roosevelt 230kV line near the Tolk East 230kV bus.*
58	FLT_58_TOLKEAST_ROSEVELTS6_230kV_1PH	*Single-phase fault similar to previous fault.*
59	FLT_59_TOLKEAST_PLANTX6_230kV_3PH	*3-Phase fault on the Tolk East – Plant X 230kV line near the Tolk East 230kV bus.*
60	FLT_60_TOLKEAST_PLANTX6_230kV_1PH	*Single-phase fault similar to previous fault.*
61	FLT_61_TOLKEAST_TOLKTAP6_230kV_3PH	*3-Phase fault on the Tolk East– Tolk Tap 230kV line near the Tolk East 230kV bus.*
62	FLT_62_TOLKEAST_TOLKTAP6_230kV_1PH	*Single-phase fault similar to previous fault.*
63	FLT_63_JONES6_LPHOLLY6_230kV_3PH	*3-Phase fault on the Jones – LP-Holly 230kV line near the Jones 230kV bus.*
64	FLT_64_JONES6_LPHOLLY6_230kV_1PH	*Single-phase fault similar to previous fault.*
65	FLT_65_JONES6_LUBBCKSTH6_230kV_3PH	*3-Phase fault on the Jones – Lubbock South 230kV line near the Jones 230kV bus.*
66	FLT_66_JONES6_LUBBCKSTH6_230kV_1PH	*Single-phase fault similar to previous fault.*
67	FLT_67_JONES6_LUBBCKEST6_230kV_3PH	*3-Phase fault on the Jones – Lubbock East 230kV line near the Jones 230kV bus.*
68	FLT_68_JONES6_LUBBCKEST6_230kV_1PH	*Single-phase fault similar to previous fault.*
69	FLT_69_JONES6_GRASSLAND_230kV_3PH	*3-Phase fault on the Jones – Grassland 230kV line near the Jones 230kV bus.*
70	FLT_70_JONES6_GRASSLAND_230kV_1PH	*Single-phase fault similar to previous fault.*
71	FLT_71_WWRDEHV7_WWRDEHV4_345_138kV_3PH	*3-Phase fault on the Woodward EHV 345kV/138kV transformer near the Woodward 345kV bus.*
72	FLT_72_NORTWST7_NORTWST4_345_138kV_3PH	*3-Phase fault on the Northwest 345kV/138kV transformer near the Northwest 345kV bus.*
73	FLT_73_HITCHLAND7_HITCHLAND6_345_230kV_3PH	*3-Phase fault on the Hitchland 345kV/230kV transformer near the Hitchland 345kV bus.*
74	FLT_74_HOLCOMB7_HOLCOMB3_345_115kV_3PH	*3-Phase fault on the Holcomb 345kV/115kV transformer near the Holcomb 345kV bus.*
75	FLT_75_HITCHLAND6_HITCHLAND3_230_115kV_3PH	*3-Phase fault on the Hitchland 230kV/115kV transformer near the Hitchland 230kV bus.*
76	FLT_76_TUCOINT7_TUCOINT6_345_230kV_3PH	*3-Phase fault on the Tuco 345kV/230kV transformer near the Tuco 345kV bus.*

