SPP Southwest Power Pool

Facility Study for Generation Interconnection Request GEN-2004-003

SPP Tariff Studies

#GEN-2004-003

December, 2005

Summary

Xcel Energy performed the following Study at the request of the Southwest Power Pool (SPP) for Generation Interconnection request GEN-2004-003, a Wind Farm in Carson County, Texas. 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.

Pursuant to the tariff, Xcel Energy was asked to perform a detailed Facility Study of the generation interconnection request to satisfy the Facility Study Agreement executed by the requesting customer and SPP.

Selective Impact Re-Study by SPP

Stability Analysis

During the course of the performing of the Facility Study, the decision was made to construct the Interconnection substation as a four breaker ring bus in the 115kV transmission line that runs from Nichols to Kirby. In doing so the Nichols-Kirby 115kV transmission line will now be broken up into two separately relayed transmission lines. This development caused the need for a selective re-study of the impact study results.

The original impact study dated May, 2005 analyzed the loss of the Nichols-Kirby 115kV transmission line which resulted in the Wind Farm being dropped by this contingency (along with the load at the Conway and Yarnell substations). The proposed Facility study configuration will now break this line up into two lines. The new configuration was restudied for the loss of the Wind Farm-Kirby transmission line and for the loss of the Wind Farm-Nichols transmission line. The results are listed below.

Season	Contingency	Result
2009 Summer Peak	3 phase Fault on the Kirby 115kV bus for 5 cycles; followed by tripping the Wind Farm to Kirby 115kV line. After 20 cycles, reclose the line into the fault for 5 cycles. After 5 cycles, trip and lockout the line.	Wind Farm stays on-line. System is stable.
2009 Summer Peak	3 phase Fault on the Nichols 115kV bus for 5 cycles; followed by tripping the Wind Farm to Nichols 115kV line. After 20 cycles, reclose the line into the fault for 5 cycles. After 5 cycles, trip and lockout the line.	Wind Farm trips off-line. System is stable.

The results show that dividing the line into two separate lines does not materially impact transmission system reliability.

Facility Analysis

An item that was addressed in the Feasibility Study but was not re-addressed in the Impact Study is possible need for additional facilities in order to export power from the Wind Farm. The Feasibility Study acknowledged the lack of transmission facilities and noted the Wind Farm would be limited to 180MW without the rebuilding of the Nichols-Kirby 115kV transmission line. The original Impact Study did not address these concerns, but they are still valid. The Customer has requested Energy Resource Interconnection service. Without re-conductoring the 115kV transmission line from Nichols-Kirby, the maximum amount of Energy Resource Interconnection Service available is 180MW on an "As Available" basis. This and any other Network Constraints would be determined with a transmission service request.

Facilities Study For
[Omitted Text] Wind Power

240 MW Wind-Generated Energy Facility
Carson County, Texas
SPP #GEN-2004-003

December 16, 2005

Xcel Energy Services, Inc.
Transmission Planning

Executive Summary

[Omitted Text] ("Interconnection Customer") has requested the connection of a wind energy facility to the Southwestern Public Service Company (SPS) (d/b/a Xcel Energy, Inc) 115kV transmission system in the vicinity of Conway Substation. This facility will connect to a new 115kV switching station located adjacent and to the west of Conway Substation, which is located approximately 23 miles east of Amarillo, TX. 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 in May 2005. This connection request was studied using 160 1.5MW GE wind turbine generators (240 MW) with the first generation low voltage (LVRT) ride through package. The proposed in-service date is December 2006.

The Interconnection Customer requested the location of the connection to be in the vicinity of Conway Substation. The new 115 kV switching station will be adjacent to Conway Substation. The new 115 kV Conway Switching Station will be a 4-breaker ring configuration to facilitate the connection of the wind farm.

The Interconnection Customer will build, own and maintain the 115 kV line from the wind farm's substation to the new 115 kV Switching Station. Xcel Energy will require the Interconnection Customer to construct the Connection Facilities in compliance with the latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW. 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 (SPP), and Federal Energy Regulatory Commission (FERC) or their successor organizations.

The Interconnection Customer is responsible for the cost of the Interconnection Facilities and any Direct Assigned Interconnection Facilities; inclusive of all construction required for the 115 kV transmission line from the Interconnection Customer's substation to the Switching Station.

It is anticipated that the construction of the new switching station, for the acceptance of wind generated electric energy from the Interconnection Customer's Wind Farm, will require approximately 14 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.

Stand-alone Network Upgrade:	**$ 1,944,021**
Network Upgrade:	**$ 281,842**
Interconnection Facilities [1]:	**$ 76,903**
Total:	**$ 2,302,766**

[1] Direct Assigned Cost To Requester

Discussion

A new switching station is required to connect the Interconnection Customer's wind-generated energy facility and it will be located adjacent to the existing 115 kV transmission line and Conway Substation. The new switching station will consist of four 115 kV breakers in a ring bus configuration. The existing transmission line will be routed in and out of the new switching station. A 115 kV bus will be built from Conway Substation to the switching station. The Interconnection Customer will connect their 115 kV transmission line from the Wind Farm's Substation to Conway Switching Station.

