Impact Study of Limited Operation for Generator Interconnection

GEN-2008-017

May 2013
Generator Interconnection

SPP Southwest Power Pool

Executive Summary

<OMITTED TEXT> (Customer; GEN-2008-017) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 300.0 MW of wind generation to be interconnected as an Energy Resource (ER) into a transmission facility of the Sunflower Electric Power Corp. (SUNC) in Scott County, Kansas. GEN-2008-017, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the ICS-2008-001 (or most recent iteration) Impact Study can be placed into service.

This LOIS addresses the effects of interconnecting the plant to the rest of the transmission system for the system topology and conditions as expected on October 1, 2015 assuming the Priority Projects, Spearville – Clark County – Thistle – Wichita double circuit 345kV and Thistle – Woodward double circuit 345kV were not in-service. GEN-2008-017 is requesting the interconnection of two-hundred (200) General Electric 1.5 MW wind turbine generators and associated facilities into the Setab 345kV substation. For the typical LOIS, both a power flow and transient stability analyses are conducted. The LOIS assumes that only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within Table 2 of this report. If additional generation projects, listed within Table 3, with queue priority equal to or higher than the study project request rights to go into commercial operation before all Network Upgrades identified within Table 2 of this report are completed, this LOIS may need to be restudied to ensure that interconnection service remains for the GEN-2008-017 request.

This study is based on the Interconnection Customer going into Commercial Operation by its GIA date of October 1, 2015. If the GEN-2008-017 Interconnection Customer later requests to accelerate its in service date from the currently scheduled October 1, 2015, a modification study will need to be performed to determine the impacts on lower queued generation already in service. If impacts to lower queued customers are found, the modification request may be denied.

Power flow analysis from this LOIS has determined that the GEN-2008-017 request can interconnect the fully requested amount of generation as an Energy Resource prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 300.0 MW of Interconnection Service available for the period of October 1, 2015 until the completion of the Spearville – Clark County – Thistle – Wichita double circuit 345kV and the Woodward – Thistle double circuit 345kV upgrades. These upgrades are scheduled for completion in December, 2014. ***Should any other projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available. It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation required of a Generator Interconnection request. Because of this, it is likely that the Customer may be required to reduce their generation output to 0 MW under certain system conditions to allow system operators to maintain the reliability of the transmission network. Examples of system conditions that could limit the generation output are listed within Table 6.***

Transient stability analysis indicates that the transmission system will remain stable for the contingencies listed within Table 7 with the addition of GEN-2008-017 generation. 15Mvars of reactor banks are found to be needed for the Customer's proposed collector system. Additionally, GEN-2008-017 was found to be in compliance with FERC Order #661A when studied as listed within this report.

Nothing in this study should be construed as a guarantee of transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

Table of Contents

Purpose

<OMITTED TEXT> (Interconnection Customer) has requested a restudy of a Limited Operation System Impact Study (LOIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) for an interconnection request into an existing transmission facility of the Sunflower Electric Power Corp. (SUNC).

The purpose of this study is to evaluate the impacts of interconnecting GEN-2008-017 request of 300.0 MW comprised of two-hundred (200) General Electric 1.5 MW wind turbine generators and associated facilities interconnecting into the SUNC Setab 345kV substation located in Scott County, Kansas. The Customer has requested this amount to be studied as an Energy Resource (ER) with a Limited Operation Interconnection Service to commence on or around October of 2015. Additionally, the Customer requested that the study be performed assuming that the Priority Projects, specifically Spearvile – Clark County – Thistle – Wichita double circuit 345kV and Thistle – Woodward double circuit 345kV, were NOT yet in service in October, 2015.

