



***Facility Study for Generation  
Interconnection Request  
GEN-2005-017***

***SPP Tariff Studies  
(#GEN-2005-017)***

**August 2007**

## **Summary**

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Xcel Energy performed the following Facility Study to satisfy the Facility Study Agreement executed by the requesting customer and SPP for SPP Generation Interconnection request Gen-2005-017. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

## **Additional Items**

Per the previously conducted Impact Study, the Customer will be required to buy the proposed G.E. wind turbines with the LVRT II low voltage ride through package to comply with FERC Order #661A. Also, the Customer will be required to install capacitors as specified in the Impact Study.

Due to the generation interconnection queue, this study may require a restudy when previous queued projects that have executed Interconnection Agreements come out of or go into suspension.



**FACILITIES STUDY  
For  
[Omitted Text] Wind Farm**

340 MW Wind-Generated Energy Facility  
Sherman County, Texas  
SPP #GEN-2005-017

August 27, 2007

Xcel Energy Services, Inc.  
Transmission Planning

## Executive Summary

[Omitted Text] Wind Farm (the “Requester” or “Interconnection Customer”) requested the interconnection of a wind energy facility to a Southwestern Public Service Company (SPS) 345 kV transmission line. This facility is a new wind energy generation facility located approximately two miles north of the south county line in Sherman County, Texas, interconnecting to the 345 kV transmission circuit between Potter County Interchange, in Amarillo, TX and Finney Switching Station in southwestern Kansas. The Southwest Power Pool (SPP) evaluated the request to interconnect this 340 MW wind energy facility to the SPS transmission system in a System Impact Study completed January 2007. This wind energy facility will consist of 226 General Electric 1.5 MW wind turbines each, for a total output of 339 MW.

A new switching station will tap the existing Xcel Energy 345 kV transmission circuit J03 between Potter County Interchange and Finney Switching Station. The new switching station will tap this transmission circuit approximately 60 circuit miles from Potter County Interchange. The new switching station will consist of 345 kV ring bus. A 80 MVA 345/115 kV and two 130 MVA, 345/34.5 kV autotransformers will provide the voltage transformation for the connection to the 345 kV ring bus, allowing for the transmission of wind energy from the three customer-owned generator collection stations onto the SPS transmission grid. An additional 345 kV breaker will be required in the Interconnection Customer’s substation. Figure A - 2 shows a one-line diagram of the interconnection facilities.

A Certificate of Convenience and Necessity from the Public Utility Commission of Texas is not required for the construction of the new switching station.

Xcel Energy will require the Interconnection Customer to construct the Interconnection Facilities in compliance with the latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW. Version 3.0 dated Dec. 31, 2006, and is available at [http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1\\_16699\\_24407-1428-0\\_0\\_0-0,00.html](http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_16699_24407-1428-0_0_0-0,00.html). This document describes the technical and protection requirements for connecting new generation to the Xcel Energy operating company transmission system and also includes commissioning, operation, and maintenance guidelines. Xcel Energy will also require that the Interconnection Customer be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issues by the North American Electric Reliability Council, (NERC), Southwest Power Pool, and Federal Energy Regulatory Commission or their successor organizations. The Requester is responsible for the cost of the Requester’s Interconnection Facilities from the Requester’s collection substation to the new SPS switching station.

It is anticipated that the construction of the new switching station, for the acceptance of wind generated electric energy from the Requester’s wind farm, will require approximately 27 months for completion. The commercial in service date request is December 2008. The cost of these upgrades, inclusive of the Requester’s cost for the Interconnection Facilities required for the interconnection of this new wind energy generation facility, is shown below:

Stand-alone Network Upgrade:	\$ 5,175,689
Network Upgrade with default from Table 1:	\$ 4,337,476
Interconnection Facilities <sup>1</sup> :	\$ 288,120
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Total:	\$ 9,801,285

A detailed description of all costs associated with the construction of this new switching station is shown in Table 3.