General Description of Modifications and New SPS[2] Facilities

1. **Construction of New 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:** The new 115 kV Switching Station is located on the west side and adjacent to Conway Substation. Conway Substation is located approximately 23 miles east of Amarillo, Texas in the northeast corner of Section 75, Block 2, T.T.R.R. Co. Survey, Carson 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 Switching Station will be built to accommodate the output from the wind energy facility. The new bus design will be a 4-breaker ring with 4 terminals expandable to a breaker and one half. The will be four terminals. One for the tap to the Conway Substation, second one for the wind farm connection from their substation, third one for the 115 kV line from Nichols and the fourth one for the 115 kV line to Kirby Interchange. The new 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 115 kV Switching Station.

   1.4. **Line Reactors:** None.

   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.

   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.

[2] All modifications to SPS facilities will be owned, maintained and operated by SPS.

1.8. **Station Power:** A 66kV/120-240 volt transformer tapped off of the 115 kV bus will provide station power. A backup station power source will be taken from local distribution. Additionally, a flip-flop to automatically transfer the station power will be installed.

1.9. **Relay and Protection Scheme**: The new switching station to the Nichols Interchange 115 kV line relaying will be directional comparison blocking (DCB) over power line carrier with a Pulsar TC10B. A SEL 321-1 (DCB) and a SEL 311-C (step distance) will be used. A SEL 279H-2 relay will be used for reclosing and a SEL 501-0 will be used for breaker failure.

The new switching station to Kirby Interchange 115 kV line relaying will utilize the same type of equipment as that of the Nichols Interchange 115 kV line.

The new switching station to the Interconnection Customer's owned line relaying will be step distance. A SEL 321-1 and a SEL 311-C will be used. A SEL 279H-2 relay will be installed; however there will not be any automatic reclosing. The SEL 279H-2 will be used for line/bus conditions and sync check along with supervisory closing of the breaker. A SEL 501-0 will be used for breaker failure.

Two sets of 115 kV PTs will be installed on the north and south buses with disconnect switches. There will be a provision made for an automatic throw-over of the PTs. A manual transfer switch will be available for maintenance purposes.

On both the Nichols Interchange and Kirby Interchange lines there will be CCVT's for line conditions. Line tuning units and wave traps will also be installed for the power line carrier communications.

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

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 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 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 with a dedicated communication circuit. The Disturbance equipment shall also be equipped with a GPS time synching clock.

1.12. **Communications:** A high-speed phone circuit will be required between the new switching station and both Nichols Interchange and Kirby Interchange, which will provide communications for line relaying.

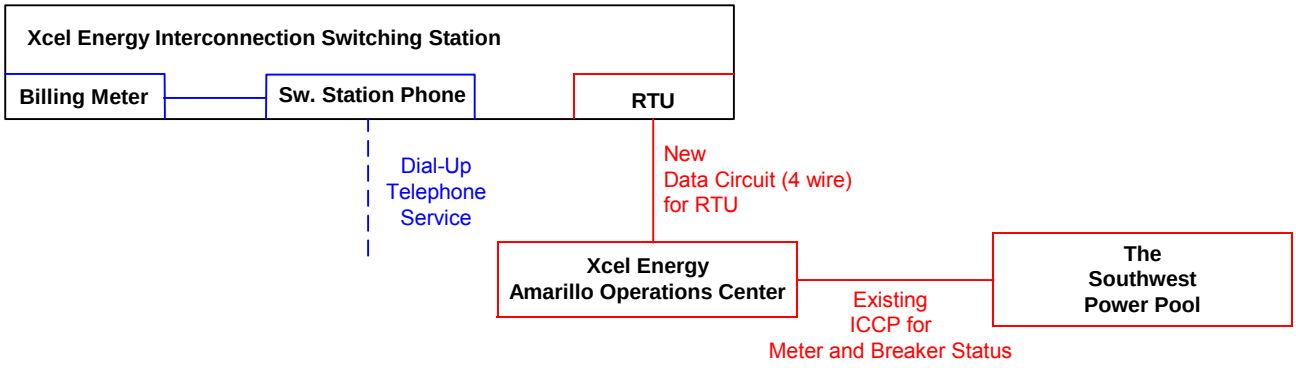
The RTU will be our standard large 5700 RTU with communications. An SEL 2020 will be installed for relay communications and other functions as required.

The Disturbance Monitoring Device will also have a dedicated phone circuit

Communications from the switching station to the Amarillo Control Center will consist of a 4-wire telephone data circuit provided by the Interconnection Customer, if it is available. If it is not available, some type of communications will have to be installed, at the Interconnection Customer'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 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 the new SPS 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 115kV 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 new switching station will be delayed until the matters are resolved. Xcel Energy will not be held responsible for these delays.***

2.1. **115 kV Termination Structure:** The existing Xcel Energy overhead 115 kV transmission line (T-53) will be terminated in and out of the new switching station. The transmission termination structures will be constructed on the west and east sides of the switching station. The existing 115 kV line between Nichols Interchange and Kirby Interchange will be re-terminated such that power flows in and out of the proposed switching station. The location of the Switching Station will be in the NE Corner of the Section 75; Block 2, of the T.T.R.R. Co. Survey, Carson County, Texas.

2.2. Another overhead 115 kV transmission termination structures will be constructed on the southeast side of the switching station to serve the existing 115 kV Conway Substation. The fourth 115 kV transmission terminations will be on the southwest side of the switching station for the Conway Wind Farm. All circuits will be dead-ending on 115 kV terminals within the new switching station. See Figure A-2.

3. **Right-Of-Way:**

3.1. **New 115 kV Transmission Line Taps**: See Figure A-3 for location of line taps relative to switching station site.

