Southwest
Power Pool

System Impact Study
For
Generation Interconnection Request
GEN-2006-047

SPP Tariff Studies
(#GEN-2006-047)

January 2008

Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 240 MW of wind generation within the control area of Southwestern Public Service (SPS) in Randall County, Texas. In the Feasibility Study the proposed point of interconnection is a new switching station on the existing Deaf Smith – Bushland 230 kV transmission line owned by SPS. The proposed in-service date of the Customer facility is December 1, 2009.

The Impact Study for Interconnection Request GEN-2006-045 has changed the requirements for interconnection from the Feasibility Study. The new interconnection facility will consist of adding two breakers to the proposed 230 kV nine-breaker, six-terminal ring-bus switching station interconnecting both the Potter County Interchange – Plant X Station 230 kV and the Bushland Interchange – Deaf Smith Interchange 230 kV transmission lines which are owned by SPS as well as generation interconnection requests GEN-2006-09 and GEN-2006-045. This station was first proposed to interconnect GEN-2006-039. The station was proposed to be expanded to breaker-and-a-half and connected to the Deaf Smith-Bushland 230kV line for GEN-2006-045. A preliminary one-line drawing of the interconnection facilities is shown in Figure 1. This substation will be constructed and maintained by SPS.

Power flow analysis has indicated that for the powerflow cases studied, it is possible to interconnect the 240 MW of generation with transmission system reinforcements within the local transmission system. In order to maintain acceptable reactive power compensation, the customer will need to install 48 MVARs of 34.5 kV capacitor banks in the Customer's collector substation on the 34.5 kV bus. Dynamic Stability studies performed as part of this impact study indicated that the required reactive compensation can be static (no SVC or STATCOM required).

The Customer did not propose a specific 230 kV line extending to serve its 230/34.5 kV facilities. It is assumed that obtaining all necessary right-of-way for the new switching station will not be a significant expense.

The total minimum cost for building the required facilities for this 240 MW of generation is approximately $2,500,000. These costs are shown in Table 2. Other Network Constraints in the American Electric Power West (AEPW), SPS, Sunflower Electric Power Corporation (SUNC), and Western Farmers Electric Cooperative (WFEC) transmission systems that may be verified with a transmission service request and associated studies are listed in Table 3. These Network Constraints are in the local area of the new generation when this generation is sunk throughout the Southwest Power Pool (SPP) footprint for the Energy Resource (ER) Interconnection request. With a defined source and sink in a Transmission Service Request (TSR), this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements. This cost does not include building the 230 kV line from the Customer substation to the POI. Also, this cost does not include the Customer's 230/34.5 kV substation or the 34.5 kV, 48 MVAR capacitor bank(s).

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer for future analyses including the determination of lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

The stability study conducted by ABB indicates that with the required upgrades the Customer generation will stay on line and not cause system instability due to interconnection. However, system instability was encountered for SPS system exports that were evaluated in the study. This is indicative of the lack of tie lines from SPS to the rest of SPP and the Eastern Interconnection. Therefore, the Customer cannot expect to export any generation from the Facility outside of SPS until new tie lines are constructed.

There are several other proposed generation additions in the general area of the Customer's facility. It was assumed in this preliminary analysis that not all of these other projects within the SPS control area will be in service. Those previously queued projects that have advanced to nearly complete phases were included in this Impact Study. In the event that another request for a generation interconnection with a higher priority withdraws, then this request will have to be re-evaluated to determine the local Network Constraints.

The required interconnection costs listed in Tables 1 and 2 and other upgrades associated with Network Constraints do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer submits a Transmission Service Request through Southwest Power Pool's OASIS.

Introduction

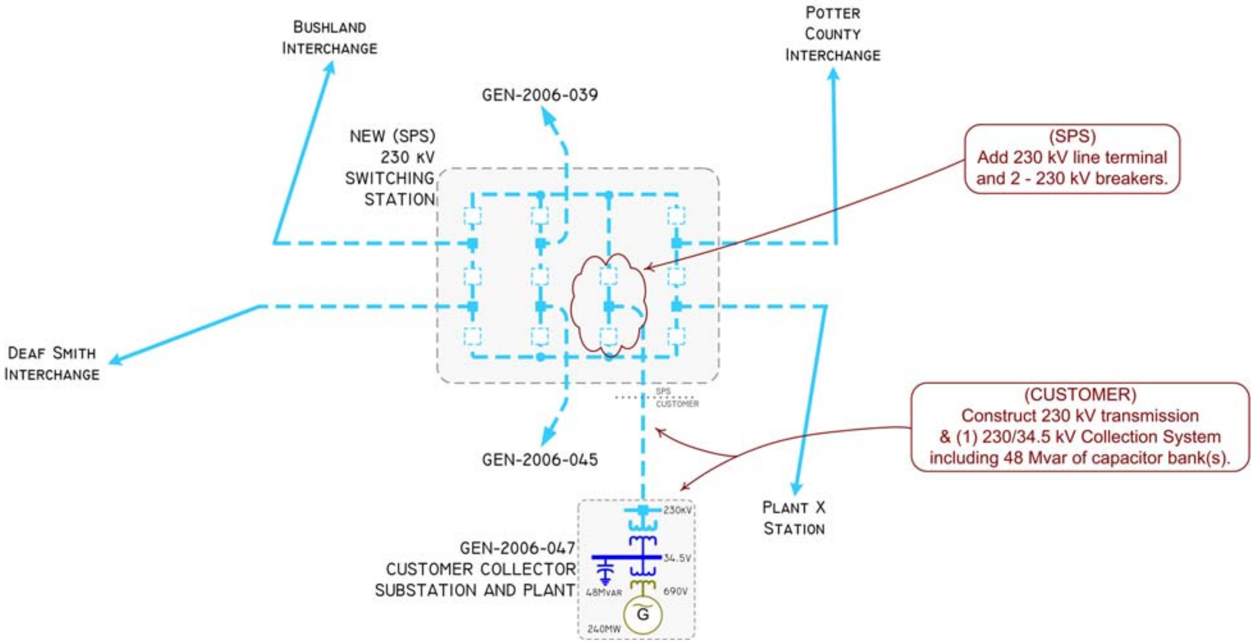
<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 240 MW of wind generation within the control area of Southwestern Public Service (SPS) in Randall County, Texas. In the Feasibility Study the proposed point of interconnection is a new switching station on the existing Deaf Smith – Bushland 230 kV transmission line owned by SPS. The proposed in-service date of the Customer facility is December 1, 2009.

Interconnection Facilities

The primary objective of this study is to identify the system problems associated with connecting the plant to the area transmission system. The Feasibility, System Impact, and other subsequent Interconnection Studies are designed to identify attachment facilities, Network Upgrades and other direct assignment facilities needed to accept power into the grid at the interconnection receipt point.

The Impact Study for GEN-2006-045 has changed the requirements for interconnection of the 240 MW from the Feasibility Study. The new interconnection facilities will consist of adding two breakers to the proposed 230 kV nine-breaker, six-terminal ring-bus switching station interconnecting both the Potter County Interchange – Plant X Station 230 kV and the Bushland Interchange – Deaf Smith Interchange 230 kV transmission lines which are owned by SPS as well as generation interconnection requests GEN-2006-039 and GEN-2006-045. A preliminary one-line drawing of the interconnection facilities is shown in Figure 1. This substation will be constructed and maintained by SPS.

