Impact Study of Limited Operation for Generator Interconnection

GEN-2011-024

May 2013
Generator Interconnection

Southwest Power Pool

Executive Summary

<OMITTED TEXT> (Customer; GEN-2011-024) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 299.0 MW of wind generation to be interconnected as an Energy Resource (ER) into the Transmission System of Oklahoma Gas and Electric Services (OKGE) in Dewey County, Oklahoma. GEN-2011-024, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-001 (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 in December 2014. GEN-2011-024 is requesting the interconnection of one hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated facilities through the existing Tatonga 345kV substation. For the typical LOIS, both a power flow and transient stability analysis are conducted. The LOIS assumes that only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within Table 2 of this report. If additional generation projects, listed within Table 3, with queue priority equal to or higher than the study project request rights to go into commercial operation before all Network Upgrades identified within Table 2 of this report are completed, this LOIS may need to be restudied to ensure that interconnection service remains for the GEN-2011-024 request.

Power flow analysis from this LOIS has determined that the GEN-2011-024 request can interconnect a limited amount of generation as an Energy Resource/Network Resource prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 58.8 MW of Limited Operation Interconnection Service available. Should any other projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available. It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, it is likely that the Customer may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Transient stability analysis for this LOIS has determined that the transmission system will remain stable for the one hundred twelve (112) selected faults for the limited operation interconnection of GEN-2011-024 and will meet Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

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.

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Purpose

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

The purpose of this study is to evaluate the impacts of interconnecting GEN-2011-024 request of 299.0 MW comprised of one hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated facilities interconnecting through the existing Tatonga 345kV substation in Dewey County, Oklahoma. 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 December 31, 2014.

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

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

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

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

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

This LOIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested December 31, 2014 in-service of GEN-2011-024 for this LOIS. Also listed in Table 1 are both the amount of MWs of interconnection service expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

Table 1: Generation Requests Included within LOIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2001-014	96.0	96.0	Wind	Ft Supply 138kV	Commercial Operation
GEN-2001-037	120.0	120.0	Wind	FPL Moreland Tap 138kV	Commercial Operation
GEN-2005-008	120.0	120.0	Wind	Woodward 138kV	Commercial Operation
GEN-2006-024S	18.9	18.9	Wind	Buffalo Bear Tap 69kV	Commercial Operation
GEN-2006-046	130.0	130.0	Wind	Dewey 138kV	Commercial Operation
GEN-2007-021	201.0	201.0	Wind	Tatonga 345kV	IA Executed/On Schedule for 2014
GEN-2007-025	300.0	300.0	Wind	Viola 345kV	Commercial Operation
GEN-2007-043	200.0	200.0	Wind	Minco 345kV	Commercial Operation
GEN-2007-044	300.0	300.0	Wind	Tatonga 345kV	IA Executed/On Schedule for 2014
GEN-2007-050	170.0	170.0	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2007-062	765.0	765.0	Wind	Woodward EHV 345kV	IA Executed/On Schedule in phases for 2014/2015/2016/2017
GEN-2008-003	101.0	101.0	Wind	Woodward EHV 138kV	Commercial Operation
GEN-2008-013	300.0	300.0	Wind	Tap Wichita - Woodring (Hunter) 345kV	Commercial Operation
GEN-2008-019	300.0	300.0	Wind	Tatonga 345kV	IA Executed/On Schedule for 2015
GEN-2008-023	150.0	150.0	Wind	Hobart Junction 138kV	Commercial Operation
GEN-2008-029	250.5	250.5	Wind	Woodward EHV 138kV	IA Executed/On Schedule for 2014
GEN-2008-044	197.8	197.8	Wind	Tatonga 345kV	Commercial Operation
GEN-2008-046	200.0	200.0	Wind	Sunnyside 345kV	IA Fully Executed/On Suspension
GEN-2008-071	76.8	76.8	Wind	Newkirk 138kV	IA Fully Executed/On Suspension
GEN-2009-016	100.8	100.8	Wind	Falcon Road 138kV	IA Fully Executed/ On Schedule for 2014
GEN-2010-011	11.5	11.5	Wind	Tatonga 345kV	Commercial Operation
GEN-2010-040	298.2	298.2	Wind	Cimarron 345kV	Commercial Operation
GEN-2011-007	250.0	250.0	Wind	Tap Cimarron - Woodring (Matthewson) 345kV	IA Executed/On Schedule for 2015
GEN-2011-010	100.8	100.8	Wind	Minco 345kV	Commercial Operation
GEN-2011-024	299.0	299.0	Wind	Tatonga 345kV	Facility Study Stage

This LOIS was required because the Customer is requesting interconnection prior to the completion of all of their required upgrades listed within the latest iteration of their Definitive Interconnection System Impact Study (DISIS). Table 2 below lists the required upgrade projects. Table 3 below lists the upgrade projects that were included but not yet in service. GEN-2011-024 was included within the DISIS-2011-001 that was studied in spring 2011 and posted July 29, 2011. The cluster has been restudied since the original posting. These reports can be located here at the following GI Study URL: http://sppoasis.spp.org/documents/swpp/transmission/GenStudies.cfm?YearType=2011_Impact_Studies.

