Southwest Power Pool

# Interim Operational Impact Study For Generation Interconnection Request GEN-2008-037

*SPP Tariff Studies*

*(#GEN-2008-037)*

**October *2010***

## Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 100.8 MW of wind generation within the balancing authority of Western Farmers Electric Cooperative (WFEC) in Caddo County, Oklahoma. SPP expects to complete the Facility Study as part of the cluster study DISIS-2010-001. SPP may not be able to complete all interconnection studies required under the OATT in time for the Customer's requested in-service date of December 1, 2011. Therefore, Customer has requested this Interim Operation Impact Study (IOIS) to determine the impacts of interconnecting its generating facility to the transmission system before all required studies can be completed and all required Network Upgrades identified in the DISIS-2010-001 posted on July 30, 2010 can be placed into service. Interim Operational Impact Studies are conducted under GIP Section 11A of the SPP OATT.

This study is intended only as an Interim Operation Study that will be used in order to tender an Interim Interconnection Agreement to the Customer for Interim Interconnection Service. If an Interim Interconnection Agreement is not executed with the Customer, this study will be inapplicable. If an Interim Interconnection Agreement is executed with the Customer, this study will be considered inapplicable upon termination of such Interim Interconnection Agreement.

This study assumed that only the certain higher queued projects identified in Table 5 of this study might go into service before the completion of all Network Upgrades identified in DISIS-2010-001. If any additional generation projects not identified in Table 5 but with queue priority higher than or equal to GEN-2008-037 request to go into commercial operation before all Network Upgrades identified through the DISIS-2010-001 study process as required, then this study must be conducted again to determine whether sufficient interim interconnection capacity exists to interconnect the GEN-2008-037 interconnection request in addition to all higher priority requests in operation or pending operation. This will also be a requirement of a Final GIA the customer signs until such time that all network upgrades are placed in service.

A power flow analysis showed that the Customer's wind facility can inject full generation capacity (100.8MW) into the WFEC transmission system once the Balanced Portfolio project Gracemont substation with an additional second 138kV circuit from Washita to Gracemont and the modifications required by WFEC to bring the rating of the Washita – Blue Canyon 138kV line up to an acceptable level so that the additional generation can operate. Until such time that the second circuit from Washita – Gracemont can be completed, the Customer will be allowed to interconnect 76MW on an interim basis. Until such time that the Gracemont 345/138kV autotransformer (Balanced Portfolio) comes into service, the maximum interconnection capacity available to the Customer is 15MW. Powerflow analysis was based on 2011 spring, 2011 summer, and 2011 winter peak conditions and light loading cases.

The power factor analysis in DISIS-2010-001 impact study showed that a power factor of at least 1.0 lagging was required at the point of interconnection (Washita 138kV). This requirement equates to approximately 55 Mvar of capacitance that the Customer will need to install. This capacitance shall be installed in multiple capacitor banks designed by the Customer to meet WFEC capacitor switching requirements. The stability study results show that with the Customer facility the transmission system remains stable for all simulated contingencies and conditions studied with the additional capacitors installed. If the Customer does not use the Vestas V90 1.8 MW wind turbines this IOIS will be considered invalid and the Customer will not be allowed to interconnect on an interim basis.

The wind generation facility was studied with fifty-six (56) Vestas V90 1.8 MW wind turbine generators. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the WFEC transmission system for the system condition as it will be on December 1, 2011. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were modified 2010 summer peak and 2010 winter peak cases that were adjusted to reflect system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Fifty (50) contingencies were identified for use in this study. The Vestas V90 1.8 MW wind turbines were modeled using information provided by the Customer.

The costs for network upgrades and the interconnection facilities for interim operation are estimated to be $9,550,000. The Customer will not be required to put down additional security to interconnect on an Interim basis.

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 shall be requested on Southwest Power Pool's OASIS by the Customer.

## 1.0 Introduction

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 100.8 MW of wind generation within the balancing authority of Western Farmers Electric Cooperative (WFEC) in Caddo County, Oklahoma. SPP expects to complete the Facility Study as part of the cluster study DISIS-2010-001. SPP may not be able to complete all interconnection studies required under the OATT in time for the Customer's requested in-service date of December 1, 2011. Therefore, Customer has requested this Interim Operation Impact Study (IOIS) to determine the impacts of interconnecting its generating facility to the transmission system before all required studies can be completed and all required Network Upgrades identified in the DISIS-2010-001 posted on July 30, 2010 can be placed into service. Interim Operational Impact Studies are conducted under GIP Section 11A of the SPP OATT.

