



***Facility Study for Generation  
Interconnection Request  
GEN-2005-021***

***SPP Tariff Studies  
(#GEN-2005-021)***

**January, 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-2005-021. 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.

Due to the G.E. wind turbines being used, the Customer will not need to install a Static Var Compensator (SVC). However, the Customer will be required to install a 34.5kV, 12Mvar capacitor bank in the Customer substation in order to accommodate losses on the wind turbine feeder collector system.



**Facilities Study For  
[Customer]**

85.5 MW Wind-Generated Energy Facility  
Donley and Gray Co, Texas  
SPP #GEN-2005-021

December 7, 2006

Xcel Energy Services, Inc.  
Transmission Planning

## Executive Summary

[Omitted Text] (“Interconnection Customer”) has requested the interconnection of a wind energy facility located in Donley and Gray Counties to the Southwestern Public Service Company (SPS) (d/b/a Xcel Energy, Inc.) 115 kV transmission system. This facility will interconnect into the existing 115 kV bus at Kirby Switch Station located approximately 20 miles south of Pampa, Texas. The Southwest Power Pool (SPP) evaluated the request to connect this wind energy facility to the SPS transmission system in a System Impact Study completed September 2006. This connection request was studied using fifty-seven (57) individual GE 1.5 MW wind turbine generators for a total of 85.5 MW. The Interconnection Customer’s requested in-service date for commercial operation date is July 15, 2007, with feedback date to customer by February 15, 2007.

The facilities required for interconnection of this wind farm include the construction of approximately ten (10) miles of new 115 kV transmission line from the Interconnection Customer wind farm facility to the new 115kV breaker line terminal at Kirby Switching Station.

Xcel Energy will require that all construction for this request be in compliance with the latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW, Version 2.0 dated Jan. 20, 2004, 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 requirements for connecting new generation to the Xcel Energy operating company transmission systems including technical, protection, commissioning, operation, and maintenance. Xcel Energy will also require that the Interconnection Customer be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Council (NERC), Southwest Power Pool, and the Federal Energy Regulatory Commission or their successor organizations.

The Interconnection Customer is responsible for the cost of the Interconnection Facilities and any Direct Assigned Interconnection Facilities, including construction of the 115 kV transmission line from the Interconnection Customer’s substation to the switching station.

It is anticipated that the construction of a new line terminal at the switching station, for the acceptance of wind generated electric energy from the Interconnection Customer’s Wind Farm, will require approximately eleven (11) months for completion from the day an interconnection agreement is signed and after all internal approvals, unless prior arrangements have been made. The cost of these upgrades, inclusive of the Interconnection Customer’s cost for the Interconnection Facilities required for the connection of this new wind energy generation facility, is shown below. See [Table 2](#) for a detail description of all the costs.

<b>Upgrade</b>	<b>Cost</b>
Network Upgrade:	\$ 75,000
Interconnection Facilities <sup>1</sup> :	\$ 475,122
<b>Total:</b>	<b>\$ 550,122</b>

<sup>1</sup> Direct Assigned Cost To Interconnection Customer

## Discussion

A new 115 kV breaker line terminal is required for the interconnection of the customer's wind-generated energy facility and it will be located at the existing 115 kV bus at Kirby Switching Station. The Interconnection Customer will connect their 115 kV transmission line from the wind farm's substation to the new line terminal at SPS's Kirby Switching Station.