	Contingency Number and Name	Description
77	FLT_77_TUCOINT6_TUCOINT3_230_115kV_3PH	*3-Phase fault on the Tuco 230kV/115kV transformer near the Tuco 230kV bus.*
78	FLT_78_LES7_LES4_345_138kV_3PH	*3-Phase fault on the Lawton East Side 345kV/138kV transformer near the Lawton East Side 345kV bus.*
79	FLT_79_WOODWRD4_WOODWRD2_138_69kV_3PH	*3-Phase fault on the Woodward 138kV/69kV transformer near the Woodward 138kV bus.*
80	FLT_80_SWISHER6_SWISHER3_230_115kV_3PH	*3-Phase fault on the Swisher 230kV/115kV transformer near the Swisher 230kV bus.*
81	FLT_81_CARLISLE6_CARLISLE3_230_115kV_3PH	*3-Phase fault on the Carlisle 230kV/115kV transformer near the Carlisle 230kV bus.*
82	* FLT_82_WWRDEHV7_BEAVERCO_345kV_3PH	*3-Phase fault on the Woodward – Beaver County 345kV line near the Woodward 345kV bus.*
83	* FLT_83_WWRDEHV7_BEAVERCO_345kV_1PH	*Single-phase fault similar to previous fault.*
84	* FLT_84_WWRDEHV7_THISTLE7_345kV_3PH	*3-Phase fault on the Woodward –Thistle 345kV line near the Woodward 345kV bus.*
85	* FLT_85_WWRDEHV7_THISTLE7_345kV_1PH	*Single-phase fault similar to previous fault.*
86	* FLT_86_BEAVERCO_HITCHLAND7_345kV_3PH	*3-Phase fault on the Beaver County – Hitchland 345kV line near the Beaver County 345kV bus.*
87	* FLT_87_BEAVERCO_HITCHLAND7_345kV_1PH	*Single-phase fault similar to previous fault.*
88	* FLT_88_THISTLE7_WICHITA7_345kV_3PH	*3-Phase fault on the Thistle – Wichita 345kV line near the Thistle 345kV bus.*
89	* FLT_89_THISTLE7_WICHITA7_345kV_1PH	*Single-phase fault similar to previous fault.*
90	* FLT_90_THISTLE7_CLARKCOUNTY7_345kV_3PH	*3-Phase fault on the Thistle – Clark County 345kV line near the Thistle 345kV bus.*
91	* FLT_91_THISTLE7_CLARKCOUNTY7_345kV_1PH	*Single-phase fault similar to previous fault.*
92	* FLT_92_CLARKCOUNTY7_SPERVIL7_345kV_3PH	*3-Phase fault on the Clark County – Spearville 345kV line near the Clark County 345kV bus.*
93	* FLT_93_CLARKCOUNTY7_SPERVIL7_345kV_1PH	*Single-phase fault similar to previous fault.*
94	* FLT_94_THISTLE7_THISTLE4_345_138kV_3PH	*3-Phase fault on the Thistle 345kV/138kV transformer near the Thistle 345kV bus.*

** Faults were simulated only for the sensitivity scenario with applicable system topology.*

Results

Results of the stability analysis are summarized in Table 10. These results are valid for GEN-2011-049**Error! Reference source not found.** interconnecting with a generation amount up to 250.7 MW with reactive equipment. The required reactive equipment, in addition to the generator capabilities, was found to include at a minimum, 30 MVar of staged switched shunt capacitors installed at the customer's 34.5kV substation. Additional reactive equipment may be necessary to achieve, at the point-of-interconnection, the +/- 0.95 power factor required by the SPP OATT. The results indicate that the transmission system remains stable for all contingencies studied. The plots will be available upon request.

Table 10: Fault Analysis Results for Limited Operation

	Contingency Number and Name	2014SP	2013WP
1	FLT_01_BORDER7_WWRDEHV7_345kV_3PH	Stable	Stable
2	FLT_02_BORDER7_WWRDEHV7_345kV_1PH	Stable	Stable
3	FLT_03_BORDER7_TUCOINT7_345kV_3PH	Stable	Stable
4	FLT_04_BORDER7_TUCOINT7_345kV_1PH	Stable	Stable
5	FLT_05_WWRDEHV7_TATONGA7_345kV_3PH	Stable	Stable
6	FLT_06_WWRDEHV7_TATONGA7_345kV_1PH	Stable	Stable
7	*FLT_07_WWRDEHV7_HITCHLAND7_345kV_3PH	Stable	Stable

