



**Facility Study  
For  
Generation Interconnection  
Request  
GEN-2012-027**

***SPP Generation  
Interconnection Studies***

***(#GEN-2012-027)***

**August 2013**

---

## Revision History

---

Date	Author	Change Description
8/06/2013	SPP	Facility Study Report Issued

## Summary

American Electric Power Service Corporation (AEPW) provided a detailed Facility Study estimate at the request of Southwest Power Pool (SPP) for Generation Interconnection request GEN-2012-027 (136.0 MW/Wind) located in Osage County, Oklahoma. The originally proposed in-service date for GEN-2012-027 was December 1, 2014. The request for interconnection was placed with SPP in accordance with SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system. Additionally, SPP notified Associated Electric Cooperative Inc. (AECI) of potential impacts on the AECI transmission system due to the impacts of the interconnection of GEN-2012-027. AECI responded with an Affected System Interconnection Facility Study for impacts on its transmission system.

## Phases of Interconnection Service

It is not expected that interconnection service will require phases however, interconnection service will not be available until all interconnection facilities and network upgrades can be placed in service.

## Interconnection Customer Interconnection Facilities

The Interconnection Customer will be responsible for all of the transmission facilities connecting the customer owned substation to the Point of Interconnection (POI), the Public Service Company of Oklahoma (AEP-PSO) owned Shidler 138kV substation. The Interconnection Customer will also be responsible for any equipment located at the Customer substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI.

## Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades

To accommodate the GEN-2012-027 Interconnection Request, the Transmission Owner will need to add three (3) 138kV circuit breakers along with all associated and miscellaneous equipment for substation and line terminal construction. At this time GEN-2012-027 is responsible for \$1,779,284.00 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades.

The Interconnection Customer was studied within the DISIS-2012-002 Impact Study. At this time, the Interconnection Customer is allocated \$0.00 for Shared Network Upgrades. If higher or equally queued interconnection customers withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued interconnection requests and the upgrades associated with those higher queued interconnection requests being placed in service. At this time, the Interconnection Customer is allocated the following cost for Shared Network Upgrade:

Share Network Upgrade Description	Allocated Cost	Total Cost
None	\$0.00	\$0.00
Total	\$0.00	

### **Affected System Non-Shared Network Upgrades**

AECI performed an Affected System Facilities Study to determine impacts on the AECI transmission system due to the interconnection of GEN-2012-027. The total costs of Affected System Non-Shared Network Upgrades are estimated at \$2,200,000.00. Those impacts are listed below.

<b>Affected System Non-Shared Network Upgrade Description</b>	<b>Allocated Cost</b>	<b>Total Cost</b>
Fairfax – Remington 138kV Circuit #1 (AECI) – Conductor Clearance to increase operating temperature to 100°C	\$400,000.00	\$400,000.00
Fairfax 138/69kV transformer replacement (84 MVA)	\$1,800,000.00	\$1,800,000.00
Total	\$2,200,000.00	

### **Conclusion**

The Interconnection Customer is responsible for \$1,779,284.00 of Transmission Owner Interconnection Facilities Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated \$0.00 for Shared Network Upgrades. Additionally, the Interconnection Customer has been assigned \$2,200,000.00 of Network Upgrades by AECI for Affected System impacts. At this time, the total allocation of costs assigned to GEN-2012-027 for Interconnection Service is estimated at \$3,979,284.00.

**1. Introduction**

<OMITTED TEXT> (Customer) has requested a Facility Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnecting a 136.0 MW wind powered generation facility in Osage County, Oklahoma to the transmission system of American Electric Cooperative Corporation (AEPW). The generation facility studied is comprised of eighty-four (84) G.E. 1.62 MW wind turbines. The wind powered generation facility will interconnect into AEPW owned Shidler 138kV Substation.