This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the WFEC transmission system for the system condition as it will be on December 1, 2011. The wind generation facility was studied with fifty-six (56) Vestas V90 1.8 MW wind turbine generators. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were modified versions of the 2011 summer peak and 2011 winter peak to reflect the system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Fifty (50) contingencies were identified for this study.

## 2.0 Purpose

The purpose of this Interim Operational Impact Study (IOIS) is to evaluate the impact of the proposed interconnection on the reliability of the Transmission System. The IOIS 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 IOIS 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 5; 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 projects not included in this study signing an interconnection agreement, may require a re-study of this request 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.

## 3.0 Facilities

### 3.1 Generating Facility

The project was modeled as a single equivalent wind turbine generator of 100.8 MW output. The wind turbines are connected to an equivalent 0.69/34.5KV generator step unit (GSU) with a rating of 106.4 MVA with an impedance of 7.8%. The high side of the GSU is connected to the 34.5/138kV substation transformer. A 138kV transmission line connects the Customer's substation transformer to the POI.

## 3.2 Interconnection Facility

The Point of Interconnection will be at the WFEC Washita substation. The point of change of ownership will be at a tap on the WFEC Washita – Blue Canyon 138kV transmission line. Figures 1 and 2 show the proposed configuration of the generation facility and its relation to other facilities in the area.

Cost to interconnect on an Interim basis is estimated as follows:

| | |
|---|---|
| • Three Breaker Ring Bus Substation on the Washita – Blue Canyon 138kV line | $3,500,000 |
| • Approximately seven (7) miles of 138kV transmission From Washita – Gracemont | $4,250,000 |
| • Substation work at Washita | $ 300,000 |
| • Substation work at Gracemont | $1,500,000 |
| • Total | $9,550,000 |

Customer's latest estimate for cost responsibility for Interconnection Service is given in DISIS-2010-001 at $9,550,000. As the cost to interconnect on an interim basis, exceeds the current estimate for final interconnection, no additional security will be required.