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

Upgrade Project	Type	Description	Status
FPL Switch – Mooreland 138kV CKT 1, Rebuild approximately 0.2 miles of 138kV transmission line	Most recent iteration of DISIS 2011-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
FPL Switch – Woodward 138kV CKT 1 , Rebuild approximately 12 miles of 138kV transmission line	Most recent iteration of DISIS 2011-001. Previous Network Upgrade not responsibility of Customer but required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
Matthewson – Cimarron 345kV CKT 2 (Build second 345kV circuit)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction
Tatonga – Matthewson 345kV CKT 2 (Build a second 345kV circuit)	Shared Network Upgrade to be designed, constructed, and owned by the Transmission Owner. Required to support full interconnection.	DISIS-2011-001 Customers	Not authorized to begin construction

Table 3: Upgrade Projects included but not yet in service

Upgrade Project	Type	Description	Status
Tuco – Woodward 345kV CKT	Balanced Portfolio	Balanced Portfolio	Current Estimated in Service Date of 5/30/2014
Hitchland-Woodward 345kV Dbl Circuit	Priority Project	Build Priority Project	Current Estimated In-Service date of 6/30/2014
Thistle – Wichita 345kV Dbl CKT	Priority Project	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Thistle – Woodward 345kV Dbl CKT	Priority Project	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Spearville – Clark County 345kV Dbl CKT	Priority Project	Build Priority Project	Current Estimated In-Service date of 12/31/2014
Thistle – Clark County 345kV Dbl CKT	Priority Project	Build Priority Project	Current Estimated In-Service date of 12/31/2014

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this LOIS at the expense of the Customer. The higher or equally queued projects that were not included in this study are listed in Table 4. 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 4: Higher or Equally Queued GI Requests not included within LOIS

Project	Remainder MW	Total MW	Fuel	POI	Status
GEN-2011-019	299.0	299.0	Wind	Woodward 345kV	IA Pending
GEN-2011-020	299.0	299.0	Wind	Woodward 345kV	IA Pending
All Interconnection requests in DISIS-2011-001 in areas outside of the northwest Oklahoma region (Woodward Group). Wind requests dispatched at lower nameplate (20% nameplate).					

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-2011-024 Interconnection Customer's request to interconnect a total of 299.0 MW is comprised of one hundred thirty (130) Siemens 2.3 MW wind turbine generators and associated interconnection facilities.

Interconnection Facilities

The POI for GEN-2011-024 Interconnection Customer is through the existing Tatonga 345kV substation in Dewey County, Oklahoma. Figure 1 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.

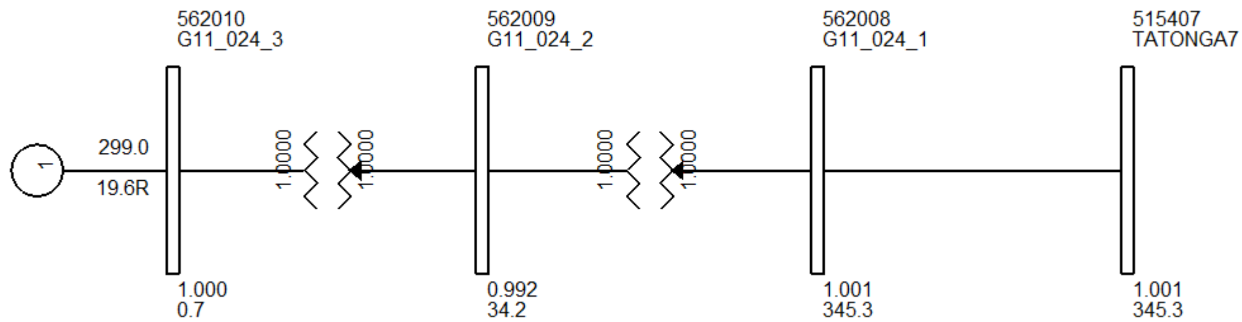

Figure 1: Proposed POI Configuration and Request Power Flow Model

Base Case Network Upgrades

The Network Upgrades included within the cases used for this LOIS study are those facilities that are a part of the SPP Transmission Expansion Plan or the Balanced Portfolio projects that have in-service dates prior to the GEN-2011-024 LOIS requested in-service date of December 31, 2014. These facilities have an approved Notice to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other upgrades were included for this LOIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer.

Power Flow Analysis

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

Model Preparation

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

Study Methodology and Criteria

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

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

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

Results

The LOIS ACCC analysis indicates that the Customer can interconnect a limited amount of generation into the OKGE transmission system before all required upgrades listed within the DISIS-2011-001 study can be placed into service. A maximum amount of 58.8 MW of generation can be placed into service at the interconnect date of September 2014 due to the interconnection constraints on the Northwest - Tatonga 345kV transmission line. Should any other GI projects, other than those listed within Table 1 of this report, come into service an additional study may be required to determine if any limited operation service is available.

ACCC results for the LOIS can be found in Table 5 and 6 below. Generator Interconnection Energy Resource analysis doesn't mitigate for those issues in which the affecting GI request has less than a 20% OTDF, Table 7 is provided for informational purposes only so that the Customer understands there may be operational conditions when they may be required to reduce their output to maintain system reliability.

