Southwest Power Pool

Expedited Impact Study For Generation Interconnection Request GEN-2006-032

SPP Tariff Studies
(#GEN-2006-032)

April, 2007

Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 201MW of generation into the transmission facilities of Midwest Energy Inc. (MIDW) in Ellis County, Kansas. The proposed method of interconnection is to add a new 230kV terminal into the South Hays 230/115kV substation that is proposed to be in service by 2007 Winter Peak. The South Hays substation is owned by MIDW. The proposed in-service date of the generation is December, 2007.

Power flow analysis has indicated that for the powerflow cases studied, it is possible to interconnect the 201MW 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 30Mvars of 34.5kV capacitor banks in the Customer's collector substation on the 34.5kV bus.

The 115kV transmission line from Knoll to Mullergren is due to be converted in late 2007. As part of this conversion, a 230kV switchyard will be added to the South Hays substation. The requirements to interconnect the 201MW of generation into South Hays substation will consist of adding a new 230kV terminal at South Hays. Customer did not propose a specific 230kV line extending to serve its 230-34.5kV 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 201MW of generation is $670,043. These costs are shown in Table 2. Other Network Constraints in the Midwest, WESTAR, and West Plains Electric (WEPL) 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 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 230kV line from the Customer substation into the South Hays substation. This cost does not include the Customer's 230-34.5kV substation or the 34.5kV, 30Mvar 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.

A transient stability analysis was conducted by Pterra Consulting, Inc. of Albany, NY for this generation interconnection request. The stability analysis indicated that the transmission system will remain stable for the studied contingencies for the addition of the proposed generation. The study determined that the generation addition would meet the requirements of FERC Order #661A Low Voltage Ride Through provisions as long as the

Customer installs the General Electric 1.5MW wind turbines with the LVRT II package as provided by the manufacturer.

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 WESTAR, West Plains (WEPL), and Midwest Electric Cooperative (MIDW) control areas will be in service. Those previously queued projects that have advanced to nearly complete phases were included in this Feasibility Study. In the event that another request for a generation interconnection with a higher priority withdraws, then this request may have to be re-evaluated to determine the local Network Constraints.

Introduction

<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 201MW of generation into the transmission facilities of Midwest Energy Inc. (MIDW) in Ellis County, Kansas. The proposed method of interconnection is to add a new 230kV terminal into the South Hays 230/115kV substation that is proposed to be in service by late 2007. The South Hays substation is owned by MIDW. The proposed in-service date of the generation is December, 2007.

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 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.

Currently, the transmission line from Knoll – Mullergren is operated at 115kV. This line is to begin 230kV operation in late 2007. As part of the conversion to 230kV operation, a new 230kV switchyard and a 230/115kV autotransformer will be added to Midwest Energy's South Hays substation. The requirements for interconnection of the 201MW consist of adding a new 230kV terminal including one (1) 230kV circuit breaker and associated equipment to the proposed South Hays 230/115kV substation that will be owned by MIDW. The Customer did not disclose a route of its 230kV line to serve its 230/34.5kV facilities. It is assumed that obtaining all necessary right-of-way for the substation construction will not be a significant expense.

The total cost for adding a new 230kV terminal at the South Hays substation, the required interconnection facility, is estimated at $670,043. Other Network Constraints in the Midwest, WESTAR, and West Plains Electric (WEPL) transmission systems that were identified are listed in Table 3. These estimates will be refined during the development of the Facility Study based on the final designs. This cost does not include building the 230kV facilities from the Customer substation into the proposed South Hays substation. The Customer is responsible for these 230kV facilities up to the point of interconnection. This cost also does not include the Customer's 230-34.5kV substation, which should be determined by the Customer.

The costs of interconnecting the facility to the MIDW transmission system are listed in Table 1 & 2. **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 Facility Study is conducted.

A preliminary one-line drawing of the interconnection and direct assigned facilities are shown in Figure 1.

Table 1: Direct Assignment Facilities

Facility	ESTIMATED COST (2007 DOLLARS)
Customer – 230-34.5 kV Substation facilities.	*
Customer – 230kV transmission line facilities between Customer facilities and South Hays 230/115kV substation.	*
Customer - Right-of-Way for Customer facilities.	*
Customer – 34.5kV, 30Mvar 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)
MIDW – Add one 230kV line terminal including one circuit breaker and associated equipment into the South Hays 230/115kV substation.	**$670,043**
Total	**$670,043**