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

The LOIS considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the LOIS is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have a pending higher queued Interconnection Request to interconnect to the Transmission System listed in Table 1; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

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

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

This LOIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested October 2015 in-service date of GEN-2008-017 for this LOIS. Also listed in Table 1 are both the amount of MWs of interconnection service

expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

Table 1: Generation Requests Included within LOIS

Project	MW	Total MW	Fuel Source	POI	Status
Lamar DC Tie Import	210.0	210.0	DC Tie	Lamar 345kV	Commercial Operation
SPS Distributed (TC-Texas County)	20.0	20.0	Wind	TC-Texas County 115kV	Commercial Operation
SPS Distributed (Sherman)	20.0	20.0	Wind	Sherman 115kV	Commercial Operation
SPS Distributed (Spearman)	10.0	10.0	Wind	Spearman 115kV	Commercial Operation
SPS Distributed (Etter)	20.0	20.0	Wind	Etter 115kV	Commercial Operation
SPS Distributed (Moore E)	25.0	25.0	Wind	Moore East 115kV	Commercial Operation
SPS Distributed (Dumas 19th St.)	20.0	20.0	Wind	Dumas 19th St. 115kV	Commercial Operation
Gray County Wind (Montezuma)	110.0	110.0	Wind	Gray County Tap 115kV	Commercial Operation
GEN-2001-039A (Shooting Star)	105.0	105.0	Wind	Shooting Star Tap 115kV	Commercial Operation
GEN-2001-039M (Central Plains)	99.0	99.0	Wind	Central Plains Tap 115kV	Commercial Operation
GEN-2002-008 (NTWC Noble)	120.0	240.0	Wind	Hitchland 345kV	Commercial Operation
GEN-2002-009 (NTWC-3 JDW-4)	80.0	80.0	Wind	Hansford 115kV	Commercial Operation
GEN-2002-025A (KCPL)	148.5	148.5	Wind	Spearville 230kV	Commercial Operation
GEN-2003-019 (Smoky Hills)	249.3	249.3	Wind	Smoky Hills Tap 230kV	Commercial Operation
GEN-2004-014 (KCPL)	51.2	154.5	Wind	Spearville 230kV	Commercial Operation
GEN-2005-012 (Westar)	160.0	248.4	Wind	Spearville 345kV	Commercial Operation
GEN-2006-020S (DeWind Frisco)	19.8	19.8	Wind	DWS Frisco 115kV	Commercial Operation
GEN-2006-021 (Flat Ridge I)	101.0	101.0	Wind	Flat Ridge Tap 138kV	Commercial Operation
GEN-2006-044 (KODE Novus)	120.0	370.0	Wind	Hitchland 345kV	Commercial Operation
GEN-2008-018	348.0	405.0	Wind	Finney 345kV	IA Executed/On Schedule
GEN-2008-017	300.0	300.0	Wind	Setab 345kV	IA Executed/On Schedule

This LOIS was requested by the Customer to determine limits to its ability to operate if the required upgrades listed within the latest iteration of their Impact Cluster Study (ICS) are delayed. Table 2 below lists the required upgrade projects for which this request has cost responsibility. GEN-2008-017 was included within the ICS-2008-001 that was last restudied in early 2013 and posted January 22, 2013. This report can be located here at the following GI Study URL: http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2008_Impact_Studies.

Table 2: Upgrade Projects Required for Full Interconnection Service

Upgrade Project	Type	Description	Status
Spearville – Post Rock – Axtel 345kV	GIA Appendix A (2e) Previous Network Upgrade not responsibility of Customer but required to support full interconnection	Build Priority Project	In-Service (included in models)
Spearville – Clark County – Thistle – Wichita 345kV double circuit	GIA Appendix A (2e) Previous Network Upgrade not responsibility of Customer but required to support full interconnection	Build Priority Project	Current Estimated In-Service date of 12/31/2014 (not included in models)

Upgrade Project	Type	Description	Status
Woodward – Thistle 345kV double circuit	GIA Appendix A (2e) Previous Network Upgrade not responsibility of Customer but required to support full interconnection	Build Priority Project	Current Estimated In-Service date of 12/31/2014 (not included in models)