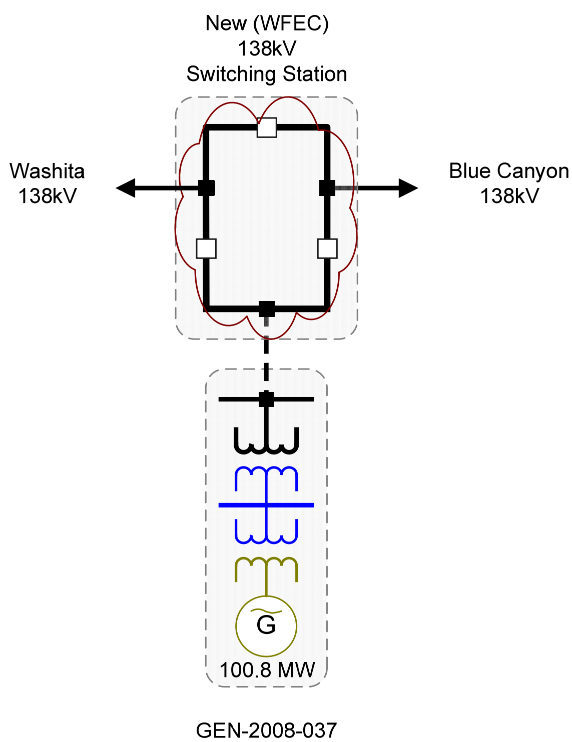


**Figure 1**: GEN-2008-037 Facility and Proposed Interconnection Configuration

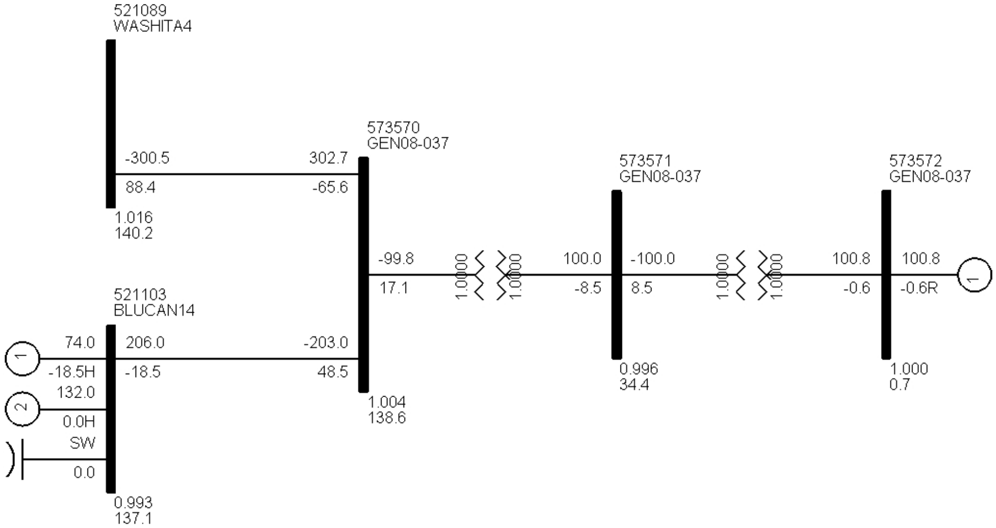


**Figure 2**: Power Flow One-line for GEN-2008-037 and adjacent equipment

## 4.0 Power Flow Analysis

A powerflow analysis was conducted for the Interconnection Customer's facility using a modified version of the 2011 spring, 2011 summer, and 2011 winter seasonal models. The output of the Interconnection Customer's facility was offset in the model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. This analysis was conducted assuming that previous queued requests in Table 5 were in-service.

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 Reliability Standards for transmission planning. All MDWG power flow models shall be tested to verify compliance with the System Performance Standards from NERC Table 1 – Category A."

The ACCC function of PSS/E was used to simulate single contingencies in portions of or all of the control area of WEFC and other control areas within SPP and the resulting data analyzed. This satisfies the "more probable" contingency testing criteria mandated by NERC and the SPP criteria.

The prior queued projects included in this analysis are listed in Table 5. Changes to these assumptions will cause the need for a restudy and potential loss of interim available interconnection capacity.

The power flow analysis indicates that, with the inclusion of the second 138kV circuit from Washita to Gracemont and modifications to the Blue Canyon – Washita 138kV line made by WFEC to accommodate the additional generation, the WEFC transmission system will accept the Customer's project at full nameplate power.

Without these transmission network upgrades the WEFC transmission system will experience thermal overloads as shown in Table 1. To mitigate these violations without the specified upgrades, the maximum power output of Customer's project shall be limited to 15MW for the interim operational interconnection.

With the inclusion of the Balance Portfolio upgrade of the Gracemont 345kV/138kV autotransformer and that the Customer's project available interconnection is increased to 76.6MW. The additional inclusion of the DISIS-2010-001 planned Washita-Gracemont circuit 2

138kV transmission line allows the WFEC transmission system to accept the full output of the Customer's project. The ACCC overloads with the inclusion of the specified DISIS-2010-001 upgrades are shown in Table 2.

