Impact Study for Generator Interconnection Request

GEN-2006-047

October 2013
Generator Interconnection Studies

Southwest Power Pool

Executive Summary

<OMITTED TEXT> (Interconnection Customer; GEN-2006-047) executed a Generator Interconnection Agreement with an Effective date of May 29, 2009. The Generator Interconnection Agreement was dependent upon two higher queued interconnection requests (GEN-2006-039 and GEN-2006-045) building network upgrades. Both GEN-2006-039 and GEN-2006-045 Interconnection Customers have had their Generator Interconnection Agreements terminated. This Impact Study has been initiated by Southwest Power Pool to determine the impacts to GEN-2006-047. GEN-2006-047 is a 240MW wind generation facility to be as an Energy Resource (ER) into a transmission facility of Southwestern Public Service (SPS) in Randall County, Texas.

This Impact Study addresses the effects of interconnecting the plant to the rest of the transmission system for the system topology and conditions as expected on January 1, 2015. GEN-2006-047 is requesting the interconnection of one-hundred fifteen (115) Suzlon 2.1MW wind turbine generators and associated facilities into a proposed substation on the Deaf Smith – Bushland 230kV line. For this Impact Study, both a power flow and transient stability analysis are conducted. The Impact Study assumes that the higher queued projects listed within Table 1 of this study go into service before the completion of all Network Upgrades identified within Table 2 of this report. Power flow analysis from this LOIS has determined that the GEN-2006-047 request can interconnect its requested generation as an Energy Resource with the completion of Network Upgrades. Prior to the completion of the required Network Upgrades, listed within Table 2 of this report, there is no more than 212 MW of Limited Operation Interconnection Service available. This determination is for the period of July 1, 2014 until the completion of the following Network Upgrades:

Energy Resource Interconnection Service (ERIS) Network Upgrades

- Bushland – Potter 230kV terminal equipment
- Bushland – Deaf Smith 230kV terminal equipment

The ERIS Network Upgrades are currently scheduled for completion in January, 2015. Transient stability analysis from this LOIS has determined that the transmission system will remain stable for all of the forty-two (42) selected faults for the limited operation interconnection of GEN-2006-047.

It should be noted that although this study 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(s) may be required to reduce their generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Nothing in this study should be construed as a guarantee of transmission service or delivery rights. If the customer wishes to obtain deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

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Purpose

<OMITTED TEXT> (Interconnection Customer; GEN-2006-047) executed a Generator Interconnection Agreement with an Effective date of May 29, 2009. The Generator Interconnection Agreement was dependent upon two higher queued interconnection requests (GEN-2006-039 and GEN-2006-045) building network upgrades. Both GEN-2006-039 and GEN-2006-045 Interconnection Customers have had their Generator Interconnection Agreements terminated. This Impact Study has been initiated by Southwest Power Pool to determine the impacts to GEN-2006-047. GEN-2006-047 is a 240MW wind generation facility to be as an Energy Resource (ERIS) into a transmission facility of Southwestern Public Service (SPS) in Randall County, Texas.

Both power flow and transient stability analysis were conducted for this Impact Study. This Impact Study 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 higher queued Interconnection Request to interconnect to the Transmission System; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

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 Impact 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 7/2014 in-service of GEN-2006-047 for this Impact Study. 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: Regional Generation Requests Included within LOIS by Scenario

Project	MW	Total MW	Fuel Source	POI	Status
Llano Estacado (White Deer)	80.00	80.00	Wind	Llano Wind 115kV	COMMERCIAL OPERATION
GEN-2002-022	240.00	240.00	Wind	Bushland 230kV	COMMERCIAL OPERATION
GEN-2007-048	400.00	400.00	Wind	Tap Amarillo S - Swisher 230kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2008-051	322.00	322.00	Wind	Potter County 345kV	COMMERCIAL OPERATION

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2008-088	50.60	50.60	Wind	Vega 69kV	IA FULLY EXECUTED/ON SCHEDULE
ASGI-2013-001	25.00	25.00	Wind	PanTex South 115kV	FACILITY STUDY IN PROGRESS
GEN-2006-047	240.00	240.00	Wind	Tap Bushland - Deaf Smith) 230kV	IA FULLY EXECUTED/ON SUSPENSION

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 or shares cost responsibility. GEN-2006-047 was included within the System Impact Study for Generation Interconnection Request GEN 2006-047 that was posted in January 2008. This report can be located here at the following GI Study URL: http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2006_Impact_Studies.