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<sup>1</sup> This is a direct assigned cost to the Requester.

## Discussion

### General Description of Existing SPS Facilities

The new switching station required to connect the requestor's wind-generated energy facility will be located adjacent to the existing 345 kV transmission line from Potter County Interchange to Finney Switching Station. The new switching station will consist of three breaker 345 kV ring bus design with expansion capability to a breaker and a half configuration. The transmission line will be routed in and out of the new switching station with 345 kV breakers on both lines towards Potter County and Finney. Figure A - 2 shows the interconnection one-line diagram for this wind-generated energy facility.

### General Description of Modifications and New SPS<sup>2</sup> Facilities

1. **Construction of New Switching Station:** See Figure A-2 in Appendix A for one-line diagram.
  - 1.1. **Location:** The new 345 kV switching station will be constructed at the interception point to the Xcel Energy transmission circuit J03, located approximately 2 miles north of the of the south boundary county line of Sherman County, Texas, which is located in T & N.O. RR Company Survey, Block 3-T, section 54. See Figure A - 1 for a location map of the area. There was not any GPS coordinates included with this request.
  - 1.2. **Bus Design:**
    - 1.2.1. The new 345 kV switching station will be built to accommodate the output from the wind energy facility. The new bus design will be a 3-breaker ring with 3 terminals expandable to a breaker and one half design. The terminals will be: One for the tap to the wind farm connection from their substation; a second one for the 345 kV line from the Potter County Interchange; and a third one for the 345 kV line to Finney Switching Station Interchange. The breaker design that is proposed is shown in [Figure A-2](#) in Appendix A.
  - 1.3. **Control House:** The control house will be utilized to house the new metering, protective relaying and control devices, terminal cabinets, and any fiber-optic cable terminations, etc. for the new 345 kV switching station.
  - 1.4. **Line Reactors:** Switchable line reactor will be installed at the new switching station to control high voltage. The reactor will be connected to the 345kV line toward Finney Switching Station (75 MVAR). This reactor was determined through an EMTP study. See Table 1 for other options for the line reactors if either one or both Wind Farms (GEN-2002-008 and GEN-2003-013) are built.
  - 1.5. **Security Fence:** The switching station will have a 7-foot chain-link fence with steel posts set in concrete, with 1-foot of barbed wire on the top in a "V" configuration. The enclosed area will be approximately 800' × 800', with a rock yard surface.

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<sup>2</sup> All modifications to SPS facilities will be owned, maintained and operated by SPS.

- 1.6. **Ground Grid:** A complete ground-grid will be installed per ANSI/IEEE STD 80-2000, with our standard 4/0 copper ground mesh on 40-foot centers with ground rods and 20-foot centers in corners and loop outside of fence.
- 1.7. **Site Grading:** Company contractor, per company specifications, will perform initial site grading and erosion control of the new switching station. Soil compaction shall be not less than 95% of laboratory density as determined by ASTM-D-698.
- 1.8. **Station Power:** A 199 kV/120-240 volt transformer tapped off of the 345 kV bus will provide station power. A backup station power source will be taken from local distribution if it is available or a generator will be installed. An automatic throw over switch to automatically transfer the station power will be installed.
- 1.9. **Relay and Protection Scheme:** The new switching station to the Potter County 345 kV line relaying will be phase comparison unblocking over power line carrier with a Pulsar TFC10B. A SEL 321-1 and a separate segregated phase comparison transmission line protect system with distance backup protection will be used with a leased phone circuit. An SEL 279H-2 with a SEL 351 relay will be used for sync check and re-closing, along with a SEL 501-0 for breaker failure. The new terminal will preserve the existing capability of high speed single pole tripping.

The new switching station to Finney Switching Station 345 kV line relaying will utilize the same type of equipment as that of the Potter County 345 kV line.