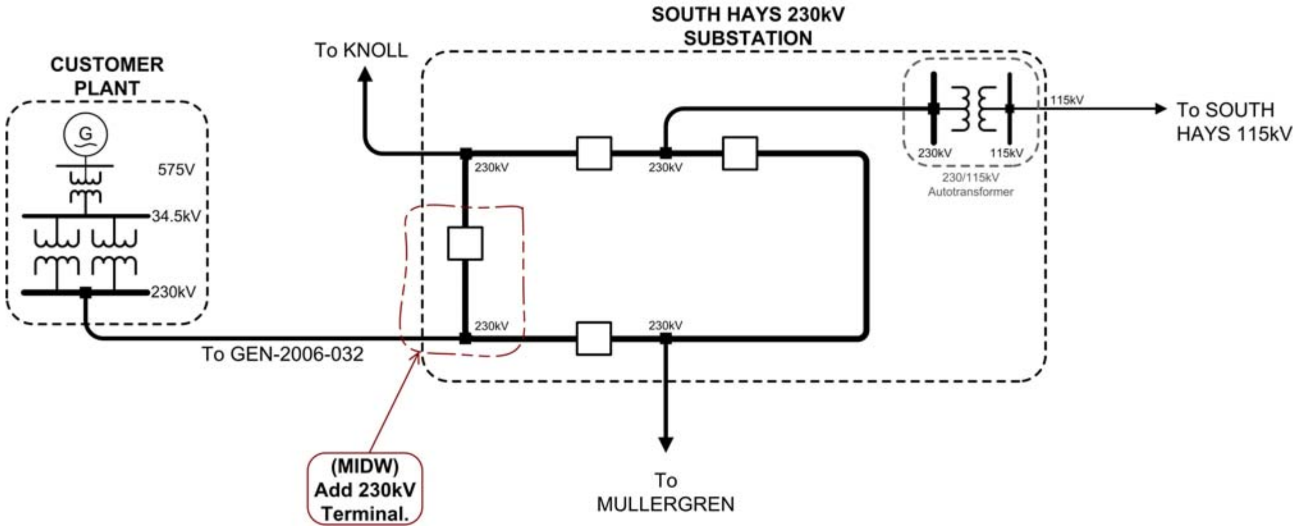

Figure 1: Proposed Interconnection
(Final substation design to be determined)

Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2008 summer and winter peak, the 2011 summer and winter peak, and 2016 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, 2007. The available seasonal models used were through the 2016 Summer Peak of 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 201MW and location, additional criteria violations will occur on the existing Westar, MIDW, and WEPL transmission systems under steady state and contingency conditions in the peak seasons.

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 5Mvar of capacitor banks in their substation on the 34.5kV buses in the Customer substation.

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 Feasibility Study. Those local projects that were previously queued and have advanced to nearly complete phases were included in this Feasibility Study.

Powerflow Analysis Methodology

The Southwest Power Pool (SPP) criteria states that: "The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable *NERC 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 (SUNC), Missouri Public Service (MIPU), Westar (WESTAR), Kansas City Power & Light (KCPL), West Plains (WEPL), Midwest Energy (MIDW), Oklahoma Gas and Electric (OKGE), 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.

Transient Stability Analysis

Pterra Consulting Inc. conducted a transient stability analysis for this request. The analysis indicated the transmission system would remain stable for the studied contingencies for the addition of the proposed generation.

The stability analysis also indicated the request will be compliant with FERC Order #661A low voltage ride through provisions without the use of an SVC or STATCOM device so long as the Customer uses the General Electric 1.5MW wind turbines with the LVRT II package as provided by the manufacturer.