## Table 1: ACCC Analysis

| SOURCE | SCENARIO | SEASON | DIRECTION | MONTCOMMONNAME | RATEB | TDF | TC%LOADING | CONTNAME | Available Interconnection (MW) |
|---|---|---|---|---|---|---|---|---|---|
| G0837 | 0 | 11G | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99172 | 133.8546 | NO OUTAGE | 16.822 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.62813 | 123.815 | NO OUTAGE | 26.488 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.56881 | 108.7136 | 'ANADARKO - SOUTHWESTERN STATION 138KV CKT 1' | 60.971 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.69008 | 103.249 | 'ONEY - WASHITA 138KV CKT 1' | 88.559 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.69008 | 102.5375 | 'BINGER NIJECT - ONEY 138KV CKT 1' | 91.240 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.82583 | 101.9799 | 'GRACMNT4 138.00 - WASHITA 138KV CKT 1' | 94.567 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.82583 | 101.9002 | 'ANADARKO - GRACMNT4 138.00 138KV CKT 1' | 94.818 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.64729 | 101.4784 | 'ANADARKO - CORN TAP 138KV CKT 1' | 94.862 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63705 | 100.5546 | 'WEATHERFORD JCT. - WEATHERFORD SOUTHEAST 138KV CKT 1' | 98.537 |
| G0837 | 0 | 11G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.69008 | 100.5316 | BINGER NIJECT - SICKLES 138KV CKT 1' | 98.797 |
| G0837 | 0 | 11SP | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99416 | 133.581 | NO OUTAGE | 17.705 |
| G0837 | 0 | 11SP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63179 | 101.5778 | NO OUTAGE | 95.905 |
| G0837 | 0 | 11WP | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99203 | 133.9193 | NO OUTAGE | 16.688 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.62431 | 127.0215 | NO OUTAGE | 15.967 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.55878 | 114.2973 | 'ANADARKO - SOUTHWESTERN STATION 138KV CKT 1' | 34.275 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.68451 | 106.6863 | 'ONEY - WASHITA 138KV CKT 1' | 75.403 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.68451 | 105.9216 | 'BINGER NIJECT - ONEY 138KV CKT 1' | 78.308 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.64209 | 105.2537 | 'ANADARKO - CORN TAP 138KV CKT 1' | 79.526 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63318 | 104.3881 | 'WEATHERFORD JCT. - WEATHERFORD SOUTHEAST 138KV CKT 1' | 82.781 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.68451 | 103.6426 | 'BINGER NIJECT - SICKLES 138KV CKT 1' | 86.964 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63318 | 103.1815 | 'HINTON - WEATHERFORD JCT. 138KV CKT 1' | 87.736 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63318 | 103.0712 | 'CAN_GAS4 138.00 - HINTON 138KV CKT 1' | 88.189 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63318 | 102.7056 | 'CAN_GAS4 138.00 - JENSEN ROAD 138KV CKT 1' | 89.690 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.62921 | 102.669 | 'WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1' | 89.771 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63697 | 102.1875 | 'ANADARKO - POCASSETT 138KV CKT 1' | 91.871 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.82695 | 101.9168 | 'GRACMNT4 138.00 - WASHITA 138KV CKT 1' | 94.773 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.62921 | 101.9054 | 'WEATHERFORD SOUTHEAST - WEATHERFORD TAP 138KV CKT 1' | 92.927 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63697 | 101.8733 | 'POCASSETT - TUTTLE 138KV CKT 1' | 93.154 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.82695 | 101.8374 | 'ANADARKO - GRACMNT4 138.00 138KV CKT 1' | 95.023 |

| SOURCE | SCENARIO | SEASON | DIRECTION | MONTCOMMONNAME | RATEB | TDF | TC%LOADING | CONTNAME | Available Interconnection (MW) |
|---|---|---|---|---|---|---|---|---|---|
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63024 | 101.4846 | 'BLUCAN5 4 138.00 - PARADISE 138KV CKT 1' | 94.675 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63697 | 101.1557 | 'SUNSHINE CANYON - TUTTLE 138KV CKT 1' | 96.083 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.65232 | 101.0586 | 'WASHITA (WASHITA) 138/69/13.8KV TRANSFORMER CKT 1' | 96.581 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.68451 | 101.0185 | 'HYDRO - SICKLES 138KV CKT 1' | 96.931 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.61824 | 100.7278 | 'LAWTON EASTSIDE - OKLAUNION 345KV CKT 1' | 97.739 |
| G0837 | 0 | 11WP | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.63024 | 100.4973 | 'PARADISE - SNYDER 138KV CKT 1' | 98.748 |

**Table 2: ACCC Analysis with Gracemont 345/138kV auto**

| SOURCE | SCENARIO | SEASON | DIRECTION | MONTCOMMONNAME | RATEB | TDF | TC%LOADING | CONTNAME | Available Interconnection (MW) |
|---|---|---|---|---|---|---|---|---|---|
| G0837 | 0 | 12G | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99172 | 133.8697 | NO OUTAGE | 16.785 |
| G0837 | 0 | 12G | 'TO->FROM' | 'GRACMNT4 138.00 - WASHITA 138KV CKT 1' | 228 | 0.79325 | 108.3896 | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 76.686 |
| G0837 | 0 | 12G | 'TO->FROM' | 'SOUTHWESTERN STATION - WASHITA 138KV CKT 1' | 260 | 0.83161 | 103.1245 | 'GRACMNT4 138.00 - WASHITA 138KV CKT 1' | 91.031 |
| G0837 | 0 | 12SP | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99416 | 133.6438 | NO OUTAGE | 17.550 |