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

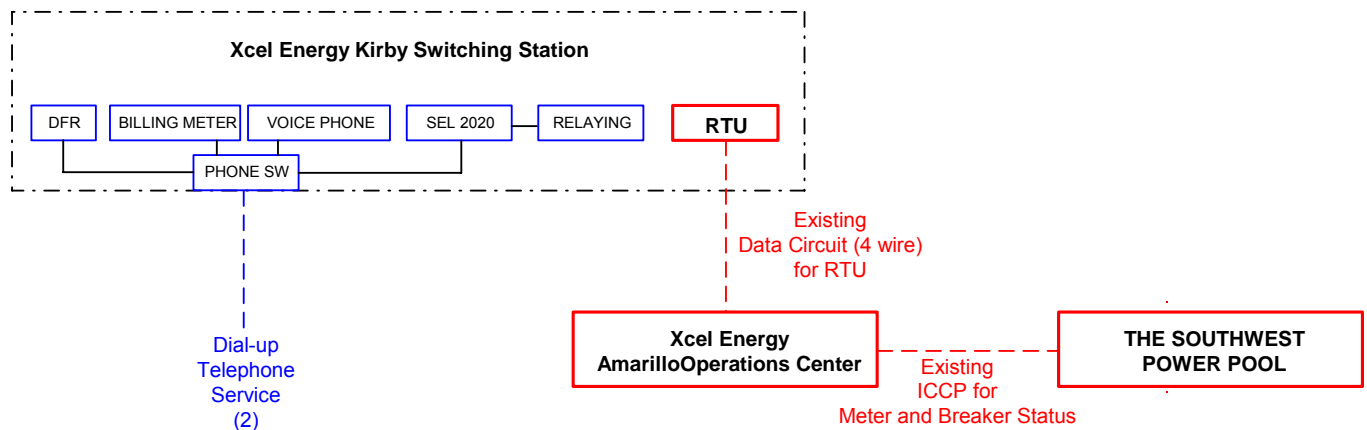
1. **Construction of a new Line Terminal at Kirby Switching Station:** See [Figure A-2](#) in [Appendix A](#) for one-line diagram and [Figure A-3](#) for a plan view of the station.
  - 1.1. **Location:** Kirby Switching Station is located approximately 20 miles South of Pampa, Texas and 8.5 miles East of State Highway 70 on FM 2477 in Gray County, Texas. See [Figure A-1](#) for a map of the local transmission system.
  - 1.2. **Bus Design:**
    - 1.2.1. The new 115 kV line terminal will be built to accommodate the output from the wind energy facility. The existing bus design at Kirby Switch Station is a straight bus design with no transfer bus and has four existing 115KV breakers. The new 115 kV line terminal proposed is shown in [Figure A-2](#) in Appendix A.
  - 1.3. **Control House:** The existing 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 115kV line breaker terminal.
  - 1.4. **Line Reactors:** None.
  - 1.5. **Security Fence:** Expansion of the existing fence at Kirby Switch Station is not required.
  - 1.6. **Ground Grid:** The switch station has an existing ground grid installed per previous versions of ANSI/IEEE STD 80 and will be extended to cover the new facilities.
  - 1.7. **Site Grading:** Company contractor, per company specifications, will perform any site grading and erosion control to accommodate the new line terminal. Soil compaction shall be not less than 95% of laboratory density as determined by ASTM-D-698.
  - 1.8. **Station Power:** The existing station power, provided from the local distribution system, will be utilized.
  - 1.9. **Relay and Protection Scheme:** The new 115kV line terminal to the customer owned line would be step distance relaying. An SEL 321-1 and an SEL 311-C will be used. An SEL 292H-2 will be installed; however no automatic re-closing scheme will be

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

used. The SEL 292H-2 will be used for line/bus re-closing conditions and sync check with supervisory closing of the 115kV breaker. Finally, a SEL-501-0 will also be installed for breaker failure.