	Contingency Number and Name	2014SP	2013WP
8	*FLT_08_WWRDEHV7_HITCHLAND7_345kV_1PH	Stable	Stable
9	FLT_09_TATONGA7_NORTWST7_345kV_3PH	Stable	Stable
10	FLT_10_TATONGA7_NORTWST7_345kV_1PH	Stable	Stable
11	FLT_11_NORTWST7_SPRNGCK7_345kV_3PH	Stable	Stable
12	FLT_12_NORTWST7_SPRNGCK7_345kV_1PH	Stable	Stable
13	FLT_13_NORTWST7_CIMARON7_345kV_3PH	Stable	Stable
14	FLT_14_NORTWST7_CIMARON7_345kV_1PH	Stable	Stable
15	FLT_15_NORTWST7_ARCADIA7_345kV_3PH	Stable	Stable
16	FLT_16_NORTWST7_ARCADIA7_345kV_1PH	Stable	Stable
17	FLT_17_HITCHLAND7_FINNEY7_345kV_3PH	Stable	Stable
18	FLT_18_HITCHLAND7_FINNEY7_345kV_1PH	Stable	Stable
19	FLT_19_HITCHLAND7_POTTERCO7_345kV_3PH	Stable	Stable
20	FLT_20_HITCHLAND7_POTTERCO7_345kV_1PH	Stable	Stable
21	FLT_21_FINNEY7_HOLCOMB7_345kV_3PH	Stable	Stable
22	FLT_22_FINNEY7_HOLCOMB7_345kV_1PH	Stable	Stable
23	FLT_23_HOLCOMB7_SETAB7_345kV_3PH	Stable	Stable
24	FLT_24_HOLCOMB7_SETAB7_345kV_1PH	Stable	Stable
25	FLT_25_HOLCOMB7_SPERVIL7_345kV_3PH	Stable	Stable
26	FLT_26_HOLCOMB7_SPERVIL7_345kV_1PH	Stable	Stable
27	FLT_27_TUCOINT7_OKU7_345kV_3PH	Stable	Stable
28	FLT_28_TUCOINT7_OKU7_345kV_1PH	Stable	Stable
29	FLT_29_OKU7_LES7_345kV_3PH	Stable	Stable
30	FLT_30_OKU7_LES7_345kV_1PH	Stable	Stable
31	FLT_31_LES7_SUNNYSD7_345kV_3PH	Stable	Stable
32	FLT_32_LES7_SUNNYSD7_345kV_1PH	Stable	Stable
33	FLT_33_LES7_GRACMNT7_345kV_3PH	Stable	Stable
34	FLT_34_LES7_GRACMNT7_345kV_1PH	Stable	Stable
35	FLT_35_WWRDEHV4_WOODWRD4_138kV_3PH	Stable	Stable
36	FLT_36_WWRDEHV4_WOODWRD4_138kV_1PH	Stable	Stable
37	FLT_37_WWRDEHV4_IODINE4_138kV_3PH	Stable	Stable
38	FLT_38_WWRDEHV4_IODINE4_138kV_1PH	Stable	Stable
39	FLT_39_WOODWRD4_WINDFRM4_138kV_3PH	Stable	Stable
40	FLT_40_WOODWRD4_WINDFRM4_138kV_1PH	Stable	Stable
41	FLT_41_IODINE4_DEWEY4_138kV_3PH	Stable	Stable
42	FLT_42_IODINE4_DEWEY4_138kV_1PH	Stable	Stable
43	FLT_43_HITCHLAND6_OCHILTREE6_230kV_3PH	Stable	Stable
44	FLT_44_HITCHLAND6_OCHILTREE6_230kV_1PH	Stable	Stable
45	FLT_45_HITCHLAND6_MOORECNTY6_230kV_3PH	Stable	Stable
46	FLT_46_HITCHLAND6_MOORECNTY6_230kV_1PH	Stable	Stable
47	FLT_47_TUCOINT6_SWISHER6_230kV_3PH	Stable	Stable
48	FLT_48_TUCOINT6_SWISHER6_230kV_1PH	Stable	Stable
49	FLT_49_TUCOINT6_TOLKEAST_230kV_3PH	Stable	Stable
50	FLT_50_TUCOINT6_TOLKEAST_230kV_1PH	Stable	Stable
51	FLT_51_TUCOINT6_CARLISLE6_230kV_3PH	Stable	Stable
52	FLT_52_TUCOINT6_CARLISLE6_230kV_1PH	Stable	Stable
53	FLT_53_TUCOINT6_JONES6_230kV_3PH	Stable	Stable
54	FLT_54_TUCOINT6_JONES6_230kV_1PH	Stable	Stable
55	FLT_55_SWISHER6_AMASOUTH6_230kV_3PH	Stable	Stable
56	FLT_56_SWISHER6_AMASOUTH6_230kV_1PH	Stable	Stable
57	FLT_57_TOLKEAST_ROSEVELTS6_230kV_3PH	Stable	Stable
58	FLT_58_TOLKEAST_ROSEVELTS6_230kV_1PH	Stable	Stable
59	FLT_59_TOLKEAST_PLANTX6_230kV_3PH	Stable	Stable
60	FLT_60_TOLKEAST_PLANTX6_230kV_1PH	Stable	Stable
61	FLT_61_TOLKEAST_TOLKTAP6_230kV_3PH	Stable	Stable
62	FLT_62_TOLKEAST_TOLKTAP6_230kV_1PH	Stable	Stable
63	FLT_63_JONES6_LPHOLLY6_230kV_3PH	Stable	Stable
64	FLT_64_JONES6_LPHOLLY6_230kV_1PH	Stable	Stable