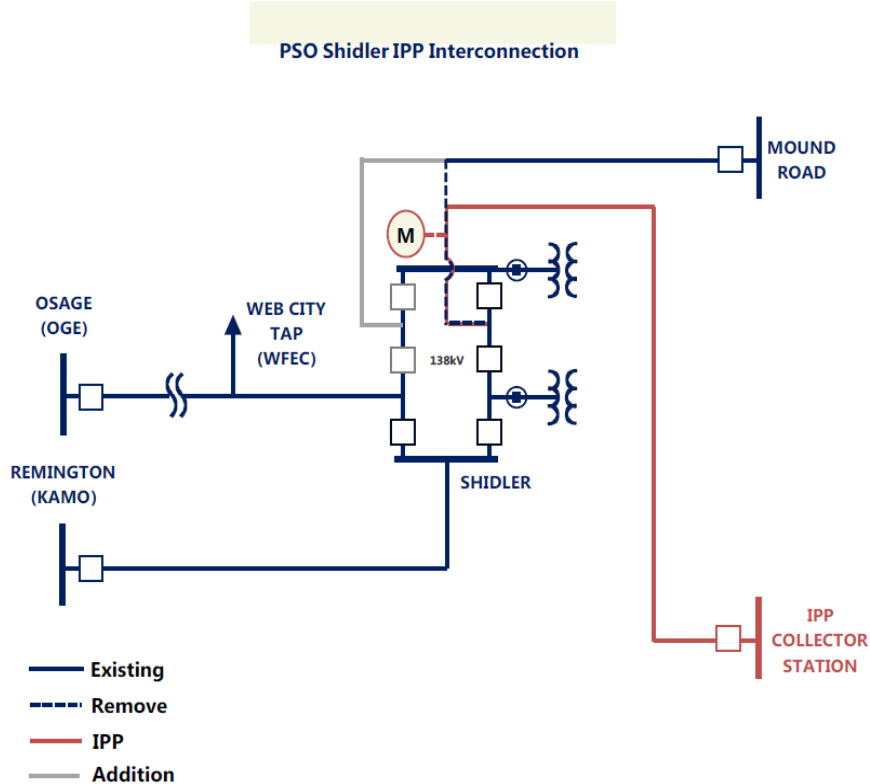
**2. Interconnection Facilities and Network Upgrades**

The cost for the Interconnection Facilities and Network Upgrades is listed below in Table 1. The one-line diagram is shown in Figure 1.

**Table 1: Required Interconnection Facilities and Non Shared Network Upgrades**

<b>Project</b>	<b>Description</b>	<b>Estimated Cost</b>
1	AEPW-Interconnection facility-build one breaker, line switches, relaying equipment, etc.	\$1,779,284.00
	<b>Total:</b>	<b>\$1,779,284.00</b>

**Figure 1: Interconnection Configuration for GEN-2012-027**



**2.1. Customer Facilities** – The Customer will be responsible for its Generating Facility and its 138/34.5 kV transformer along with the 34.5/.69kV GSU transformers that will connect to the eighty-four (84) G.E. 1.62 MW wind turbines. In addition, the Customer will be required to install the following equipment in its facilities.

**2.1.1. Reactive Power Equipment** – The Customer will be responsible for reactive power compensation equipment to maintain 95% lagging (providing vars) and 95% leading (absorbing vars) power factor at the point of interconnection. Any capacitor banks installed by the Interconnection Customer shall not cause voltage distortion in accordance with Article 9.7.4 of the standard SPP Generation Interconnection Agreement.

**3. Conclusion**

The Interconnection Customer’s interconnection facilities are estimated at \$1,779,284.00.



Associated Electric Cooperative, Inc.

Your Touchstone Energy® Partner 

The Touchstone Energy logo consists of a stylized human figure in blue, with two arms raised, flanked by two curved lines in red and orange, suggesting energy or a path.

# Affected System Study Shidler Wind Generation



July 2013

**Contents**

---

Executive Summary ..... 3  
Introduction ..... 4  
System Representation ..... 4  
    Model Development..... 4  
Results..... 6  
Mitigation Improvements..... 7  
Cost of Improvements..... 8  
Assessment..... 9



### ***Executive Summary***

Associated Electric Cooperative, Inc. (AECI) was identified as an Affected System in the Southwest Power Pool's (SPP) analysis of their GEN-2012-027 interconnection request. SPP requested AECI perform an Affected System Study for the interconnection of 136 MW<sup>1</sup> of wind generation at the AEP Shidler Substation under SPP GI Queue # GEN-2012-027 with an anticipated commercial operation date of December 1, 2014<sup>2</sup>.

The impact was evaluated against NERC Reliability Standards TPL-001, -002 and -003 for no contingencies, n-1, and n-2 contingencies using AECI's Planning Criteria. The Affected System Study was a load flow analysis only. Stability and short circuit analysis have been performed by SPP and were not performed as part of the Affected System Study.