3.2. **Permitting**: Currently, permitting for the construction of the new switching station is not required in the State of Texas.

3.3. **Switching Station Location:** The new switching station will be constructed adjacent to the existing 115 kV transmission circuit T-53, assuming the land can be procured from the landowner.

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 Transmission group, the Interconnection Customer's Personnel and local operating groups will be imperative to have this project in service on the scheduled date.

6. **Short Circuit Study Results:**

The Short Circuit Analysis was performed internally by Xcel Energy Services to determine the available fault current at the 115 kV bus of the new switching station. These values may be used as a starting point for the determination of the available fault currents and interrupting capability of their facilities. The results are shown in Table 1, and the impedances are in per-unit at the specified voltage.

Table 1: Short Circuit Information

Fault Location	Fault Current (A)		Impedance (p.u Ω)[3]	
	Line-to-Ground	3–Phase	Z^+	Z^0
New Switching Facility 115 kV Bus	3,050	4,650	0.0224 + j0.1055	0.0713 + j0.2696

Estimated Construction Costs:

The projects required for the interconnection of the 240 MW wind energy generating facility consist of the projects summarized in the table below:

Table 2, Required Interconnection Projects

Project	Description	Estimated Cost
	Stand-alone Network Upgrade	
1	115 kV 4-breakers ring configuration	$ 1,929,021
2	Right-of-Way Cost (station land, surveying, etc.)	$ 15,000
	Subtotal:	$ 1,944,021
	Network Upgrade	
3	Relay Modifications at Kirby Interchange	$ 58,606
4	115 kV Transmission Line Work	$ 223,236
	Subtotal:	**$ 281,842**
	Interconnection Facilities (at the Interconnection Customer's Expense)	
5	Communications Cost	$ 50,000
6	115 kV Arresters and Metering	**$** 26,903
	Subtotal:	**$ 76,903**
	Total Cost:	**$ 2,302,766**

These costs were estimated using 2005 costs (2005 dollars) with no AFUDC[4] added with an estimated accuracy is ± 10%.

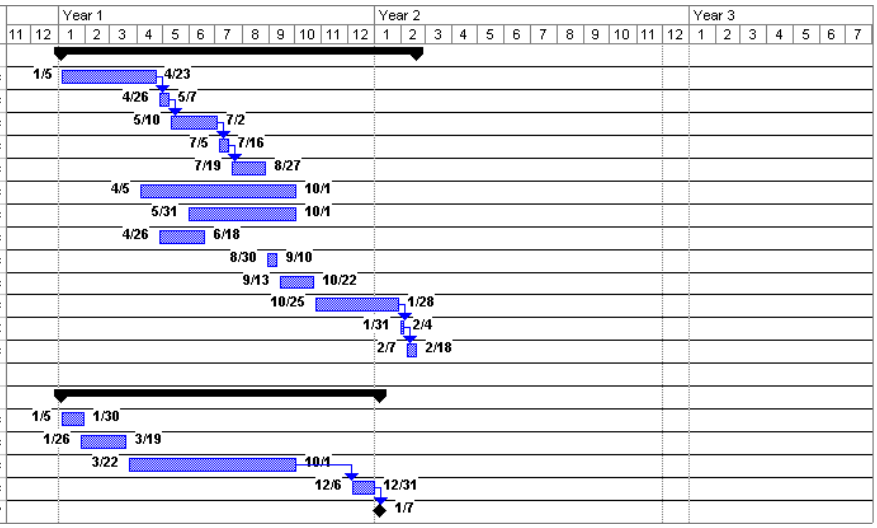
Capital budget approval has not been sought for this project as of the date of this report. The required approval process may impact the projected in-service date requested by the Interconnection Customer.

[3] 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
[4] AFUDC - Allowance for Funds Used During Construction.

7. **Engineering and Construction Schedule:**

It is anticipated that the switching station and all associated components will be constructed and ready to receive power from the Interconnection Customer's wind farm approximately 14 months from the day an interconnection agreement is signed and after all internal approvals, unless prior arrangements have been made. This is the earliest Xcel Energy can complete the project as a result of other scheduling considerations. A construction schedule is shown below.

ID	Task Name	Duration
2	**Substation - Conway**	**295 days**
3	Substation Engineering & Design	16 wks
4	Substation site Survey	2 wks
5	Dirt prints complete	8 wks
6	Dirt bids	2 wks
7	Dirt pad & road work	6 wks
8	Order Long lead Equipment	26 wks
9	Material order & delivery	18 wks
10	Manifest Construction drawings	8 wks
11	Fence Construction	2 wks
12	Foundation work complete	6 wks
13	Substation construction	14 wks
14	Testing and inspection	1 wk
15	Commission Substation	2 wks
16		
17	**Transmission Line Project**	**265 days**
18	Engineering	4 wks
19	Transmisison line design	8 wks
20	Material order and delivery	28 wks
21	Transmission Line Construction	4 wks
22	Transmission Completion	1 day