Table 2: Network Upgrade Projects not included (unless otherwise noted) but required for full Interconnection Service

Upgrade Project	Type	Description	Status
BUSHLAND INTERCHANGE 230.00 - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1	SPP-2011-AG3-AFS-9	Replace line traps	In Service 12/31/2014
BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1	--	Replace line traps	In Service 12/31/2014

Any changes to these assumptions (for either scenario), 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 Table 3 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 Group 5 (Amarillo Area) GI Requests not included within LOIS

Project	Remainder MW	Total MW	Fuel	POI	Status
None					

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

Facilities

Generating Facility

GEN-2006-047 Interconnection Customer's request to interconnect a total of 241.5 MW is comprised of one-hundred fifteen (115) Suzlon 2.1 MW wind turbine generators and associated interconnection facilities.

Interconnection Facilities

The POI for GEN-2006-047 Interconnection Customer is a new tap on the SPS Bushland – Deaf Smith 230kV transmission line in Randall County, Texas. 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.

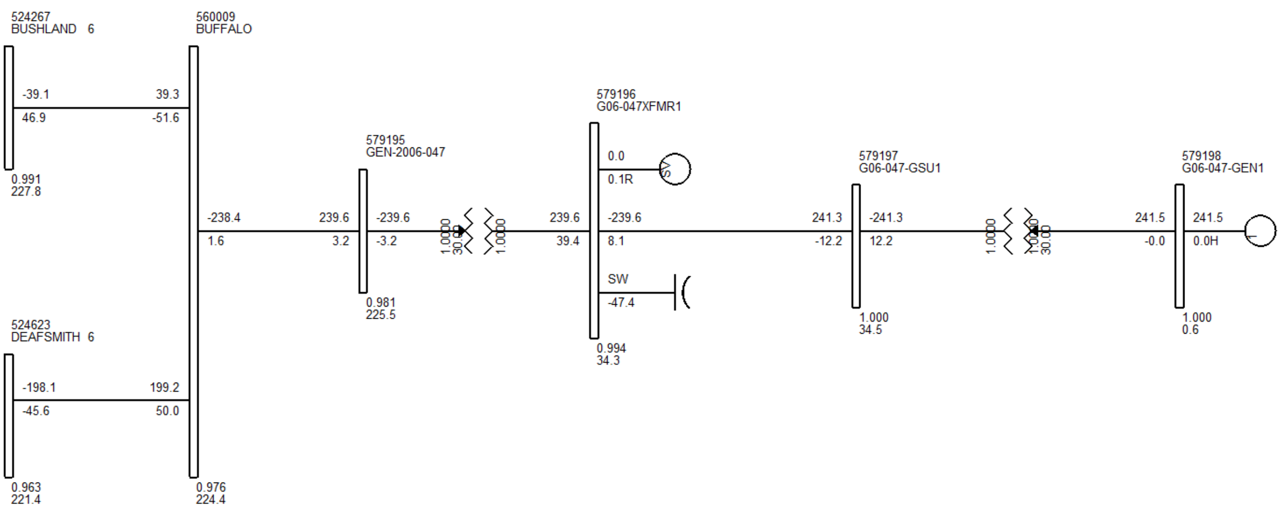

Figure 1: Proposed POI Configuration and Request Power Flow Model

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-2006-047 LOIS requested in-service date of July 1, 2014. These facilities have an approved Notification 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 Interconnection Request (ERIS). 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 Factor 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

Power flow analysis from this LOIS has determined that the GEN-2006-047 request can interconnect a limited amount of generation as an Energy Resource prior to the completion of the required Network Upgrades, listed within Table 2 of this report. AC Contingency Calculation (ACCC) results for this LOIS can be found below in Table 4 and Table 5. Under the assumptions defined by this LOIS, there is no more than 212 MW of Limited Operation Interconnection Service available. These determinations are for the period of July 1, 2014 until the completion of the following required Network Upgrades listed within Table 2. The ERIS Network Upgrades are scheduled for completion in December, 2014.

Should any other Generation Interconnection 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.