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

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

Project	Remainder MW	Total MW	Fuel	POI	Status
GEN-2002-008 (NTWC Noble)	120.0	240.0	Wind	Hitchland 345kV	Commercial Operation for 120.0 MW
GEN-2004-014 (KCPL)	103.3	154.5	Wind	Spearville 230kV	Commercial Operation for 51.2 MW
GEN-2005-012 (Westar)	88.4	248.4	Wind	Spearville 345kV	Commercial Operation for 160.0 MW
GEN-2006-006 (EDF Renewable)	205.5	205.5	Wind	Spearville 345kV	IA Executed/On Schedule for 10/01/2015
GEN-2006-022 (Ninnescah)	150.0	150.0	Wind	Ninnescah 115kV	IA Executed/On Schedule for 8/15/2014
GEN-2006-044 (KODE Novus)	290.0	370.0	Wind	Hitchland 345kV	Commercial Operation for 120.0 MW
GEN-2007-038 (Clipper)	200.0	200.0	Wind	Spearville 345kV	IA Executed/On Schedule for 8/25/2015
GEN-2008-018 (Buffalo Dunes)	57.0	405.0	Wind	Finney 345kV	IA Executed/On Schedule for 2013
GEN-2008-051 (Spinning Spur)	322.0	322.0	Wind	Potter County 345kV	IA Executed/On Schedule for 12/31/2014

This study is based on the Interconnection Customer going into Commercial Operation by its GIA date of October 1, 2015. If the GEN-2008-017 Interconnection Customer later requests to accelerate its in service date from the currently scheduled October 1, 2015, a modification study will need to be performed to determine the impacts on lower queued generation already in service. If impacts to lower queued customers are found, the modification request may be denied. Lower queued interconnection customers that are currently in service are listed below in Table 4.

Table 4: Lower Queued GI Requests not included within LOIS

Project	Remainder MW	Total MW	Fuel	POI	Status
GEN-2007-040 (Cimarron II)	132.0	200.1	Wind	Buckner 345kV	Commercial Operation for 132.0 MW
GEN-2008-079 (Ensign)	99.2	99.2	Wind	Crooked Creek 115kV	Commercial Operation for 99.2 MW
GEN-2010-009 (Cimarron)	165.6	165.6	Wind	Buckner 345kV	Commercial Operation for 165.6 MW

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

Facilities

Generating Facility

GEN-2008-017 Interconnection Customer's request to interconnect a total of 300.0 MW is comprised of two-hundred (200) General Electric 1.5 MW wind turbine generators and associated interconnection facilities.

Interconnection Facilities

The POI for GEN-2008-017 Interconnection Customer is SUNC Setab 345kV substation in Scott County, Kansas. 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.