**Table 3: ACCC Analysis with Gracemont 345/138kV auto and Gracemont-Washita 138kV ckt. 2**

| SOURCE | SCENARIO | SEASON | DIRECTION | MONTCOMMONNAME | RATEB | TDF | TC%LOADING | CONTNAME | Available Interconnection (MW) |
|---|---|---|---|---|---|---|---|---|---|
| G0837 | 2 | 12G | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99172 | 133.7878 | NO OUTAGE | 16.988 |
| G0837 | 2 | 12SP | 'FROM->TO' | 'GEN08-037 138.00 - WASHITA 138KV CKT 1' | 324 | 0.99416 | 133.6353 | NO OUTAGE | 17.571 |

## 5.0 Power Factor Analysis

Power Factor Analysis for GEN-2008-037 was performed in the DISIS-2010-001 impact study. The results showed that a power factor of 1.0 lagging is required at Washita 138kV substation for reliable operation. This requires approximately 55 Mvars of capacitors to be installed for the GEN-2008-037 project. These capacitor banks should be designed by the customer in multiple banks so as not to violate WFEC capacitor switching standards for voltage deviation.

## 6.0 Stability Analysis

### 6.1 Contingencies Simulated

Fifty (50) contingencies were considered for the transient stability simulations. These contingencies included three phase faults and single phase line faults at locations defined by SPP. Single-phase line 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.

The faults that were defined and simulated are listed in Table 4 below.

**Table 4: Contingencies Evaluated**

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 1 | FLT05-3PH | 3 phase fault on the Lawton Eastside (511468) to Sunnyside (515136) 345kV line, near Lawton Eastside.<br>a. Apply fault at the Lawton Eastside 345kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 2 | FLT06-1PH | *Single phase fault and sequence like previous* |
| 3 | FLT07-3PH | 3 phase fault on the Weatherford (521092) to Clinton. (520856) 138kV line, near Weatherford.<br>a. Apply fault at the Weatherford 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 4 | FLT08-1PH | *Single phase fault and sequence like previous* |
| 5 | FLT09-3PH | 3 phase fault on the Clinton Jct. (511485) to CL_NGTP (511534) 138kV line, near Clinton Jct.<br>a. Apply fault at the Clinton Jct. 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 6 | FLT10-1PH | *Single phase fault and sequence like previous* |
| 7 | FLT11-3PH | 3 phase fault on the Weatherford (521092) to Hydro. (520950) 138kV line, near Weatherford .<br>a. Apply fault at the Weatherford 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 8 | FLT12-1PH | *Single phase fault and sequence like previous* |
| 9 | FLT15-3PH | 3 phase fault on the Elk City (511458) to Clinton AFB (511446) 138kV line, near Elk City.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 10 | FLT16-1PH | *Single phase fault and sequence like previous* |
| 11 | FLT17-3PH | 3 phase fault on the Elk City (511490) 230/138kV autotransformer.<br>a. Apply fault at the Elk City 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted transformer. |
| 12 | FLT18-1PH | *Single phase fault and sequence like previous* |
| 13 | FLT23-3PH | 3 phase fault on the Hobart Jct (511463) to Carnegie South (511445) 138kV line, near Hobart Jct.<br>a. Apply fault at Hobart Jct.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 14 | FLT24-1PH | *Single phase fault and sequence like previous* |
| 15 | FLT27-3PH | 3 phase fault on the Hobart Jct. (511463) 138/69kv autotransformer.<br>a. Apply fault at Hobart Jct.<br>b. Clear fault after 5 cycles by tripping the faulted auto. |
| 16 | FLT28-1PH | *Single phase fault and sequence like previous* |
| 17 | FLT31-3PH | 3 phase fault on the Altus (511440) to Snyder (511435) 138kV line, near Altus.<br>a. Apply fault at Altus 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 18 | FLT32-1PH | *Single phase fault and sequence like previous* |
| 19 | FLT33-3PH | 3 phase fault on the Morewood (521001) to Nine Mile (521128) 138kV line, near Moorewood.<br>a. Apply fault at Morewood 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 20 | FLT34-1PH | *Single phase fault and sequence like previous* |
| 21 | FLT35-3PH | 3 phase fault on the Anadarko (520814) to Southwest (511477) 138kV line, near Anadarko.<br>a. Apply fault at the Anadarko 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 22 | FLT36-1PH | *Single phase fault and sequence like previous* |
| 23 | FLT37-3PH | 3 phase fault on the Southwest (511477) to Verden (511421) 138kV line, near Southwest.<br>a. Apply fault at the Southwest 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 24 | FLT38-1PH | *Single phase fault and sequence like previous* |
| 25 | FLT39-3PH | 3 phase fault on the Southwest (511477) to Elgin Jct. (511486) 138kV line, near Southwest.<br>a. Apply fault at the Southwest 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 26 | FLT40-1PH | *Single phase fault and sequence like previous* |
| 27 | FLT41-3PH | 3 phase fault on the Anadarko (520814) to Cornville Tap (520867) 138kV line, near Anadarko.<br>a. Apply fault at the Anadarko 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 28 | FLT42-1PH | *Single phase fault and sequence like previous* |