The Customer did not propose a specific route of its 230 kV line to serve its 230/34.5 kV collection system facilities. It is assumed that obtaining all necessary right-of-way for construction of the Customer 230 kV transmission line and the 230/34.5 kV collector substation will not be a significant expense. The Customer is responsible for these 230 kV facilities up to the point of interconnection.



(SPS)
Add 230 kV line terminal
and 2 - 230 kV breakers.

(CUSTOMER)
Construct 230 kV transmission
& (1) 230/34.5 kV Collection System
including 48 Mvar of capacitor bank(s).

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

Interconnection Estimated Costs

The minimum cost for adding a 230 kV line termination and breakers to the proposed switching station is $2,500,000. The costs are shown in Tables 1 and 2. These estimates will be refined during the development of the System Impact Study based on the final designs. This cost does not include building the Customer's 230 kV transmission line extending from the point of interconnection to serve its 230/34.5 kV collection facilities. This cost also does not include the Customer's 230/34.5 kV collector substation or the 48 MVAR of capacitor bank(s), all of which should be determined by the Customer. The Customer is responsible for these 230 kV – 34.5 kV facilities up to the point of interconnection.

Other Network Constraints in the American Electric Power West (AEPW), SPS, Sunflower Electric Power Corporation (SUNC), and Western Farmers Electric Cooperative (WFEC) transmission systems that were identified are listed in Table 3

These costs do not include any cost that might be associated with short circuit study results. These costs will be determined when and if a System Facility Study is conducted.

Table 1: Direct Assignment Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
Customer – 230/34.5 kV Substation facilities.	*
Customer – 230 kV transmission line facilities between Customer facilities and the Point of Interconnection.	*
Customer - Right-of-Way for Customer facilities.	*
Customer – 34.5 kV, 48 MVAR capacitor bank(s) in Customer substation.	*
Total	*****

*Note: * Estimates of cost to be determined by Customer.*

Table 2: Required Interconnection Network Upgrade Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
SPS – Add 230kV line terminal to the proposed nine (9) breaker breaker-and-a-half station proposed to be built for GEN-2006-045. Work to include two (2) additional 230 kV circuit breakers and switches, control relaying, high speed communications, metering and related equipment and all structures.	**$2,500,000**
Total	**$2,500,000**

Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2009 and the 2012 winter peak models and the 2012 and the 2017 summer peak models. The output of the Customer's facility was offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ER) Interconnection request. The proposed in-service date of the generation is December 31, 2009. The available seasonal models used were through the 2017 summer peak which is the end of the current SPP planning horizon.

The analysis of the Customer's project indicates that, given the requested generation level of 240 MW and location, additional criteria violations will occur on the existing AEPW, SPS, SUNC, and WFEC transmission systems under steady state and contingency conditions in the peak seasons. The overloaded facilities are shown in Table 3.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

In order to maintain a zero reactive power flow exchanged at the point of interconnection, additional reactive compensation is required at the point of interconnection. The Customer will be required to install 48 MVAR of capacitor banks in its substation on the 34.5 kV bus. The Dynamic Stability studies performed as part of the impact study indicated that all of the reactive compensation can be static (no SVC or STATCOM required). The Impact Study showed that the Customer facility will meet the requirements of FERC Order 661A Low Voltage Ride Through Provisions (LVRT) which went into effect January 1, 2006. FERC Order 661A orders that wind farms stay on line for 3 phase faults at the point of interconnection even if that requires the installation of a SVC or STATCOM device.

There are several other proposed generation additions in the general area of the Customer's facility. Some of the local projects that were previously queued were assumed to be in service in this Impact Study. Those local projects that were previously queued and have advanced to nearly complete phases were included in this Impact Study.

Powerflow Analysis Methodology

The 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 Planning Standards* for System Adequacy and Security – Transmission System Table I (hereafter referred to as NERC Table I) and its applicable standards and measurements".

Using the created models and the ACCC function of PSS\E, single contingencies in portions or all of the modeled control areas of Sunflower Electric Power Corporation (SUNC), Missouri Public Service (MIPU), Westar (WESTAR), Kansas City Power & Light (KCPL), West Plains (WEPL), Midwest Energy (MIDW), Oklahoma Gas and Electric OKGE, American Electric Power West (AEPW), Grand River Dam Authority (GRDA), Southwestern Public Service Company (SPS), Western Farmers Electric Cooperative (WFEC) and other control areas were applied and the resulting scenarios analyzed. This satisfies the ‘more probable’ contingency testing criteria mandated by NERC and the SPP criteria.

Table 3: Network Constraints

AREA	OVERLOADED ELEMENT
AEPW	CLINTON JUNCTION - ELK CITY 138KV CKT 1
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
AEPW	JERICHO (JERIC2WT) 115/69/14.4KV TRANSFORMER CKT 1
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1
AEPW	SHAMROCK (SHAMRCK2) 138/69/14.4KV TRANSFORMER CKT 1
AEPW-SPS	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1
AEPW-WFEC	LAKE PAULINE - RUSSELL 138KV CKT 1
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1
SPS	DALHART INTERCHANGE - RITA BLANCA REC-HOGUE 115KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
SPS	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	HERRING TAP - RIVERVIEW INTERCHANGE 115KV CKT 1
SPS	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1
SPS	LAMB COUNTY REC-SOUTH OLTON - PLANT X STATION 115KV CKT 1
SPS	LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	MCCLELLAN SUB - MCLEAN RURAL SUB 115KV CKT 1
SPS	MOORE COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	MOORE COUNTY INTERCHANGE E. - RITA BLANCA REC-HOGUE 115KV CKT 1
SPS	POTTER (POTTRC6) 345/230/13.2KV TRANSFORMER CKT 1
SPS	SPEARMAN INTERCHANGE - SPEARMAN SUB 115KV CKT 1
SPS	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
SPS	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
SUNC	SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1
WFEC	GYPSUM - RUSSELL 69KV CKT 1
AEPW	AMERICAN ELECTRIC POWER WEST
SPS	SOUTHWESTERN PUBLIC SERVICE COMPANY
SUNC	SUNFLOWER ELECTRIC POWER CORPORATION
WFEC	WESTERN FARMERS ELECTRIC COOPERATIVE

Table 4: Contingency Analysis

AREA	OVERLOADED ELEMENT	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
	2009 Winter Peak				
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	287	173.6	0	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
AEPW-SPS	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	351	143.9	0	SPP-SWPS-04A
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1	69	142.5	0	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
AEPW	SHAMROCK (SHAMRCK2) 138/69/14.4KV TRANSFORMER CKT 1	69	129.5	0	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
AEPW	CLINTON JUNCTION - ELK CITY 138KV CKT 1	143	120.4	0	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
SPS	CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1	168	116.0	0	LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	706	115.2	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	706	114.9	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
SPS	POTTER (POTTRC6) 345/230/13.2KV TRANSFORMER CKT 1	560	123.9	19	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
SUNC	SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1	336	112.9	20	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
SPS	LEA COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	168	118.4	46	CUNNINGHAM STATION 230/115KV TRANSFORMER CKT 1
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	188	112.1	75	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
SPS	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1	560	112.7	132	SPP-SWPS-04A
SPS	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1	107	101.1	212	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
AEPW-WFEC	LAKE PAULINE - RUSSELL 138KV CKT 1	72	102.3	214	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
	2012 Summer Peak				
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	173	133.1	0	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	173	126.5	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2	173	126.5	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	635	118.3	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	635	118.0	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1	161	108.6	0	NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1
AEPW-SPS	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	351	446.8	23	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1

Table 4: Contingency Analysis (continued)