Limited Operation and System Reliability

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

Table 5: Interconnection Constraints for Mitigation of GEN-2011-024 LOIS @ 299.0MW

Season	Dispatch Group	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	Max MW Available	Contingency
2018 Winter	00G11_024	TO->FROM	NORTHWEST - TATONGA7 345.00 345KV CKT 1	1195	1195	1.000	120.1	58.8	TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1
2013 Winter	00G11_024	TO->FROM	NORTHWEST - TATONGA7 345.00 345KV CKT 1	1195	1195	1.000	120.1	58.9	TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1
2013 Spring	01G11_024	TO->FROM	NORTHWEST - TATONGA7 345.00 345KV CKT 1	1195	1195	1.000	118.9	73.3	TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1
2013 Summer	00G11_024	TO->FROM	NORTHWEST - TATONGA7 345.00 345KV CKT 1	1195	1195	1.000	118.0	84.2	TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1
2018 Summer	00G11_024	TO->FROM	NORTHWEST - TATONGA7 345.00 345KV CKT 1	1195	1195	1.000	117.8	86.8	TATONGA7 345.00 - WOODWARD DISTRICT EHV 345KV CKT 1

Table 6: Additional Constraints of GEN-2011-024 LOIS @ 299.0MW

Season	Dispatch Group	Flow	Monitored Element	RATEA (MVA)	RATEB (MVA)	TDF	TC% LOADING	ATC Available	Contingency
2013 Spring	01G11_024	TO->FROM	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.101	142.7	0	NORTHWEST - TATONGA7 345.00 345KV CKT 1
2013 Spring	1	TO->FROM	FPL SWITCH - WOODWARD 138KV CKT 1	133	153	0.101	123.1	0	NORTHWEST - TATONGA7 345.00 345KV CKT 1
2013 Summer	00G11_024	FROM->TO	NORTHWEST (NORTWST2) 345/138/13.8KV TRANSFORMER CKT 1	493	493	0.054	101.8	0	NORTHWEST (NORTWST3) 345/138/13.8KV TRANSFORMER CKT 1
2013 Spring	01G11_024	FROM->TO	FPL SWITCH - MOORELAND 138KV CKT 1	268	287	0.101	101.1	0	NORTHWEST - TATONGA7 345.00 345KV CKT 1
2013 Summer	00G11_024	FROM->TO	NORTHWEST (NORTWST2) 345/138/13.8KV TRANSFORMER CKT 1	493	493	0.054	100.0	0	NORTHWEST (NORTWST3) 345/138/13.8KV TRANSFORMER CKT 1

Stability Analysis

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

Model Preparation

Transient stability analysis was performed using modified versions of the 2012 series of Model Development Working Group (MDWG) dynamic study models including the 2014 summer and 2013 winter peak dynamic cases. The cases were adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally the prior queued and study generation was dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

