Interconnection Facilities Study
For
Generator Interconnection
Request
GEN-2013-027
(IFS-2014-002-02)

SPP Generator
Interconnection Studies

(#GEN-2013-027)
(#IFS-2014-002-02)

February 2016

Revision History

Date	Author	Change Description
9/15/2015	SPP	Draft Interconnection Facilities Study Report Revision 0 Issued
11/4/2015	SPP	Final Interconnection Facilities Study Report Revision 1 Issued
2/2/2016	SPP	Facilities Study Report Revised for changes in Shared Network Upgrades

Summary

Southwestern Public Service Company (SPS), an operating company subsidiary of Xcel Energy Inc., performed a detailed Interconnection Facilities Study (IFS) at the request of Southwest Power Pool (SPP) for Generator Interconnection request GEN-2013-027/IFS-2014-002-02 (150.00 MW/Wind) located in Bailey County, Texas. The Interconnection Customer's originally proposed in-service date for GEN-2013-027/IFS-2014-002-02 is March 31, 2016. SPP has proposed the full interconnection service in-service date will be after the assigned Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are completed. Full Interconnection Service will require the Network Upgrade(s) listed in the "Other Network Upgrades" section. 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.

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's generation facility consists of sixty-five (65) Siemens 2.3 MW wind turbines with four (4) of the sixty-five (65) Siemens 2.3 MW wind turbines including an additional wind turbine vendor "Power Boost" feature that will increase generator nameplate rating from 2.3 MW to 2.415 MW. The total nameplate rating for GEN-2013-027/IFS-2014-002-02 is 149.96 MW. The 34.5kV collector system for this wind facility is planned to be connected to one (1) 230/34.5kV Interconnection Customer owned and maintained transformer at the Interconnection Customer owned substation. An approximate three (3) mile overhead 230kV transmission circuit will connect GEN-2013-027/IFS-2014-002-02 to the Point of Interconnection (POI) at a new SPS owned switching station (Needmore) tapping and looping into the existing SPS owned Tolk – Yoakum 230kV transmission circuit. This new switching station, Needmore, will be location approximately seventeen (17) miles from Tolk Substation along the Tolk – Yoakum 230kV transmission circuit. The Interconnection Customer will be responsible for all of the transmission facilities connecting the Interconnection Customer owned substation to the POI.

The Interconnection Customer will 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, including approximately 6.4 Mvar[1] of reactors to compensate for injection of reactive power from GEN-2013-027/IFS-2014-002-02 Interconnection Customer Facilities into the transmission system under reduced generating conditions. Also, the Interconnection Customer will need to coordinate with the Transmission Owner for relay, protection, control, and communication system configurations.

[1] This approximate amount of reactors is an approximate minimum amount needed for the configuration of the wind farm studied in DISIS-2014-002 Group 06 reduced generation analysis.

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s)
To allow interconnection the Transmission Owner will construct a new three breaker ring bus switching station (Needmore) with three (3) 3000A continuous ampacity 230kV circuit breakers and associated terminal equipment for acceptance of the Interconnection Customer's Interconnection Facilities. Currently, SPS estimates an Engineering and Construction (E&C) lead time of approximately thirty-six (36) months after a fully executed Generator Interconnection Agreement (GIA) for the completion of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, GEN-2013-027/IFS-2014-002-02 is responsible for $6,004,592 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s). **Table *1*** displays the estimated costs for Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s).

Table 1: GEN-2013-027/IFS-2014-002-02 TOIF and Non-Shared Network Upgrade(s)

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
Interconnection Substation - Transmission Owner Interconnection Facilities 230kV Substation work for a new line terminal position, line switch, dead end structure, communications, revenue metering, and line arrestors	$260,000	100%	$260,000
Interconnection Substation - Network Upgrade(s) 230kV Substation work for a new 3-breaker ring configuration switching station, build three (3) 3000A continuous ampacity 230kV circuit breakers and associated switches, structures, other terminal equipment.	$5,744,592	100%	$5,744,592
Total	$6,004,592	100%	$6,004,592