The results of the n-1 simulations show that the Fairfax 138/69 kV transformer overloads for the loss of the Fairfax-Fairfax Tap 138 kV line and the Remington-Fairfax 138 kV line overloads for the loss of the Shidler-W.Pauhuska 138 kV line. The Fairfax Tap is the point at which the 138 kV line from Fairfax interconnects to the Cleveland to Stillwater 138 kV line.

To address these impacts, the Fairfax 138/69 kV transformer can be upgraded to an 84 MVA unit and the Remington-Fairfax 138 kV line can be uprated to an operating temperature of 100° C with a rating of 245 MW. The estimated cost for these improvements is \$2,200,000 (2013 Dollars).

The above results assume the Network Upgrades and affected system network upgrades as identified in the GIA-27 Generator Interconnection on AECI's system are constructed and in service.

The Affected System network upgrades identified in this study can be installed and placed in service within an estimated timeframe of 18 months from the date of execution of an agreement between the Interconnection Customer and Associated or Associated's member G&T, KAMO Power ("KAMO"). Such agreement shall provide for the terms and conditions, under which Associated and/or KAMO will design, engineer, procure and construct the identified network upgrades and also define the Interconnection Customer's responsibility for reimbursement to Associated and/or KAMO for such activities. The timeframe provided should be considered non-binding and subject to change dependent upon Associated and/or KAMO's current construction work-plan and outage coordination.

---

<sup>1</sup> On an April 22, 2013 call with SPP, the generation value was dropped to 136 MW from the 142 MW requested to be studied in the March 6, 2013 letter from SPP to AECI.

<sup>2</sup> Pursuant to May 14, 2013 Affected System Interconnection Facilities Study Agreement between Associated and Customer

### **Introduction**

Associated Electric Cooperative, Inc. (AECI) was identified as an Affected System in the Southwest Power Pool's (SPP) analysis of their GEN-2012-027 interconnection request. SPP requested AECI perform an Affected System Study for the interconnection of 136 MW<sup>2</sup> of wind generation at the AEP Shidler Substation under SPP GI Queue # GEN-2012-027 with an anticipated commercial operation date of December 1, 2014.

The objective of the affected system study is to confirm SPP's study and evaluate the impact of the addition of wind generation at AEP's Shidler Substation upon AECI's transmission system, develop solutions/system improvements with cost estimates, and determine a schedule for completing the improvements.

The impact was evaluated against NERC Reliability Standards TPL-001, -002 and -003 for no contingencies, n-1, and n-2 contingencies using AECI's Planning Criteria. The Affected System Study was a load flow analysis only. Stability and short circuit analysis have been performed by SPP and were not performed as part of the Affected System Study.

### **System Representation**

The base models used for the Affected System Study was the 2013 Spring & Summer Peak (2012 Series) models SPP developed for the GEN-2012-027 interconnection request. These models were checked against other AECI models to identify any needed topology changes and updated as appropriate.

#### **Model Development**

- AECI compared the SPP model to similar season/year models developed by AECI.
- Topology updates were applied as appropriate.
- Load updates were applied as appropriate.
- Generation in close proximity (within 10 buses) to the study area was fully dispatched. All other AECI generation was economically dispatched.

The following updates were made to arrive at the study cases:

- Renumbered & Renamed GRDA Pawnee Sw 69 to Fairfax Tap
- Renamed GRDA Pawnee Sw 138 to Fairfax Tap
- Added missing Fairfax Tap-Fairfax 69 kV line
- Some GRDA lines between AECI buses have different ratings. (If GRDA changed they didn't coordinate.)
- Added Glencoe & Cimarron loads near Fairfax.
- Added bus at Stillwater.
- Updated transformers at 'THOMAS H', 'CALIFORN', 'STILLWAT', 'FISHER', 'FLETCHER', 'MISSOURI', 'STROUD 1', 'VALLEY'
- Added Osage GSU, moved Osage to 0.6 kV bus
- Added Stroud 138 kV

---

<sup>2</sup> On an April 22, 2013 call with SPP, the generation value was dropped to 136 MW from the 142 MW requested to be studied in the March 6, 2013 letter from SPP to AECI.

Figure 1 below shows a one-line plot of the study area modeled.