Disturbances

The one hundred twelve (112) 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_Tatonga_Woodward_345kV_3PH	*3-Phase fault on the Tatonga – Woodward 345kV line near the Tatonga 345kV bus.*
2	FLT_02_Tatonga_Woodward_345kV_1PH	*Single-phase fault similar to previous fault.*
3	FLT_03_Tatonga_Northwest_345kV_3PH	*3-Phase fault on the Tatonga – Northwest 345kV line near the Tatonga 345kV bus.*
4	FLT_04_Tatonga_Matthewson1_345kV_1PH	*Single-phase fault similar to previous fault.*
5	FLT_05_Woodward_Border_345kV_3PH	*3-Phase fault on the Woodward – Border 345kV line near the Woodward 345kV bus.*
6	FLT_06_Woodward_Border_345kV_1PH	*Single-phase fault similar to previous fault.*
7	FLT_07_Woodward_Thistle_345kV_3PH	*3-Phase fault on the Woodward – Thistle 345kV circuit 1 line near the Woodward 345kV bus.*
8	FLT_08_Woodward_Thistle_345kV_1PH	*Single-phase fault similar to previous fault.*
9	FLT_09_Woodward_Thistle_345kV_3PH	*3-Phase fault on the Woodward – Thistle 345kV circuit 2 line near the Woodward 345kV bus.*
10	FLT_10_Woodward_Thistle_345kV_1PH	*Single-phase fault similar to previous fault.*
11	FLT_11_Woodward_Beaver_345kV_3PH	*3-Phase fault on the Woodward – Beaver 345kV circuit 1 line near the Woodward 345kV bus.*
12	FLT_12_Woodward_Beaver_345kV_1PH	*Single-phase fault similar to previous fault.*
13	FLT_13_Woodward_Beaver_345kV_3PH	*3-Phase fault on the Woodward – Beaver 345kV circuit 2 line near the Woodward 345kV bus.*
14	FLT_14_Woodward_Beaver_345kV_1PH	*Single-phase fault similar to previous fault.*
15	FLT_15_Woodward_Woodward_345_138kV_3PH	*3-Phase fault on the Woodward 345kV/138kV transformer circuit 1 near the Woodward 345kV bus.*
16	FLT_16_Woodward_Woodward_345_138kV_3PH	*3-Phase fault on the Woodward 345kV/138kV transformer circuit 2 near the Woodward 345kV bus.*
17	FLT_17_Border_TUCO_345kV_3PH	*3-Phase fault on the Border – Tuco 345kV line near the Border 345kV bus.*
18	FLT_18_Border_TUCO_345kV_1PH	*Single-phase fault similar to previous fault.*
19	FLT_19_TUCO_OKU_345kV_3PH	*3-Phase fault on the Tuco –Oklaunion 345kV line near the Tuco 345kV bus.*
20	FLT_20_TUCO_OKU_345kV_1PH	*Single-phase fault similar to previous fault.*
21	FLT_21_TUCO_TUCO_345_230kV_3PH	*3-Phase fault on the Tuco 345kV/230kV transformer circuit 1 near the Tuco 345kV bus.*
22	FLT_22_TUCO_TUCO_345_230kV_3PH	*3-Phase fault on the Tuco 345kV/230kV transformer circuit 2 near the Tuco 345kV bus.*
23	FLT_23_OKU_LES_345kV_3PH	*3-Phase fault on the Oklaunion – Lawton Eastside 345kV line near the Oklaunion 345kV bus.*
24	FLT_24_OKU_LES_345kV_1PH	*Single-phase fault similar to previous fault.*
25	FLT_25_Thistle_Wichita_345kV_3PH	*3-Phase fault on the Thistle –Wichita 345kV circuit 1 line near the Thistle 345kV bus.*
26	FLT_26_Thistle_Wichita_345kV_1PH	*Single-phase fault similar to previous fault.*
27	FLT_27_Thistle_Wichita_345kV_3PH	*3-Phase fault on the Thistle –Wichita 345kV circuit 2 line near the Thistle 345kV bus.*
28	FLT_28_Thistle_Wichita_345kV_1PH	*Single-phase fault similar to previous fault.*
29	FLT_29_Thistle_ClarkCounty_345kV_3PH	*3-Phase fault on the Thistle –Clark County 345kV circuit 1 line near the Thistle 345kV bus.*
30	FLT_30_Thistle_ClarkCounty_345kV_1PH	*Single-phase fault similar to previous fault.*
31	FLT_31_Thistle_ClarkCounty_345kV_3PH	*3-Phase fault on the Thistle –Clark County 345kV circuit 2 line near the Thistle 345kV bus.*
32	FLT_32_Thistle_ClarkCounty_345kV_1PH	*Single-phase fault similar to previous fault.*
33	FLT_33_Thistle_Thistle_345_138kV_3PH	*3-Phase fault on the Thistle 345kV/138kV transformer near the Thistle 345kV bus.*
34	FLT_34_Wichita_EMPEC7_345kV_3PH	*3-Phase fault on the Wichita.– Empire 345kV line near the Wichita 345kV bus.*
35	FLT_35_Wichita_EMPEC7_345kV_1PH	*Single-phase fault similar to previous fault.*