Appendix A

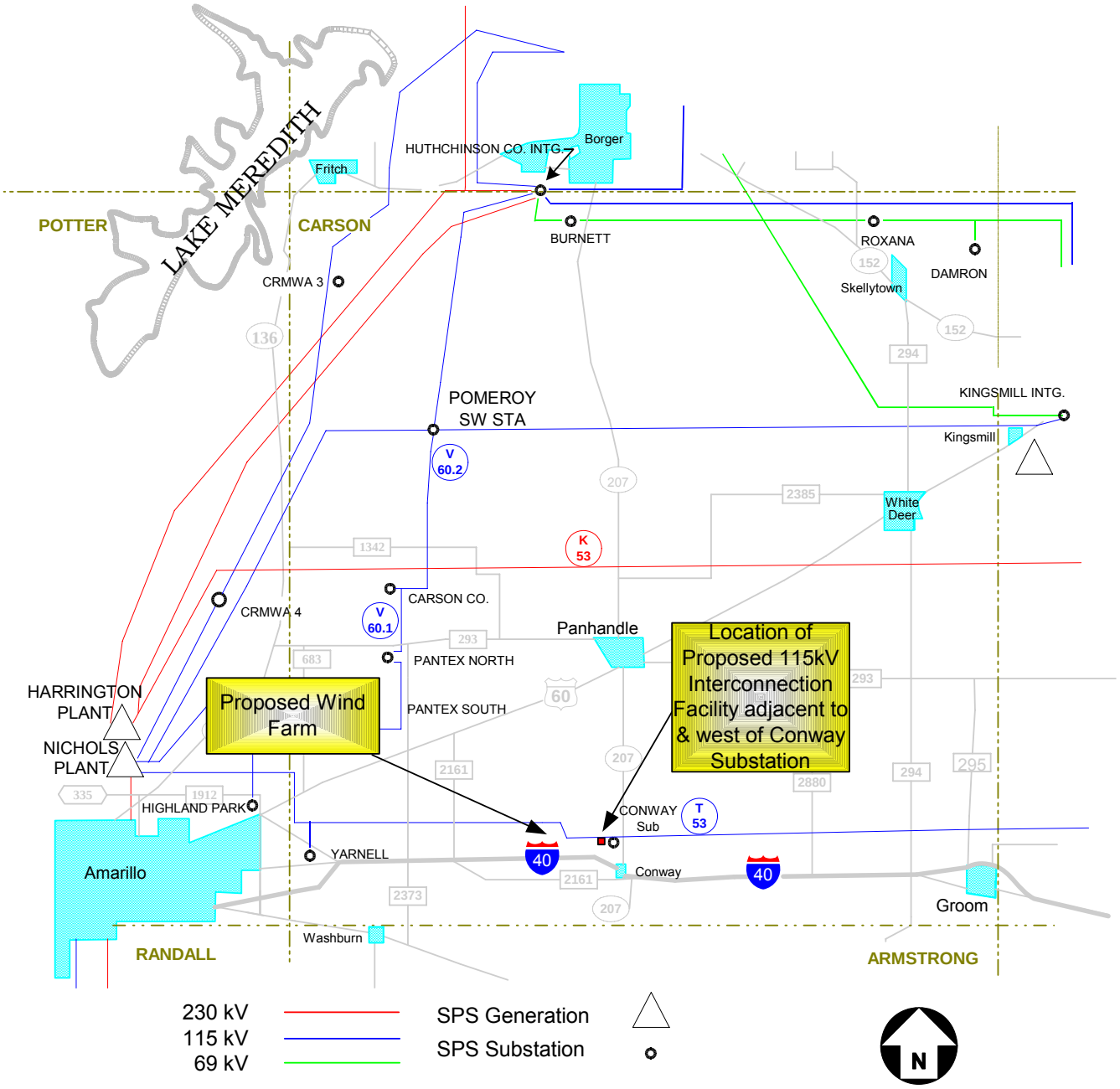


Figure A-1. Proposed Interception Point to the Xcel Energy 115 kV Circuit T-53.

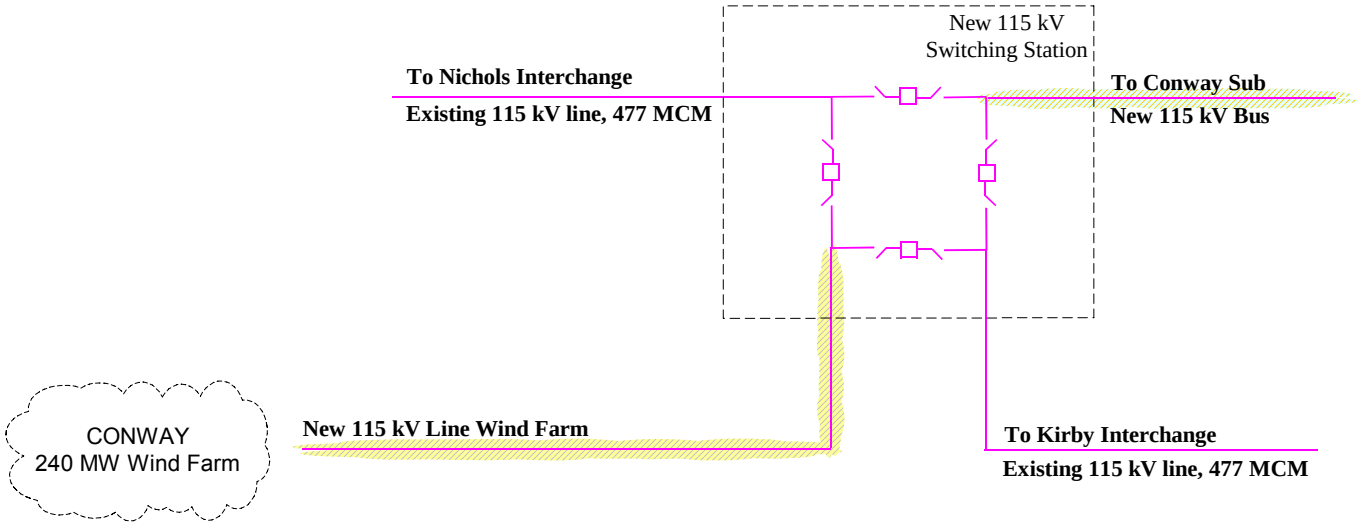


Figure A - 2. One-line diagram for Conway Wind and a new 115 kV Switching Station in Carson County.