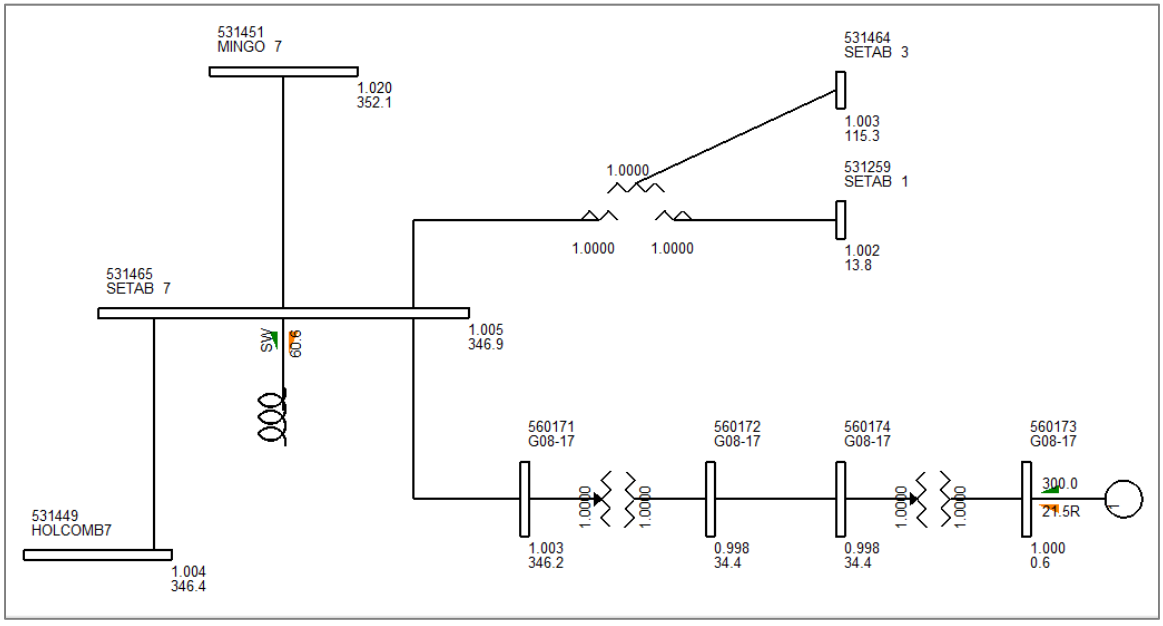

Figure 1: Proposed POI Configuration and Request Power Flow Model

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-2008-017 LOIS requested in-service date of October 1, 2015. These facilities have an approved Notice to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other upgrades were included for this LOIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer. For this LOIS, the Customer requested that the Priority Projects, specifically Spearville – Clark County – Thistle – Wichita double circuit 345kV and Thistle – Woodward double circuit 345kV, NOT be included in this analysis.

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 for the system topology and conditions as expected in October 2015. To incorporate the Interconnection Customer's request, a re-dispatch of existing generation within SPP was performed with respect to the amount of the Customer's injection and the interconnecting Balancing Authority. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. For this LOIS, only the previous queued requests listed in Table 1 were assumed to be in-service.

Study Methodology and Criteria

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

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

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

Results

The LOIS ACCC analysis indicates that the Customer can interconnect generation into the SUNC transmission system as requested before all required upgrades listed within the ICS-2008-001 study can be placed into service. There is no more than 300 MW of Interconnection Service available for the period of October 1, 2015 until the completion of the Spearville – Clark – Thistle – Wichita 345kV double circuit and the Woodward – Thistle 345kV double circuit upgrades. Should any other GI projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available.

ACCC results for the LOIS can be found in Table 5 below. Table 5 shows no that there are no ERIS constraints, however it should be noted that shows several system conditions that could cause the generator to be curtailed depending on the system conditions. **Since ER service doesn't require**

mitigation for those issues in which the affecting GI request has less than a 20% OTDF, Table 6 is provided for informational purposes only so that the Customer understands there may be times when the generating facility will be required to reduce their output to maintain system reliability.

Limited Operation and System Reliability

In no way does this study guarantee limited operation for all periods of time. It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, it is likely that the Customer may be required to reduce their generation output to 0 MW under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Table 5: Interconnection Constraints for Mitigation of GEN-2008-017 LOIS

Model Season	Dispatch Group	Flow	Overloaded Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max MW Available	Contingency
All			None			>20%		300.0	

Table 6: Additional Constraints of GEN-2008-017 LOIS Not for Mitigation
System conditions which may require curtailment for certain system conditions

Model Season	Dispatch Group	Flow	Overloaded Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Contingency
2013G	03ALL	TO->FROM	MULLERGREN - SPEARVILLE 230KV CKT 1	330.3	355.3	0.179	108.6	POST ROCK - SPEARVILLE 345KV CKT 1
2013G	03ALL	FROM->TO	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1	319	319	0.144	110.7	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03ALL	FROM->TO	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1	319	319	0.144	110.7	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03ALL	FROM->TO	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1	319	319	0.133	104.2	CIRCLE - MULLERGREN 230KV CKT 1
2013G	03ALL	FROM->TO	MOUNDRIDGE (MOUND10X) 138/115/13.8KV TRANSFORMER CKT 1	100	110	0.046	123.2	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03ALL	FROM->TO	MOUNDRIDGE (MOUND10X) 138/115/13.8KV TRANSFORMER CKT 1	100	110	0.046	123.0	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03G08_017	FROM->TO	MOUNDRIDGE (MOUND10X) 138/115/13.8KV TRANSFORMER CKT 1	100	110	0.046	109.0	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03G08_017	FROM->TO	MOUNDRIDGE (MOUND10X) 138/115/13.8KV TRANSFORMER CKT 1	100	110	0.046	108.9	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	142.0	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	141.9	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	124.1	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	120.2	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	120.1	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	113.5	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	112.0	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	112.0	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	112.0	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	112.0	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03G08_017	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	101.4	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)