Contingency Number and Name		Description
36	FLT_36_Wichita_Reno_345kV_3PH	*3-Phase fault on the Wichita.– Reno 345kV line near the Wichita 345kV bus.*
37	FLT_37_Wichita_Reno_345kV_1PH	*Single-phase fault similar to previous fault.*
38	FLT_38_Wichita_Benton_345kV_3PH	*3-Phase fault on the Wichita.– Benton 345kV line near the Wichita 345kV bus.*
39	FLT_39_Wichita_Benton_345kV_1PH	*Single-phase fault similar to previous fault.*
40	FLT_40_Wichita_Viola_345kV_3PH	*3-Phase fault on the Wichita.– Viola 345kV line near the Wichita 345kV bus.*
41	FLT_41_Wichita_Viola_345kV_1PH	*Single-phase fault similar to previous fault.*
42	FLT_42_Wichita_Evans_345_138kV_3PH	*3-Phase fault on the Wichita.– Evans 345kV circuit 1 line near the Wichita 345kV bus.*
43	FLT_43_Wichita_Evans_345_138kV_1PH	*Single-phase fault similar to previous fault.*
44	FLT_44_Wichita_Evans_345_138kV_3PH	*3-Phase fault on the Wichita.– Evans 345kV circuit 2 line near the Wichita 345kV bus.*
45	FLT_45_Wichita_Evans_345_138kV_1PH	*Single-phase fault similar to previous fault.*
46	FLT_46_ClarkCounty_Spearville_345kV_3PH	*3-Phase fault on the Clark County – Spearville 345kV circuit 1 line near the Clark County 345kV bus.*
47	FLT_47_ClarkCounty_Spearville_345kV_1PH	*Single-phase fault similar to previous fault.*
48	FLT_48_ClarkCounty_Spearville_345kV_3PH	*3-Phase fault on the Clark County – Spearville 345kV circuit 2 line near the Clark County 345kV bus.*
49	FLT_49_ClarkCounty_Spearville_345kV_1PH	*Single-phase fault similar to previous fault.*
50	FLT_50_Spearville_Buckner_345kV_3PH	*3-Phase fault on the Spearville – Buckner 345kV line near the Spearville 345kV bus.*
51	FLT_51_Spearville_Buckner_345kV_1PH	*Single-phase fault similar to previous fault.*
52	FLT_52_Spearville_PostRock_345kV_3PH	*3-Phase fault on the Spearville – Post Rock 345kV line near the Spearville 345kV bus.*
53	FLT_53_Spearville_PostRock_345kV_1PH	*Single-phase fault similar to previous fault.*
54	FLT_54_Spearville_Spearville_345_115kV_3PH	*3-Phase fault on the Spearville 345kV/115kV transformer near the Spearville 345kV bus.*
55	FLT_55_Spearville_Spearville_345_230kV_3PH	*3-Phase fault on the Spearville 345kV/230kV transformer near the Spearville 345kV bus.*
56	FLT_56_Beaver_Hitchland_345kV_3PH	*3-Phase fault on the Beaver – Hitchland 345kV circuit 1 line near the Beaver 345kV bus.*
57	FLT_57_Beaver_Hitchland_345kV_1PH	*Single-phase fault similar to previous fault.*
58	FLT_58_Beaver_Hitchland_345kV_3PH	*3-Phase fault on the Beaver – Hitchland 345kV circuit 2 line near the Beaver 345kV bus.*
59	FLT_59_Beaver_Hitchland_345kV_1PH	*Single-phase fault similar to previous fault.*
60	FLT_60_Hitchland_Finney_345kV_3PH	*3-Phase fault on the Hitchland – Finney 345kV line near the Hitchland 345kV bus.*
61	FLT_61_Hitchland_Finney_345kV_1PH	*Single-phase fault similar to previous fault.*
62	FLT_62_Hitchland_Potter_345kV_3PH	*3-Phase fault on the Hitchland – Potter 345kV line near the Hitchland 345kV bus.*
63	FLT_63_Hitchland_Potter_345kV_1PH	*Single-phase fault similar to previous fault.*
64	FLT_64_Hitchland_Hitchland_345_230kV_3PH	*3-Phase fault on the Hitchland 345kV/230kV transformer circuit 1 near the Knoll 230kV bus.*
65	FLT_65_Hitchland_Hitchland_345_230kV_3PH	*3-Phase fault on the Hitchland 345kV/230kV transformer circuit 2 near the Knoll 230kV bus.*
66	FLT_66_Northwest_SpringCreek_345kV_3PH	*3-Phase fault on the Northwest – Spring Creek 345kV line near the Northwest 345kV bus.*
67	FLT_67_Northwest_SpringCreek_345kV_1PH	*Single-phase fault similar to previous fault.*
68	FLT_68_Northwest_Cimarron_345kV_3PH	*3-Phase fault on the Northwest – Cimarron 345kV line near the Northwest 345kV bus.*
69	FLT_69_Northwest_Cimarron_345kV_1PH	*Single-phase fault similar to previous fault.*
70	FLT_70_Northwest_Arcadia_345kV_3PH	*3-Phase fault on the Northwest – Arcadia 345kV line near the Northwest 345kV bus.*
71	FLT_71_Northwest_Arcadia_345kV_1PH	*Single-phase fault similar to previous fault.*
72	FLT_72_Northwest_Northwest_345_138kV_3PH	*3-Phase fault on the Northwest 345kV/138kV transformer circuit 1 near the Northwest 345kV bus.*