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

Table 3: Network Constraints

OWNER	NETWORK CONSTRAINT
WERE	'16TH & WOODLAWN JUNCTION - MEADOWLARK 69KV CKT 1'
MIDW-WERE	'2003-19T 230 - SUMMIT 230KV CKT 1'
WERE	'95TH & WAVERLY - CAPTAIN JUNCTION 115KV CKT 1'
WERE	'AUBURN ROAD - JEFFREY ENERGY CENTER 230KV CKT 1'
WEPL	'CIMARRON RIVER PLANT - NORTH LIBERAL TAP 115KV CKT 1'
WEPL	'CIMARRON RIVER TAP - EAST LIBERAL 115KV CKT 1'
WERE	'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'
WEPL	'CLEARWT - MILAN TAP 138KV CKT 1'
WEPL	'CLIFTON - GREENLEAF 115KV CKT 1'
WEPL	'EAST LIBERAL - TEXAS COUNTY INTERCHANGE PHSF 115KV CKT 1'
WEPL	'G06-21T 138 - HARPER 138KV CKT 1'
WEPL	'G06-21T 138 - MEDICINE LODGE 138KV CKT 1'
WEPL	'GREENSBURG - JUDSON LARGE 115KV CKT 1'
WEPL	'HARPER - MILAN TAP 138KV CKT 1'
MIDW	'HAYS PLANT - VINE STREET 115KV CKT 1'
WERE	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
MIDW	'HUNTSVILLE - HUTCHINSON ENERGY CENTER 115KV CKT 1'
MIDW	'HUNTSVILLE - ST JOHN 115KV CKT 1'
MIDW	'KNOLL - VINE STREET 115KV CKT 1'
WERE	'LAWRENCE ENERGY CENTER UNIT 5 - LAWRENCE HILL 230KV CKT 1'
WERE	'LAWRENCE HILL - MIDLAND JUNCTION 230KV CKT 1'
WERE	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
WERE	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
WERE	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
WEPL	'MEDICINE LODGE - PRATT 115KV CKT 1'
WEPL	'MEDICINE LODGE - SUN CITY 115KV CKT 1'
WEPL	'MEDICINE LODGE (MED-LDG4) 138/115/2.72KV TRANSFORMER CKT 1'
WERE	'MIDLAND JUNCTION (MIDJ126X) 230/115/18.0KV TRANSFORMER CKT 1'
WERE	'MOUNDRIDGE - SPRING CREEK JUNCTION 115KV CKT 1'
WERE	'NORTH AMERICAN PHILIPS - NORTH AMERICAN PHILIPS JUNCTION (SOUTH) 115KV CKT 1'
WERE	'NORTHVIEW - SUMMIT 115KV CKT 1'
WEPL	'PRATT - ST JOHN 115KV CKT 1'
WEPL	'SEWARD - ST JOHN 115KV CKT 1'
WEPL	'ST JOHN - ST JOHN 115KV CKT 1'
WERE	'SWISSVALE (SWISV10X) 345/230/14.4KV TRANSFORMER CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
2008 SUMMER PEAK					
'16TH & WOODLAWN JUNCTION - 3RD & VAN BUREN 69KV CKT 1'	08sp	65	143.5	0	'HUTCHINSON ENERGY CENTER (HEC 122X) 115/69/34.5KV TRANSFORMER CKT 1'
'16TH & WOODLAWN JUNCTION - MEADOWLARK 69KV CKT 1'	08sp	71	131.3	0	'HUTCHINSON ENERGY CENTER (HEC 122X) 115/69/34.5KV TRANSFORMER CKT 1'
'95TH & WAVERLY - CAPTAIN JUNCTION 115KV CKT 1'	08sp	118	111.7	0	'HOYT - STRANGER CREEK 345KV CKT 1'
'AUBURN ROAD - JEFFREY ENERGY CENTER 230KV CKT 1'	08sp	565	126.3	0	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'	08sp	110	208.6	0	'FINNEY STATION - HOLCOMB 345KV CKT 1'
'CLEARWT - MILAN TAP 138KV CKT 1'	08sp	110	220.2	0	'FINNEY STATION - HOLCOMB 345KV CKT 1'
'G06-21T 138 - HARPER 138KV CKT 1'	08sp	71.7	384.7	0	'FINNEY STATION - HOLCOMB 345KV CKT 1'
'HARPER - MILAN TAP 138KV CKT 1'	08sp	95.6	270.0	0	'FINNEY STATION - HOLCOMB 345KV CKT 1'
'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'	08sp	1076	114.5	0	'JEFFERY ENERGY CENTER - MORRIS COUNTY 345KV CKT 1'
'HUNTSVILLE - ST JOHN 115KV CKT 1'	08sp	88	116.5	0	'SPP-WERE-34A'
'LAWRENCE ENERGY CENTER UNIT 5 - LAWRENCE HILL 230KV CKT 1'	08sp	478	112.2	0	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'	08sp	308	130.7	0	'MIDLAND JUNCTION (MIDJ126X) 230/115/18.0KV TRANSFORMER CKT 1'
'NORTHVIEW - SUMMIT 115KV CKT 1'	08sp	181	105.1	0	'EXIDE JUNCTION - SUMMIT 115KV CKT 1'
'POTTER COUNTY INTERCHANGE (POTTR CO) 345/230/13.2KV TRANSFORMER CKT 1'	08sp	560	118.3	0	'GEN:51442 1'
'ST JOHN - ST JOHN 115KV CKT 1'	08sp	88	168.8	0	'SPP-WERE-34A'
'HUNTSVILLE - HUTCHINSON ENERGY CENTER 115KV CKT 1'	08sp	92	107.6	3	'SPP-WERE-34A'
'CLIFTON - GREENLEAF 115KV CKT 1'	08sp	89.6	105.0	67	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'LAWRENCE HILL - MIDLAND JUNCTION 230KV CKT 1'	08sp	359	101.3	118	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