	Contingency Number and Name	2014SP	2013WP
65	FLT_65_JONES6_LUBBCKSTH6_230kV_3PH	Stable	Stable
66	FLT_66_JONES6_LUBBCKSTH6_230kV_1PH	Stable	Stable
67	FLT_67_JONES6_LUBBCKEST6_230kV_3PH	Stable	Stable
68	FLT_68_JONES6_LUBBCKEST6_230kV_1PH	Stable	Stable
69	FLT_69_JONES6_GRASSLAND_230kV_3PH	Stable	Stable
70	FLT_70_JONES6_GRASSLAND_230kV_1PH	Stable	Stable
71	FLT_71_WWRDEHV7_WWRDEHV4_345_138kV_3PH	Stable	Stable
72	FLT_72_NORTWST7_NORTWST4_345_138kV_3PH	Stable	Stable
73	FLT_73_HITCHLAND7_HITCHLAND6_345_230kV_3PH	Stable	Stable
74	FLT_74_HOLCOMB7_HOLCOMB3_345_115kV_3PH	Stable	Stable
75	FLT_75_HITCHLAND6_HITCHLAND3_230_115kV_3PH	Stable	Stable
76	FLT_76_TUCOINT7_TUCOINT6_345_230kV_3PH	Stable	Stable
77	FLT_77_TUCOINT6_TUCOINT3_230_115kV_3PH	Stable	Stable
78	FLT_78_LES7_LES4_345_138kV_3PH	Stable	Stable
79	FLT_79_WOODWRD4_WOODWRD2_138_69kV_3PH	Stable	Stable
80	FLT_80_SWISHER6_SWISHER3_230_115kV_3PH	Stable	Stable
81	FLT_81_CARLISLE6_CARLISLE3_230_115kV_3PH	Stable	Stable
82	*FLT_82_WWRDEHV7_BEAVERCO_345kV_3PH	Stable	Stable
83	*FLT_83_WWRDEHV7_BEAVERCO_345kV_1PH	Stable	Stable
84	*FLT_84_WWRDEHV7_THISTLE7_345kV_3PH	Stable	Stable
85	*FLT_85_WWRDEHV7_THISTLE7_345kV_1PH	Stable	Stable
86	*FLT_86_BEAVERCO_HITCHLAND7_345kV_3PH	Stable	Stable
87	*FLT_87_BEAVERCO_HITCHLAND7_345kV_1PH	Stable	Stable
88	*FLT_88_THISTLE7_WICHITA7_345kV_3PH	Stable	Stable
89	*FLT_89_THISTLE7_WICHITA7_345kV_1PH	Stable	Stable
90	*FLT_90_THISTLE7_CLARKCOUNTY7_345kV_3PH	Stable	Stable
91	*FLT_91_THISTLE7_CLARKCOUNTY7_345kV_1PH	Stable	Stable
92	*FLT_92_CLARKCOUNTY7_SPERVIL7_345kV_3PH	Stable	Stable
93	*FLT_93_CLARKCOUNTY7_SPERVIL7_345kV_1PH	Stable	Stable
94	*FLT_94_THISTLE7_THISTLE4_345_138kV_3PH	Stable	Stable

** Faults were simulated only for the sensitivity scenario with applicable system topology.*

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 11.

Table 11: LVRT Contingencies

	Contingency Number and Name	Description
1	FLT_01_BORDER7_WWRDEHV7_345kV_3PH	*3-Phase fault on the Border – Woodward 345kV line near the Woodward 345kV bus.*
2	FLT_03_BORDER7_TUCOINT7_345kV_3PH	*3-Phase fault on the Border – Tuco 345kV line near the Woodward 345kV bus.*

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. GEN-2011-049 is found to be in compliance with FERC Order #661A.

Conclusion

<OMITTED TEXT> (Interconnection Customer, GEN-2011-049) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 250.7 MW of wind generation to be interconnected as an Energy Resource (ER) into the transmission facility of Oklahoma Gas and Electric Services (OKGE) in Beckham County, Oklahoma. The point of interconnection will be through the Border substation on the Woodward (OKGE) – Tuco (SPS) 345kV transmission line. GEN-2011-049, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-002 (or most recent iteration) Impact Study can be placed into service.

Power flow analysis from this LOIS has determined that the GEN-2011-049 request can interconnect a limited amount of generation as an Energy Resource (ER) prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 156.0 MW of Limited Operation Interconnection Service available due to interconnection constraints on the FPL Switch - Woodward 138KV transmission line.

Transient stability analysis indicates that with the reactive equipment identified for GEN-2011-049, the transmission system will remain stable for the contingencies listed within Table 9 with the addition of GEN-2011-049 generation. Additionally, GEN-2011-049 was found to be in compliance with FERC Order #661A when studied as listed within this report. The LOIS study determined that a minimum of 30MVars of capacitors are required on the 34.5kV bus for voltage recovery from certain simulated fault conditions.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, will require a re-study of this LOIS 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.