	Contingency Number and Name	Description
73	FLT_73_Northwest_Northwest_345_138kV_3PH	*3-Phase fault on the Northwest 345kV/138kV transformer circuit 2 near the Northwest 345kV bus.*
74	FLT_74_SpringCreek_Sooner_345kV_3PH	*3-Phase fault on the Spring Creek – Sooner 345kV line near the Spring Creek 345kV bus.*
75	FLT_75_SpringCreek_Sooner_345kV_1PH	*Single-phase fault similar to previous fault.*
76	FLT_76_Sooner_Cleveland_345kV_3PH	*3-Phase fault on the Sooner – Cleveland 345kV line near the Sooner 345kV bus.*
77	FLT_77_Sooner_Cleveland_345kV_1PH	*Single-phase fault similar to previous fault.*
78	FLT_78_Sooner_Woodring_345kV_3PH	*3-Phase fault on the Sooner – Woodring 345kV line near the Sooner 345kV bus.*
79	FLT_79_Sooner_Woodring_345kV_1PH	*Single-phase fault similar to previous fault.*
80	FLT_80_Sooner_RoseHill_345kV_3PH	*3-Phase fault on the Sooner – Rose Hill 345kV line near the Sooner 345kV bus.*
81	FLT_81_Sooner_RoseHill_345kV_1PH	*Single-phase fault similar to previous fault.*
82	FLT_82_Sooner_Sooner_345_138kV_3PH	*3-Phase fault on the Sooner 345kV/138kV transformer near the Sooner 345kV bus.*
83	FLT_83_Cimarron_Minco_345kV_3PH	*3-Phase fault on the Cimarron – Minco 345kV line near the Cimarron 345kV bus.*
84	FLT_84_Cimarron_Minco_345kV_1PH	*Single-phase fault similar to previous fault.*
85	FLT_85_Cimarron_Draper_345kV_3PH	*3-Phase fault on the Cimarron – Draper 345kV line near the Cimarron 345kV bus.*
86	FLT_86_Cimarron_Draper_345kV_1PH	*Single-phase fault similar to previous fault.*
87	FLT_87_Cimarron_Gen2011007tap_345kV_3PH	*3-Phase fault on the Cimarron – Gen-2011-007 tap 345kV line near the Cimarron 345kV bus.*
88	FLT_88_Cimarron_Gen2011007tap_345kV_1PH	*Single-phase fault similar to previous fault.*
89	FLT_89_Minco_Gracemont_345kV_3PH	*3-Phase fault on the Minco – Gracemont 345kV line near the Minco 345kV bus.*
90	FLT_90_Minco_Gracemont_345kV_1PH	*Single-phase fault similar to previous fault.*
91	FLT_91_Draper_Seminole_345kV_3PH	*3-Phase fault on the Draper – Seminole 345kV line near the Dra[er 345kV bus.*
92	FLT_92_Draper_Seminole_345kV_1PH	*Single-phase fault similar to previous fault.*
93	FLT_93_Gen2011007tap_Woodring_345kV_3PH	*3-Phase fault on the Gen-2011-007 tap – Woodring 345kV line near the Gen-2011-007 tap 345kV bus.*
94	FLT_94_Gen2011007tap_Woodring_345kV_1PH	*Single-phase fault similar to previous fault.*
95	FLT_95_Arcadia_Redbud_345kV_3PH	*3-Phase fault on the Arcadia – Redbud 345kV circuit 1 line near the Arcadia 345kV bus.*
96	FLT_96_Arcadia_Redbud_345kV_1PH	*Single-phase fault similar to previous fault.*
97	FLT_97_Arcadia_Redbud_345kV_3PH	*3-Phase fault on the Arcadia – Redbud 345kV circuit 2 line near the Arcadia 345kV bus.*
98	FLT_98_Arcadia_Redbud_345kV_1PH	*Single-phase fault similar to previous fault.*
99	FLT_99_Arcadia_Seminole_345kV_3PH	*3-Phase fault on the Arcadia – Seminole 345kV line near the Arcadia 345kV bus.*
100	FLT_100_Arcadia_Seminole_345kV_1PH	*Single-phase fault similar to previous fault.*
101	FLT_101_Redbud_RSS_345kV_3PH	*3-Phase fault on the Redbud – RSS 345kV line near the Redbud 345kV bus.*
102	FLT_102_Redbud_RSS_345kV_1PH	*Single-phase fault similar to previous fault.*
103	FLT_103_Seminole_Pittsburgh_345kV_3PH	*3-Phase fault on the Seminole – Pittsburgh 345kV line near the Seminole 345kV bus.*
104	FLT_104_Seminole_Pittsburgh_345kV_1PH	*Single-phase fault similar to previous fault.*
105	FLT_105_Seminole_Draper_345kV_3PH	*3-Phase fault on the Seminole – Draper 345kV circuit 1 line near the Seminole 345kV bus.*
106	FLT_106_Seminole_Draper_345kV_1PH	*Single-phase fault similar to previous fault.*
107	FLT_107_Seminole_Draper_345kV_3PH	*3-Phase fault on the Seminole – Draper 345kV circuit 2 line near the Seminole 345kV bus.*
108	FLT_108_Seminole_Draper_345kV_1PH	*Single-phase fault similar to previous fault.*
109	FLT_109_Seminole_Draper_345kV_3PH	*3-Phase fault on the Seminole – Draper 345kV circuit 3 line near the Seminole 345kV bus.*
110	FLT_110_Seminole_Draper_345kV_1PH	*Single-phase fault similar to previous fault.*

	Contingency Number and Name	Description
111	FLT_111_Seminole_Muskogee_345kV_3PH	*3-Phase fault on the Seminole –Muskogee 345kV circuit 3 line near the Seminole 345kV bus.*
112	FLT_112_Seminole_Muskogee_345kV_1PH	*Single-phase fault similar to previous fault.*