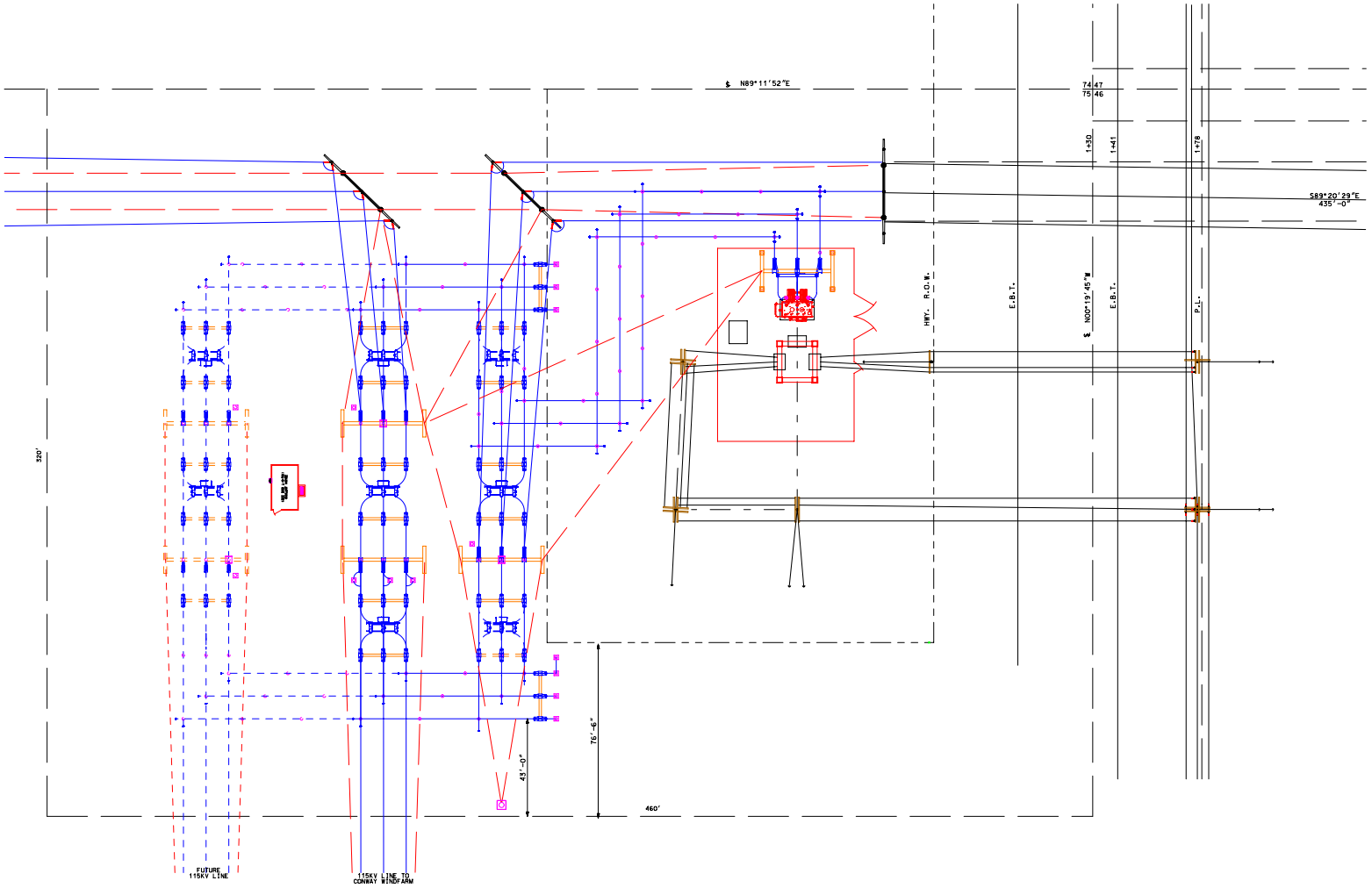


Figure A-3. Site Layout 115 kV Conway Switching Station.