- 1.10. **Revenue Metering:** On the 115 kV line to the Interconnection Customer’s substation, a billing meter will be installed along with an ION 8400 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 will utilize new CT/PT combo metering class equipment. 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 recording 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 using a new communication circuit. The disturbance equipment will have separate dial-up communications telephone circuit. The disturbance equipment shall also be equipped with a GPS time syncing clock. ***It is the Interconnection Customer’s responsibility to make arrangements with the local phone company to provide a new telephone circuit to the disturbance-monitoring device. Prior to any construction the Interconnection Customer is required to contact the Xcel Energy substation-engineering department for all details.***
- 1.12. **Communications:** The existing RTU will be utilized with communications. An SEL 2020 will be installed for relay communications and other functions as required. A diagram outlining the proposed communications is provided below:



## 2. Transmission Line:

The Interconnection Customer will construct, own, operate, and maintain the new customer owned 115 kV transmission line from the Interconnection Customer’s 115/34.5 kV substation to SPS Kirby Switching Station. [Figure A-4](#) shows the Point of Connection and Change of Ownership. ***The Xcel Energy transmission design group will require an engineering review of the Interconnection Customer’s transmission line design prior to any***

**construction by the Interconnection Customer or its contractor on the customer owned 115 kV transmission line or doing work in close proximity to any SPS transmission line, will require an engineering review in a timely manner before construction of the 115 kV transmission line begins. If the review has not been made or the design at any of the aforementioned locations is deemed inadequate, the crossing(s) and or termination into the existing switching station will be delayed until the matters are resolved. Xcel Energy will not be held responsible for these delays.**

- 2.1. **Termination Structure:** The Requester's 115kV line termination structure located outside Kirby Switch Station will require final approval from the Xcel Energy Transmission Design Group. This is to assure, but is not limited to, the maintaining of proper clearance on the slack span from the termination structure into the substation. The Requester is required to terminate their 115kV transmission line at Kirby Switch Station. See [Figure A-4](#), which shows the Point of Interconnection and Change of Ownership.
  - 2.2. **Crossing Structure:** In the event that a joint crossing structure is necessary, the Interconnection Customer shall build per Xcel Energy specifications to provide proper clearance between SPS 115kV line from Kirby to W.T.U Shamrock sub (T54) and the Interconnection Customer owned 115 KV transmission line. The Interconnection Customer shall be responsible for the cost of building the structure. An Xcel inspector will have final authority on whether proper clearance has been maintained.
  - 2.3. **Distribution Line Crossings:** Proper clearance shall also be maintained above any Xcel Energy owned distribution circuit that will be crossed. An Xcel Energy inspector will have final authority on whether proper clearance above these circuits has been maintained.
3. **Right-Of-Way:**
    - 3.1. **Permitting:** Permitting for the construction of the new line terminal is not required from the Public Utility Commission in the State of Texas.
  4. **Construction Power and Distribution Service:** Both construction and station power, in addition to any distribution service required for the Interconnection Customer's wind-generated energy facility, are the sole responsibility of the Interconnection Customer. **Xcel Energy, Inc. cannot provide station power (retail distribution service) for the Interconnection Customer's substation if the location of the Interconnection Customer's substation lies outside of the Xcel Energy service area.**
  5. **Project and Operating Concerns:** Close work between the SPS Transmission Design Group, the Interconnection Customer's personnel, and local operating groups will be imperative to have this project in service on the scheduled date.

6. **Fault Current:** The available fault current at the 115kV interconnection location, without any contribution from the wind farm, is shown in [Table 1](#).

<b>Table 1: Short Circuit Information</b>				
Fault Location	Fault Current (A)		Impedance (p.u $\Omega$ ) <sup>3</sup>	
	Line-to-Ground	3-Phase	Z <sup>+</sup>	Z <sup>0</sup>
Existing Facility 115 kV Bus	3,800	4,450	0.0204 + j0.1102	0.0214 + j0.1662

This study does not simulate the exact fault contribution due to the specific wind turbines when checking existing breaker interrupting levels. A fault study was run assuming a gas turbine of equal size to the wind plant and no circuit breakers had fault currents above their ratings. Based on this, the fault contribution of the wind farm is not expected to over stress the fault capability of the breakers.