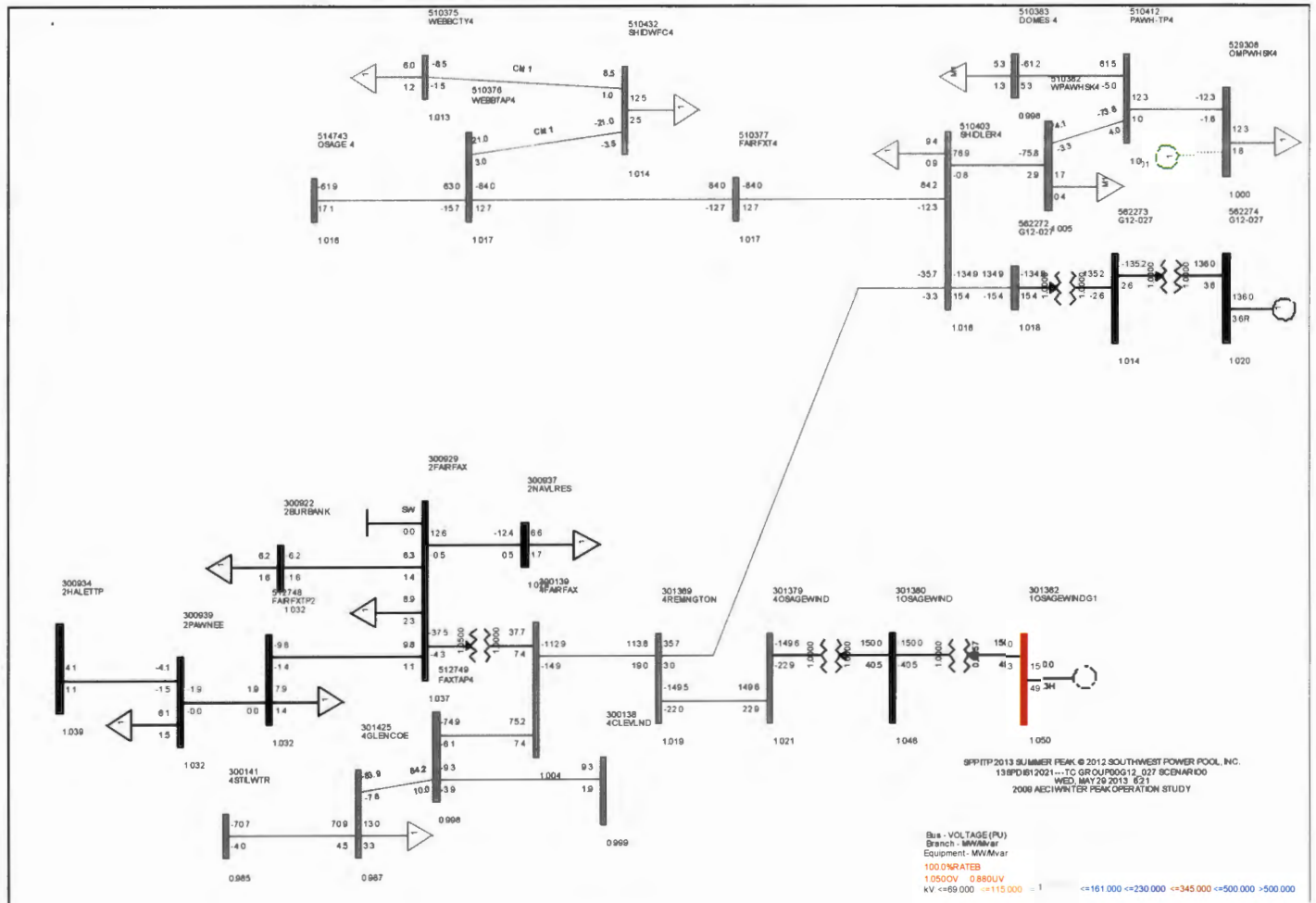


Figure 1: Study Area One-Line

### System Analysis Methodology

Normal conditions and Contingency analysis were simulated on the updated GEN-2012-027 SPP models.

- Normal conditions
- All n-1 single-element contingencies 69 kV and above in AECI's KAMO-OK zone and in AEP's zone 547 (PSO\_Northern) were evaluated. These contingencies did not include manual transfer of load or manual switching.
- Selected n-2 Contingencies 69 kV and above in the project area were evaluated.
- AECI developed corrective plans for all N-1 violations identified.