'2003-19T 230 - SUMMIT 230KV CKT 1'	08sp	319	109.1	139	'CIRCLE - MULLERGREN 230KV CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'NORTH AMERICAN PHILIPS JUNCTION (SOUTH) - WEST MCPHERSON 115KV CKT 1'	08sp	68	104.4	140	'2004-16T 230 - SUMMIT 230KV CKT 1'
'HAYS PLANT - VINE STREET 115KV CKT 1'	08sp	88	110.8	174	'KNOLL - S HAYS6 230 230KV CKT 1'
'EAST LIBERAL - TEXAS COUNTY INTERCHANGE PHSF 115KV CKT 1'	08sp	119	101.4	183	'SPP-SWPS-04A'
'KNOLL - VINE STREET 115KV CKT 1'	08sp	88	102.8	194	'KNOLL - S HAYS6 230 230KV CKT 1'
2008 WINTER PEAK					
'AUBURN ROAD - JEFFREY ENERGY CENTER 230KV CKT 1'	08wp	565	121.8	0	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'	08wp	110	250.2	0	'PRATT - ST JOHN 115KV CKT 1'
'CLEARWT - MILAN TAP 138KV CKT 1'	08wp	110	263.2	0	'PRATT - ST JOHN 115KV CKT 1'
'G06-21T 138 - HARPER 138KV CKT 1'	08wp	71.7	439.1	0	'PRATT - ST JOHN 115KV CKT 1'
'HARPER - MILAN TAP 138KV CKT 1'	08wp	95.6	316.1	0	'PRATT - ST JOHN 115KV CKT 1'
'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'	08wp	1076	113.7	0	'JEFFERY ENERGY CENTER - MORRIS COUNTY 345KV CKT 1'
'MEDICINE LODGE (MED-LDG4) 138/115/2.72KV TRANSFORMER CKT 1'	08wp	65	343.4	0	'CLEARWT - MILAN TAP 138KV CKT 1'
'PRATT - ST JOHN 115KV CKT 1'	08wp	79.7	303.8	0	'CLEARWT - MILAN TAP 138KV CKT 1'
'ST JOHN - ST JOHN 115KV CKT 1'	08wp	88	154.6	0	'HARPER - MILAN TAP 138KV CKT 1'
'MEDICINE LODGE - PRATT 115KV CKT 1'	08wp	79.7	140.5	37	'CLEARWT - MILAN TAP 138KV CKT 1'
'2003-19T 230 - SUMMIT 230KV CKT 1'	08wp	319	112.6	120	'MULLERGREN - S HAYS6 230 230KV CKT 1'
'SEWARD - ST JOHN 115KV CKT 1'	08wp	79.7	139.4	194	'CLEARWT - MILAN TAP 138KV CKT 1'
2011 SUMMER PEAK					
'AUBURN ROAD - JEFFREY ENERGY CENTER 230KV CKT 1'	11sp	565	123.2	0	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'	11sp	110	225.3	0	'PRATT - ST JOHN 115KV CKT 1'
'CLEARWT - MILAN TAP 138KV CKT 1'	11sp	110	240.3	0	'PRATT - ST JOHN 115KV CKT 1'
'EAST LIBERAL - TEXAS COUNTY INTERCHANGE PHSF 115KV CKT 1'	11sp	119	121.1	0	'SPP-SWPS-04A'
'G06-21T 138 - HARPER 138KV CKT 1'	11sp	71.7	424.6	0	'PRATT - ST JOHN 115KV CKT 1'
'HARPER - MILAN TAP 138KV CKT 1'	11sp	95.6	293.3	0	'PRATT - ST JOHN 115KV CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'	11sp	1076	110.6	0	'JEFFERY ENERGY CENTER - MORRIS COUNTY 345KV CKT 1'
'LAWRENCE ENERGY CENTER UNIT 5 - LAWRENCE HILL 230KV CKT 1'	11sp	478	113.1	0	'GILL ENERGY CENTER EAST (GEC3 GSU) 138/69/14.4KV TRANSFORMER CKT 1'
'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'	11sp	308	129.8	0	'MIDLAND JUNCTION (MIDJ126X) 230/115/18.0KV TRANSFORMER CKT 1'
'MEDICINE LODGE (MED-LDG4) 138/115/2.72KV TRANSFORMER CKT 1'	11sp	65	162.5	0	'GEN:99933 1'
'NORTH AMERICAN PHILIPS - NORTH AMERICAN PHILIPS JUNCTION (SOUTH) 115KV CKT 1'	11sp	160	116.2	0	'2004-16T 230 - SUMMIT 230KV CKT 1'
'NORTH AMERICAN PHILIPS JUNCTION (SOUTH) - WEST MCPHERSON 115KV CKT 1'	11sp	68	126.2	0	'2004-16T 230 - SUMMIT 230KV CKT 1'
'NORTHVIEW - SUMMIT 115KV CKT 1'	11sp	181	104.5	0	'EXIDE JUNCTION - SUMMIT 115KV CKT 1'
'POTTER COUNTY INTERCHANGE (POTTR CO) 345/230/13.2KV TRANSFORMER CKT 1'	11sp	560	116.9	0	'SPP-AEPW-03'
'ST JOHN - ST JOHN 115KV CKT 1'	11sp	88	147.4	0	'HARPER - MILAN TAP 138KV CKT 1'
'WEBRERICHARD'	11sp	1250	114.6	0	'BASE CASE'
'CLIFTON - GREENLEAF 115KV CKT 1'	11sp	89.6	105.2	58	'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'
'NORTH AMERICAN PHILIPS JUNCTION (SOUTH) - WEST MCPHERSON 115KV CKT 2'	11sp	92	110.1	61	'2004-16T 230 - SUMMIT 230KV CKT 1'
'HAYS PLANT - VINE STREET 115KV CKT 1'	11sp	88	109.5	133	'KNOLL 230/115KV TRANSFORMER CKT 1'
'MOUNDRIDGE - SPRING CREEK JUNCTION 115KV CKT 1'	11sp	80	103.7	143	'2004-16T 230 - SUMMIT 230KV CKT 1'
'LAWRENCE HILL - MIDLAND JUNCTION 230KV CKT 1'	11sp	359	100.6	163	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
'MEDICINE LODGE - PRATT 115KV CKT 1'	11sp	79.7	102.2	165	'GEN:99933 1'
2011 WINTER PEAK					
'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'	11wp	110	240.8	0	'PRATT - ST JOHN 115KV CKT 1'