On both the Potter County and Finney Switching Station lines there will be three coupling capacitor voltage transformers (CCVT) for line conditions. Line tuning units and wave traps will also be installed for the power line carrier communications.

A transfer trip scheme will be installed such that for any line dropping or fault clearing of either line from the new switching station to Potter County or Finney, the appropriate breaker(s) at the new switching station will be opened first. Additionally, a switching scheme that checks that the appropriate breaker(s) at Potter County or Finney are closed prior to closing any line breaker(s) at the new switching station will also be installed. This is required to avoid reclosing or energizing of these lines from the new switching station as recommended in the results of the EMTP study.

The batteries will be our standard set of 306 or 204 AH Varta batteries with a 35 or 25 amp charger.

At Potter County or Finney, carrier frequencies will need to be changed on the existing wave traps and line-tuning units to maintain carrier frequency separation. Additionally, one line terminal may require changing if compatible relays cannot be located.

Line arresters will be installed at each line termination on the dead-end towers.

- 1.10. **Revenue Metering:** On the 345 kV line to the Interconnection Customer's substation, a billing meter will be installed along with an ION 8600 meter unit, ANSI C12.1

accuracy class 0.2 (3 PTs IEEE C57.13 accuracy class 0.3 and 3 CTs IEEE C57.13 accuracy class 0.15) for full 3 phase 4-wire metering. The metering unit will have 1000/600:1 PTs and 200/400:5 CTs. There will be two meters; one will be primary and the other will be back up, and each will have full 4 quadrant metering. Pulses out of the primary billing meter will be sent via SCADA to the Amarillo Control Center. Metering at this new switching station will be installed to comply with present SPP market protocols.

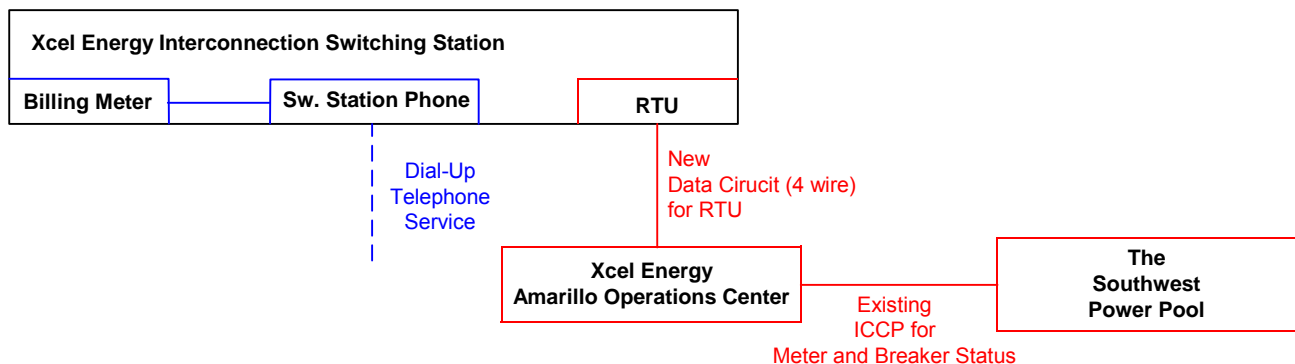
- 1.11. **Disturbance Monitoring Device:** Disturbance-monitoring equipment, capable of recoding faults, swings, and long term trending, will be installed to monitor and record conditions in the substation and on the transmission lines. This equipment will have communication capability with a dedicated communication circuit. The Disturbance equipment shall also be equipped with a GPS time syncing clock.
- 1.12. **Communications:** A high-speed phone circuit will be required between the new switching station and both Potter County Interchange and Finney County substation, which will provide communications for line relaying.

The RTU will be our standard Large 5700 RTU with communications. A SEL 2020 will be installed for relay communications and other functions as required.

Communications from the switching station to the Amarillo Control Center will consist of a 4-wire telephone data circuit provided by the Requester, if it is available. If it is not available, some type of communications will have to be installed, at the Requester's expense, to get the metering data to the Amarillo Control Center, along with the RTU information.