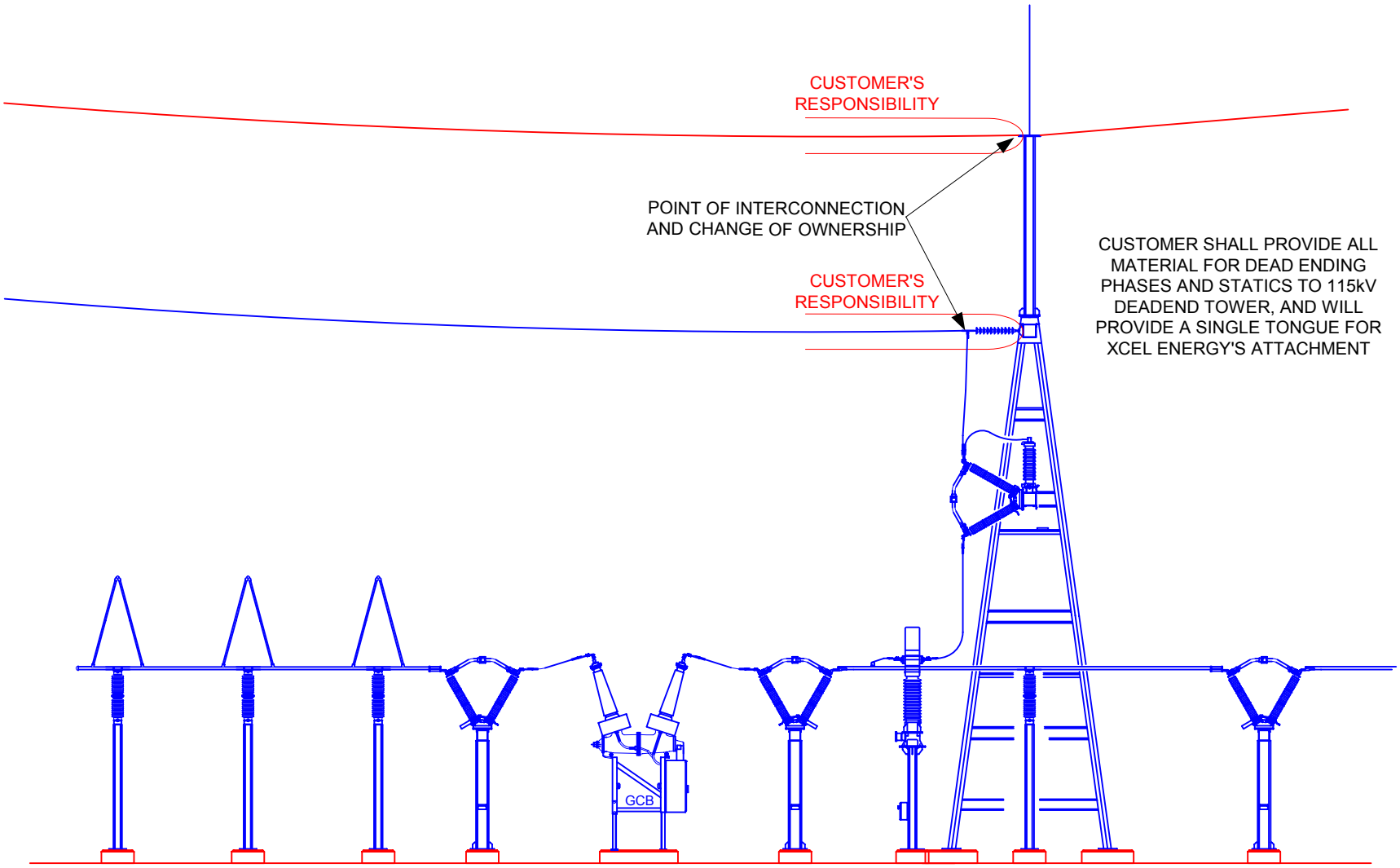
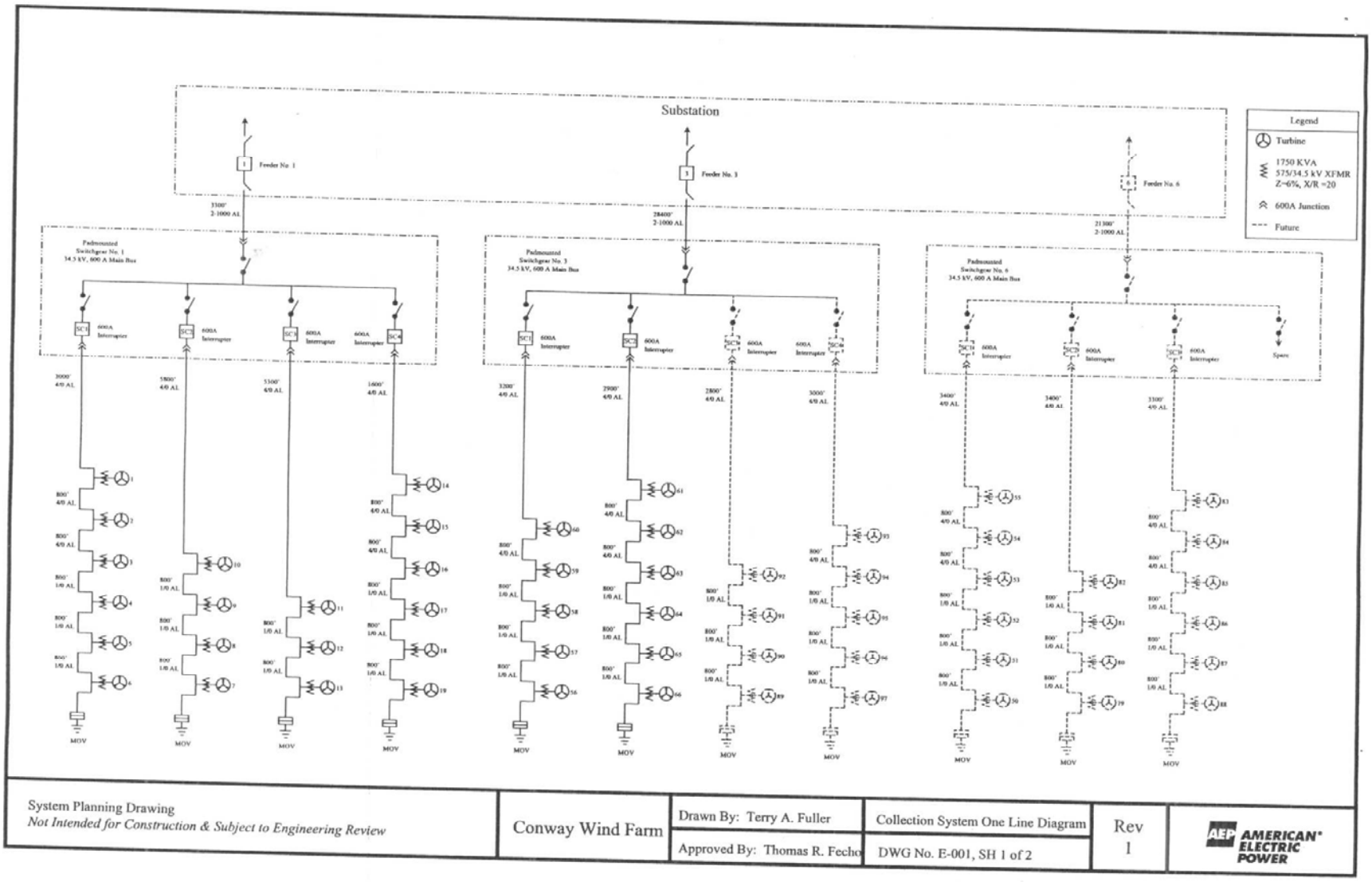