**Estimated Construction Costs:**

The projects required for the interconnection of the 85.5 MW wind energy generating facility consist of the projects summarized in [Table 2](#) shown below:

<b>Table 2: Required Interconnection Projects</b>		
Project	Description	Estimated Cost
<b>Network Upgrade</b>		
1	Disturbance Monitoring Device <sup>4</sup>	\$ 75,000
2	115 kV Transmission Line Work	None
	<b>Subtotal:</b>	<b>\$ 75,000</b>
<b>Interconnection Facilities (at the Interconnection Customer's Expense)</b>		
3	Communications <sup>4</sup>	See footnote
4	115 kV Breaker Line Terminal	\$ 411,994
5	Revenue metering <sup>6</sup>	\$ 53,628
6	115 kV Arresters	\$ 9,500
	<b>Subtotal:</b>	<b>\$ 475,122</b>
<b>Total Cost:</b>		<b>\$ 550,122</b>

These costs were estimated using 2006 costs (2006 dollars), with no AFUDC<sup>5</sup> added, with an estimated accuracy of  $\pm 20\%$ .

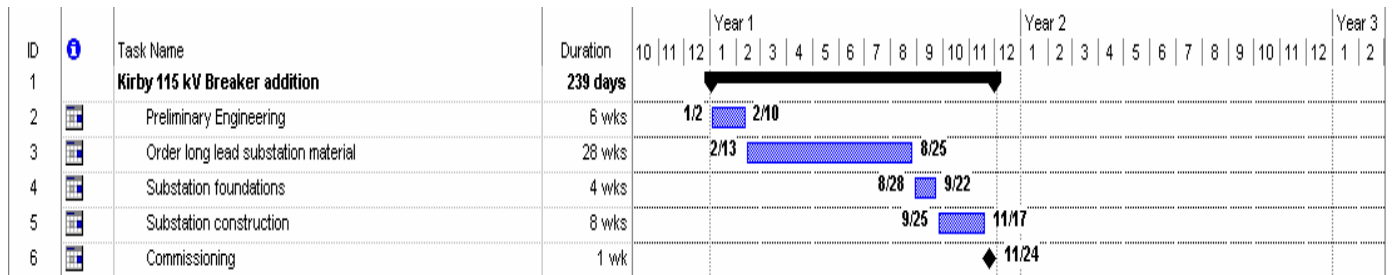
<sup>3</sup> Z<sup>+</sup> – Positive Sequence Impedance in p.u on a 100 MVA base  
<sup>4</sup> Z<sup>0</sup> – Zero Sequence Impedance in p.u on a 100 MVA base  
<sup>5</sup> It is the Requesters responsibility to provide the dial-up telephone circuit, see Section 1.11.  
<sup>6</sup> AFUDC - Allowance for Funds Used During Construction.  
<sup>7</sup> Includes CT/PT combo Units/Meters/Communication



**As of the date of this report, this project has not been granted internal management approval by Xcel Energy, nor has the necessary construction resource planning been performed. The required approval process and construction resource planning may impact this project’s feasible in-service date.**

**7. Engineering and Construction Schedule:**

An engineering and construction schedule for this project is depicted below and is estimated at approximately 11 months. The schedule is shown for project duration purposes only and other factors associated with clearances, equipment delays and work schedules could cause additional delays. The schedule below is applicable after all required agreements are signed and internal approvals are granted.



All additional cost for work not identified in this study is the sole responsibility of the Interconnection Customer unless other arrangements are made.