A station telephone will be installed in the control house. A telephone switch will be installed to transfer between the SEL-2020 and the billing meters along with the station talk service.

A schematic outlining the proposed communications is provided below:





## 2. Transmission Line:

The Requester will construct, own, operate, and maintain their new 345 kV transmission lines from the collection stations to the new switching station. The new 345 kV line taps into the new switching station will be owned, operated and maintained by Xcel Energy. ***The Xcel Energy transmission design group will require an engineering review of the customer's design prior to any construction by the Requester or its contractor on the customer owned transmission lines, or doing work in close proximity to any SPS transmission line.***

- 2.1. **345 kV Line Taps:** An existing Xcel Energy overhead 345 kV transmission line (identified as circuit J03) will be tapped by the requestor in the southern portion of Sherman County.

The 345 kV overhead 3-phase lines will utilize double 795-kCMIL conductors per phase in vertical bundle configuration. Two ½" extra high strength steel static wires will provide necessary shielding to the line. The line will be supported by wooden H-frame tangent (in-line structures) and self-supporting steel structures for the angles, corners, and terminations of the line.

The section of existing 345 kV line between these two tap points will be removed such that power flows in and out of the proposed substation.

***It is the Requester's responsibility to initiate the design review in a timely manner before construction of any 345 kV transmission line. If the review has not been made or the 345 kV design is deemed inadequate, the termination into the new switching station will be delayed until the matters are resolved. Xcel Energy will not be held responsible for these delays.***

## 3. Right-Of-Way:

- 3.1. **New 345 kV Transmission Line Taps:** Each of the 345 kV transmission line taps will require a 150' wide right-of-way, 75' each side of the power line centerline.

- 3.2. **Permitting:** Currently, permitting for the switching station construction is not required in the State of Texas, and the short 345 kV lines into the new switching facility do not require permitting due to their length.

- 3.3. **Switching Station Location:** The new switching station will be constructed adjacent to the existing 345 kV transmission circuit J-03. SPS will provide the Interconnection Customer with easement detailing the metes and bounds description for the required real estate. The Interconnection Customer will obtain all necessary signatures from landowner(s) for the easement needed on the land where the new SPS switching station will be built.

4. **Construction Power and Distribution Service:** It is the sole responsibility of the Requester to make arrangements for both construction and station power which may be required for the Requester's wind energy facility. **Additionally, if the Requester's substation(s) and/or construction site(s) lie outside of the Xcel Energy service area, Xcel Energy cannot**

provide station power (retail distribution service) and the Requester needs to make arrangements for distribution service from the local retail provider.

**5. Project and Operating Concerns:**

Close work between the Transmission group, the Requester’s Personnel and local operating groups will be imperative to have this project in service on the scheduled date.

**6. EMTP Study Results:**

As a final analysis, an EMTP<sup>3</sup> study was performed to investigate over voltage and insulation coordination of the proposed modification to the 345 kV transmission circuit. Also, included in the study were two other wind projects that are in suspension, GEN-2002-008 and GEN-2003-013. The results of the study analyzed both wind projects coming off suspension and being built; either one of the two coming off suspension and being built and neither one coming off suspension and not being built. Depending on which scenario happens will determine what sizes of line reactors are required and their location. If both are built, a 50 MVAR SVC will need to be installed at GEN-2002-008. The existing fixed line reactors at both the Finney Switching Station and Potter County Interchange can remain at the present location. See Table 1 for a description of the Scenarios.