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 29 | FLT43-3PH | 3 phase fault on the Southwest (511477) to Washita (521089) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 30 | FLT44-1PH | *Single phase fault and sequence like previous* |
| 31 | FLT45-3PH | 3 phase fault on the Washita (521089) to Gracemont (515802) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 32 | FLT46-1PH | *Single phase fault and sequence like previous* |
| 33 | FLT47-3PH | 3 phase fault on the Oney (521017) to Washita (521089) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 34 | FLT48-1PH | *Single phase fault and sequence like previous* |
| 35 | FLT49-3PH | 3 phase fault on the Carter Jct. (520846) to Dill Jct. (520876) 69kV line, near Carter Jct.<br>a. Apply fault at the Carter Jct. 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 36 | FLT50-1PH | *Single phase fault and sequence like previous* |
| 37 | FLT51-3PH | 3 phase fault on the Carter Jct. (520846) to Lake Creek (520978) 69kV line, near Carter Jct.<br>a. Apply fault at the Carter Jct. 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 38 | FLT52-1PH | *Single phase fault and sequence like previous* |
| 39 | FLT53-3PH | 3 phase fault on the Lake Creek (520978) to Lone Wolf (520982) 69kV line, near Lake Creek.<br>a. Apply fault at the Lake Creek 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 40 | FLT54-1PH | *Single phase fault and sequence like previous* |
| 41 | FLT55-3PH | 3 phase fault on the Lake Creek (520978) to Granite (520927) 69kV line, near Lake Creek.<br>a. Apply fault at the Lake Creek 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 42 | FLT56-1PH | *Single phase fault and sequence like previous* |

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 43 | FLT57-3PH | 3 phase fault on the Clinton Jct (511485) to Elk City (511458) 138kV line, near Clinton Jct.<br>a. Apply fault at the Clinton Jct 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 44 | FLT58-1PH | *Single phase fault and sequence like previous* |
| 45 | FLT59-3PH | 3 phase fault on the Gotebo (520925) to Cordell (520866) 69kV line, near Gotebo.<br>a. Apply fault at the Gotebo 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 46 | FLT60-1PH | *Single phase fault and sequence like previous* |
| 47 | FLT61-3PH | 3 phase fault on the Gotebo (520925) to Lonewolf (520982) 69kV line, near Lonewolf.<br>a. Apply fault at the Lonewolf 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 48 | FLT62-1PH | *Single phase fault and sequence like previous* |
| 49 | FLT63-3PH | 3 phase fault on the Gotebo (520925) to Mountain View (521003) 69kV line, near Mountain View.<br>a. Apply fault at the Mountain View 69kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 50 | FLT64-1PH | *Single phase fault and sequence like previous* |

## 6.2 Further Model Preparation

The base cases contain prior queued projects as shown in Table 5. Should any additional prior queued projects achieve their in service date before all network upgrades in DISIS-2010-001 are placed in service, this interim study will need to be re-performed.