# Appendix A

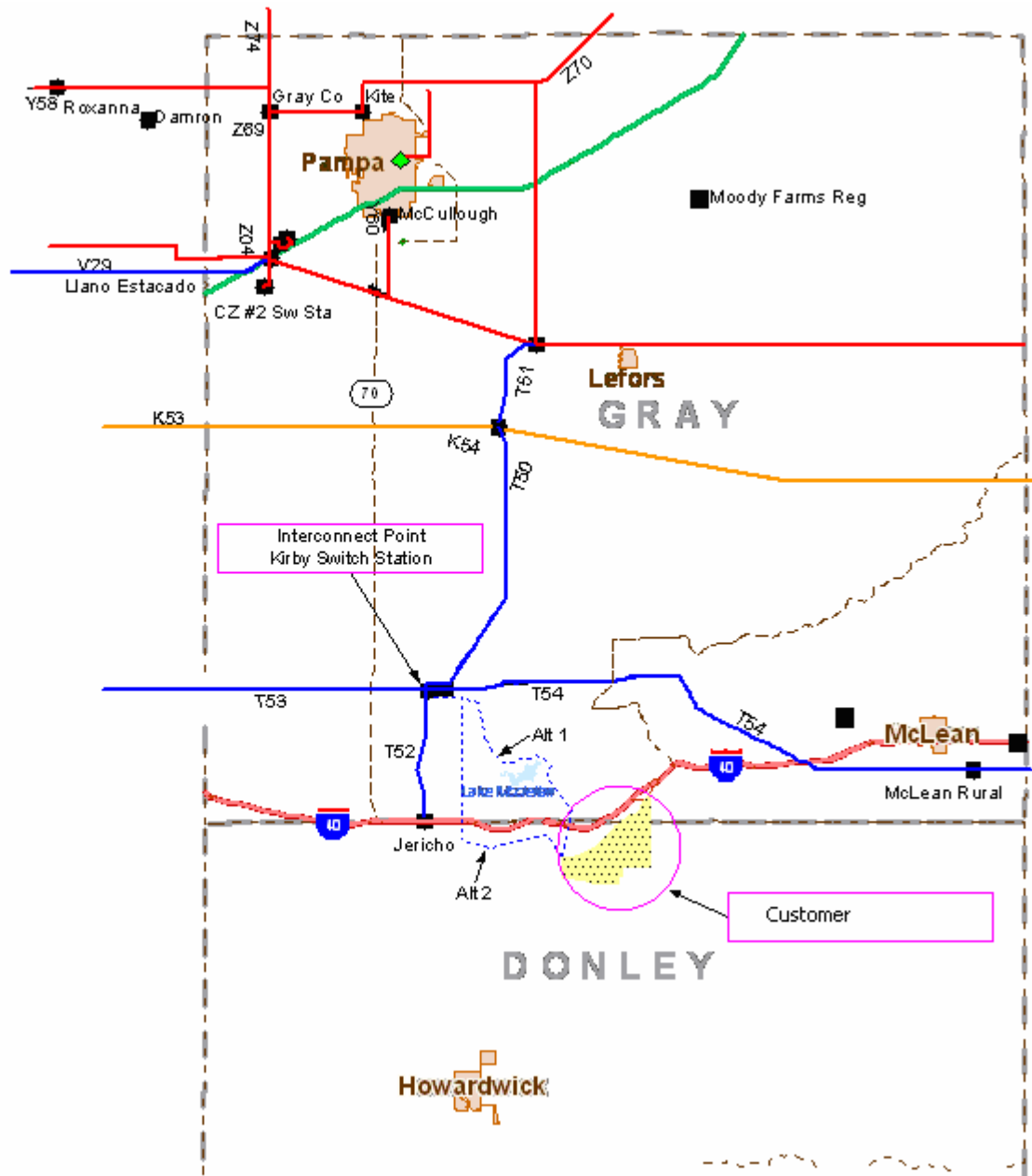