**Table 1: Scenarios for GEN-2005-017**

Scenario	Line Reactors/Static Var Compensators to be installed	Estimated Cost
GEN-2002-008 and GEN-2003-013 come off of suspension and are both built.	<ul style="list-style-type: none"> <li>• 25 MVAR Line Reactor to be installed at GEN-2005-017</li> <li>• 115 kV, 50 MVAR SVC to be installed at GEN-2002-008</li> </ul>	\$ 2,991,252 \$ 6,500,000
GEN-2002-008 comes off suspension; GEN-2003-013 does not.	<ul style="list-style-type: none"> <li>• 27 MVAR Line Reactor to be installed at GEN-2005-017</li> <li>• 50 MVAR Line Reactor to be installed at GEN-2002-008</li> </ul>	\$ 2,991,252 \$3,392,164
GEN-2003-013 comes off suspension; GEN-2002-008 does not.	<ul style="list-style-type: none"> <li>• 30 MVAR Line Reactor to be installed at GEN-2005-017</li> <li>• 27 MVAR Line Reactor to be installed at GEN-2003-013</li> </ul>	\$ 3,124,889 \$ 2,991,252
GEN-2002-008 and GEN-2003-013 both do not come off suspension ( <b>Default, See Table 3</b> ).	<ul style="list-style-type: none"> <li>• 75 MVAR Line Reactor to be installed at GEN-2005-017</li> </ul>	\$ 3,793,075

<sup>3</sup> Electromagnetic Transient Program

7. **Fault Current:** The available fault current on the 345 kV bus at this new switching station location, without any contribution from the wind farm, is shown in Table 2.

**Table 2, Available Fault Current At Switching Station 345kV Bus**

Table 2: Short Circuit Information			
Fault Location	Fault Location		Impedance (p.u $\Omega$ ) <sup>4</sup>
	Line-to-Ground	3-Phase	
New Switching Facility 345 kV Bus	2,725	3,800	$Z^+$
			$Z^0$
			0.0033 + j 0.0439
			0.0222 + j 0.0946

**8. Estimated Construction Costs:**

The projects required for the interconnection of the 340 MW wind energy generating facility consist of the projects summarized in the table below based on the other two wind projects (GEN-2002-008 and GEN-2003-013) staying on suspension:

**Table 3, Required Interconnection Projects**

Project	Description	Estimated Cost
	<b>Stand-alone Network Upgrade</b>	
1	Ring Bus, 345 kV	\$ 5,075,689
2	Right-of-Way Cost (station land, surveying, etc.)	\$ 100,000
	<b>Subtotal:</b>	<b>\$ 5,175,689</b>
	<b>Network Upgrade</b>	
3	Relay Modifications, Potter County and Finney Station	\$ 240,000
4	345 kV Transmission Line Work	\$ 304,401
5	75 MVAR Line Reactor ( <b>Default from Table 1</b> )	\$ 3,793,075
	<b>Subtotal:</b>	<b>\$ 4,337,476</b>
	<b>Transmission Owner's Interconnection Facilities<sup>5</sup> (at the Requester's Expense)</b>	
6	Communications <sup>6</sup>	See footnote
7	Remote Terminal Unit (RTU)	\$ 54,120
8	Revenue metering	\$ 234,000
	<b>Subtotal:</b>	<b>\$ 288,120</b>
	<b>Interconnection Customer's Interconnection Facilities (at the Requester's Expense)</b>	
9	345 kV Breaker (required by transmission owner)	
	<b>Total Cost:</b>	<b>\$ 9,801,285</b>

<sup>4</sup>  $Z^+$  – Positive Sequence Impedance in p.u on a 100 MVA base

$Z^0$  – Zero Sequence Impedance in p.u on a 100 MVA base

<sup>5</sup> This is a direct assigned cost to the Requester.

<sup>6</sup> It is the Requester's responsibility to provide both the data circuit and both dial-up telephone circuits, see Section 1.13.