Power Flow Analysis

Model Season	Dispatch Group	Flow	Overloaded Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Contingency
2013G	03G08_017	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	101.4	SPP-SWPS-05 (LAMAR – FINNEY 345KV AND FINNEY – HITCHLAND 345KV)
2013G	03G08_017	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	101.4	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03G08_017	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.041	101.4	FINNEY SWITCHING STATION - Hitchland Interchange 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.041	100.2	FINNEY SWITCHING STATION - HOLCOMB 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.034	123.1	MINGO - SETAB 345KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.034	112.5	MINGO - SETAB 345KV CKT 1
2013G	03ALL	FROM->TO	ST JOHN - ST_JOHN 115KV CKT 1	86	86	0.034	100.7	FLATRDG3 - HARPER 138KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.033	130.9	POST ROCK - SPEARVILLE 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.033	127.1	CIRCLE - MULLERGREN 230KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.033	116.5	CIRCLE - MULLERGREN 230KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.033	114.7	POST ROCK - SPEARVILLE 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.033	102.5	POST ROCK - SPEARVILLE 345KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.033	101.0	CIRCLE - MULLERGREN 230KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	129.2	ST JOHN - ST_JOHN 115KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	128.2	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	124.2	HUNTSVILLE - ST_JOHN 115KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	124.2	MIDW-CATB05 (ST JOHN – HUNTSVILLE 115KV AND HUNTSVILLE – HUTCHINSON ENERGY CENTER 115KV)
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	123.4	HUNTSVILLE - HUTCHINSON ENERGY CENTER 115KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.032	118.6	ST JOHN - ST_JOHN 115KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.032	117.5	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.032	113.6	HUNTSVILLE - ST_JOHN 115KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.032	113.6	MIDW-CATB05 (ST JOHN – HUNTSVILLE 115KV AND HUNTSVILLE – HUTCHINSON ENERGY CENTER 115KV)
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.032	112.8	HUNTSVILLE - HUTCHINSON ENERGY CENTER 115KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	102.5	ST JOHN - ST_JOHN 115KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.032	102.3	RENO COUNTY - WICHITA 345KV CKT 1
2013G	03ALL	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.031	130.8	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1
2013G	03ALL	FROM->TO	HARPER - MILAN TAP 138KV CKT 1	95.6	95.6	0.031	114.7	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1
2013G	03G08_017	FROM->TO	FLATRDG3 - HARPER 138KV CKT 1	95.6	95.6	0.031	102.4	SMOKYHL6 230.00 - SUMMIT 230KV CKT 1

Stability Analysis

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

Model Preparation

Transient stability analysis was performed using modified versions of the 2012 series of Model Development Working Group (MDWG) dynamic study models including the 2014 (summer and winter) seasonal models for the system topology and conditions as expected in October 2015. 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 thirty-six (36) contingencies were identified for the Limited Operation scenario for use in this study. These faults are listed within Table 7. 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 7: Contingencies Evaluated for Limited Operation

	Contingency Number and Name	Description
1	FLT_01_FINNEY7_HITCHLAND7_345kV_3PH*	*3-Phase fault on the Finney – Hitchland 345kV near the Finney 345kV bus.*
2	FLT_02_FINNEY7_HITCHLAND7_345kV_1PH	*Single-phase fault similar to previous fault.*
3	FLT_03_FINNEY7_HOLCOMB7_345kV_3PH*	*3-Phase fault on the Finney – Holcomb 345kV near the Finney 345kV bus.*
4	FLT_04_FINNEY7_HOLCOMB7_345kV_1PH	*Single-phase fault similar to previous fault.*