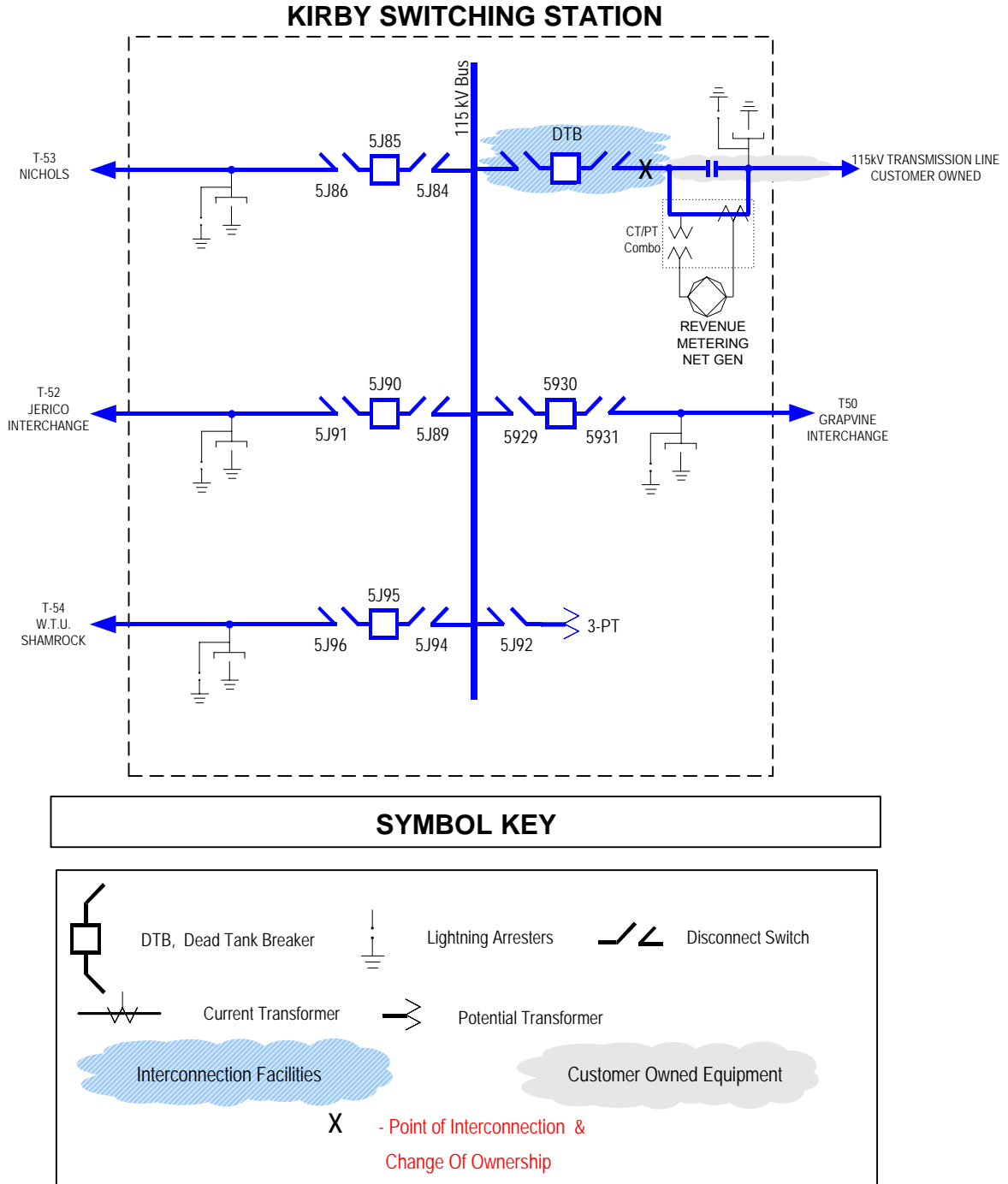