AREA	OVERLOADED ELEMENT	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
	2012 Summer Peak (Continued)				
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	150	104.6	121	BASE CASE
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	287	122.8	125	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
AEPW	JERICHO (JERIC2WT) 115/69/14.4KV TRANSFORMER CKT 1	46	105.9	131	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1	69	114.7	160	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
SPS	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1	90	104.1	171	SPP-SWPS-02
SPS	MCCLELLAN SUB - MCLEAN RURAL SUB 115KV CKT 1	90	102.1	205	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
SPS	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1	129	100.1	238	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
SPS	HERRING TAP - RIVERVIEW INTERCHANGE 115KV CKT 1	180	100.3	239	MOORE3 115 KV - MOORE6 230 KV CKT1
	2012 Winter Peak				
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	287	157.2	0	SPP-SWPS-04A
AEPW-SPS	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	351	154.4	0	SPP-SWPS-01
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1	69	131.0	0	SPP-SWPS-01
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	706	119.1	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	706	119.0	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
AEPW	SHAMROCK (SHAMRCK2) 138/69/14.4KV TRANSFORMER CKT 1	69	115.9	0	SPP-SWPS-01
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	188	116.0	2	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
SUNC	SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1	336	107.1	93	SPP-SWPS-01
SPS	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1	560	116.5	131	SPP-SWPS-04A
AEPW	CLINTON JUNCTION - ELK CITY 138KV CKT 1	143	109.6	149	SPP-SWPS-04A
AEPW	JERICHO (JERIC2WT) 115/69/14.4KV TRANSFORMER CKT 1	46	106.9	165	SPP-SWPS-04A
AEPW-WFEC	LAKE PAULINE - RUSSELL 138KV CKT 1	72	101.8	217	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
WFEC	GYPSUM - RUSSELL 69KV CKT 1	26	100.4	237	LAKE PAULINE - RUSSELL 138KV CKT 1

Table 4: Contingency Analysis (continued)

AREA	OVERLOADED ELEMENT	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
	2017 Summer Peak				
SPS	MOORE COUNTY INTERCHANGE E. - RITA BLANCA REC-HOGUE 115KV CKT 1	99	183.1	0	ETTER3 115 KV - MOOREE3 115 KV CKT 1
SPS	DALHART INTERCHANGE - RITA BLANCA REC-HOGUE 115KV CKT 1	99	170.8	0	ETTER3 115 KV - MOOREE3 115 KV CKT 1
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	173	144.4	0	BUSHLAND INTERCHANGE - POTTER COUNTY INTERCHANGE 230KV CKT 1
AEPW	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1	287	141.7	0	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	173	136.2	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2
SPS	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 2	173	136.2	0	DEAF SMITH COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1
SPS	DEAF SMITH COUNTY INTERCHANGE - HEREFORD INTERCHANGE 115KV CKT 1	161	118.3	0	NORTHEAST HEREFORD INTERCHANGE 115/69KV TRANSFORMER CKT 1
SPS	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1	635	118.2	0	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2
SPS	HARRNG_MID6 230.00 - NICHOLS STATION 230KV CKT 2	635	117.9	0	HARRINGTON STATION - NICHOLS STATION 230KV CKT 1
SPS	BUSHLAND INTERCHANGE 230/115KV TRANSFORMER CKT 1	150	113.9	0	BASE CASE
SPS	SPEARMAN INTERCHANGE - SPEARMAN SUB 115KV CKT 1	161	108.3	0	HANSFORD 3 115.00 - TEXAS COUNTY INTERCHANGE 115KV CKT 1
SPS	LAMB COUNTY REC-SOUTH OLTON - PLANT X STATION 115KV CKT 1	161	107.7	20	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1
SPS	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1	129	105.8	28	ELK CITY 230KV (ELKCTY-6) 230/138/13.8KV TRANSFORMER CKT 1
SPS	MOORE COUNTY INTERCHANGE 230/115KV TRANSFORMER CKT 1	252	107.0	45	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
SUNC	SPEARVILLE (SPEARVL) 345/230/13.8KV TRANSFORMER CKT 1	336	109.3	65	HOLCOMB - SETAB 345KV CKT 1
AEPW	SHAMROCK (SHAMRCK1) 115/69/14.4KV TRANSFORMER CKT 1	69	114.4	70	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
AEPW	ELK CITY 230KV - GRAPEVINE INTERCHANGE 230KV CKT 1	351	115.9	100	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
SPS	TOLK STATION EAST - TUCO INTERCHANGE 230KV CKT 1	497	107.6	114	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1
SPS	KIRBY SWITCHING STATION - MCCLELLAN SUB 115KV CKT 1	90	100.5	232	HOLCOMB7 345 KV - FINNEY7 345 KV CKT 1

Note: When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

Transient Stability Analysis

ABB T&D Consulting conducted the transient stability analysis for this request. The analysis indicated the generation can be interconnected with the proposed interconnection configuration described in this study. With the studied Suzlon 2.1 MW wind turbines, the wind farm will meet FERC Order #661A low voltage ride through requirements.

The analysis indicated that due to lack of tie lines from SPS, exports to systems outside of SPS will not be possible until new tie lines are constructed.

The entire stability analysis can be found in Attachment 1 at the end of this study.