	Contingency Number and Name	Description
5	FLT_05_FINNEY7_LAMAR7_345kV_3PH*	*3-Phase fault on the Finney – Lamar 345kV near the Finney 345kV bus.*
6	FLT_06_FINNEY7_LAMAR7_345kV_1PH	*Single-phase fault similar to previous fault.*
7	FLT_07_HOLCOMB7_BUCKNER7_345kV_3PH*	*3-Phase fault on the Holcomb – Bucker 345kV near the Holcomb 345kV bus.*
8	FLT_08_HOLCOMB7_BUCKNER7_345kV_1PH	*Single-phase fault similar to previous fault.*
9	FLT_09_HOLCOMB7_HOLCOMB3_345_115kV_3PH	*3-Phase fault on the Holcomb 345/115/13.8kV transformer near the Holcomb 345kV bus.*
10	FLT_10_HOLCOMB7_SETAB7_345kV_3PH*	*3-Phase fault on the Holcomb – Setab 345kV near the Holcomb 345kV bus.*
11	FLT_11_HOLCOMB7_SETAB7_345kV_1PH	*Single-phase fault similar to previous fault.*
12	FLT_12_SETAB_MINGO_345Kv_3PH*	*3-Phase fault on the Setab – Mingo 345kV near the Setab 345kV bus.*
13	FLT_13_SETAB_MINGO_345Kv_1PH	*Single-phase fault similar to previous fault.*
14	FLT_14_SETAB_SETAB3_345_115kV_3PH	*3-Phase fault on the Setab 345/115/13.8kV transformer near the Setab 345kV bus.*
15	FLT_15_SETAB_CTYSERT_115kV_3PH	*3-Phase fault on the Setab – City Services Tap 115kV near the Setab 115kV bus.*
16	FLT_16_SETAB_CTYSERT_115kV_1PH	*Single-phase fault similar to previous fault.*
17	FLT_17_SETAB_SCOTCTY_115kV_3PH	*3-Phase fault on the Setab – Scott City 115kV near the Setab 115kV bus.*
18	FLT_18_SETAB_SCOTCTY_115kV_1PH	*Single-phase fault similar to previous fault.*
19	FLT_19_SCOTCTY_MANNGT_115kV_3PH	*3-Phase fault on the Scott City – Manning Tap 115kV near the Scott City 115kV bus.*
20	FLT_20_SCOTCTY_MANNGT_115kV_1PH	*Single-phase fault similar to previous fault.*
21	FLT_21_SCOTCTY_PILE_115kV_3PH	*3-Phase fault on the Scott City – Pile 115kV near the Scott City 115kV bus.*
22	FLT_22_SCOTCTY_PILE_115kV_1PH	*Single-phase fault similar to previous fault.*
23	FLT_23_SCOTCTY_SCOTCTY2_115_69kV_3PH	*3-Phase fault on the Scott City 115/69/13.8kV transformer near the Scott City 115kV bus.*
24	FLT_24_CTYSERT_CNTRLPL_115kV_3PH	*3-Phase fault on the City Services Tap – Central Plains Tap 115kV near the City Services Tap 115kV bus.*
25	FLT_25_CTYSERT_CNTRLPL_115kV_1PH	*Single-phase fault similar to previous fault.*
26	FLT_28_MINGO_REDWILLOW_345kV_3PH*	*3-Phase fault on the Mingo – Red Willow 345kV near the Mingo 345kV bus.*
27	FLT_29_MINGO_REDWILLOW_345kV_1PH	*Single-phase fault similar to previous fault.*
28	FLT_30_REDWILLOW_GENTLEMN_345kV_3PH*	*3-Phase fault on the Red Willow – Gerald Gentleman Station 345kV near the Red Willow 345kV bus.*
29	FLT_31_REDWILLOW_GENTLEMN_345kV_1PH	*Single-phase fault similar to previous fault.*
30	FLT_32_SPERVIL7_SPEARVL6_345_230kV_3PH	*3-Phase fault on the Spearville 345/230/13.8kV transformer near the Spearville 345kV bus.*
31	FLT_33_SPERVL7_BUCKNER7_345kV_3PH*	*3-Phase fault on the Spearville – Buckner 345kV near the Spearville 345kV bus.*
32	FLT_34_SPERVL7_BUCKNER7_345kV_1PH	*Single-phase fault similar to previous fault.*
33	FLT_35_SPERVL7_G11017_345kV_3PH*	*3-Phase fault on the Spearville – GEN-2011-017T – Post Rock 345kV near the Spearville 345kV bus.*
34	FLT_36_SPERVL7_G11017_345kV_1PH	*Single-phase fault similar to previous fault.*
35	FLT_37_HITCHLAND7_POTTERCO7_345kV_3PH*	*3-Phase fault on the Hitchland – Potter County 345kV near the Hitchland 345kV bus.*
36	FLT_38_HITCHLAND7_POTTERCO7_345kV_1PH	*Single-phase fault similar to previous fault.*