The wind generation from the study customer and the previously queued customers were dispatched into the SPP footprint.

Initial simulations were carried out on both base cases and cases with the added generation for a no-disturbance run of 20 seconds to verify the numerical stability of the model. All cases were confirmed to be stable.

**Table 5: Prior Queued Projects**

| Project | MW |
|---|---|
| GEN-2001-026 | 74 |
| GEN-2003-004 | 101 |
| GEN-2003-005 | 100 |
| GEN-2003-022 | 120 |
| GEN-2004-020 | 20 |
| GEN-2005-003 | 30 |
| GEN-2006-043 | 99 |
| GEN-2007-052 | 150 |

## 6.3 Results

Results of the stability analysis are summarized in Table 6. The results indicate that, with network upgrades and capacitors in service for all contingencies studied the transmission system remains stable.

Stability plots for the simulations are in Appendix A.

**Table 6: Results of Simulated Contingencies**

| Cont. No. | Cont. Name | Description | 2010 Summer | 2010 Winter |
|---|---|---|---|---|
| 1 | FLT05-3PH | 3 phase fault on the Lawton Eastside (511468) to Sunnyside (515136) 345kV line, near Lawton Eastside. | Stable | Stable |
| 2 | FLT06-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 3 | FLT07-3PH | 3 phase fault on the Weatherford WFEC (GEN-2009-030) (521092) to Clinton. (520856) 138kV line, near Weatherford. | Stable | Stable |
| 4 | FLT08-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 5 | FLT09-3PH | 3 phase fault on the Clinton Jct. (511485) to CL_NGTP (511534) 138kV line, near Clinton Jct. | Stable | Stable |
| 6 | FLT10-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 7 | FLT11-3PH | 3 phase fault on the Weatherford WFEC (GEN-2009-030) (521092) to Hydro. (520950) 138kV line, near Weatherford. | Stable | Stable |
| 8 | FLT12-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 9 | FLT15-3PH | 3 phase fault on the Elk City (511458) to Clinton AFB (511446) 138kV line, near Elk City. | Stable | Stable |
| 10 | FLT16-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 11 | FLT17-3PH | 3 phase fault on the Elk City (511490) 230/138kV autotransformer. | Stable | Stable |
| 12 | FLT18-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 13 | FLT23-3PH | 3 phase fault on the Hobart Jct (511463) to Carnegie South (511445) 138kV line, near Hobart Jct. | Stable | Stable |
| 14 | FLT24-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 15 | FLT27-3PH | 3 phase fault on the Hobart Jct. (511463) 138/69kv auto. | Stable | Stable |
| 16 | FLT28-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 17 | FLT31-3PH | 3 phase fault on the Altus (511440) to Snyder (511435) 138kV line, near Altus. | Stable | Stable |
| 18 | FLT32-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 19 | FLT33-3PH | 3 phase fault on the Morewood (521001) to Nine Mile (521128) 138kV line, near Moorewood. | Stable | Stable |
| 20 | FLT34-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 21 | FLT35-3PH | 3 phase fault on the Anadarko (520814) to Southwest (511477) 138kV line, near Anadarko. | Stable | Stable |
| 22 | FLT36-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 23 | FLT37-3PH | 3 phase fault on the Southwest (511477) to Verden (511421) 138kV line, near Southwest. | Stable | Stable |
| 24 | FLT38-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 25 | FLT39-3PH | 3 phase fault on the Southwest (511477) to Elgin Jct. (511486) 138kV line, near Southwest. | Stable | Stable |
| 26 | FLT40-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 27 | FLT41-3PH | 3 phase fault on the Anadarko (520814) to Cornville Tap (520867) 138kV line, near Anadarko. | Stable | Stable |
| 28 | FLT42-1PH | *Single phase fault and sequence like previous* | Stable | Stable |