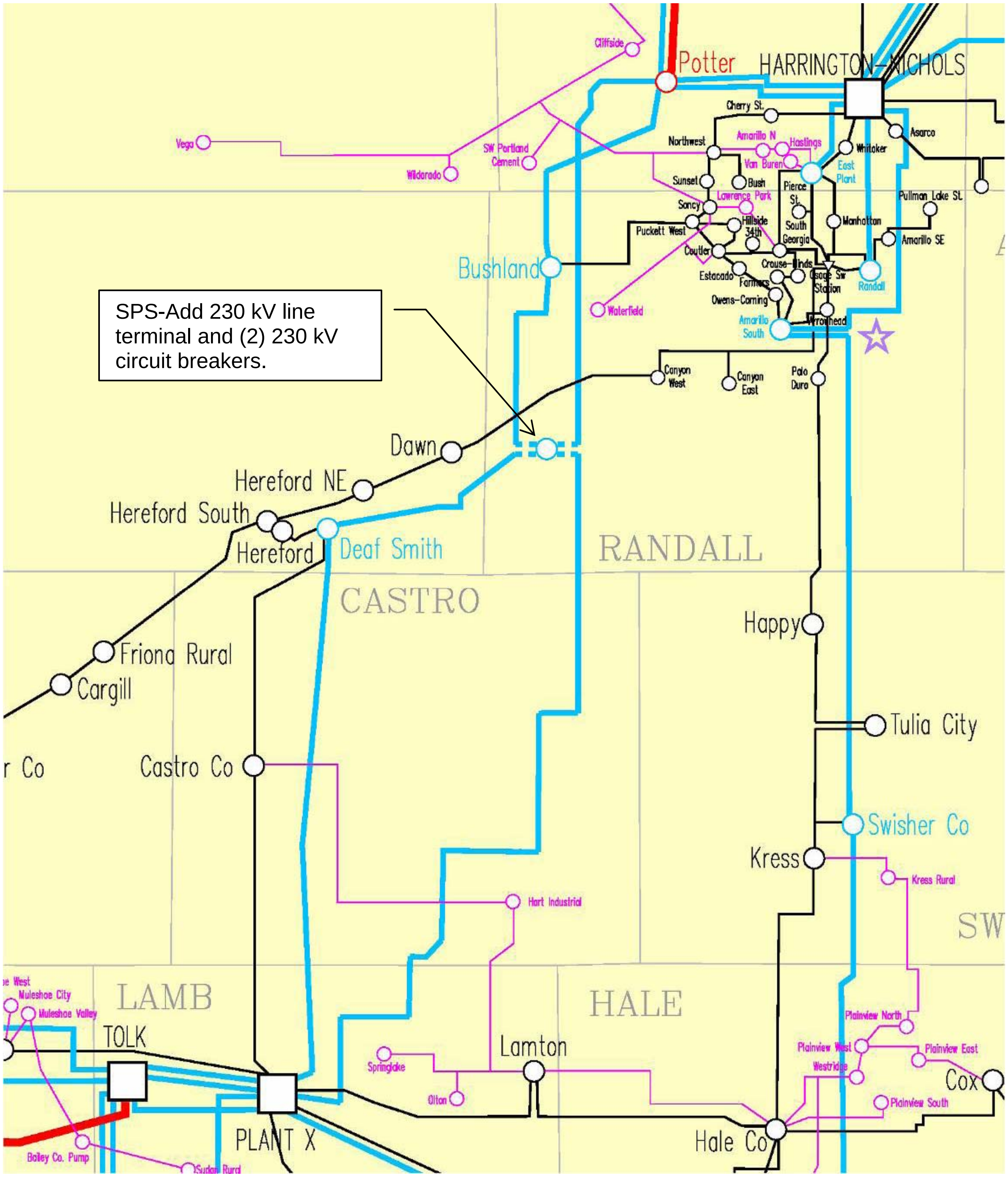
Conclusion

The minimum cost of interconnecting the Customer's interconnection request is estimated at $2,500,000 for Direct Assignment facilities and Network Upgrades listed in Tables 1 and 2. At this time, the cost estimates for other Direct Assignment facilities including those in Table 1 have not been defined by the Customer. In addition to the Customer's proposed interconnection facilities, the Customer will be responsible for installing 48 MVARs of 34.5 kV capacitors in the Customer substation for reactive support. Dynamic stability analysis has shown that the reactive compensation can be all static. As stated earlier, some but not all of the local projects that were previously queued are assumed to be in service in this Impact Study.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

These interconnection costs do not include any cost that may be associated with short circuit or transient stability analysis.

The required interconnection costs listed in Tables 1 and 2 and other upgrades associated with Network Constraints listed in Table 3 do not include all 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 SPP's OASIS.



SPS-Add 230 kV line terminal and (2) 230 kV circuit breakers.

FIGURE 2: Point of Interconnection Area Map

Attachment 1

Stability Analysis
For
Generation Interconnection
Request
GEN-2006-047

Summary

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), ABB Grid Systems Consulting (ABB) performed the following Impact Study to satisfy the Impact Study Agreement executed by the requesting customer and SPP for SPP Generation Interconnection request GEN-2006-047. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

POWER SYSTEMS DIVISION
GRID SYSTEMS CONSULTING

IMPACT STUDY FOR GENERATION INTERCONNECTION REQUEST
GEN-2006-047

FINAL REPORT

REPORT NO.: 2007-11603-R0
Issued: January 9, 2008

ABB Inc.
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Impact Study for Generation Interconnection Request GEN-2006-047	1/9/2008	# Pages 21

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Executive Summary

Southwest Power Pool (SPP) has a commissioned ABB Inc. to perform a generator interconnection study for a 240 MW wind farm in Randall County, Texas. The wind farm will interconnect into a proposed substation located on the Potter – Plant X 230 kV line to be built for prior-queued project GEN-2006-039. The Bushland – Deaf Smith 230 kV line will be folded into this station for the GEN-2006-045 project. These lines are owned by Southwestern Public Service (d/b/a Xcel Energy). As per the developer's request, the 240 MW of additional generation was studied assuming Suzlon 2.1 MW wind turbines. Several faults were simulated on the SPP system for Winter Peak 2008 and Summer Peak 2012 conditions.

The faults involving loss of one of the major transmission outlets from the Texas Panhandle gave unstable results in both pre- and post-project system conditions. Potential stability problems with large power exports from the Texas Panhandle are already known to SPP. Hence, the mitigation of these problems was considered out of scope and not required for interconnection of the wind farm.

GEN-2006-047 will remain on-line through all other simulated faults, and the SPP system will be stable following these faults in both Summer Peak and Winter Peak system conditions.

To achieve 1.0 power factor at the POI, 48 MVAR of capacitors are required at the GEN-2006-047 substation 34.5 kV bus for both Summer Peak and Winter Peak system conditions.

Based on the results of stability analysis it can be concluded that the proposed GEN-2006-047 project does not adversely impact the stability of the SPP system if shunt capacitors and planned 230 kV line upgrades are added as mentioned above.

The results of this analysis are based on available data and assumptions made at the time of conducting this study. If any of the data and/or assumptions made in developing the study model change, the results provided in this report may not apply.

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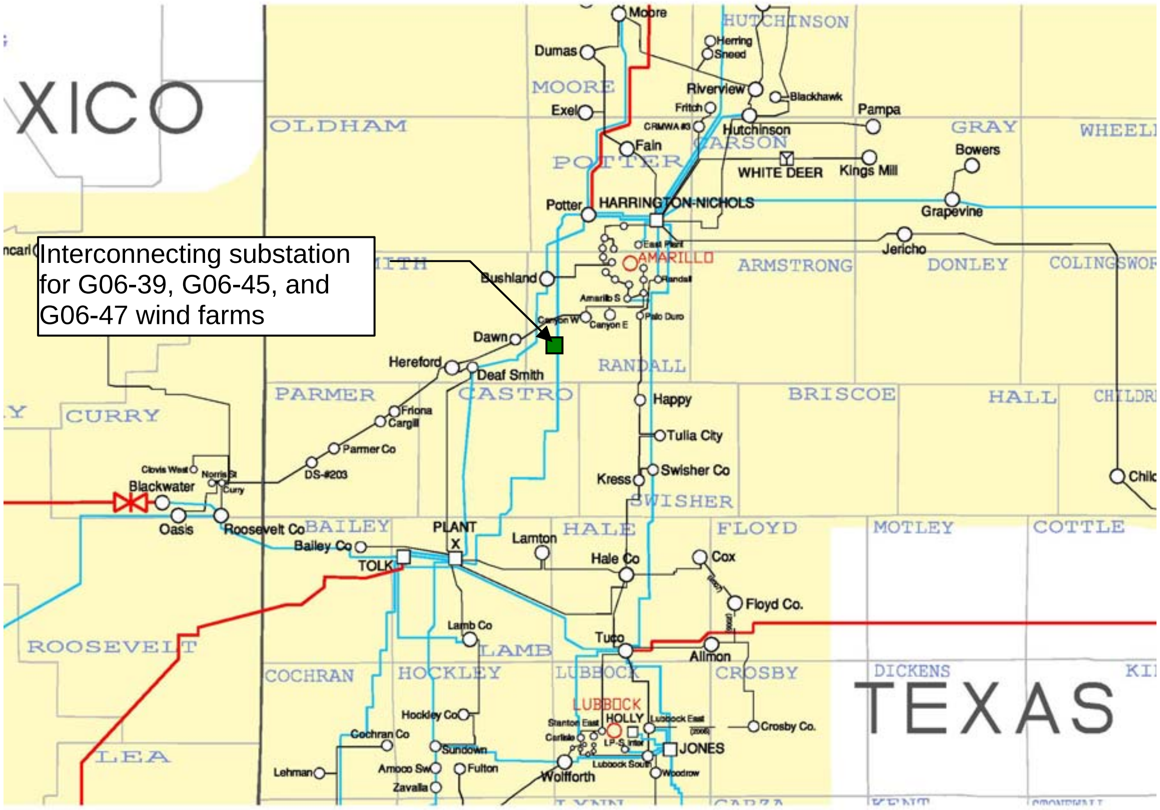
1 INTRODUCTION

SPP has commissioned ABB Inc. to perform an interconnection impact study for a 240 MW wind farm in Randall County, Texas. The wind farm will interconnect into a proposed substation located on the Potter – Plant X 230 kV line to be built for prior-queued project GEN-2006-039. The Bushland – Deaf Smith 230 kV line will be folded into this station for the GEN-2006-045 project. These lines are owned by Southwestern Public Service (d/b/a Xcel Energy). The feasibility (power flow) study was not performed as a part of this study.