'CLEARWT - MILAN TAP 138KV CKT 1'	11wp	110	253.8	0	'PRATT - ST JOHN 115KV CKT 1'
'G06-21T 138 - HARPER 138KV CKT 1'	11wp	71.7	432.7	0	'PRATT - ST JOHN 115KV CKT 1'
'G06-21T 138 - MEDICINE LODGE 138KV CKT 1'	11wp	71.7	357.1	0	'G06-21T 138 - HARPER 138KV CKT 1'
'GREENSBURG - JUDSON LARGE 115KV CKT 1'	11wp	79.7	137.1	0	'G06-21T 138 - HARPER 138KV CKT 1'
'HARPER - MILAN TAP 138KV CKT 1'	11wp	95.6	305.4	0	'PRATT - ST JOHN 115KV CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'	11wp	1076	110.4	0	'JEFFERY ENERGY CENTER - MORRIS COUNTY 345KV CKT 1'
'HUNTSVILLE - ST JOHN 115KV CKT 1'	11wp	88	111.8	0	'G06-21T 138 - HARPER 138KV CKT 1'
'MEDICINE LODGE - SUN CITY 115KV CKT 1'	11wp	79.7	153.3	0	'G06-21T 138 - HARPER 138KV CKT 1'
'MEDICINE LODGE (MED-LDG4) 138/115/2.72KV TRANSFORMER CKT 1'	11wp	65	372.5	0	'G06-21T 138 - HARPER 138KV CKT 1'
'PRATT - ST JOHN 115KV CKT 1'	11wp	79.7	316.4	0	'G06-21T 138 - HARPER 138KV CKT 1'
'ST JOHN - ST JOHN 115KV CKT 1'	11wp	88	160.8	0	'G06-21T 138 - HARPER 138KV CKT 1'
'MEDICINE LODGE - PRATT 115KV CKT 1'	11wp	79.7	158.7	17	'G06-21T 138 - HARPER 138KV CKT 1'
'SWISSVALE (SWISV10X) 345/230/14.4KV TRANSFORMER CKT 1'	11wp	440	106.6	22	'LANG - MORRIS COUNTY 345KV CKT 1'
'2003-19T 230 - SUMMIT 230KV CKT 1'	11wp	319	106.7	174	'MULLERGREN - S HAYS6 230 230KV CKT 1'
'SEWARD - ST JOHN 115KV CKT 1'	11wp	79.7	138.4	194	'G06-21T 138 - HARPER 138KV CKT 1'
'HUNTSVILLE - HUTCHINSON ENERGY CENTER 115KV CKT 1'	11wp	92	104.1	200	'G06-21T 138 - HARPER 138KV CKT 1'
2016 SUMMER PEAK					
'CIMARRON RIVER PLANT - NORTH LIBERAL TAP 115KV CKT 1'	16sp	115.3	125.1	0	'CIMARRON RIVER TAP - EAST LIBERAL 115KV CKT 1'
'CIMARRON RIVER TAP - EAST LIBERAL 115KV CKT 1'	16sp	119.5	120.4	0	'CIMARRON RIVER PLANT - NORTH LIBERAL TAP 115KV CKT 1'
'CLEARWT - GILL ENERGY CENTER WEST 138KV CKT 1'	16sp	110	214.2	0	'PRATT - ST JOHN 115KV CKT 1'
'CLEARWT - MILAN TAP 138KV CKT 1'	16sp	110	229.7	0	'PRATT - ST JOHN 115KV CKT 1'
'G06-21T 138 - HARPER 138KV CKT 1'	16sp	71.7	410.1	0	'PRATT - ST JOHN 115KV CKT 1'
'G06-21T 138 - MEDICINE LODGE 138KV CKT 1'	16sp	71.7	128.5	0	'GEN:99933 1'
'HARPER - MILAN TAP 138KV CKT 1'	16sp	95.6	281.6	0	'PRATT - ST JOHN 115KV CKT 1'
'HAYS PLANT - VINE STREET 115KV CKT 1'	16sp	88	116.5	0	'KNOLL 230/115KV TRANSFORMER CKT 1'
'HOYT - JEFFERY ENERGY CENTER 345KV CKT 1'	16sp	1076	107.1	0	'JEFFERY ENERGY CENTER - MORRIS COUNTY 345KV CKT 1'
'LAWRENCE ENERGY CENTER UNIT 5 - LAWRENCE HILL 230KV CKT 1'	16sp	478	112.1	0	'GILL ENERGY CENTER EAST (GEC3 GSU) 138/69/14.4KV TRANSFORMER"
'LAWRENCE HILL - MIDLAND JUNCTION 230KV CKT 1'	16sp	359	103.2	0	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'	16sp	308	133.5	0	'MIDLAND JUNCTION (MIDJ126X) 230/115/18.0KV TRANSFORMER CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'MEDICINE LODGE (MED-LDG4) 138/115/2.72KV TRANSFORMER CKT 1'	16sp	65	142.3	0	'GEN:99933 1'
'MIDLAND JUNCTION (MIDJ126X) 230/115/18.0KV TRANSFORMER CKT 1'	16sp	308	120.9	0	'LAWRENCE HILL (LAWHL29X) 230/115/13.8KV TRANSFORMER CKT 1'
'NORTH AMERICAN PHILIPS - NORTH AMERICAN PHILIPS JUNCTION (SOUTH) 115KV CKT 1'	16sp	160	119.9	0	'2004-16T 230 - SUMMIT 230KV CKT 1'
'NORTH AMERICAN PHILIPS JUNCTION (SOUTH) - WEST MCPHERSON 115KV CKT 1'	16sp	68	130.2	0	'2004-16T 230 - SUMMIT 230KV CKT 1'
'PECAN CREEK (PECANCK1) 345/161/13.8KV TRANSFORMER CKT 1'	16sp	370	109.7	0	'CLARKSVILLE - MUSKOGEE 345KV CKT 1'
'POTTER COUNTY INTERCHANGE (POTTR CO) 345/230/13.2KV TRANSFORMER CKT 1'	16sp	560	117.8	0	'GEN:54208 1'
'SPPSPSTIES'	16sp	899	108.8	0	'BASE CASE'
'WEBRERICHARD'	16sp	1250	101.7	0	'BASE CASE'
'NORTH AMERICAN PHILIPS JUNCTION (SOUTH) - WEST MCPHERSON 115KV CKT 2'	16sp	92	113.6	26	'2004-16T 230 - SUMMIT 230KV CKT 1'
'MOUNDRIDGE - SPRING CREEK JUNCTION 115KV CKT 1'	16sp	80	105.5	103	'2004-16T 230 - SUMMIT 230KV CKT 1'
'KNOLL - VINE STREET 115KV CKT 1'	16sp	88	104.1	171	'KNOLL 230/115KV TRANSFORMER 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.