Since ERIS analysis doesn't provide for transmission reinforcements for issues in which the affecting Generation Interconnection request has less than a 20% TDF, Table 5 is provided for informational purposes only so that the Customer understands there may be times when they may be required to reduce their output to maintain system reliability.

Curtailment and System Reliability

In no way does this study guarantee limited operation for all periods of time. It should be noted that although this study 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 4: Interconnection Constraints (ACCC) of GEN-2006-047 LOIS @ 241.5MW

Season	Dispatch Group	Flow	Overloaded Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max MW Available	Contingency
13G	05ALL	FROM->TO	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1	319	351	0.83105	106.7959	212	G0647 230.00 - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1
13G	05ALL	FROM->TO	G0647 230.00 - DEAF SMITH COUNTY INTERCHANGE 230KV CKT 1	319	351	0.70723	100.9774	236	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1

Table 5: Additional Constraints (ACCC) of GEN-2006-047 LOIS @ 241.5MW (Not for mitigation within LOIS but possible curtailment issues)

Season	Dispatch Group	Flow	Overloaded Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Contingency
13G	05ALL	'TO->FROM'	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.04823	135.5632	Double-Woodward – Thistle 345kV
13G	05ALL	'TO->FROM'	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.0322	106.3238	G12-016 TAP 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1
13G	05ALL	'FROM->TO'	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	287	287	0.11584	100.231	Double-Hitchland – Beaver 345kV

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 winter) seasonal models. The cases are then adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally the prior queued and study generation 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 forty-two (42) contingencies were identified for use in this study. These faults are listed within Table 6. 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 6: Contingencies Evaluated for Limited Operation of GEN-2006-047

Contingency Number and Name		Description
1	FLT_01_G0647_DEAFSMITH_230kV_3PH	*3-Phase fault on the Buffalo – Deaf Smith 230kV CKT 1 near the Buffalo 230kV bus.*
2	FLT_02_G0647_DEAFSMITH_230kV_1PH	*Single-phase fault similar to previous fault.*
3	FLT_03_G0647_BUSHLAND_230kV_3PH	*3-Phase fault on the Buffalo – Bushland 230kV CKT 1 near the Buffalo 230kV bus.*