The objective of the impact study is to evaluate the impact on system stability after connecting the additional 240 MW wind farm to the interconnection point and its effect on the nearby transmission system and generating stations. The study is performed on two system scenarios, 2008 Winter Peak and the 2012 Summer Peak, provided by SPP. Figure 1-1 shows the location of the proposed 240 MW wind farm interconnecting station and Figure 1-2 shows a one-line of the proposed interconnection with the existing network.



Interconnecting substation for G06-39, G06-45, and G06-47 wind farms

Figure 1-1 Wind farm (G06-39, G06-45, and G06-47) interconnecting substation

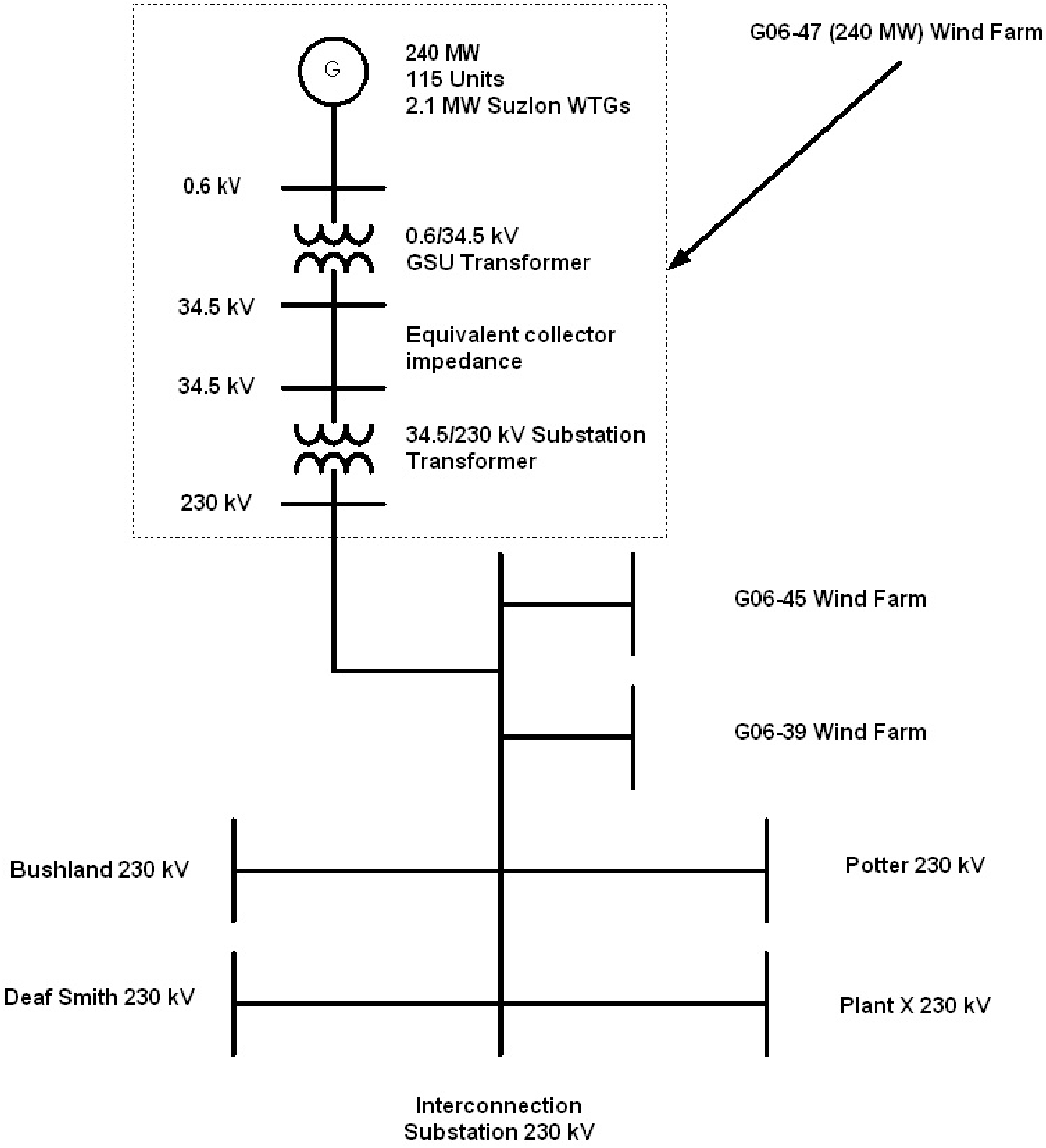


Figure 1-2 Proposed 240 MW wind farm interconnection

2 STABILITY ANALYSIS

In this stability study, ABB investigated the stability of the system for a series of faults specified by SPP that are in the vicinity of the proposed plant, as well as some faults of regional significance. Three-phase and single-line-to-ground (SLG) faults with reclosing in the vicinity of the proposed project were considered.

2.1 STABILITY ANALYSIS METHODOLOGY

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

“Power system stability is defined as that condition in which the differences of the angular positions of synchronous machine rotors become constant following an aperiodic system disturbance.”

In addition, new wind generators (which are usually asynchronous) are required to stay on-line following normally cleared faults at the Point of Interconnection (POI).

Stability analysis was performed using Siemens-PTI’s PSS/E^{TM} dynamics program V30.2.1. Three-phase and single-phase line faults were simulated for the specified durations, including re-closing, and the synchronous machine rotor angles were monitored to make sure they maintained synchronism following the fault removal. Stability of asynchronous machines was monitored as well.

Single-phase line faults were simulated with the standard method of applying fault impedance to the positive sequence network 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 fault location of approximately 60% of pre-fault voltage, which is a typical value.

The ability of the wind generators to stay connected to the grid during the disturbances and during the fault recovery was monitored. This is primarily determined by their low-voltage ride-through capabilities, or lack thereof, as represented in the models by low-voltage trip settings.

2.2 STUDY MODEL DEVELOPMENT

The study model consists of power flow cases and dynamics databases, developed as follows.

__Power Flow Case__

This studied started with two (2) pre-project PSS/E power flow cases called "*WP08-GEN-06-045_Line.SAV*" representing the 2008 Winter Peak conditions and the "*SP12-GEN-06-045_Line.SAV*" representing the 2012 Summer Peak conditions. These cases were developed by ABB in the GEN-2006-045 system impact study based on pre-project cases provided by SPP.