Shared Network Upgrade(s)
The Interconnection Customer was studied within the DISIS-2014-002 Impact Study, and its subsequent restudies, the latest iteration being DISIS-2014-002-5, with Energy Resource Interconnection Service (ERIS) only. At this time, the Interconnection Customer is allocated $4,929,850 for Shared Network Upgrades. If higher 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:

Table 2: GEN-2013-027/IFS-2014-002-02 Shared Network Upgrade(s)

Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
Tolk – Plant X 230kV Circuit #1 & #2: Rebuild Tolk – Plant X circuits #1 and #2	$3,701,930	36.5	$9,921,693
TUCO Substation 345/230kV Transformer replacement: Replace existing 345/230kV 560MVA transformer with unit with emergency ratings of 644MVA(summer)/700MVA(winter)	$1,227,920	36.3	$3,374,036
Total	$4,929,850		$13,295,729

Other Network Upgrades

Certain Other Network Upgrades are currently not the cost responsibility of the Customer but will be required for full Interconnection Service. Currently, the following Other Network Upgrades are assigned to GEN-2013-027/IFS-2014-002-02:

- Agave Hill 115kV Reactive Power Support build assigned in 2015 Integrated Transmission Plan Near Term Assessment (ITPNT) per SPP-NTC-C-200324
- China Draw 115kV Reactive Power Support build assigned in 2015 Integrated Transmission Plan Near Term Assessment (ITPNT) per SPP-NTC-C-200324
- Ochoa 115kV Reactive Power Support assigned in 2015 Integrated Transmission Plan Near Term Assessment (ITPNT) per SPP-NTC-C-200324
- Potash Junction Project 230/115kV assigned in High Priority Increment Load Study (HPILs) per SPP-NTC-200282 with current on schedule 12/1/2015 in-service
- Road Runner 115kV Reactive Power Support assigned in 2015 Integrated Transmission Plan Near Term Assessment (ITPNT) per SPP-NTC-C-200324

Depending upon the status of higher or equally queued customers, the Interconnection Customer's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

Conclusion

Interconnection Service for GEN-2013-027/IFS-2014-002-02 will be delayed until the Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades are constructed. The Interconnection Customer is responsible for $6,004,592 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated $4,929,850 for Shared Network Upgrades. After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 150.00 MW, as requested by GEN-2013-027/IFS-2014-002-02, can be allowed.

At this time the total allocation of costs assigned to GEN-2013-027/IFS-2014-002-02 for interconnection Service are estimated at $10,934,442.

Facilities Study For
Southwest Power Pool (SPP)

Bailey County, Texas
GEN-2013-027
150MW Wind Farm
Generation Facilities

March 24, 2015

Transmission Planning South
Xcel Energy Services

Executive Summary

("Interconnection Customer") in 2015 requested an interconnection of a wind energy facility located in Bailey County, Texas to the Southwestern Public Service Company (SPS) transmission network. SPS is a New Mexico Corporation and wholly owned subsidiary of Xcel Energy Inc. This facility has a net capacity of 150 MW. The Interconnection Customer's facility will connect to SPS's existing Tolk to Yoakum 230 kV transmission line which is located approximately seventeen (17) miles south of Tolk Station. The Interconnection Customer's requested commercial operation date is October 2016.

The Southwest Power Pool (SPP) evaluated the request (GEN-2013-027) to interconnect the wind generation facility to the SPS transmission system in a Definitive Interconnection System Impact Study (DISIS-2014-002), which was completed in January 2015. The interconnection request was studied using sixty-five (65) turbines, which are Siemens 2.3MW wind turbines, with four (4) of the sixty-fix (65) turbines with the "Power Boost" feature to increase output to 2.415MW for a total of 149.96 MW. The Interconnection Customer is required to build a 230 kV transmission line from their substation wind farm facility to a new SPS Switching Station to be named Needmore. The Interconnection Customer will be required to maintain a Power Factor between 0.95 lagging and 0.95 leading at the Point of Interconnection (POI).