	Contingency Number and Name	Description
4	FLT_04_G0647_BUSHLAND_230kV_1PH	*Single-phase fault similar to previous fault.*
5	FLT_05_BUSHLAND_POTTERCO6_230kV_3PH	*3-Phase fault on the Bushland – Potter County 230kV near the Bushland 230kV bus.*
6	FLT_06_BUSHLAND_POTTERCO6_230kV_1PH	*Single-phase fault similar to previous fault.*
7	FLT_07_POTTERCO6_MOORECNTY_230kV_3PH	*3-Phase fault on the Potter County – Moore County 230kV near the Potter County 230kV bus.*
8	FLT_08_POTTERCO6_MOORECNTY_230kV_1PH	*Single-phase fault similar to previous fault.*
9	FLT_09_POTTERCO6_HARRINGTONE_230kV_3PH	*3-Phase fault on the Potter County – Harrington East 230kV near the Potter County 230kV bus.*
10	FLT_10_POTTERCO6_HARRINGTONE_230kV_1PH	*Single-phase fault similar to previous fault.*
11	FLT_11_POTTERCO6_CHERRY_230kV_3PH	*3-Phase fault on the Potter County – Cherry 230kV near the Potter County 230kV bus.*
12	FLT_12_POTTERCO6_CHERRY_230kV_1PH	*Single-phase fault similar to previous fault.*
13	FLT_13_POTTERCO6_PLANTX_230kV_3PH	*3-Phase fault on the Potter County – Plant X 230kV near the Potter County 230kV bus.*
14	FLT_14_POTTERCO6_PLANTX_230kV_1PH	*Single-phase fault similar to previous fault.*
15	FLT_15_MOORECNTY_G1112Tap_230kV_3PH	*3-Phase fault on the Moore County – GEN 2011-012 tap 230kV near the Moore County 230kV bus.*
16	FLT_16_MOORECNTY_G1112Tap_230kV_1PH	*Single-phase fault similar to previous fault.*
17	FLT_17_G1112Tap_HITCHLAND6_230kV_3PH	*3-Phase fault on the GEN 2011-012 tap – Hitchland 230kV near the GEN 2011-012 tap 230kV bus.*
18	FLT_18_G1112Tap_HITCHLAND6_230kV_1PH	*Single-phase fault similar to previous fault.*
19	FLT_19_HARRINGTONE_PRINGLE_230kV_3PH	*3-Phase fault on the Harrington East – Pringle 230kV near the Harrington East 230kV bus.*
20	FLT_20_HARRINGTONE_PRINGLE_230kV_1PH	*Single-phase fault similar to previous fault.*
21	FLT_21_HARRINGTONE_HARRNGMID6_230kV_3PH	*3-Phase fault on the Harrington East – Harrington Mid 230kV near the Harrington East 230kV bus.*
22	FLT_22_HARRINGTONE_HARRNGMID6_230kV_1PH	*Single-phase fault similar to previous fault.*
23	FLT_23_HARRINGTONE_RANDALL_230kV_3PH	*3-Phase fault on the Harrington East – Randall 230kV CKT 1 near the Harrington East 230kV bus.*
24	FLT_24_HARRINGTONE_RANDALL_230kV_1PH	*Single-phase fault similar to previous fault.*
25	FLT_25_CHERRY_HARRNGWST_230kV_3PH	*3-Phase fault on the Cherry – Harrington West 230 kV CKT 1 near the Cherry 230kV bus.*
26	FLT_26_CHERRY_HARRNGWST_230kV_1PH	*Single-phase fault similar to previous fault.*
27	FLT_27_POTTERCO7_HITCHLAND7_345kV_3PH	*3-Phase fault on the Potter County – Hitchland 345 kV CKT 1 near the Potter County 345kV bus.*
28	FLT_28_POTTERCO7_HITCHLAND7_345kV_1PH	*Single-phase fault similar to previous fault.*
29	FLT_29_DEAFSMITH6_PLANTX6_230kV_3PH	*3-Phase fault on the Deaf Smith – Plant X 230 kV near the Deaf Smith 230kV bus.*
30	FLT_30_DEAFSMITH6_PLANTX6_230kV_1PH	*Single-phase fault similar to previous fault.*
31	FLT_31_PLANTX6_TOLKEAST6_230kV_3PH	*3-Phase fault on the Plant X –Tolk East 230kV near the Plant X 230kV bus.*
32	FLT_32_PLANTX6_TOLKEAST6_230kV_1PH	*Single-phase fault similar to previous fault.*
33	FLT_33_PLANTX6_TOLKWEST_230kV_3PH	*3-Phase fault on the Plant X – Tolk West 230kV near the Plant X 230kV bus.*
34	FLT_34_PLANTX6_TOLKWEST_230kV_1PH	*Single-phase fault similar to previous fault.*
35	FLT_35_PLANTX6_SUNDOWN_230kV_3PH	*3-Phase fault on the Plant X – Sundown 230kV CKT 1 near the Plant X 230kV bus.*
36	FLT_36_PLANTX6_SUNDOWN_230kV_1PH	*Single-phase fault similar to previous fault.*
37	FLT_37_BUSHLAND_BUSHLAND3_230_115kV_3PH	*3-Phase fault on the Bushland 230/115kV transformer near the Bushland 230kV bus.*

	Contingency Number and Name	Description
38	FLT_38_POTTERCO6_POTTERCO7_230_345kV_3PH	*3-Phase fault on the Potter County 345/230kV transformer near the Potter County 230kV bus.*
39	FLT_39_POTTERCO6_POTTERCO3_230_115kV_3PH	*3-Phase fault on the Potter County 230/115kV transformer near the Potter County 230kV bus.*
40	FLT_40_MOORECNTY_MOOREE3_230_115kV_3PH	*3-Phase fault on the Moore County 230/115kV transformer near the Moore County 230kV bus.*
41	FLT_41_CHERRY6_CHERRY3_230_115kV_3PH	*3-Phase fault on the Cherry 230/115kV transformer near the Cherry 230kV bus.*
42	FLT_42_DEAFSMITH6_DEAFSMITH3_230_115kV_3PH	*3-Phase fault on the Deaf Smith 230/115kV transformer near the Deaf Smith 230kV bus.*

NOTE: The faults denoted by an asterisk (*) were adjusted to allow for no re-closing into the fault. Some 345kV faults on these lines have special operating procedures for re-closing into a three-phase fault.