The proposed GEN-2006-047 project is comprised of 115 Suzlon 2.1 MW wind turbine generators. The plant will be connected to the 230 kV interconnection bus (560109) with an 8-mile 230 kV transmission line and a 230/34.5 kV transformer. The proposed project was added to the pre-project cases and the generation was dispatched by turning off GEN-2006-025 (2nd 150 MW wind farm on the Tuco-OKU line which has been withdrawn) and scaling down Harrington generation by 90 MW. Table 2-1 summarizes the dispatch. Thus two power flow cases with GEN-2006-047 were established:

- WP08-GEN-06-047.SAV – a 2008 winter peak case
- SP12-GEN-06-047.SAV – a 2012 summer peak case

Table 2-1: GEN-2006-047 project details

System condition	MW	Location	Point of Interconnection	Sink
Winter Peak	240	Randall County, Texas	Substation at Deaf Smith – Bushland 230kV line (#560109)	GEN-2006-025 (150MW) Harrington (90MW)
Summer Peak	240	Randall County, Texas	Substation at Deaf Smith – Bushland 230kV line (#560109)	GEN-2006-025 (150MW) Harrington (90MW)

__Wind Farm Power Flow Model__

A single equivalent of the 115 Suzlon 2.1 MW wind turbine generators was modeled (see Figure 2-1). The equivalent generator is connected to an equivalent collector system through a single equivalent generator step-up transformer (0.60/34.5 kV). The wind farm collector system is connected to the POI through a step-up transformer (34.5/230 kV) and a 230 kV line. The detailed process of wind farm model development is described in Appendix A. In order to maintain a unity p.f. at the Point Of Interconnection (POI) a 48 Mvar shunt capacitor was added in Winter Peak 2008 and 2012 Summer Peak cases.

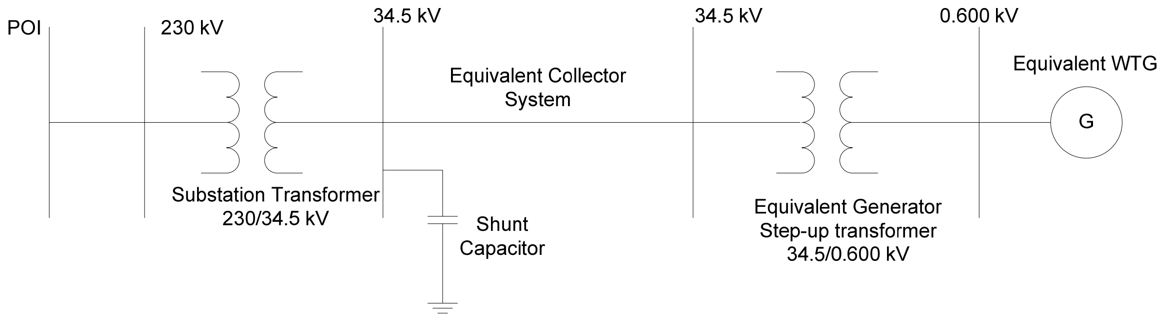


Figure 2-1: Wind farm modeling for the stability analysis

Figure 2-2 and Figure 2-3 show the PSS/E one-line diagrams for the local area with the GEN-2006-047 project for 2008 Winter Peak and 2012 Summer Peak respectively.

Stability Database

The pre-project stability database snapshot files were taken from the GEN-2006-045 system impact study. The files are named “*WP08-GEN-06-045.SNP*” for the 2008 Winter Peak configuration and “*SP12-GEN-06-045.SNP*” for the 2012 Summer Peak configuration. These files are in the format of PSS/E version 30.2.1.

The stability data for GEN-2006-047 was appended to the pre-project data. The dynamic model provided for the Suzlon S88 wind turbines is called S88001. The provided object code file is called “S88001_MODEL_60_V201_V30.OBJ”. The voltage trip settings included in this model are shown in Table 2-2.

Table 2-2: Suzlon S88001 Voltage Trip Settings

V (pu)	time (s)
1.20	0.08
1.15	60.00
0.90	60.00
0.80	2.80
0.60	1.60
0.40	0.70
0.15	0.08

The PSS/E power flow and stability model data for GEN-2006-047 are included in Appendix B.

Table 2-3 lists the faults simulated for stability analysis.