SPP requires that each generator shall implement Automatic Under Frequency Load Shedding (UFLS) according to the SPP UFLS Plan at the following link: http://www.spp.org/publications/SPP%20UFLS%20Plan_Final.pdf. To fulfill this requirement, coordination with Xcel Energy is required during the under-frequency relay-setting phase for the generation. The Interconnection Customer is required to report their generation off-nominal frequency tripping relay settings to SPP and SPS. SPS specifies that generators shall not trip at frequencies above 58.5 Hz unless exceptions in the Transmission Provider Criteria are met. The Interconnection Customer agrees that the energy generating units installed at this interconnection will not be tripped for under-frequency conditions above 58.5 Hz in compliance with Transmission Provider criteria. This means that the generation subject to this Interconnection Agreement may not trip for under-frequency conditions on the transmission system until all under-frequency load shedding relays have operated. SPS 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 Corporation (NERC), SPP, and the Federal Energy Regulatory Commission (FERC) or their successor organizations.

The Interconnection Customer is responsible for all the cost of the Interconnection Facilities, installation of the Direct Assigned Interconnection Facilities; inclusive of all construction required for the 230 kV to interconnect at SPS's Needmore Switching Station.

The network upgrades for the Interconnection at Needmore is $5,744,592.

It is anticipated that the entire process of building a new 3-ring 230 kV switching station at Needmore for the acceptance of the GEN-2013-027 facility output and the network upgrades allocated to this project will require approximately 36 months to complete after an Interconnection Agreement is signed and an authorization to proceed is received. The cost of these upgrades, inclusive of the Interconnection Customer's cost for the interconnection of this Wind Farm facility, is shown below in Table 1, with the detailed description of the cost shown in Table 3.

Table 1, Cost Summary[a]

Network Upgrades:	**$**	**5,744,592**
Transmission Owner Interconnection Facilities:	**$**	**260,000**
Total:	**$**	**6,004,592**

[a] The cost estimates are 2013 dollars with an accuracy level of ±20%.

General Description of SPS[b] Facilities

1. **Construction of New Needmore Switching Station:** See Appendix A, Figure A-1 for general vicinity location map.

   1.1. **Location:** Customer will build a new 230 kV line from their substation to SPS's new 230 kV Needmore Switching Station which includes three (3) 230 kV breakers. Appendix A, Figure A-2, shows a preliminary one-line of Needmore Switching Station, while Figure A-3 shows a typical elevation view of the normal Point of Interconnection (POI).

   1.2. **Bus Design:** The new 230 kV three-breaker ring-bus switching station will be built to accommodate the output from the wind energy facility. This is shown in Appendix A, Figure A-2.

   1.3. **Line Terminals:** The 230 kV lines and static wire terminals will be designed to accommodate 14,000 pounds per phase conductor (28,000 Bundle) at maximum tension, with a maximum 15-degree pull off from normal.

   1.4. **Control House:** The new control house will accommodate the new metering, protective relaying and control devices, terminal cabinets, and any fiber-optic cable terminations, etc. for the new 230 kV line breaker terminals.

   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 400' x 400', with a rock yard surface.

   1.6. **Ground Grid**: A complete ground grid will be installed per ANSI/IEEE STD 80-1986, 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 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**: A 133 kV/120-240volt transformer tapped off of the 230 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 if none is available. A flip-flop to automatically transfer the station power will be installed.

   1.9. **Relay and Protection Scheme**: The new 230 kV breaker line terminal primary protection to the interconnection customer 230 kV transmission line will use line current differential relaying over optical fiber installed in the static of the customer's 230 kV transmission line. Secondary relaying will use mirrored bit, Permissive Overreaching Transfer Trip (POTT) over the optical fiber. An SEL 311L and an SEL 421 will be used as primary and secondary relays, respectively. The SEL 421 will be used for line/bus SCADA closing conditions for the 230 kV breakers. Also, a SEL 351S will be used for breaker failure.

   An SEL 421 will display the bus voltage, GCB amps, MW, MVAR, and fault location. A communication relay will be installed and for other functions as required.