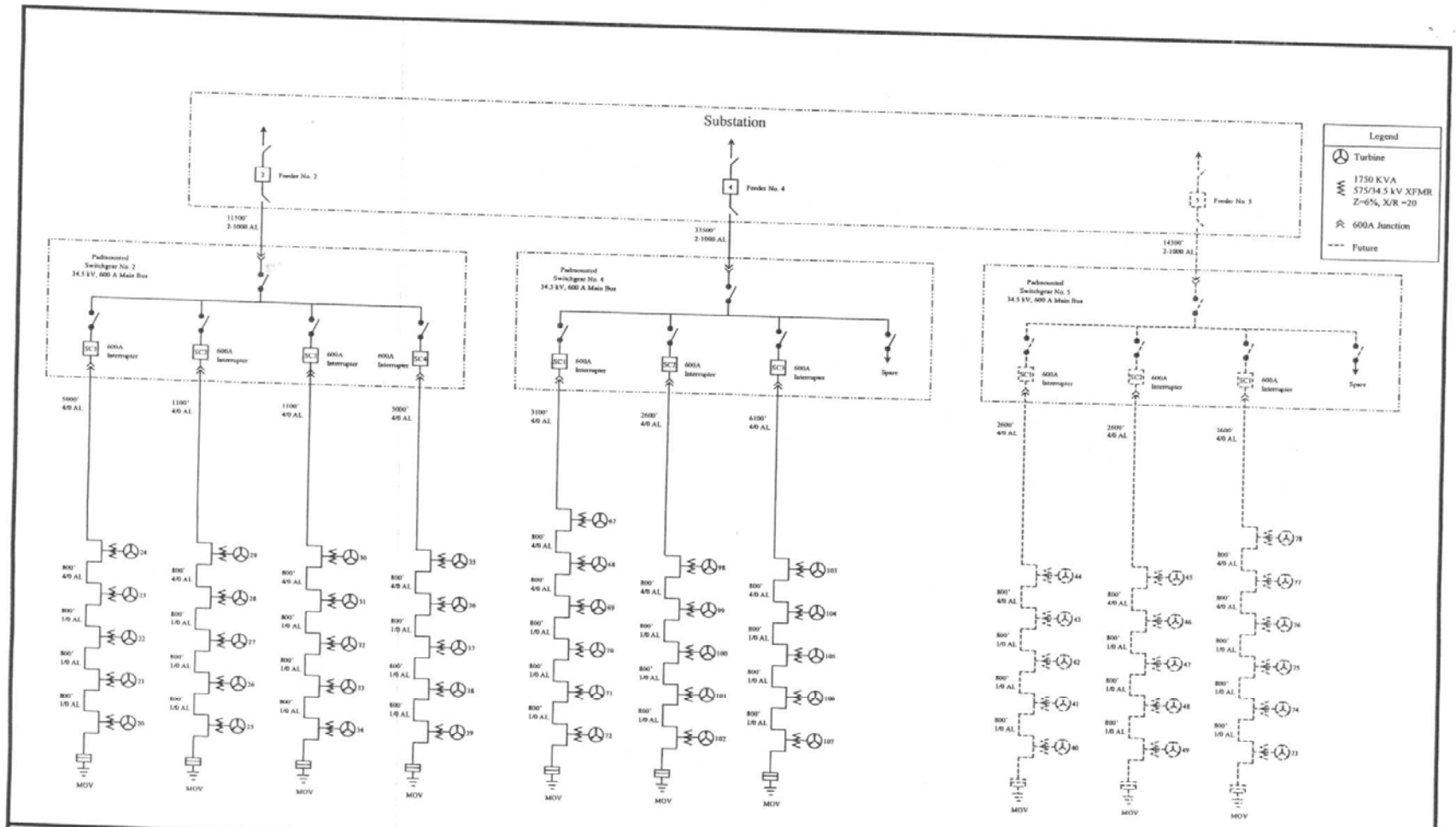
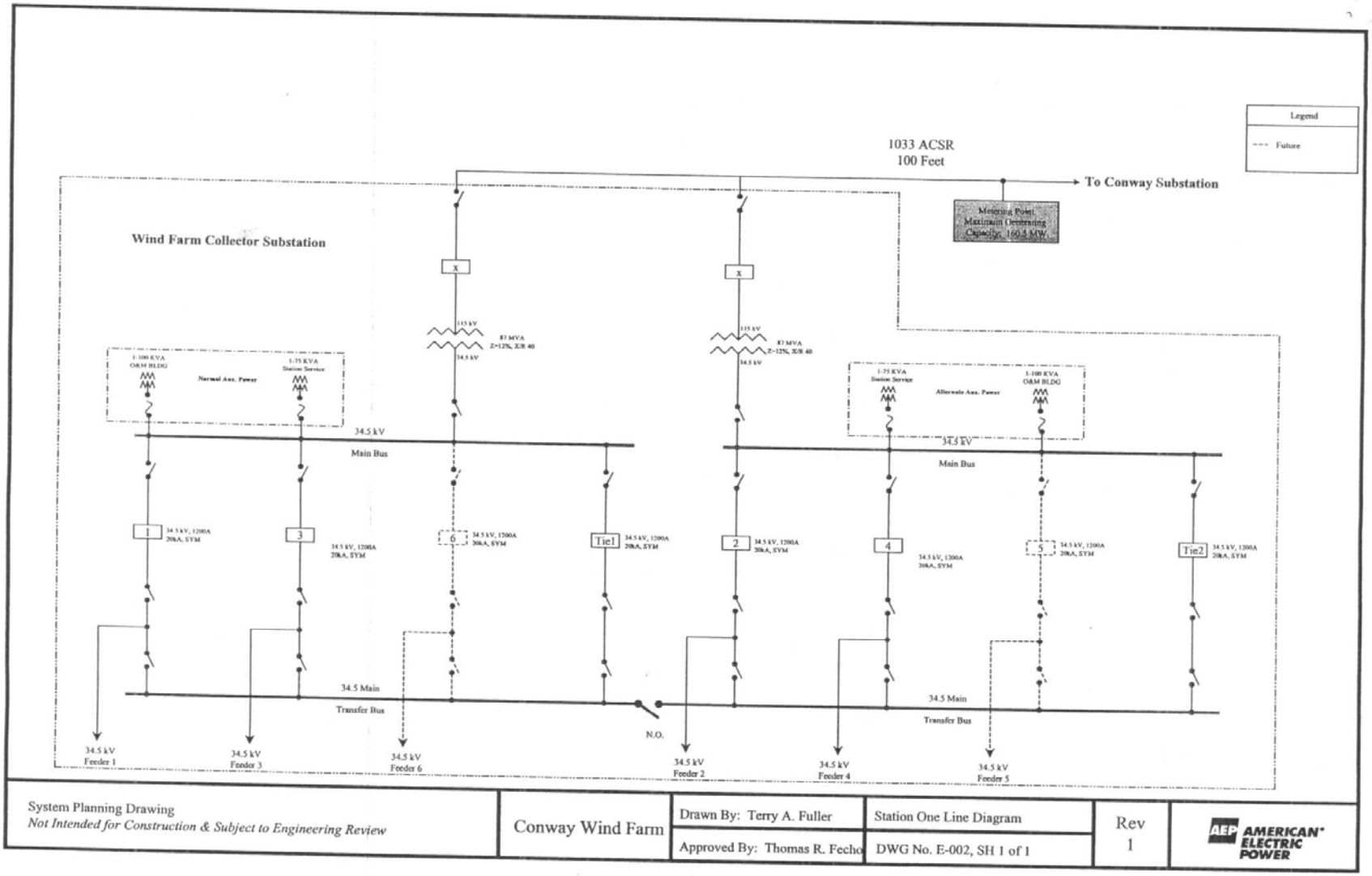