Results

Results of the transient stability analysis are summarized within Table 7. For faults at the Point of Interconnection, the generator was found to not have stable voltage recovery after the faults were cleared. These results are somewhat common for the Suzlon wind turbines. Low Voltage Ride-Through (LVRT) analysis indicates that an +/-8Mvar Static Condenser device is required on the 34.5kV bus of the wind farm in addition to approximately 50Mvars of capacitor banks in multiple stages. These results are valid for Customers interconnecting up to 241.5 MW, including specified reactive equipment. The results indicate that the transmission system remains stable for all contingencies studied. The plots will be made available upon request.

Table 7: Fault Analysis Results for Limited Operation of GEN-2006-047

	Contingency Number and Name	2014SP	2014WP
1	FLT_01_G0647_DEAFSMITH_230kV_3PH	Unstable	Unstable
2	FLT_01_G0647_DEAFSMITH_230kV_3PH with reactive compensation equipment	Stable	Stable
3	FLT_02_G0647_DEAFSMITH_230kV_1PH	Stable	Stable
4	FLT_03_G0647_BUSHLAND_230kV_3PH	Unstable	Unstable
5	FLT_03_G0647_BUSHLAND_230kV_3PH with reactive compensation equipment	Stable	Stable
6	FLT_04_G0647_BUSHLAND_230kV_1PH	Stable	Stable
7	FLT_05_BUSHLAND_POTTERCO6_230kV_3PH	Stable	Stable
8	FLT_06_BUSHLAND_POTTERCO6_230kV_1PH	Stable	Stable
9	FLT_07_POTTERCO6_MOORECNTY_230kV_3PH	Stable	Stable
10	FLT_08_POTTERCO6_MOORECNTY_230kV_1PH	Stable	Stable
11	FLT_09_POTTERCO6_HARRINGTONE_230kV_3PH	Stable	Stable
12	FLT_10_POTTERCO6_HARRINGTONE_230kV_1PH	Stable	Stable
13	FLT_11_POTTERCO6_CHERRY_230kV_3PH	Stable	Stable
14	FLT_12_POTTERCO6_CHERRY_230kV_1PH	Stable	Stable
15	FLT_13_POTTERCO6_PLANTX_230kV_3PH	Stable	Stable
16	FLT_14_POTTERCO6_PLANTX_230kV_1PH	Stable	Stable
17	FLT_15_MOORECNTY_G1112Tap_230kV_3PH	Stable	Stable
18	FLT_16_MOORECNTY_G1112Tap_230kV_1PH	Stable	Stable
19	FLT_17_G1112Tap_HITCHLAND6_230kV_3PH	Stable	Stable
20	FLT_18_G1112Tap_HITCHLAND6_230kV_1PH	Stable	Stable
21	FLT_19_HARRINGTONE_PRINGLE_230kV_3PH	Stable	Stable
22	FLT_20_HARRINGTONE_PRINGLE_230kV_1PH	Stable	Stable
23	FLT_21_HARRINGTONE_HARRNGMID6_230kV_3PH	Stable	Stable
24	FLT_22_HARRINGTONE_HARRNGMID6_230kV_1PH	Stable	Stable
25	FLT_23_HARRINGTONE_RANDALL_230kV_3PH	Stable	Stable

	Contingency Number and Name	2014SP	2014WP
26	FLT_24_HARRINGTONE_RANDALL_230kV_1PH	Stable	Stable
27	FLT_25_CHERRY_HARRNGWST_230kV_3PH	Stable	Stable
28	FLT_26_CHERRY_HARRNGWST_230kV_1PH	Stable	Stable
29	FLT_27_POTTERCO7_HITCHLAND7_345kV_3PH	Stable	Stable
30	FLT_28_POTTERCO7_HITCHLAND7_345kV_1PH	Stable	Stable
31	FLT_29_DEAFSMITH6_PLANTX6_230kV_3PH	Stable	Stable
32	FLT_30_DEAFSMITH6_PLANTX6_230kV_1PH	Stable	Stable
33	FLT_31_PLANTX6_TOLKEAST6_230kV_3PH	Stable	Stable
34	FLT_32_PLANTX6_TOLKEAST6_230kV_1PH	Stable	Stable
35	FLT_33_PLANTX6_TOLKWEST_230kV_3PH	Stable	Stable
36	FLT_34_PLANTX6_TOLKWEST_230kV_1PH	Stable	Stable
37	FLT_35_PLANTX6_SUNDOWN_230kV_3PH	Stable	Stable
38	FLT_36_PLANTX6_SUNDOWN_230kV_1PH	Stable	Stable
39	FLT_37_BUSHLAND_BUSHLAND3_230_115kV_3PH	Stable	Stable
40	FLT_38_POTTERCO6_POTTERCO7_230_345kV_3PH	Stable	Stable
41	FLT_39_POTTERCO6_POTTERCO3_230_115kV_3PH	Stable	Stable
42	FLT_40_MOORECNTY_MOOREE3_230_115kV_3PH	Stable	Stable
43	FLT_41_CHERRY6_CHERRY3_230_115kV_3PH	Stable	Stable
44	FLT_42_DEAFSMITH6_DEAFSMITH3_230_115kV_3PH	Stable	Stable