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

1.10. Revenue Metering: An individual billing meter will be installed at Needmore Switching Station on the 230 kV line terminal from the Interconnection Customer's substation, which meets the standards: ANSI C12.1 accuracy class 0.2 (3-PT's IEEE C57.13 accuracy class 0.3 and 3-CT's IEEE C57.13 accuracy class 0.15) for full 3-phase 4-wire metering. There will be two meters per line terminal: one will be primary and the other will be back up, each will have full 4 quadrant metering. Pulses out of the primary billing meter will be sent via SCADA to the Transmission Owner's Control Center in Amarillo, Texas.

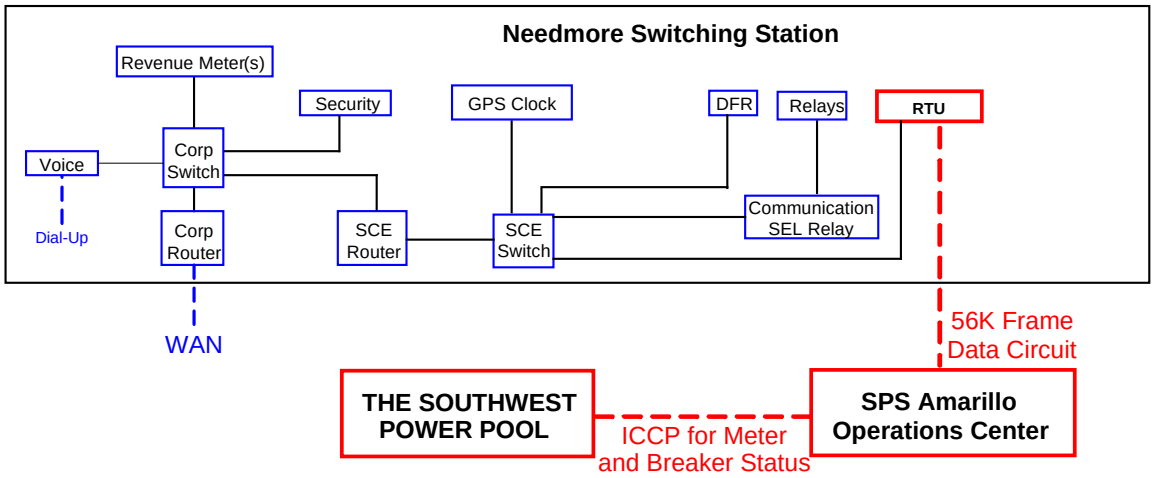
1.11. Disturbance Monitoring Device: A Disturbance Fault Recorder (DFR), capable of recording faults, swings, and long term trending, will be installed to monitor and record conditions in the substation and on the transmission lines. The disturbance equipment shall also be equipped with a GPS time synching clock. This equipment will have communication capability with a dedicated communication circuit. The disturbance equipment will have its own dedicated communications circuit.

1.12. Remote Terminal Unit (RTU): A new RTU will be utilized with communications for the new switching station. A Communication SEL Relay will be installed for relay communications and other functions as required. SPS will provide and install an RTU for metering and telemetry at the Interconnection Customer's facility as required by the latest Xcel Energy Interconnection Guidelines. The direct cost will be charged to the Interconnection Customer.

1.13. Communications: To meet its Communications obligations, the Interconnection Customer shall be responsible for making arrangements with the local phone company to provide telephone circuits as required by the Transmission Owner. Transmission Owner equipment may include, but is not limited to, the following: relay communication equipment, RTU, and disturbance monitoring equipment. Prior to any construction, the Interconnection Customer is required to contact the Transmission Owner substation-engineering department for all communication details.

The following communications schematic diagram, which includes communication equipment information for the Interconnection Customer, Transmission Provider (Southwest Power Pool) and Transmission Owner (Southwestern Public Service), is provided to assist the Parties.