Results

Results of the stability analysis are summarized in Table 8. These results are valid for GEN-2011-024 interconnecting with a generation amount up to 299.0 MW with reactive equipment. 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	2013WP
1	FLT_01_Tatonga_Woodward_345kV_3PH	Stable	Stable
2	FLT_02_Tatonga_Woodward_345kV_1PH	Stable	Stable
3	FLT_03_Tatonga_Northwest_345kV_3PH	Stable	Stable
4	FLT_04_Tatonga_Matthewson1_345kV_1PH	Stable	Stable
5	FLT_05_Woodward_Border_345kV_3PH	Stable	Stable
6	FLT_06_Woodward_Border_345kV_1PH	Stable	Stable
7	FLT_07_Woodward_Thistle_345kV_3PH	Stable	Stable
8	FLT_08_Woodward_Thistle_345kV_1PH	Stable	Stable
9	FLT_09_Woodward_Thistle_345kV_3PH	Stable	Stable
10	FLT_10_Woodward_Thistle_345kV_1PH	Stable	Stable
11	FLT_11_Woodward_Beaver_345kV_3PH	Stable	Stable
12	FLT_12_Woodward_Beaver_345kV_1PH	Stable	Stable
13	FLT_13_Woodward_Beaver_345kV_3PH	Stable	Stable
14	FLT_14_Woodward_Beaver_345kV_1PH	Stable	Stable
15	FLT_15_Woodward_Woodward_345_138kV_3PH	Stable	Stable
16	FLT_16_Woodward_Woodward_345_138kV_3PH	Stable	Stable
17	FLT_17_Border_TUCO_345kV_3PH	Stable	Stable
18	FLT_18_Border_TUCO_345kV_1PH	Stable	Stable
19	FLT_19_TUCO_OKU_345kV_3PH	Stable	Stable
20	FLT_20_TUCO_OKU_345kV_1PH	Stable	Stable
21	FLT_21_TUCO_TUCO_345_230kV_3PH	Stable	Stable
22	FLT_22_TUCO_TUCO_345_230kV_3PH	Stable	Stable
23	FLT_23_OKU_LES_345kV_3PH	Stable	Stable
24	FLT_24_OKU_LES_345kV_1PH	Stable	Stable
25	FLT_25_Thistle_Wichita_345kV_3PH	Stable	Stable
26	FLT_26_Thistle_Wichita_345kV_1PH	Stable	Stable
27	FLT_27_Thistle_Wichita_345kV_3PH	Stable	Stable
28	FLT_28_Thistle_Wichita_345kV_1PH	Stable	Stable
29	FLT_29_Thistle_ClarkCounty_345kV_3PH	Stable	Stable
30	FLT_30_Thistle_ClarkCounty_345kV_1PH	Stable	Stable
31	FLT_31_Thistle_ClarkCounty_345kV_3PH	Stable	Stable
32	FLT_32_Thistle_ClarkCounty_345kV_1PH	Stable	Stable
33	FLT_33_Thistle_Thistle_345_138kV_3PH	Stable	Stable
34	FLT_34_Wichita_EMPEC7_345kV_3PH	Stable	Stable
35	FLT_35_Wichita_EMPEC7_345kV_1PH	Stable	Stable
36	FLT_36_Wichita_Reno_345kV_3PH	Stable	Stable
37	FLT_37_Wichita_Reno_345kV_1PH	Stable	Stable
38	FLT_38_Wichita_Benton_345kV_3PH	Stable	Stable
39	FLT_39_Wichita_Benton_345kV_1PH	Stable	Stable
40	FLT_40_Wichita_Viola_345kV_3PH	Stable	Stable

	Contingency Number and Name	2014SP	2013WP
41	FLT_41_Wichita_Viola_345kV_1PH	Stable	Stable
42	FLT_42_Wichita_Evans_345_138kV_3PH	Stable	Stable
43	FLT_43_Wichita_Evans_345_138kV_1PH	Stable	Stable
44	FLT_44_Wichita_Evans_345_138kV_3PH	Stable	Stable
45	FLT_45_Wichita_Evans_345_138kV_1PH	Stable	Stable
46	FLT_46_ClarkCounty_Spearville_345kV_3PH	Stable	Stable
47	FLT_47_ClarkCounty_Spearville_345kV_1PH	Stable	Stable
48	FLT_48_ClarkCounty_Spearville_345kV_3PH	Stable	Stable
49	FLT_49_ClarkCounty_Spearville_345kV_1PH	Stable	Stable
50	FLT_50_Spearville_Buckner_345kV_3PH	Stable	Stable
51	FLT_51_Spearville_Buckner_345kV_1PH	Stable	Stable
52	FLT_52_Spearville_PostRock_345kV_3PH	Stable	Stable
53	FLT_53_Spearville_PostRock_345kV_1PH	Stable	Stable
54	FLT_54_Spearville_Spearville_345_115kV_3PH	Stable	Stable
55	FLT_55_Spearville_Spearville_345_230kV_3PH	Stable	Stable
56	FLT_56_Beaver_Hitchland_345kV_3PH	Stable	Stable
57	FLT_57_Beaver_Hitchland_345kV_1PH	Stable	Stable
58	FLT_58_Beaver_Hitchland_345kV_3PH	Stable	Stable
59	FLT_59_Beaver_Hitchland_345kV_1PH	Stable	Stable
60	FLT_60_Hitchland_Finney_345kV_3PH	Stable	Stable
61	FLT_61_Hitchland_Finney_345kV_1PH	Stable	Stable
62	FLT_62_Hitchland_Potter_345kV_3PH	Stable	Stable
63	FLT_63_Hitchland_Potter_345kV_1PH	Stable	Stable
64	FLT_64_Hitchland_Hitchland_345_230kV_3PH	Stable	Stable
65	FLT_65_Hitchland_Hitchland_345_230kV_3PH	Stable	Stable
66	FLT_66_Northwest_SpringCreek_345kV_3PH	Stable	Stable
67	FLT_67_Northwest_SpringCreek_345kV_1PH	Stable	Stable
68	FLT_68_Northwest_Cimarron_345kV_3PH	Stable	Stable
69	FLT_69_Northwest_Cimarron_345kV_1PH	Stable	Stable
70	FLT_70_Northwest_Arcadia_345kV_3PH	Stable	Stable
71	FLT_71_Northwest_Arcadia_345kV_1PH	Stable	Stable
72	FLT_72_Northwest_Northwest_345_138kV_3PH	Stable	Stable
73	FLT_73_Northwest_Northwest_345_138kV_3PH	Stable	Stable
74	FLT_74_SpringCreek_Sooner_345kV_3PH	Stable	Stable
75	FLT_75_SpringCreek_Sooner_345kV_1PH	Stable	Stable
76	FLT_76_Sooner_Cleveland_345kV_3PH	Stable	Stable
77	FLT_77_Sooner_Cleveland_345kV_1PH	Stable	Stable
78	FLT_78_Sooner_Woodring_345kV_3PH	Stable	Stable
79	FLT_79_Sooner_Woodring_345kV_1PH	Stable	Stable
80	FLT_80_Sooner_RoseHill_345kV_3PH	Stable	Stable
81	FLT_81_Sooner_RoseHill_345kV_1PH	Stable	Stable
82	FLT_82_Sooner_Sooner_345_138kV_3PH	Stable	Stable
83	FLT_83_Cimarron_Minco_345kV_3PH	Stable	Stable
84	FLT_84_Cimarron_Minco_345kV_1PH	Stable	Stable
85	FLT_85_Cimarron_Draper_345kV_3PH	Stable	Stable
86	FLT_86_Cimarron_Draper_345kV_1PH	Stable	Stable
87	FLT_87_Cimarron_Gen2011007tap_345kV_3PH	Stable	Stable
88	FLT_88_Cimarron_Gen2011007tap_345kV_1PH	Stable	Stable
89	FLT_89_Minco_Gracemont_345kV_3PH	Stable	Stable
90	FLT_90_Minco_Gracemont_345kV_1PH	Stable	Stable
91	FLT_91_Draper_Seminole_345kV_3PH	Stable	Stable
92	FLT_92_Draper_Seminole_345kV_1PH	Stable	Stable
93	FLT_93_Gen2011007tap_Woodring_345kV_3PH	Stable	Stable
94	FLT_94_Gen2011007tap_Woodring_345kV_1PH	Stable	Stable
95	FLT_95_Arcadia_Redbud_345kV_3PH	Stable	Stable
96	FLT_96_Arcadia_Redbud_345kV_1PH	Stable	Stable
97	FLT_97_Arcadia_Redbud_345kV_3PH	Stable	Stable