### Monitoring of Facilities

- AECI monitored all facilities in the KAMO-OK zone and the AEP PSO\_Northern zone 69 kV and above.

**Results**

The simulation results show that in the 2013 Spring case, the Fairfax 138/69 kV transformer overloads for the loss of the Fairfax-Fairfax Tap 138 kV line and the Remington-Fairfax 138 kV line overloads for the loss of the Shidler-W.Pauhuska 138 kV line.

Table 1 below shows the results of the simulations with 136 MW generating at G12-027.

**Table 1: N-1 & N-2 Simulation Results**

	DIS12021TC08G12_027- 13G0_136 Spring 2013	DIS12021TC00G12_027- 13SP0_136 Summer 2013
<b>NORMAL SYSTEM CONFIGURATION</b>		
Osage Wind Generation 0.69 kV Voltage	104.8%	105.0%
Osage Wind 34.5/0.69kV Xfmr #1 Loading	97.7%	98.7%
<b>FAIRFAX-FAIRFAX TAP 138KV CKT #1 OUT</b>		
Fairfax 138/69kV Xfmr #1 Loading	105.8%	97.7%
<b>FAIRFAX-REMINGTON 138KV CKT #1 OUT</b>		
Fairfax T4-Shidler 138kV Ckt 1 Line Loading	61.0%	99.1%
WEBBTAP4 FAIRFXT4 Ckt 1 Line Loading	61.0%	99.0%
<b>SHIDLER-FAIRFAX T4 138KV CKT #1 OUT</b>		
Osage Wind 34.5 kV Voltage	105.1%	104.1%
Osage Wind Generation 0.69 kV Voltage	105.2%	104.3%
Fairfax-Remington 138kV Ckt 1 (75C) Line Loading	88.5%	93.8%
<b>SHIDLER-REMINGTON 138KV CKT #1 OUT</b>		
Osage Wind 34.5 kV Voltage	104.2%	105.1%
<b>SHIDLER-WPAWHUSKA 138KV CKT #1 OUT</b>		
Osage Wind 34.5 kV Voltage	105.1%	104.9%
Osage Wind Generation 0.69 kV Voltage	105.2%	105.1%
Fairfax-Remington 138kV Ckt 1 (75C) Line Loading	106.6%	86.4%
<b>N-2 CONTINGENCIES</b>		
<b>FAIRFAX 138/69 XFMR &amp; FAXTAP-CLEVELAND 138 KV OUT</b>		
Osage Wind 34.5 kV Voltage	104.7%	105.1%
<b>FAIRFAX 138/69 XFMR &amp; FAXTAP-GLENCOE 138 KV OUT</b>		
<i>None</i>		
<b>FAIRFAX T4-SHIDLER-WPAWHUSKA 138 KV LINES OUT</b>		
Fairfax-Remington 138kV Ckt 1 (75C) Line Loading	159.7%	160.0%
Fairfax 138/69kV Xfmr #1 Loading	106.4%	111.5%
<b>GLENCOE-FAXTAP-CLEVELAND 138 KV LINES OUT</b>		
Fairfax 138/69kV Xfmr #1 Loading	104.3%	95.8%

**Mitigation Improvements**

To address the Fairfax 138/69 kV transformer overload, the transformer was increased from a 56 MVA unit to an 84 MVA unit. To address the Remington-Fairfax 138 kV line overload, the line was uprated to 100°C (from 174 MW to 245 MW). The contingency simulations were then run again on the updated models.

Table 2 below shows the results of the simulations without and with the improvements.