A schematic outlining the proposed communications is provided below:



Interconnection Customer shall be responsible for providing fiber optic communication circuit installed in the overhead transmission line static wire for protective relaying from the customer substation to Needmore Switching Station.

2. **Transmission Work:**

2.13. The Interconnection Customer will construct, own, operate, and maintain any customer owned 230 kV transmission line from the Interconnection Customer's substation to the Interconnection Point at SPS's new 230 kV Switching Station. This line is shown in Appendix A, Figure A-1 and is approximately 2.5 miles from customer's substation POI. **The SPS transmission design group prior to any construction by the Interconnection Customer or its contractor on any customer 230 kV transmission lines, or doing work in close proximity to any SPS transmission line, will require an engineering review of the customer's design. It is the Interconnection Customer's responsibility to initiate the design review in a timely manner before construction of any 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 interchange will be delayed until the matters are resolved. SPS will not be held responsible for these delays.**

2.1 **.**

3. Right-Of-Way:

3.1 **Permitting**: Permitting for the construction of a new 230 kV line terminal at the new 230 kV Switching Station is not required from the Public Utility Commission in the State of Texas. The interconnection customer will be responsible for any permitting and right of way of their substation and the 230 kV transmission line from their substation to the Interconnection Point at new 230 kV Switching Station.

4. **Construction Power and Retail Service:** It is the sole responsibility of the Interconnection Customer to make arrangements for both construction and station power, which may be required for the Interconnection Customer's wind farm facility. **Additionally, if the Interconnection Customer's substation(s) and/or construction site(s) are located outside of the SPS service area, SPS cannot provide station power (retail service) and the Interconnection Customer needs to make arrangements for retail service from the local retail provider. Retail provider and Customer will be responsible for making any necessary transmission service arrangements as required under the SPP OATT.**

5. Project and Operating Concerns:

5.1 Close work between the Transmission group, the Interconnection Customer's personnel and local operating groups will be imperative in order to meet any in-service date that has been established.

5.2 The Interconnection customer will be required to maintain a Power Factor between 0.95 lagging and a 0.95 leading at the Point of Interconnection (POI). All capacitors required will be installed on the 34.5 kV at customer's substation. This is required to maintain acceptable dynamic voltage rise as per latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW. The capacitor banks need to be switched in stages where the voltage rise is less than 3%.

6 **Fault Current Study:** The available fault current at the interconnection location on the 230 kV at Needmore Switching Station located approximately 17 miles south of Tolk Station on circuit K-25, without any contribution from the new generator facilities, is shown in Table 2.

Table 2, - Available fault current at interconnection location

Short Circuit Information without contribution from new Generator Facilities (GEN 2013-027)				
Fault Location	Fault Current (Amps)		Impedance (Ω)	
	Line-to-Ground	3–Phase	Z^+	Z^0
230 kV Bus	6,015	8,587	2.31 + j15.35	8.43 + j34.57

Estimated Construction Costs

The projects required for the interconnection of 150 MW Wind Generation facilities consist of the projects summarized in the table below.

Table 3, Required Interconnection Projects[c]

Project	Description	Estimated Cost
	Network Upgrades (at the Interconnection Customer's expense)	
2	Communication Equipment (DFR, RTU and other related items)	$ 409,894
3	Land Approximately 20 acre	$ 144,698
4	Build new 3-ring bus for new Needmore switching Station with three new 230 kV breakers.	$ 5,190,000
	Subtotal:	**$ 5,744,592**
	Transmission Owner Interconnection Facilities (at the Interconnection Customer's expense)	
5	Communications [d]	*$ See footnote*
6	Revenue metering	$ 230,000
7	230 kV Line arrestors	$ 30,000
	Subtotal:	**$ 260,000**
	Total Cost	**$ 6,004,592**

Engineering and Construction:

An engineering and construction schedule for this project is estimated at approximately 36 months. Other factors associated with clearances, equipment delays and work schedules could cause additional delays. This 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.

[c] The cost estimates are 2015 dollars with an accuracy level of ±20%.

[d] It is the Requester's responsibility to provide both the data circuit and communication circuits, see Section 1.13.