Figure A-4. Point of Interconnection & Change of Ownership


Substation
Feeder No. 1
Feeder No. 3
Feeder No. 6
3300' 2-1000 AL
28400' 2-1000 AL
21300' 2-1000 AL
Padmounted Switchgear No. 1 34.5 kV, 600 A Main Bus
Padmounted Switchgear No. 3 34.5 kV, 600 A Main Bus
Padmounted Switchgear No. 6 34.5 kV, 600 A Main Bus
600A Interrupter
Spare
MOV
Legend
Turbine
1750 KVA 575/34.5 kV XFMR Z=6%, X/R =20
600A Junction
Future
System Planning Drawing
Not Intended for Construction & Subject to Engineering Review
Conway Wind Farm
Drawn By: Terry A. Fuller
Approved By: Thomas R. Fecho
Collection System One Line Diagram
DWG No. E-001, SH 1 of 2
Rev 1
AEP AMERICAN ELECTRIC POWER



System Planning Drawing *Not Intended for Construction & Subject to Engineering Review*	Conway Wind Farm	Drawn By: Terry A. Fuller	Collection System One Line Diagram	Rev 1	AEP AMERICAN ELECTRIC POWER
		Approved By: Thomas R. Fecho	DWG No. E-001, SH 2 of 2		



System Planning Drawing *Not Intended for Construction & Subject to Engineering Review*	Conway Wind Farm	Drawn By: Terry A. Fuller	Station One Line Diagram	Rev 1	AEP AMERICAN ELECTRIC POWER
		Approved By: Thomas R. Fecho	DWG No. E-002, SH 1 of 1		