Figure A-1. Proposed Interconnection Point to the Xcel Energy 115 kV Kirby SW Station



**Figure A - 2. One-line diagram for new 115 kV Line Terminal for Trew Ranch Wind Farm at Kirby Switching Station in Donley and Gray Counties.**

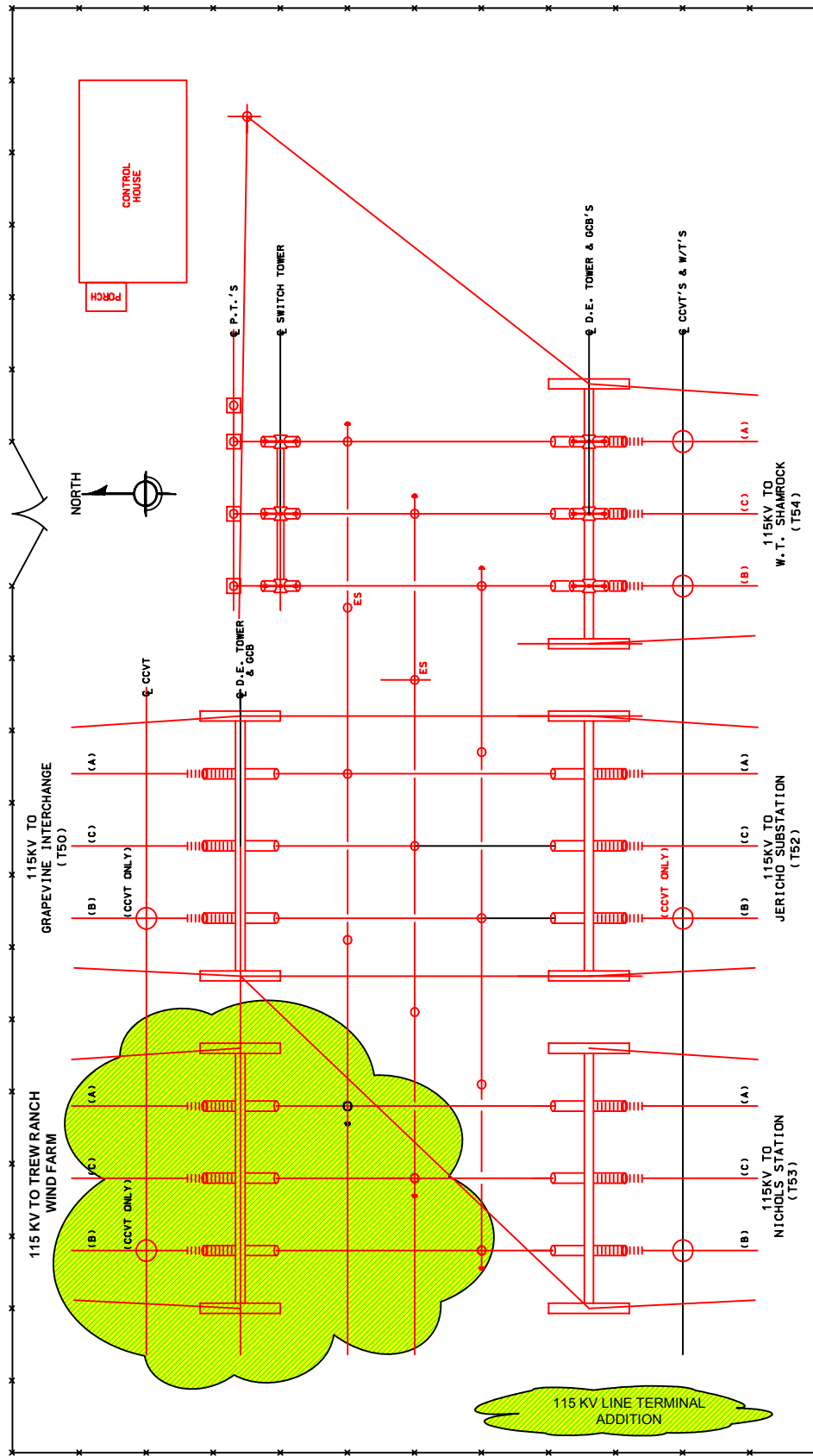