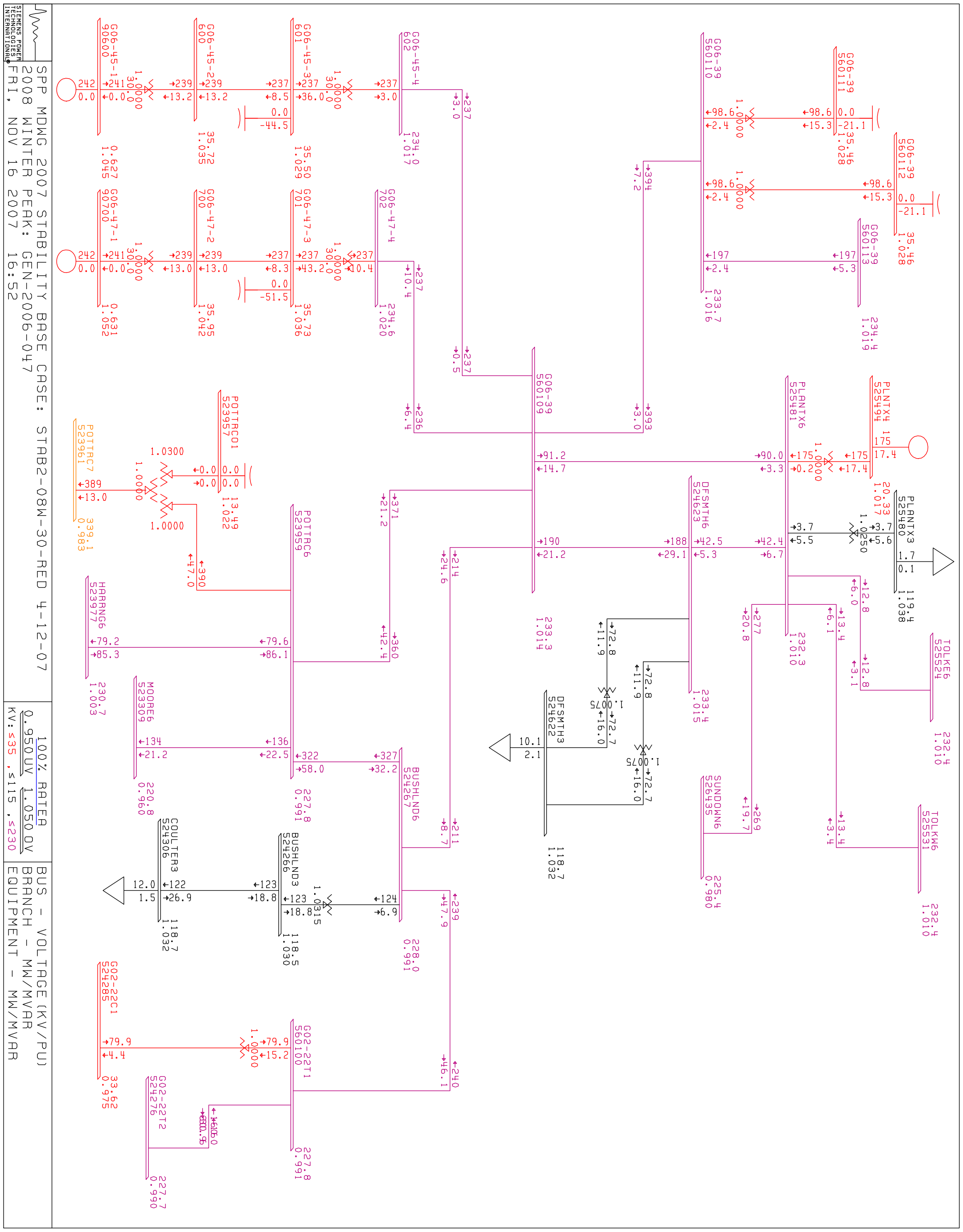


Figure 2-2 Winter Peak Flows and Voltages with GEN-2006-047

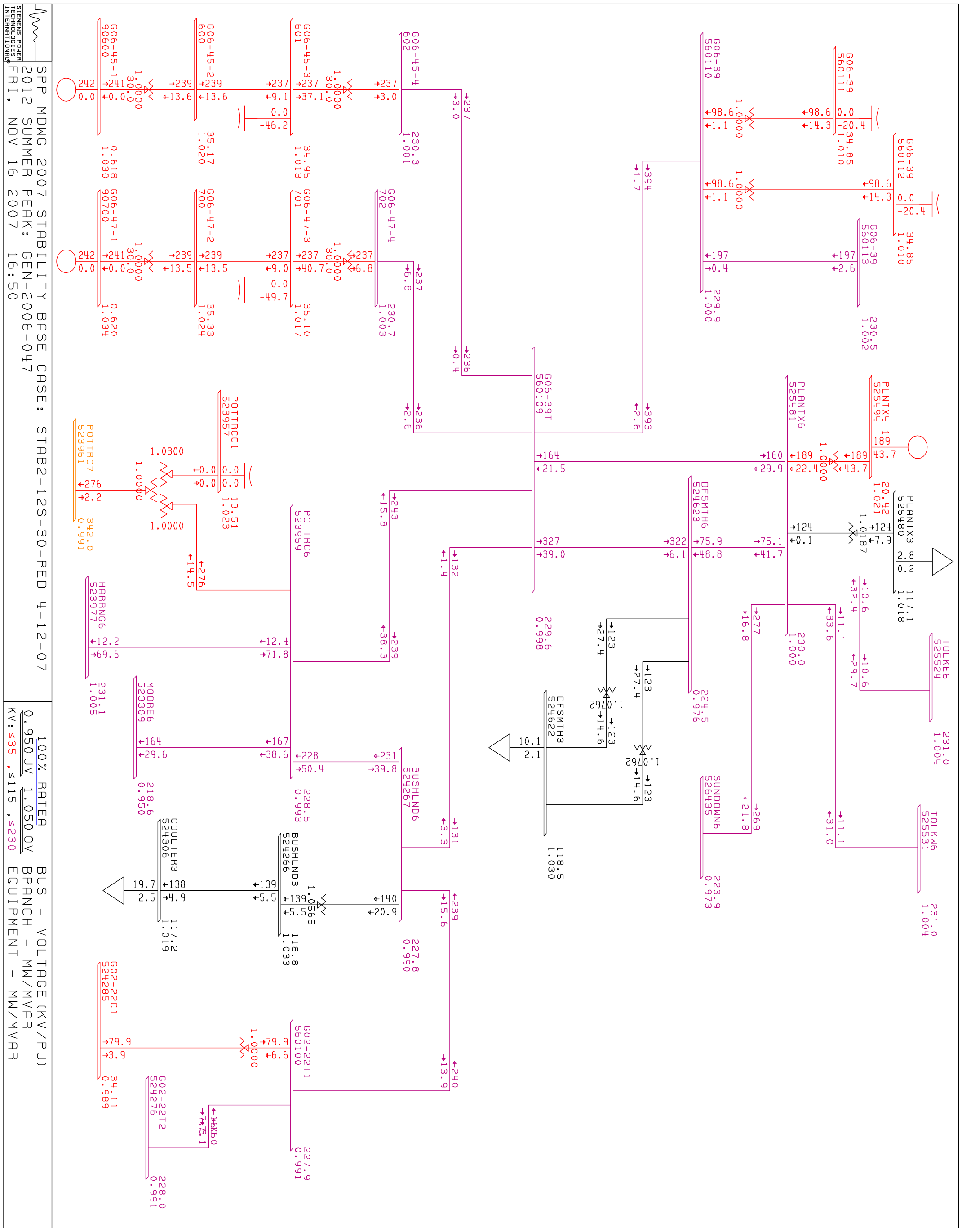


Figure 2-3 Summer Peak Flows and Voltages with GEN-2006-047

Table 2-3 List of Faults for Stability Analysis

Fault Name	***Description***
FLT_1_3PH	Three phase fault on the Wind Farm (560109) to Deaf Smith (524623) 230 kV line, near the Wind Farm. a) Apply fault at the Wind Farm 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm-Deaf Smith. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_2_1PH	Single phase fault on the Wind Farm (560109) to Deaf Smith (524623) 230 kV line, near the Wind Farm. a) Apply fault at the Wind Farm 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm-Deaf Smith. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_3_3PH	Three phase fault on the Wind Farm (560109) to Bushland (524267) 230 kV line, near the Wind Farm. a) Apply fault at the Wind Farm 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm-Bushland. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_4_1PH	Single phase fault on the Wind Farm (560109) to Bushland (524267) 230 kV line, near the Wind Farm. a) Apply fault at the Wind Farm 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm-Bushland. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_5_3PH	Three phase fault on the GEN-2006-039 (560109) – Potter (523959) 230kV line, near Potter. a) Apply fault at the Potter 230kV bus. b) Clear fault after 5 cycles by tripping the line from GEN-2006-039 – Potter. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_6_1PH	Single phase fault on the GEN-2006-039 (560109) – Potter (523959) 230kV line, near Potter. a) Apply fault at the Potter 230kV bus. b) Clear fault after 5 cycles by tripping the line from GEN-2006-039 – Potter. 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.

Fault Name	***Description***
FLT_7_3PH	Three phase fault on the GEN-2006-039 (560109) – Plant X (525481) 230kV line, near Plant X. a) Apply fault at the Plant X 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm – Plant X.
FLT_8_1PH	Single phase fault on the GEN-2006-039 (560109) – Plant X (525481) 230kV line, near Plant X. a) Apply fault at the Plant X 230kV bus. b) Clear fault after 5 cycles by tripping the line from the Wind Farm – Plant X.
FLT_9_3PH	Three phase fault on the Potter (523961) – Finney (523853) 345kV line, near Potter. a) Apply fault at the Potter 345kV bus. b) Clear fault after 4 cycles by tripping the line from the Potter – Finney.
FLT_10_1PH	Single phase fault on the Potter (523961) – Finney (523853) 345kV line, near Potter. a) Apply fault at the Potter 345kV bus. b) Clear fault after 4 cycles by tripping the line from the Potter – Finney.
FLT_11_3PH	Three phase fault on the GEN-2005-015 (560040) – Oklaunion (511456) 345kV line near Oklaunion. a) Apply fault at the Oklaunion bus. b) Clear fault after 5 cycles by tripping the line from the Oklaunion – GEN-2005-015 c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_12_1PH	Single phase fault on the GEN-2005-015 (560040) – Oklaunion (511456) 345kV line near Oklaunion. a) Apply fault at the Oklaunion bus. b) Clear fault after 5 cycles by tripping the line from the Oklaunion – GEN-2005-015 c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_13_3PH	Three phase fault on the Potter (523959) – Moore (523309) 230kV line near Moore. a) Apply fault at the Moore 230kV bus. b) Clear fault after 5 cycles by tripping the line Potter - Moore c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_14_1PH	Single phase fault on the Potter (523959) – Moore (523309) 230kV line near Moore. a) Apply fault at the Moore 230kV bus. b) Clear fault after 5 cycles by tripping the line Potter - Moore c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_15_3PH	Three phase fault on the Potter (523959)-Harrington (523977) 230kV line near Potter. a) Apply fault at the Potter 230kV bus. b) Clear fault after 5 cycles by tripping the line from Potter-Harrington.