Power Factor Analysis

The power factor analysis was performed for this study and is designed to demonstrate the reactive power requirements at the point of interconnection. In order to perform the analysis the request and equivalent transmission lines and collectors systems were modeled using specifications provided by the Customer. Table 8 shows a summary of the power factor analysis at the POI, and Table 9 shows the contingencies and the resultant power factors at the POI.

Table 8: Summary of Power Factor Analysis at the POI

Request	Capacity	POI	Fuel	Generator	Power Factor at POI Leading (absorbing vars)	Power Factor at POI Lagging (providing vars)
GEN-2006-047	241.5MW	Bushland – Deaf Smith 230kV transmission line	Wind	Suzlon 2.1MW	0.9758	0.9826

NOTE: As reactive power is required for all projects, the final requirement in the Generation Interconnection Agreement will be the pro-forma 95% lagging to 95% leading at the point of interconnection.

Table 9: Power Factor Analysis at the POI

DISIS-2013-001 Group 5 POI – Pantex South 115kV (523945)		2014 Summer Voltage = .97568 pu				2014 Winter Voltage = 1.00005 pu			
Cont. No.	Cont. Name	Power @ POI	VARS @ POI	Power Factor		Power @ POI	VARS @ POI	Power Factor	
0	No Fault	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
1	FLT_01_G0647_DEAFSMITH_230kV_3PH	241.5	-54.1	0.9758	LEAD	241.5	12.2	0.9987	LAG
3	FLT_03_ G0647_BUSHLAND_230kV_3PH	241.5	46.7	0.9818	LAG	241.5	-16.9	0.9976	LEAD
5	FLT_05_BUSHLAND_POTTERCO6_230kV_3PH	241.5	30	0.9924	LAG	241.5	45.2	0.9829	LAG
7	FLT_07_POTTERCO6_MOORECNTY_230kV_3PH	241.5	-2.7	0.9999	LEAD	241.5	7.2	0.9996	LAG
9	FLT_09_POTTERCO6_HARRINGTONE_230kV_3PH	241.5	4.3	0.9998	LAG	241.5	5.7	0.9997	LAG
11	FLT_11_POTTERCO6_CHERRY_230kV_3PH	241.5	-1.1	1.0000	LEAD	241.5	2.2	1.0000	LAG
13	FLT_13_POTTERCO6_PLANTX_230kV_3PH	241.5	-0.4	1.0000	LEAD	241.5	11.1	0.9989	LAG
15	FLT_15_MOORECNTY_G1112Tap_230kV_3PH	241.5	0.7	1.0000	LAG	241.5	6.9	0.9996	LAG
17	FLT_17_G1112Tap_HITCHLAND6_230kV_3PH	241.5	0.1	1.0000	LAG	241.5	5.5	0.9997	LAG
19	FLT_19_HARRINGTONE_PRINGLE_230kV_3PH	241.5	-2	1.0000	LEAD	241.5	4.2	0.9998	LAG
21	FLT_21_HARRINGTONE_HARRNGMID6_230kV_3PH	241.5	-1.6	1.0000	LEAD	241.5	4.3	0.9998	LAG
23	FLT_23_HARRINGTONE_RANDALL_230kV_3PH	241.5	-1.3	1.0000	LEAD	241.5	4.6	0.9998	LAG
25	FLT_25_CHERRY_HARRNGWST_230kV_3PH	241.5	8.3	0.9994	LAG	241.5	10.3	0.9991	LAG
27	FLT_27_POTTERCO7_HITCHLAND7_345kV_3PH	241.5	1.4	1.0000	LAG	241.5	12.4	0.9987	LAG
29	FLT_29_DEAFSMITH6_PLANTX6_230kV_3PH	241.5	45.6	0.9826	LAG	241.5	20.6	0.9964	LAG
31	FLT_31_PLANTX6_TOLKEAST6_230kV_3PH	241.5	-2	1.0000	LEAD	241.5	4.2	0.9998	LAG
33	FLT_33_PLANTX6_TOLKWEST_230kV_3PH	241.5	-2	1.0000	LEAD	241.5	4.2	0.9998	LAG
35	FLT_35_PLANTX6_SUNDOWN_230kV_3PH	241.5	-1.1	1.0000	LEAD	241.5	1.9	1.0000	LAG
37	FLT_37_BUSHLAND_BUSHLAND3_230_115kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
39	FLT_39_POTTERCO6_POTTERCO7_230_345kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
41	FLT_41_POTTERCO6_POTTERCO3_230_115kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
43	FLT_43_MOORECNTY_MOOREE3_230_115kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
45	FLT_45_CHERRY6_CHERRY3_230_115kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG
47	FLT_47_DEAFSMITH6_DEAFSMITH3_230_115kV_3PH	241.5	-1.8	1.0000	LEAD	241.5	4.2	0.9998	LAG