NOTE: The faults denoted by an asterisk (*) were adjusted to allow for no re-closing into the fault. Because the Southwestern region of SPP is connected via few and very long tie lines to the rest of SPP, 345kV faults on these lines have special operating procedures for re-closing into a three-phase fault.

Power Factor and Reactive Compensation Analysis

Power Factor Analysis was performed as part of the ICS-2008-001 impact study and is listed in the Generator Interconnection Agreement for GEN-2008-017. The Interconnection Customer is required to maintain a 95% lagging (supplying vars) and 95% leading (absorbing vars) at the Point of Interconnection (Setab 345kV substation).

An additional analysis for reactor sizing was performed as part of this study. In order to perform this analysis, the Customer transmission lines and collectors systems were modeled using specifications provided by the Customer. The facility was such that the generation and capacitor banks are switched out of service but the wind farm's collector subsystem (345kV and 34.5kV) remains in-service. The charging from these open-ended transmission facilities is then monitored for worst case reactive power injections into the POI under differing system conditions.

Analysis shows that the approximate amount of charging provided by the GEN-2008-017 subsystem is 15.0 Mvars. It is recommended that the Customer install at least 15.0 Mvars of Reactors to compensate for this injection into the transmission system.

Results

Results of the stability analysis are summarized in Table 8. These results are valid for GEN-2008-017 interconnecting with a generation amount up to 300.0 MW. The results indicate that the transmission system remains stable for all contingencies studied. The plots will be available upon request.

Table 8: Fault Analysis Results for Limited Operation

	Contingency Number and Name	2014SP	2014WP
1	FLT_01_FINNEY7_HITCHLAND7_345kV_3PH	Stable	Stable
2	FLT_02_FINNEY7_HITCHLAND7_345kV_1PH	Stable	Stable
3	FLT_03_FINNEY7_HOLCOMB7_345kV_3PH	Stable	Stable
4	FLT_04_FINNEY7_HOLCOMB7_345kV_1PH	Stable	Stable
5	FLT_05_FINNEY7_LAMAR7_345kV_3PH	Stable	Stable
6	FLT_06_FINNEY7_LAMAR7_345kV_1PH	Stable	Stable
7	FLT_07_HOLCOMB7_BUCKNER7_345kV_3PH	Stable	Stable
8	FLT_08_HOLCOMB7_BUCKNER7_345kV_1PH	Stable	Stable
9	FLT_09_HOLCOMB7_HOLCOMB3_345_115kV_3PH	Stable	Stable
10	FLT_10_HOLCOMB7_SETAB7_345kV_3PH	Stable	Stable
11	FLT_11_HOLCOMB7_SETAB7_345kV_1PH	Stable	Stable
12	FLT_12_SETAB_MINGO_345Kv_3PH	Stable	Stable
13	FLT_13_SETAB_MINGO_345Kv_1PH	Stable	Stable
14	FLT_14_SETAB_SETAB3_345_115kV_3PH	Stable	Stable
15	FLT_15_SETAB_CTYSERT_115kV_3PH	Stable	Stable
16	FLT_16_SETAB_CTYSERT_115kV_1PH	Stable	Stable
17	FLT_17_SETAB_SCOTCTY_115kV_3PH	Stable	Stable
18	FLT_18_SETAB_SCOTCTY_115kV_1PH	Stable	Stable
19	FLT_19_SCOTCTY_MANNGT_115kV_3PH	Stable	Stable
20	FLT_20_SCOTCTY_MANNGT_115kV_1PH	Stable	Stable
21	FLT_21_SCOTCTY_PILE_115kV_3PH	Stable	Stable
22	FLT_22_SCOTCTY_PILE_115kV_1PH	Stable	Stable
23	FLT_23_SCOTCTY_SCOTCTY2_115_69kV_3PH	Stable	Stable
24	FLT_24_CTYSERT_CNTRLPL_115kV_3PH	Stable	Stable
25	FLT_25_CTYSERT_CNTRLPL_115kV_1PH	Stable	Stable