Appendix A

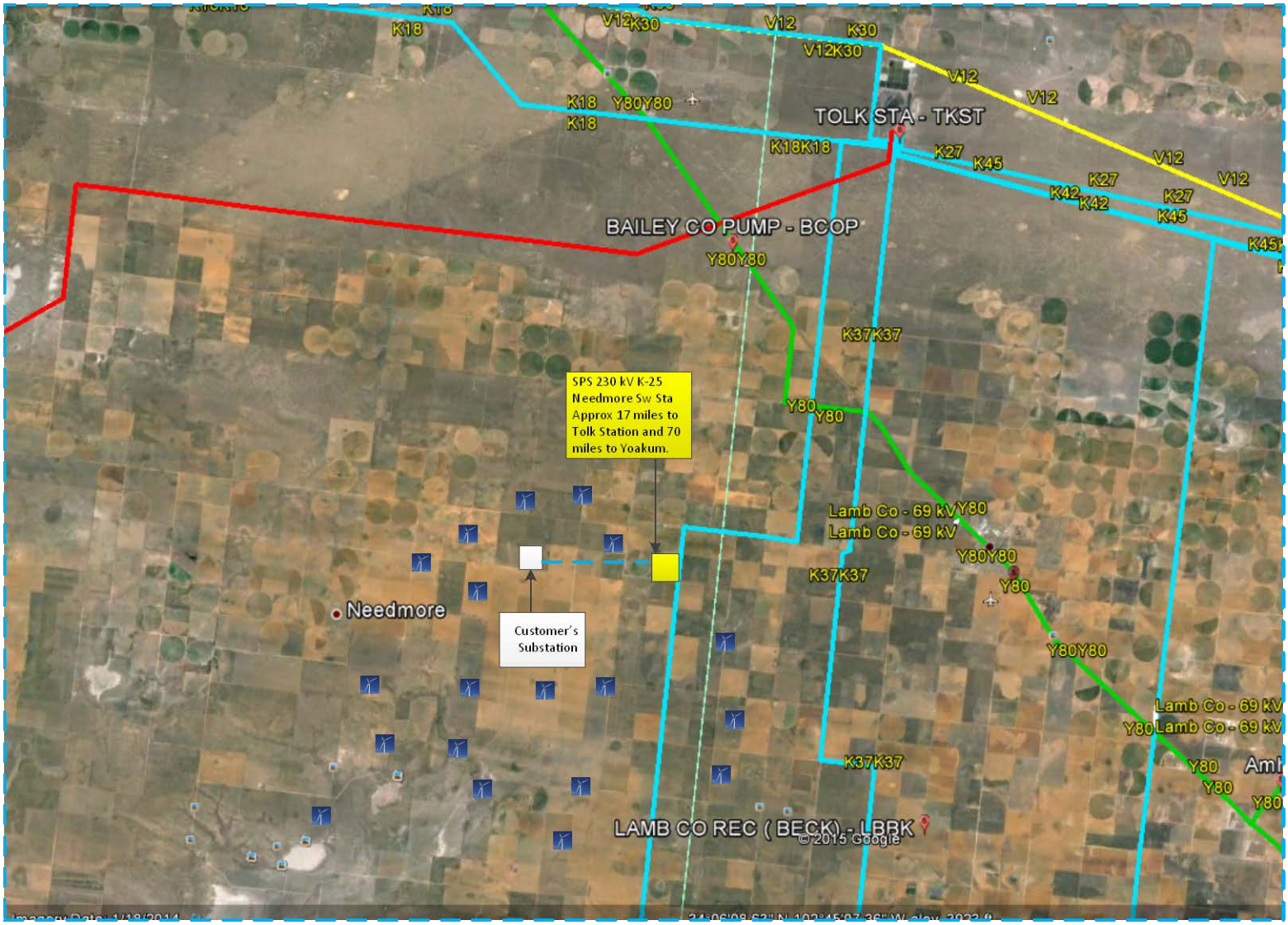


Figure A-1. Approximate location of Needmore Switching Station and Wind Farm