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 .

Table 10: LVRT Contingencies for GEN-2006-047

Contingency Number and Name		Description	2014SP	2014WP
1	FLT_01_G0647_DEAFSMITH_230kV_3PH	*3-Phase fault on the GEN 2006-047 tap – Deaf Smith 230kV CKT 1 near the GEN 2006-047 tap 230kV bus.*	Unstable	Unstable
2	FLT_01_ G0647_DEAFSMITH_230kV_3PH with reactive compensation equipment	*3-Phase fault on the GEN 2006-047 tap – Deaf Smith 230kV CKT 1 near the GEN 2006-047 tap 230kV bus.*	Stable	Stable
3	FLT_02_ G0647_DEAFSMITH_230kV_1PH	*Single-phase fault similar to previous fault.*	Stable	Stable
4	FLT_03_ G0647_BUSHLAND_230kV_3PH	*3-Phase fault on the GEN 2006-047 tap – Bushland 230kV CKT 1 near the GEN 2006-047 tap 230kV bus.*	Unstable	Unstable
5	FLT_03_ G0647_BUSHLAND_230kV_3PH with reactive compensation equipment	*3-Phase fault on the GEN 2006-047 tap – Bushland 230kV CKT 1 near the GEN 2006-047 tap 230kV bus.*	Stable	Stable
6	FLT_04_ G0647_BUSHLAND_230kV_1PH	*Single-phase fault similar to previous fault.*	Stable	Stable

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-2006-047 is found to be in compliance with FERC Order #661A.

Conclusion

This Impact Study has been initiated by Southwest Power Pool to determine the impacts to GEN-2006-047 for the withdrawals of GEN-2006-039 and GEN-2006-045. GEN-2006-047 is a 240MW wind generation facility to be interconnected as an Energy Resource into a transmission facility on the Southwestern Public Service (SPS) in Randall County, Texas. The Point of Interconnection studied is a new station on the Deaf Smith – Bushland 230kV transmission line.
Power flow analysis from this Impact Restudy has determined that the GEN-2006-047 request can interconnect with the completion of the completion of the required Network Upgrades, listed within Table 2 of this report. <u>There is no more than **212** MW of Limited Operation Interconnection Service available only as an Energy Resource</u> for the period of July 1, 2014 until the completion of the following Network Upgrades:

Energy Resource Interconnection Service (ERIS) Network Upgrades

- Bushland – Potter 230kV terminal equipment
- Bushland – Deaf Smith 230kV terminal equipment

After these network upgrades are completed, limited operation may be available until such time that higher queued projects listed in Table 3 come into service.

Transient stability analysis indicates that the transmission system will remain stable for the contingencies listed within Table 6 with the addition of GEN-2006-047 generation. Additionally, GEN-2006-047 was found to be in compliance with FERC Order #661A when studied as listed within this report.

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 in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.