| Cont. No. | Cont. Name | Description | 2010 Summer | 2010 Winter |
|---|---|---|---|---|
| 29 | FLT43-3PH | 3 phase fault on the Southwest (511477) to Washita (521089) 138kV line, near Washita. | Stable | Stable |
| 30 | FLT44-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 31 | FLT45-3PH | 3 phase fault on the Washita (521089) to Gracemont (515802) 138kV line, near Washita. | Stable | Stable |
| 32 | FLT46-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 33 | FLT47-3PH | 3 phase fault on the Oney (521017) to Washita (521089) 138kV line, near Washita. | Stable | Stable |
| 34 | FLT48-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 35 | FLT49-3PH | 3 phase fault on the Carter Jct. (520846) to Dill Jct. (520876) 69kV line, near Carter Jct. | Stable | Stable |
| 36 | FLT50-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 37 | FLT51-3PH | 3 phase fault on the Carter Jct. (520846) to Lake Creek (520978) 69kV line, near Carter Jct. | Stable | Stable |
| 38 | FLT52-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 39 | FLT53-3PH | 3 phase fault on the Lake Creek (520978) to Lone Wolf (520982) 69kV line, near Lake Creek. | Stable | Stable |
| 40 | FLT54-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 41 | FLT55-3PH | 3 phase fault on the Lake Creek (520978) to Granite (520927) 69kV line, near Lake Creek. | Stable | Stable |
| 42 | FLT56-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 43 | FLT57-3PH | 3 phase fault on the Clinton Jct (511485) to Elk City (511458) 138kV line, near Clinton Jct. | Stable | Stable |
| 44 | FLT58-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 45 | FLT59-3PH | 3 phase fault on the Gotebo (520925) to Cordell (520866) 69kV line, near Gotebo. | Stable | Stable |
| 46 | FLT60-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 47 | FLT61-3PH | 3 phase fault on the Gotebo (520925) to Lonewolf (520982) 69kV line, near Lonewolf. | Stable | Stable |
| 48 | FLT62-1PH | *Single phase fault and sequence like previous* | Stable | Stable |
| 49 | FLT63-3PH | 3 phase fault on the Gotebo (520925) to Mountain View (521003) 69kV line, near Mountain View. | Stable | Stable |
| 50 | FLT64-1PH | *Single phase fault and sequence like previous* | Stable | Stable |

## 6.4 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.

Three fault contingencies were developed to verify that the wind farm will remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table 7.

**Table 7: LVRT Fault Contingencies**

| Cont. Name | Description |
|---|---|
| FLT43-3PH | 3 phase fault on the Southwest (511477) to Washita (521089) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT45-3PH | 3 phase fault on the Washita (521089) to Gracemont (515802) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| FLT47-3PH | 3 phase fault on the Oney (521017) to Washita (521089) 138kV line, near Washita.<br>a. Apply fault at the Washita 138kV bus.<br>b. Clear fault after 5 cycles by tripping the faulted line.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |

With the required 55 Mvars of capacitance in service, the project wind farm remained online for the fault contingencies described in this section and for all the fault contingencies described in section 6.2. GEN-2008-037 is found to be in compliance with FERC Order #661A.

## 7.0 Conclusion

<OMITTED TEXT> (Customer) has requested an Interim Operation Impact Study for interim interconnection service of 100.8 MW of wind generation within the balancing authority of Western Farmers Electric Cooperative (WFEC) in Caddo County, Oklahoma, in accordance with Section 11A of Attachment V of the OATT.

The results of this study show that the wind generation facility and the transmission system remain stable for all contingencies studied. Also, GEN-2008-037 is found to be in compliance with FERC Order #661A.

A power flow analysis showed that the Customer's wind facility can inject full capacity (100.8MW) into the WFEC transmission system with certain Balanced Portfolio and DISIS-2010-001 upgrades in-service and that the GEN-2008-037 – Washita 138kV transmission line rating is increased to meet the requirements of the additional generation. Without the upgrades discussed in this report the Customer's wind facility is limited to a maximum of 15.9 MW during the interim operation due to existing transmission system line capacities near GEN-2008-037.

The Customer's wind facility must be capable of meeting a 1.0 lagging to 0.974 leading power factor at the POI which equates to approximately 55 Mvars of capacitor banks to be designed by Interconnection Customer in accordance with WFEC transmission requirements for capacitor switching.

The cost to interconnect on an Interim basis is $9,550,000. The Customer will not be required to put down additional security to interconnect on an Interim basis

The estimates do not include any 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. It should be noted that the models used for simulation do not contain all SPP transmission service.

**APPENDIX A.**

## STABILITY PLOTS

All plots available on request