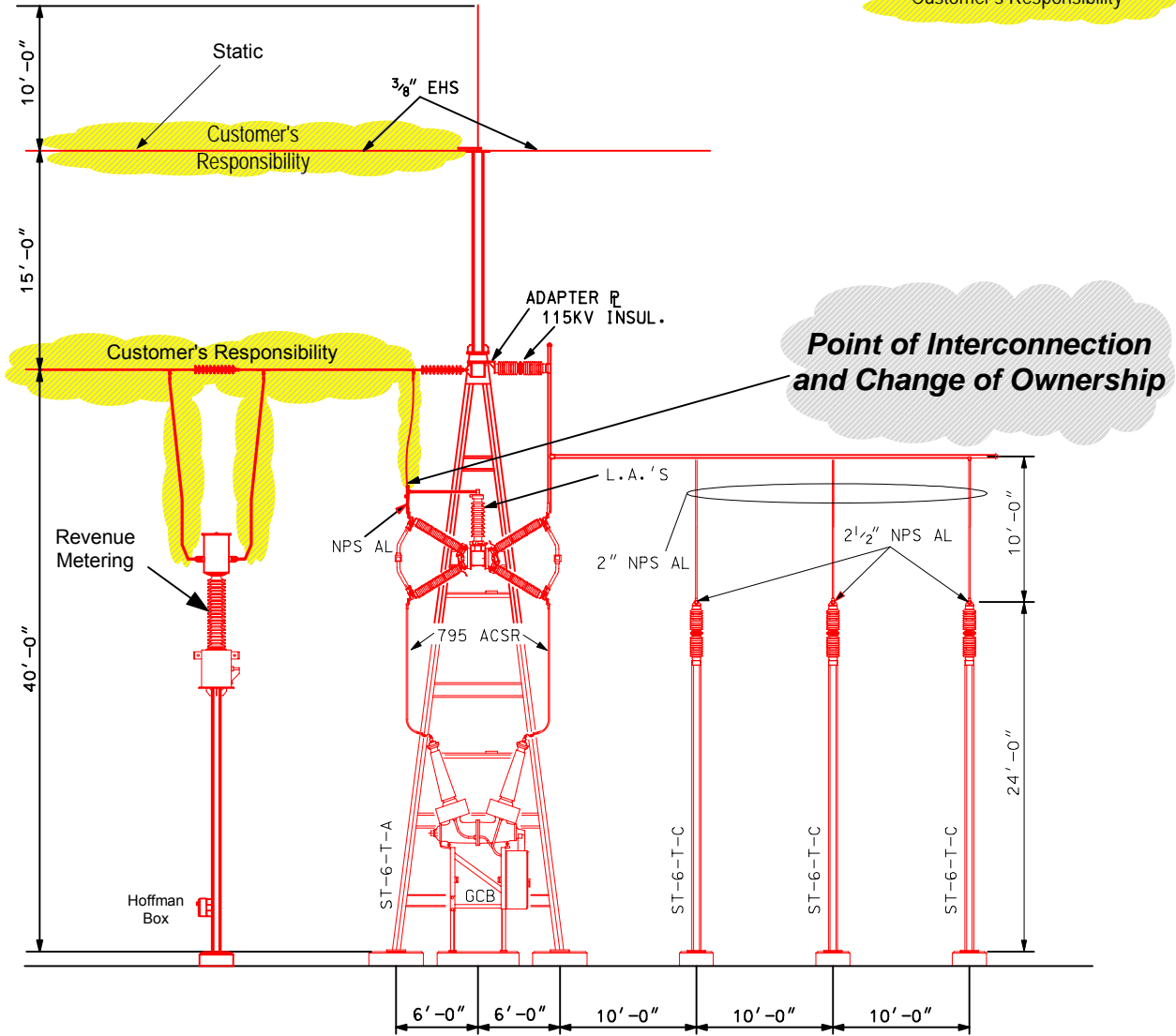


Figure A-3. Site Layout 115kV Kirby Switching Station.

**CUSTOMER SHALL PROVIDE ALL MATERIAL FOR DEAD ENDING PHASES AND STATIC TO 115 KV DEAD END TOWER.**

Customer's Responsibility



**Figure A-4. Point of Interconnection & Change of Ownership.**