**Table 2: N-1 & N-2 Simulation Results without and with Improvements (Case A1)**

	DIS12021TC08G12_027- 13GO_136	DIS12021TC08G12_027- 13GO_136-A1	DIS12021TC00G12_027- 13SPO_136	DIS12021TC00G12_027- 13SPO_136_A1
	Spring 2013	Spring 2013	Summer 2013	Summer 2013
<b>NORMAL SYSTEM CONFIGURATION</b>				
Osage Wind Generation 0.69 kV Voltage	104.8%	104.5%	105.0%	105.1%
Osage Wind 34.5/0.69kV Xfmr #1 Loading	97.7%	97.3%	98.7%	98.7%
<b>FAIRFAX-FAIRFAX TAP 138KV CKT #1 OUT</b>				
Fairfax 138/69kV Xfmr #1 Loading	105.8%	82.3%	97.7%	74.7%
<b>FAIRFAX-REMINGTON 138KV CKT #1 OUT</b>				
Fairfax T4-Shidler 138kV Ckt 1 Line Loading	61.0%	61.0%	99.1%	99.1%
WEBBTAP4 FAIRFXT4 Ckt 1 Line Loading	61.0%	61.0%	99.0%	99.1%
<b>SHIDLER-FAIRFAX T4 138KV CKT #1 OUT</b>				
Osage Wind 34.5 kV Voltage	105.1%	104.9%	104.1%	104.3%
Osage Wind Generation 0.69 kV Voltage	105.2%	105.0%	104.3%	104.5%
Fairfax-Remington 138kV Ckt 1 (100C) Line Loading	88.5%	63.6%	93.8%	67.4%
<b>SHIDLER-REMINGTON 138KV CKT #1 OUT</b>				
Osage Wind 34.5 kV Voltage	104.2%	104.0%	105.1%	105.0%
<b>SHIDLER-WPAWHSKA 138KV CKT #1 OUT</b>				
Osage Wind 34.5 kV Voltage	105.1%	104.9%	104.9%	105.0%
Osage Wind Generation 0.69 kV Voltage	105.2%	105.0%	105.1%	105.2%
Fairfax-Remington 138kV Ckt 1 (100C) Line Loading	106.6%	76.7%	86.4%	62.2%
<b>N-2 CONTINGENCIES</b>				
<b>FAIRFAX 138/69 XFMR &amp; FXTAP-CLEVELAND 138 KV OUT</b>				
Osage Wind 34.5 kV Voltage	104.7%	104.7%	105.1%	105.1%
<b>FAIRFAX 138/69 XFMR &amp; FXTAP-GLENCOE 138 KV OUT</b>				
<i>None</i>				
<b>FAIRFAX T4-SHIDLER-WPAWHUSKA 138 KV LINES OUT</b>				
Fairfax-Remington 138kV Ckt 1 (100C) Line Loading	159.7%	113.0%	160.0%	113.1%
Fairfax 138/69kV Xfmr #1 Loading	106.4%	84.4%	111.5%	87.2%
<b>GLENCOE-FAXTAP-CLEVELAND 138 KV LINES OUT</b>				
Fairfax 138/69kV Xfmr #1 Loading	104.3%	81.1%	95.8%	73.2%

**Cost of Improvements**

The estimated cost for the improvements is shown in Table 3 below.

**Table 3: Cost Estimates of Improvements**

<b>Option / Description</b>	<b>Current Cost (2013 Dollars)</b>
Upgrade Fairfax 138/69 kV transformer to 84 MVA unit	\$1,800,000
Uprate Remington-Fairfax 138 kV line to 100C (10.38 mi)	\$400,000
<b>Total Cost</b>	<b>\$2,200,000</b>

**Assessment**

The results of the n-1 simulations show that the Fairfax 138/69 kV transformer overloads for the loss of the Fairfax-Fairfax Tap 138 kV line and the Remington-Fairfax 138 kV line overloads for the loss of the Shidler-W.Pauhuska 138 kV line. The Fairfax Tap is the point at which the 138 kV line from Fairfax interconnects to the Cleveland to Stillwater 138 kV line.

To address these impacts, the Fairfax 138/69 kV transformer can be upgraded to an 84 MVA unit and the Remington-Fairfax 138 kV line can be uprated to an operating temperature of 100°C with a rating of 245 MW. The estimated cost for these improvements is \$2,200,000.

These results assume the Network Upgrades and affected system network upgrades as identified in the GIA-27 Generator Interconnection on AECI's system are constructed and in service.

The Affected System network upgrades identified in this study can be installed and placed in service within an estimated timeframe of 18 months from the date of execution of an agreement between the Interconnection Customer and Associated or Associated's member G&T, KAMO Power ("KAMO"). Such agreement shall provide for the terms and conditions, under which Associated and/or KAMO will design, engineer, procure and construct the identified network upgrades and also define the Interconnection Customer's responsibility for reimbursement to Associated and/or KAMO for such activities. The timeframe provided should be considered non-binding and subject to change dependent upon Associated and/or KAMO's current construction work-plan and outage coordination.