Conclusion

The minimum cost of interconnecting the Customer's interconnection request is estimated at $670,043 for Network Upgrades as listed in Table 2. These costs exclude upgrades of other transmission facilities by WESTAR, MIPU, OKGE, and KACP listed in Table 3 of which are Network Constraints. 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 30Mvar of 34.5kV capacitors in the Customer substation for reactive support. As stated earlier, some but not all of the local projects that were previously queued are assumed to be in service in this Feasibility 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.

Transient Stability analysis indicates that the transmission system will remain stable with the addition of the proposed generation.

These interconnection costs do not include any cost that may be associated with short circuit study results. These studies will be performed if the Customer signs a Facility Study Agreement.

The required interconnection costs listed in Table 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 Southwest Power Pool's OASIS.

FIGURE 2. MAP OF THE LOCAL AREA

ATTACHMENT 1.

STABILITY STUDY

Pterra Consulting

Report No. R112-07

"Impact Study for Generation Interconnection Request GEN-2006-032"

Submitted to

The Southwest Power Pool

March 2007

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Report No. R112-07

"Impact Study for Generation Interconnection Request GEN-2006-032"

1. Executive Summary

This report presents the stability simulation findings of the impact study of a proposed interconnection (GEN-2006-032). The analysis was conducted through the Southwest Power Pool Tariff for a proposed 201 MW wind farm located in Ellis County, Kansas. This wind farm would be interconnected to a new 230 kV position in the new planned South Hays 230/115kV substation. The South Hays substation will include a 230 kV line terminal to Mullergren (West Plains) and a 230kV line terminal to Summit (via Knoll). The South Hays substation is owned by Midwest Electric Cooperative (MIDW). The customer has asked for a study case of 100% MW. GE 1.5 MW Wind Turbine Generators (WTGs) were studied according to the customer's request.

Two base cases each comprising of a power flow and corresponding dynamics database for 2011 summer and 2007 winter were provided by SPP. Transient stability simulations were conducted with the proposed wind farm in service with a full output of 201 MW. In order to integrate the proposed 201 MW wind farm in SPP system, the existing generation in the SPP footprint was re-dispatched. Unity power factor at the interconnection point was achieved by using a 5 MVAR capacitor located on the 34.5kV Customer side bus.

Twenty four (24) disturbances were considered for the transient stability simulations which included 3-phase faults, as well as, 1-phase to ground faults, at the locations defined by SPP.

The proposed GE WTGs were modeled with under/over voltage/frequency ride through protection package II. The settings were in accordance with standard or default settings. The simulations conducted in the study using the GE 1.5 MW WTGs did not find any angular or voltage instability problems for the 24 disturbances. The study finds that the proposed 201 MW project shows stable performance of SPP system for the contingencies tested on the supplied base cases.

2. Introduction

2.1 Project Overview

The proposed 201 MW wind farm will be connected to a new ring position on the planned South Hays 230 kV substation. Figure 1 shows a conceptual interconnection diagram of the proposed GEN-2006-032 project to the 230 kV transmission network. The detailed connection diagram of the wind farm was provided by SPP.

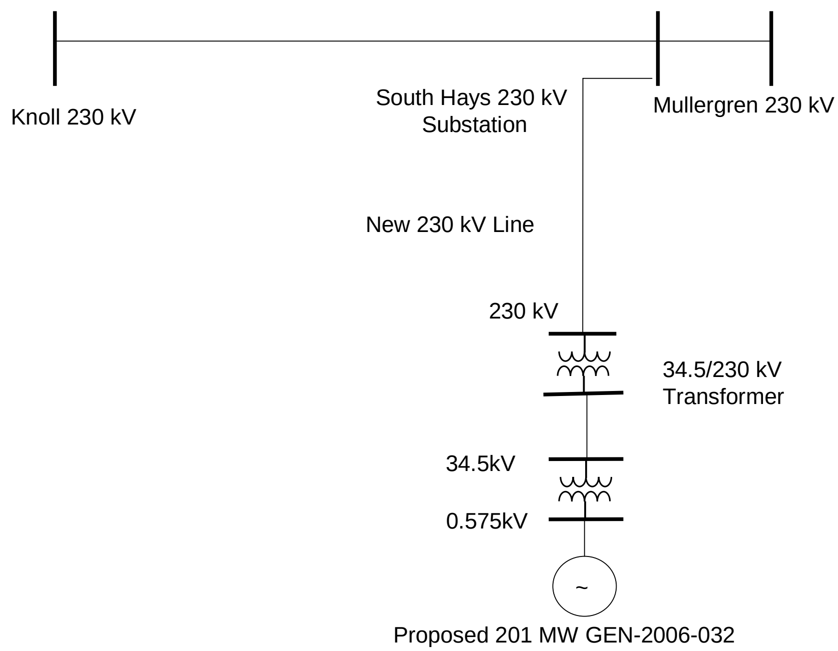

Figure 1 Interconnection Plan for GEN-2006-032 to the 230 kV System

In order to integrate the proposed 201 MW wind farm in SPP system as an Energy Resource, existing generation in the SPP footprint is redispatched.

To simplify the model of the wind farm while capturing the effect of the different impedances of cables (due to change of the conductor size and length), the wind turbines connected to the same 34.5 kV feeder end points were aggregated into one equivalent unit. An equivalent impedance of that feeder was represented by taking the equivalent series impedances of the different feeders connecting the wind turbines. Using this approach, the proposed 201 MW wind farm was modeled with 60 equivalent units (GE 1.5 MW WTGs) as shown in Figure 2. The number in each circle in the diagram shows the number of individual wind turbine units that were aggregated at that bus. SPP provided the impedance values for the different feeders at 34.5 kV level. SPP provided the data for the following equipment:

1. 34.5 kV feeders.
2. Generating unit step up transformers.

3. 230/34.5 kV transformers.
4. Parameters of the new 230 kV line.

Unity power factor was achieved at the interconnection point using a 5 MVAR capacitor bank located at the 34.5 kV side of the 230/34.5 kV Transformer.

2.2 Objective

The objective of the study is to determine the impact on system stability of connecting the proposed 201 MW wind farm to SPP's transmission system.