	Contingency Number and Name	2014SP	2013WP
98	FLT_98_Arcadia_Redbud_345kV_1PH	Stable	Stable
99	FLT_99_Arcadia_Seminole_345kV_3PH	Stable	Stable
100	FLT_100_Arcadia_Seminole_345kV_1PH	Stable	Stable
101	FLT_101_Redbud_RSS_345kV_3PH	Stable	Stable
102	FLT_102_Redbud_RSS_345kV_1PH	Stable	Stable
103	FLT_103_Seminole_Pittsburgh_345kV_3PH	Stable	Stable
104	FLT_104_Seminole_Pittsburgh_345kV_1PH	Stable	Stable
105	FLT_105_Seminole_Draper_345kV_3PH	Stable	Stable
106	FLT_106_Seminole_Draper_345kV_1PH	Stable	Stable
107	FLT_107_Seminole_Draper_345kV_3PH	Stable	Stable
108	FLT_108_Seminole_Draper_345kV_1PH	Stable	Stable
109	FLT_109_Seminole_Draper_345kV_3PH	Stable	Stable
110	FLT_110_Seminole_Draper_345kV_1PH	Stable	Stable
111	FLT_111_Seminole_Muskogee_345kV_3PH	Stable	Stable
112	FLT_112_Seminole_Muskogee_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_01_Tatonga_Woodward_345kV_3PH	*3-Phase fault on the Tatonga – Woodward 345kV line near the Tatonga 345kV bus.*
2	FLT_03_Tatonga_Northwest_345kV_3PH	*3-Phase fault on the Tatonga – Northwest345kV line near the Tatonga 345kV bus.*

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. GEN-2011-024 is found to be in compliance with FERC Order #661A.

Conclusion

<OMITTED TEXT> (Interconnection Customer, GEN-2011-024) has requested a Limited Operation System Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for 299.0 MW of wind generation to be interconnected as an Energy Resource (ER)/Network Resource (NR) into the transmission facility of Oklahoma Gas and Electric Services (OKGE) in Dewey County, Oklahoma. The point of interconnection will be through the existing Tatonga 345kV substation. GEN-2011-024, under GIA Section 5.9, has requested this Limited Operation Interconnection Study (LOIS) to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2011-001 (or most recent iteration) Impact Study can be placed into service.

Power flow analysis from this LOIS has determined that the GEN-2011-024 request can interconnect a limited amount of generation as an Energy Resource (ER) prior to the completion of the required Network Upgrades, listed within Table 2 of this report. There is no more than 58.8 MW of Limited Operation Interconnection Service available due to interconnection constraints on the Northwest - Tatonga 345kV transmission line

Transient stability analysis indicates that with the reactive equipment identified for GEN-2011-024, the transmission system will remain stable for the contingencies listed within Table 7 with the addition of GEN-2011-024 generation. Additionally, GEN-2011-024 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.