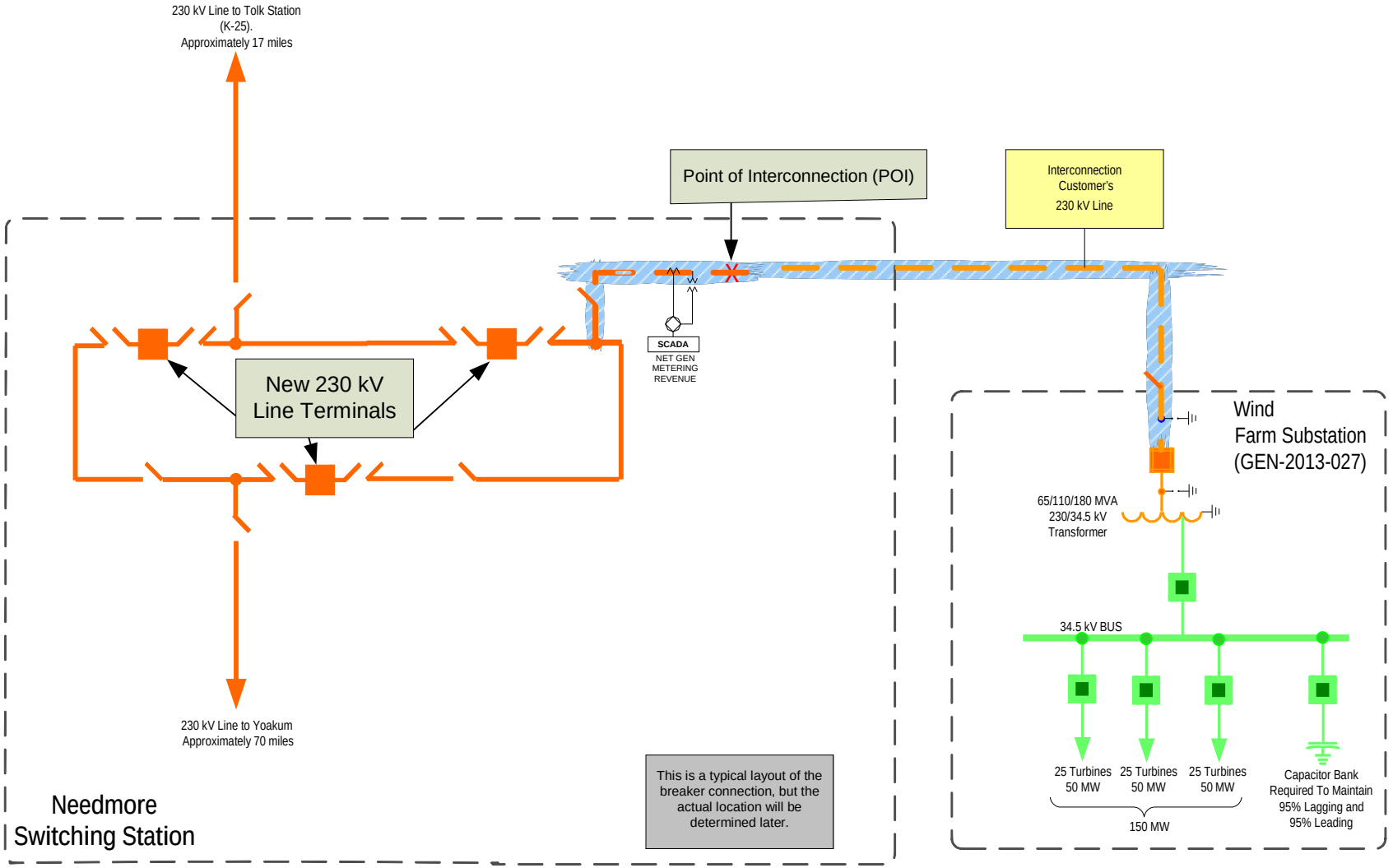


Figure A-2. One-line Diagram of New Needmore Switching Station

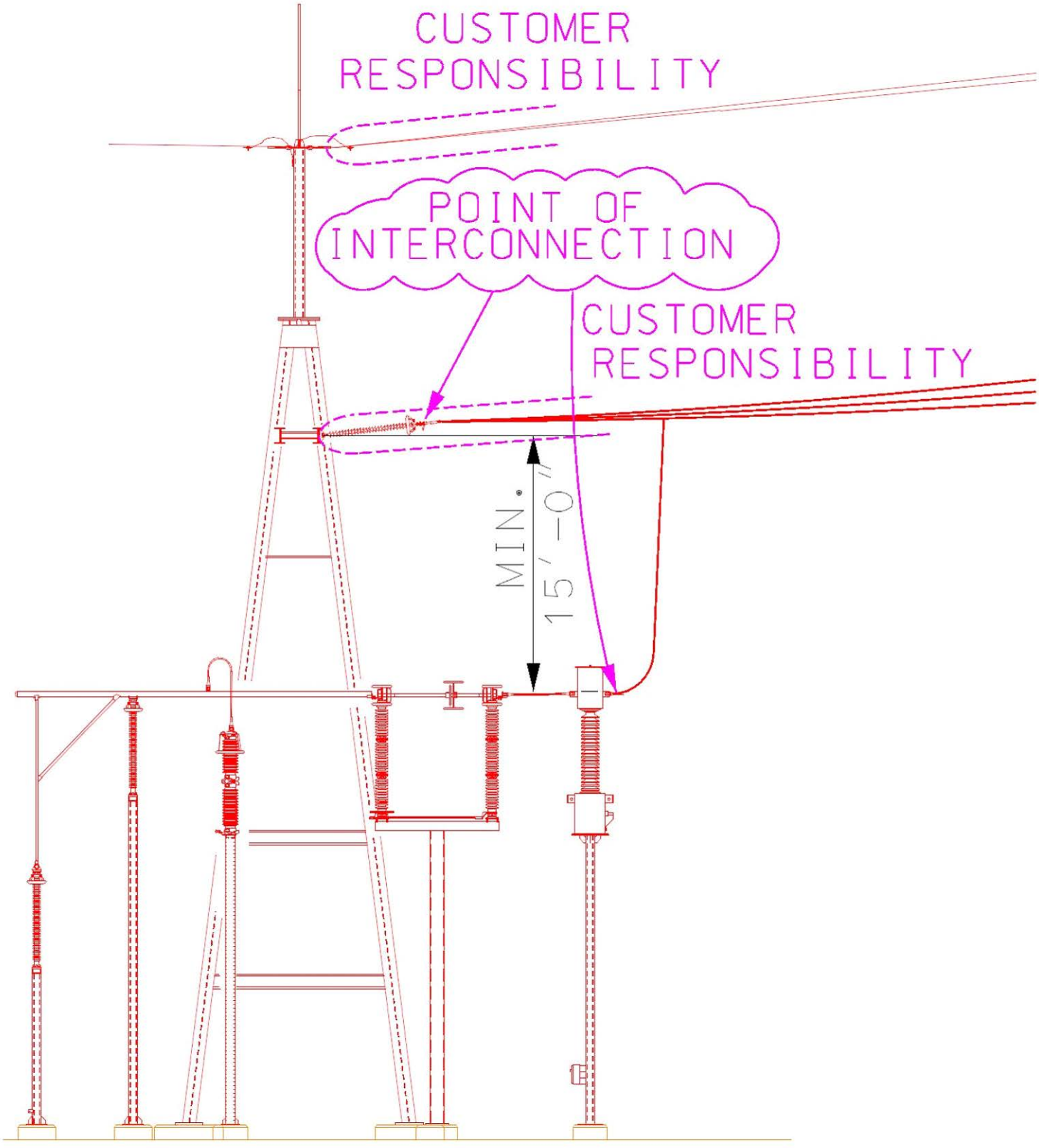


Figure A-3 Point of Interconnection & Change of Ownership (Typical)

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