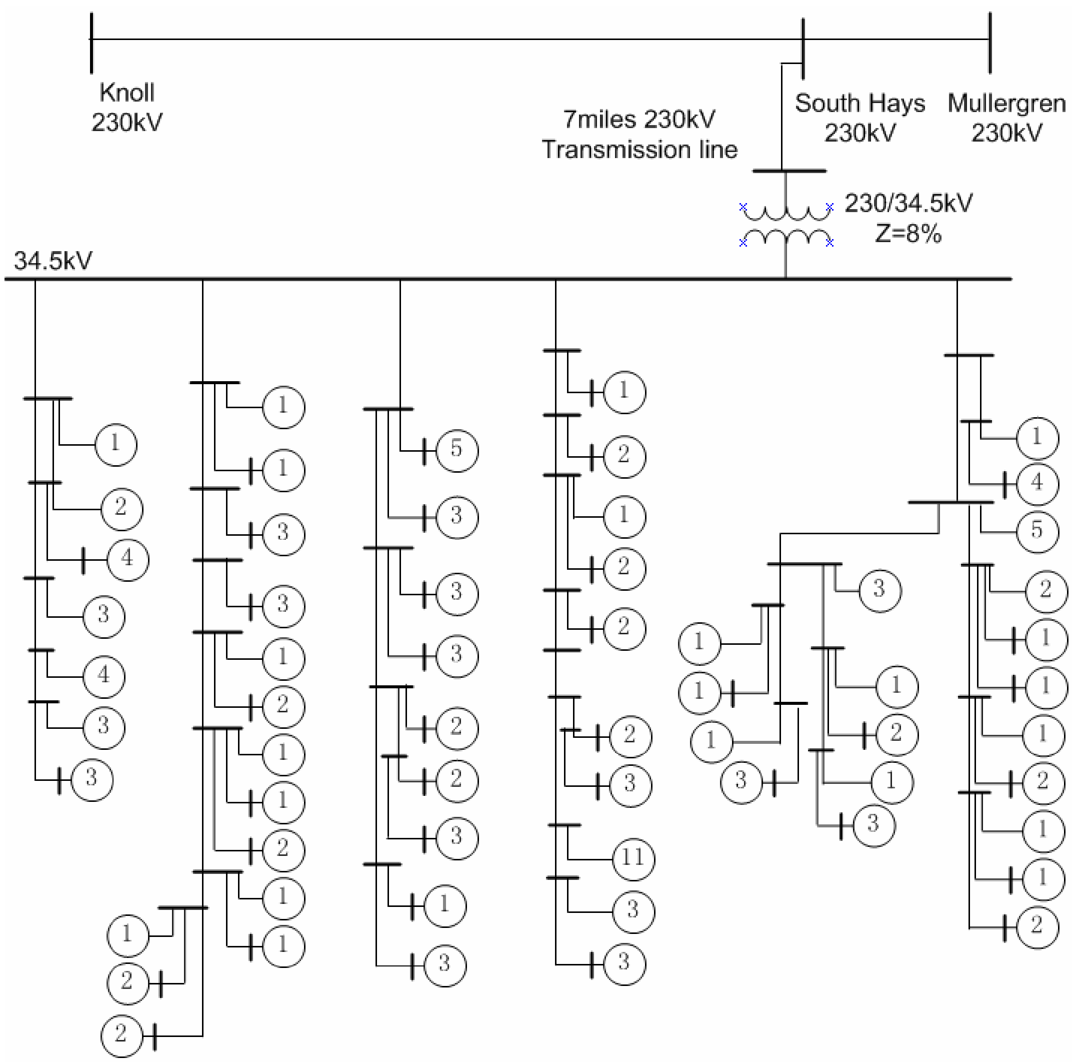

Figure 2 Wind Farm Model in Load Flow (134 GE 1.5 MW WTGs)

3. Stability Analysis

3.1 Modeling of the General Electric 1.5 MW Wind Turbine Generators

Equivalents for the wind turbine and generator step-up (GSU) transformer in the load flow case were modeled. For the stability simulations, the GE 1.5 MW WTGs were modeled using the provided GE 1.5 MW wind turbine dynamic model set.

Table 1 GE 1.5 MW WTGs Data

Parameter	Value
BASE KV	0.575
WTG MBASE	1.667
TRANSFORMER MBASE	1.750
TRANSFORMER R ON TRANSFORMER BASE	0.0077
TRANSFORMER X ON TRANSFORMER BASE	0.0579
GTAP	1.0
PMAX (MW)	1.5
PMIN(MW)	0.0
XEQ, PU	0.8
LA	0.1714
LM	2.904
R1	0.005
L1	0.1563
INERTIA	0.558
DAMPING	0.0
QMAX(MVAR)	0.490
QMIN(MVAR)	-0.730

The wind turbine generators have ride-through capability for voltage and frequency. Detailed relay settings are shown in the following tables:

Table 2 Over/Under Frequency Relay Settings for GE 1.5 MW WTGs

Frequency Settings in Hertz	Time Delay in Seconds	Breaker time in Seconds
f≤56.5	0.02	0.08
56.5<f≤57.5	10	0.08
61.5≤f<62.5	30	0.08
f≥62.5	0.02	0.08

Table 3 Over/Under Voltage Relay Settings for GE 1.5 MW WTGs

Voltage Settings Per Unit	Time Delay in Seconds	Breaker time in Seconds
V ≤ 0.3	0.625	0.08
0.3 < V ≤ 0.70	0.625	0.08
0.70 < V ≤ 0.75	1.0	0.08
0.75 < V ≤ 0.85	10	0.08
1.1 < V ≤ 1.15	1.0	0.08
1.15 < V ≤ 1.3	0.1	0.08

3.2 Assumptions

The following assumptions were adopted for the study:

1. Constant maximum and uniform wind speed for the entire period of study.
2. Wind turbine control models with their default values.
3. Under/over voltage/frequency protection set to standard manufacturer data.

3.3 Disturbances Simulated

Twenty four (24) disturbances were considered for the transient stability simulations which included three phase faults, as well as single phase faults, at the locations defined by SPP. Single-phase faults were simulated by applying a fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice. Table 4 shows the list of simulated disturbances. The table also shows the fault clearing time and the time delay before re-closing for all the study disturbances.