Fault Name	***Description***
FLT_16_1PH	Single phase fault on the Potter (523959)-Harrington (523977) 230kV line near Potter. a) Apply fault at the Potter 230kV bus. b) Clear fault after 5 cycles by tripping the line from Potter-Harrington.
FLT_17_3PH	Three phase fault on the Conway (524079)-Kirby (524088) 115kV line near Kirby a) Apply fault at the Kirby bus. b) Clear fault after 5 cycles by tripping the line Conway - Kirby c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_18_1PH	Single phase fault on the Conway (524079)-Kirby (524088) 115kV line near Kirby a) Apply fault at the Kirby bus. b) Clear fault after 5 cycles by tripping the line Conway - Kirby c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_19_3PH	Three phase fault on the Nichols (524044)-Grapevine (523771) 230kV line near Grapevine a) Apply fault at the Grapevine bus. b) Clear fault after 5 cycles by tripping the line Nichols – Grapevine. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault
FLT_20_1PH	Single phase fault on the Nichols (524044)-Grapevine (523771) 230kV line near Grapevine a) Apply fault at the Grapevine bus. b) Clear fault after 5 cycles by tripping the line Nichols – Grapevine. c) Wait 20 cycles, and then re-close the line in (b) back into the fault. d) Leave fault on for 5 cycles, then trip the line in (b) and remove fault
FLT_21_3PH	Three phase fault on the Tolk (525549) - Eddy (527802) 345kV line near Tolk a) Apply fault at the Tolk bus. b) Clear fault after 5 cycles by tripping the Tolk – Eddy 345kV 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.
FLT_22_1PH	Single phase fault on the Tolk (525549) - Eddy (527802) 345kV line near Tolk a) Apply fault at the Tolk bus. b) Clear fault after 5 cycles by tripping the Tolk – Eddy 345kV 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.
FLT_23_3PH	Three phase fault on the Plant X (525481) to Deaf Smith (524623) 230 kV line, near the Deaf Smith. a) Apply fault at the Deaf Smith bus. b) Clear fault after 5 cycles by tripping the line from the Deaf Smith – Plant X.

Fault Name	***Description***
FLT_24_1PH	Single phase fault on the Plant X (525481) to Deaf Smith (524623) 230 kV line, near the Deaf Smith. a) Apply fault at the Deaf Smith bus. b) Clear fault after 5 cycles by tripping the line from the Deaf Smith – Plant X.

2.3 STUDY RESULTS

The results for the simulated disturbances are summarized in Table 2-4. The pre-project results listed there come from the GEN-2006-045 study. The post-project plots showing the simulation results are included in Appendix C.

Faults 9, 10, 11, and 12 result in instability for the 2008 Winter Peak case and faults 9 and 10 result in instability for the 2012 Summer Peak case. These faults involve loss of one of the two major interconnections between the Texas Panhandle and the eastern part of Southwest Power Pool:

- Potter – Finney 345 kV line
- Tuco – Oklaunion 345 kV line

These faults were unstable in the pre-project scenario as well, so the problem is not introduced by the addition of GEN-2006-047.

Due to the large amount of proposed wind generation in the Texas Panhandle, the ability of the above transmission lines to reliably export power to the north and east is reaching a limit. However, generation of GEN-2006-047 is dispatched to Texas Panhandle area and does not greatly influence these major interconnections in this study. Fixing these unstable faults is not considered to be required for interconnection, and these faults were not studied further. However, these results indicate that dispatching restrictions may be imposed on GEN-2006-047 under high Texas Panhandle export conditions.

For all other faults, all generators remain on-line and stable.

Table 2-4: Results of Stability Simulations

	2008 Winter Peak		**2012 Summer Peak**	
FAULT	**Pre-project**	**Post-project**	**Pre-project**	**Post-project**
FLT_1_3PH	STABLE	STABLE	STABLE	STABLE
FLT_2_1PH	STABLE	STABLE	STABLE	STABLE
FLT_3_3PH	STABLE	STABLE	STABLE	STABLE
FLT_4_1PH	STABLE	STABLE	STABLE	STABLE
FLT_5_3PH	STABLE	STABLE	STABLE	STABLE
FLT_6_1PH	STABLE	STABLE	STABLE	STABLE
FLT_7_3PH	STABLE	STABLE	STABLE	STABLE
FLT_8_1PH	STABLE	STABLE	STABLE	STABLE
FLT_9_3PH	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
FLT_10_1PH	UNSTABLE	UNSTABLE	UNSTABLE	UNSTABLE
FLT_11_3PH	UNSTABLE	UNSTABLE	STABLE	STABLE
FLT_12_1PH	UNSTABLE	UNSTABLE	STABLE	STABLE
FLT_13_3PH	STABLE	STABLE	STABLE	STABLE
FLT_14_1PH	STABLE	STABLE	STABLE	STABLE
FLT_15_3PH	STABLE	STABLE	STABLE	STABLE
FLT_16_1PH	STABLE	STABLE	STABLE	STABLE
FLT_17_3PH	STABLE	STABLE	STABLE	STABLE
FLT_18_1PH	STABLE	STABLE	STABLE	STABLE
FLT_19_3PH	STABLE	STABLE	STABLE	STABLE
FLT_20_1PH	STABLE	STABLE	STABLE	STABLE
FLT_21_3PH	STABLE	STABLE	STABLE	STABLE
FLT_22_1PH	STABLE	STABLE	STABLE	STABLE
FLT_23_3PH	STABLE	STABLE	STABLE	STABLE
FLT_24_1PH	STABLE	STABLE	STABLE	STABLE

Notes:
The speeds of the Siemens wind turbines at GEN-2002-022 show instability both pre-project and post-project for a number of faults, reaching extremes of +750% and -750%. However, the active and reactive power outputs look fine. Since speeds of this magnitude are not realistic, the SMK203 model must be inaccurate, and it is ignored.

3 CONCLUSIONS

The objective of this study is to evaluate the impact of the proposed GEN-2006-047 wind farm on the stability of SPP system. The study is performed for two system scenarios: the 2008 Winter Peak and the 2012 Summer Peak.

The faults involving loss of one of the major transmission outlets from the Texas Panhandle gave unstable results in both pre- and post-project system conditions. Potential stability problems with large power exports from the Texas Panhandle are already known to SPP. Hence, the mitigation of these problems was considered out of scope and not required for interconnection of the wind farm.

GEN-2006-047 will remain on-line through all other simulated faults, and the SPP system will be stable following these faults in both Summer Peak and Winter Peak system conditions.

To achieve 1.0 power factor at the POI, 48 MVAR of capacitors are required at the GEN-2006-047 substation 34.5 kV bus for both Summer Peak and Winter Peak system conditions.

Based on the results of stability analysis it can be concluded that the proposed GEN-2006-047 project does not adversely impact the stability of the SPP system if shunt capacitors and planned 230 kV line upgrades are added as mentioned above.

The results of this analysis are based on available data and assumptions made at the time of conducting this study. If any of the data and/or assumptions made in developing the study model change, the results provided in this report may not apply.

APPENDIX A - Wind Farm Model Development

APPENDIX B - Load Flow and Stability Data

APPENDIX C - Plots for Stability Simulations