## Appendix A

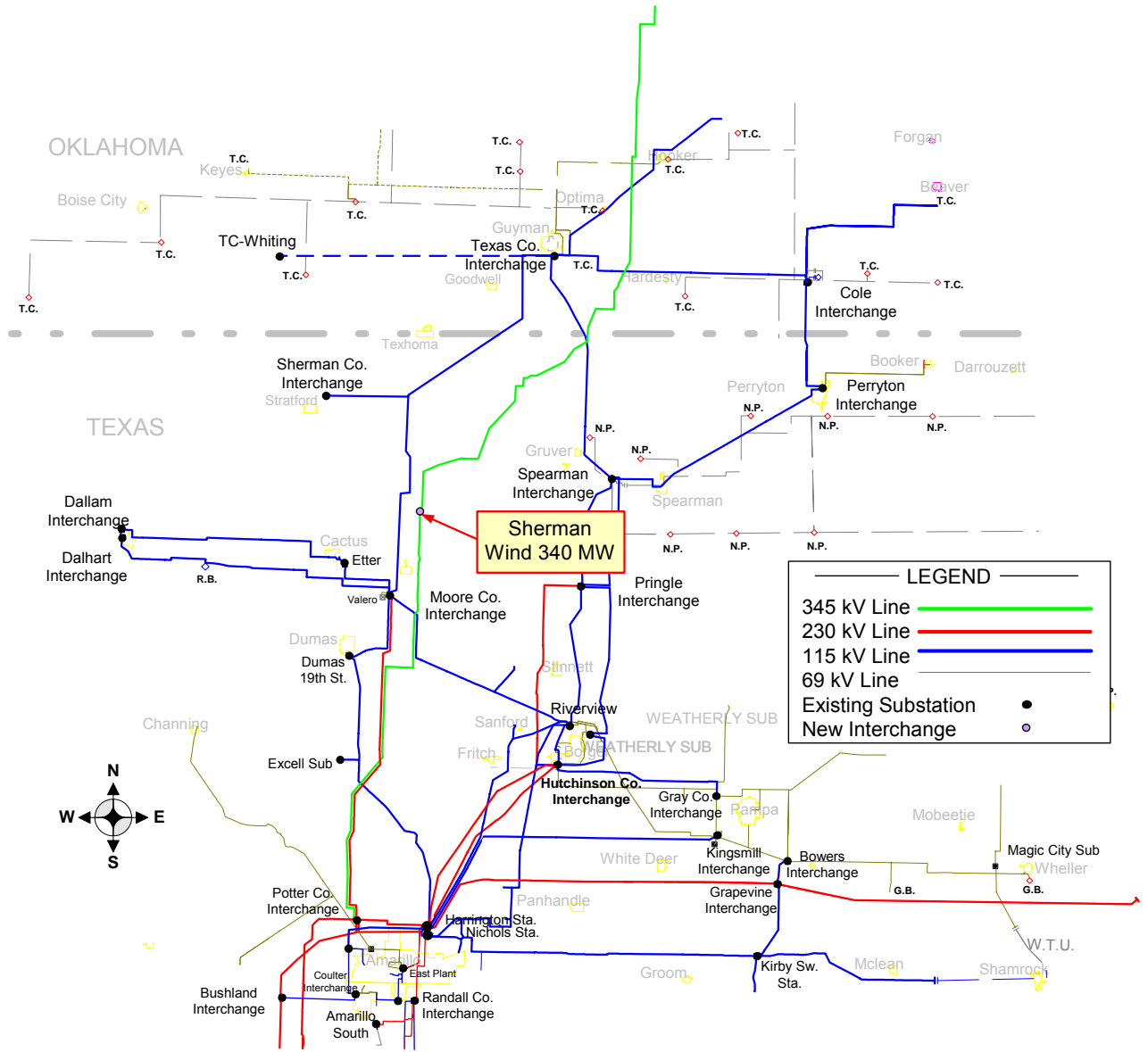
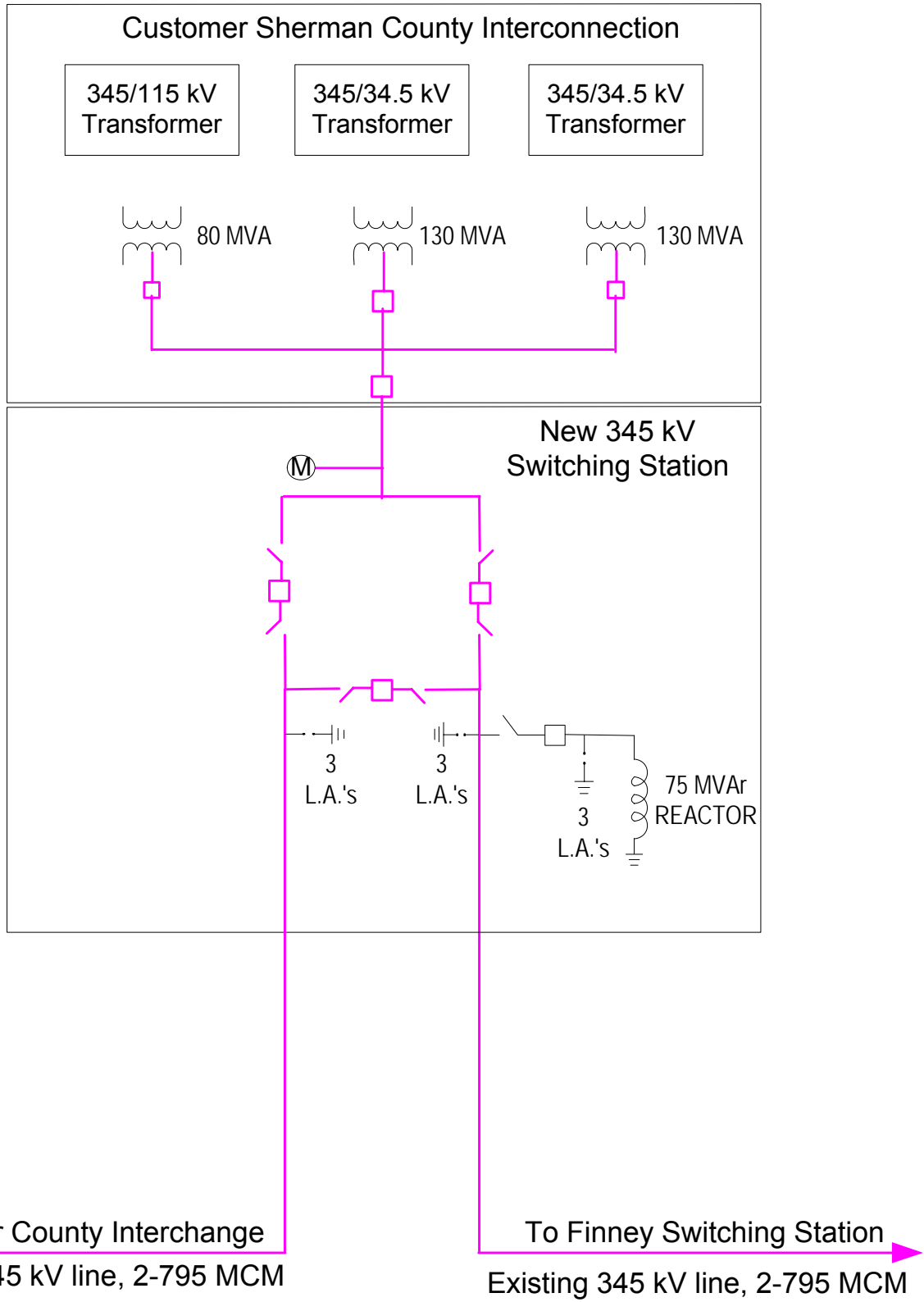


Figure A - 1 Proposed Interception Point to the Xcel Energy 345 kV Circuit J03



**Figure A - 2 Switching Station and Interconnection One-Line Diagram based on the Default Scenario shown in Table 1.**