The following prior queued projects were monitored in the simulations:

a. GEN-2003-019; 250MW wind farm on the Summitt-Knoll 230kV line

b. GEN-2004-014 154MW wind farm on the Mullergren-Spearville 230kv line

c. GEN-2004-016 150MW wind farm on the Summitt-E McPherson 230kV line

d. GEN-2006-031; 75MW of internal combustion turbines at Hays 115kV substation

Table 4 List of Simulated Disturbances

Fault #	Fault Description
FLT_1_3PH	Fault on the South Hays (56599) to Mullergren (58779) 230 kV line, near South Hays a. Apply Fault at the South Hays bus (56599). b. Clear Fault after 5 cycles by removing the line from South Hays to Mullergen 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	Same as FLT13PH above
FLT_3_3PH	Fault on the South Hays (56599) to Knoll (56558) 230 kV line, near South Hays a. Apply Fault at the S Hays (565599). b. Clear Fault after 5 cycles by removing the line from South Hays - Knoll 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	Same as FLT33PH above
FLT_5_3PH	Fault on the Wind Farm Gen-2003-019 Switching Station (99950) to Knoll (56558) 230 kV line, near the Knoll. a. Apply fault at the Knoll bus (56558). b. Clear fault after 5 cycles by removing the line from the Gen-2003-019 Switching Station (99950) to Knoll (56558).

Fault #	Fault Description
	c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_6_1PH	Same as FLT53PH above
FLT_7_3PH	Fault on the Circle (56871) to Mullergren (58799) 230 kV line, near Circle. a. Apply Fault at the Circle bus (56871). b. Clear fault after 5 cycles by removing the line from Circle (56871) to Mullergren (58799). c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_8_1PH	Same as FLT73PH above
FLT_9_3PH	Fault on the Spearville (58795) to GEN-2004-014 tap (90) 230 kV line, near GEN-2004-014 tap. a. Apply Fault at the GEN-2004-014 Tap bus (90). b. Clear fault after 5 cycles by removing the line 04-14 tap - Spearville. c. Wait 20 cycles, and then re-close the line in (b) into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_10_1PH	Same as FLT93PH above
FLT_11_3PH	Fault on the Manhattan (56861) to Concordia (58758) 230 kV line, near Manhattan. a. Apply fault at the Manhattan bus (56861). b. Clear fault after 5 cycles by tripping the line from Manhattan (56861) to Concordia (58758). 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	Same as FLT113PH above
FLT_13_3PH	Fault on the Jefferies Energy Center (56766) to Summit (56773) 345 kV line, near Summit. a. Apply fault at the Summit bus (56773). b. Clear fault after 5 cycles by tripping the line from Jefferies Energy Center (56766) to Summit (56773). c. Wait 30 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	Same as FLT133PH above
FLT_15_3PH	Fault on the Morris (56863) to Summit (56873) 230 kV line, near Summit. a. Apply fault at the Summit bus (56873). b. Clear fault after 5 cycles by tripping the line Morris (56863) to Summit (56873). c. Wait 20 cycles, and then re-close line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
FLT_16_1PH	Same as FLT153PH above
FLT_17_3PH	Fault on the Knoll (56561) to Redline (56605) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Knoll (56561) to Redline (56605).

Fault #	Fault Description
	c. Wait 15 cycles, and then re-close 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	Same as FLT173PH above
FLT_19_3PH	Fault on the Knoll (56561) to Vine (56591) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Hays (56562) to Vine (56591). c. Wait 15 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	Same as FLT193PH above
FLT_21_3PH	Fault on the Knoll (56561) to Saline (56551) 115 kV line, near Knoll. a. Apply fault at the Knoll bus (56561). b. Clear fault after 5 cycles by tripping the line from Knoll (56561) to Saline (56551). c. Wait 15 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	Same as FLT213PH above
FLT_23_3PH	Fault on the Knoll 230/115kV autotransformer. a. Apply fault at the Knoll bus (56558). b. Clear fault after 5 cycles by tripping the auto
FLT_24_1PH	Same as FLT233PH above

3.5 Simulation Results

Simulations were performed with a 0.1-second steady-state run followed by the appropriate disturbance as described in Table 4. Simulations were run for a minimum 10-second duration to confirm proper machine damping.

The results of the stability simulations, for the disturbances listed in Table 4, did not find any angular or voltage instability problems with the SPP system or with the proposed project's WTGs.

A complete set of transient stability plots for rotor angle, speed, frequency, and voltages for the monitored buses in SPP is provided in the accompanying CD.

4. Conclusion

The stability simulation findings of the impact study of a proposed interconnection (Gen-2006-032) were presented in this report. The impact study case considered 100% MW of the wind farm proposed output. GE 1.5 MW WTGs were studied according to the customer request.

The 2011 summer and 2007 winter load flow cases together with the necessary data needed for the transient stability simulations were provided by SPP. Transient stability simulations were conducted with the proposed wind farm in service with a full output of 201 MW. In order to integrate the proposed 201 MW wind farm in SPP system, the existing SPP footprint generation was redispatched. Unity power factor at the interconnection point was achieved by adding a 5 MVAR capacitor bank at the 34.5kV side of the project substation.

Twenty four (24) disturbances were considered for the transient stability simulations which included three phase faults, as well as single line to ground faults, at the locations defined by SPP.

The results of the stability simulations for the studied disturbances did not find any angular or voltage instability problems associated with the proposed project's GE 1.5 MW WTGs. The study finds that the proposed 201 MW project shows stable performance of SPP system for the contingencies tested on the supplied base cases.