	Contingency Number and Name	2014SP	2014WP
26	FLT_28_MINGO_REDWILLOW_345kV_3PH	Stable	Stable
27	FLT_29_MINGO_REDWILLOW_345kV_1PH	Stable	Stable
28	FLT_30_REDWILLOW_GENTLEMN_345kV_3PH	Stable	Stable
29	FLT_31_REDWILLOW_GENTLEMN_345kV_1PH	Stable	Stable
30	FLT_32_SPERVIL7_SPEARVL6_345_230kV_3PH	Stable	Stable
31	FLT_33_SPERVL7_BUCKNER7_345kV_3PH	Stable	Stable
32	FLT_34_SPERVL7_BUCKNER7_345kV_1PH	Stable	Stable
33	FLT_35_SPERVL7_G11017_345kV_3PH	Stable	Stable
34	FLT_36_SPERVL7_G11017_345kV_1PH	Stable	Stable
35	FLT_37_HITCHLAND7_POTTERCO7_345kV_3PH	Stable	Stable
36	FLT_38_HITCHLAND7_POTTERCO7_345kV_1PH	Stable	Stable

FERC LVRT Compliance

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu.

Fault contingencies were developed to verify that wind farms remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table 9.

Table 9: LVRT Contingencies

	Contingency Number and Name	Description
1	FLT_10_HOLCOMB7_SETAB7_345kV_3PH	*3-Phase fault on the Holcomb – Setab 345kV near the Holcomb 345kV bus.*
2	FLT_11_HOLCOMB7_SETAB7_345kV_1PH	*Single-phase fault similar to previous fault.*
3	FLT_12_SETAB_MINGO_345Kv_3PH	*3-Phase fault on the Setab – Mingo 345kV near the Setab 345kV bus.*
4	FLT_13_SETAB_MINGO_345Kv_1PH	*Single-phase fault similar to previous fault.*
5	FLT_14_SETAB_SETAB3_345_115kV_3PH	*3-Phase fault on the Setab 345/115/13.8kV transformer near the Setab 345kV bus.*

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. GEN-2008-017 is found to be in compliance with FERC Order #661A.

Conclusion

<OMITTED TEXT> (Interconnection Customer, GEN-2008-017) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 300.0 MW of wind generation to be interconnected as an Energy Resource (ER) into a transmission facility of the Sunflower Electric Power Corp. (SUNC) in Scott County, Kansas. The point of interconnection will be the Setab 345kV substation. GEN-2008-017, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the ICS-2008-001 (or most recent iteration) Impact Study can be placed into service.

Power flow analysis from this LOIS has determined that the GEN-2008-017 request can interconnect prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 300.0 MW of Limited Operation Interconnection Service available for the period of October 1, 2015 until the completion of the Spearville – Clark County – Thistle – Wichita 345kV double circuit and the Woodward – Thistle 345kV double circuit upgrades. These upgrades are scheduled for completion in December, 2014. After this network upgrade is completed, limited operation may be available until such time that higher queued projects listed in Table 3 come into service.

This study is based on the Interconnection Customer going into Commercial Operation by its GIA date of October 1, 2015. If the GEN-2008-017 Interconnection Customer later requests to accelerate its in service date from the currently scheduled October 1, 2015, a modification study will need to be performed to determine the impacts on lower queued generation already in service. If impacts to lower queued customers are found, the modification request may be denied.

Transient stability analysis indicates that the transmission system will remain stable for the contingencies listed within Table 7 with the addition of GEN-2008-017 generation. 15Mvars of reactor banks are found to be needed for the Customer's proposed collector system. Additionally, GEN-2008-017 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.