



**INTERCONNECTION
FACILITIES STUDY
REPORT**

GEN-2015-031
(IFS-2015-002-27)

Published June 2018

By SPP Generator Interconnections Dept.

REVISION HISTORY

| DATE OR VERSION NUMBER | AUTHOR | CHANGE DESCRIPTION |
|------------------------|--------|--|
| 4/05/2017 | SPP | Initial draft report issued. |
| 6/29/2018 | SPP | Revised draft report issued due to DISIS-2015-002-4. |
| | | |

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SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2015-031/IFS-2015-002-27 is for a 150.53 MW generating facility located in Swisher County, Texas. The Interconnection Request was studied in the DISIS-2015-002 Impact Study for Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). Prior to an executed IFS agreement, the Interconnection Customer requested to withdraw NRIS and lower its Interconnection Service from 300 MW to 150.53 MW per Section 4.4.1 of the Southwest Power Pool (SPP) Generator Interconnection Procedures (GIP), therefore ERIS-only and reduced Interconnection Service amount was analyzed for this request in the DISIS-2015-002-1 Impact Restudy, DISIS-2015-002-2 Impact Restudy and DISIS-2015-002-4 Impact Restudy. The Interconnection Customer's requested in-service date is November 1, 2017.

The interconnecting Transmission Owner, Southwestern Public Service Company (SPS), performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times needed to grant the requested Interconnection Service.

PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

Interconnection Customer shall be entitled to compensation in accordance with Attachment Z2 of the SPP OATT for the cost of SPP creditable-type Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, that are not otherwise refunded to the Interconnection Customer. Compensation shall be in the form of either revenue credits or incremental Long Term Congestion Rights (iLTCR).

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of sixty (60) 2.3 MW General Electric (G.E.) and seven (7) 1.79 G.E. wind generators for a total generating nameplate capacity of 150.53 MW.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collection circuits;
- 34.5 kV to 230 kV transformation substation with associated 34.5 kV and 230 kV switchgear;
- One (1) 230/34.5 kV 100/133/166 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- A five-and-a-half (5.5) mile overhead 230 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 230 kV bus at a new SPS substation ("Tule Creek") to be owned and maintained by SPS. Tule Creek will be located approximately five-and-a-half (5.5) miles from Swisher Interchange 230 kV on the Amarillo - Swisher Interchange 230 kV transmission circuit;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a power factor at the POI between 95% lagging and 95% leading, including approximately 8.1 Mvars¹ of reactors to compensate for injection of reactive power into the transmission system under no/reduced generating conditions. The Interconnection Customer may use wind turbine manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met.

The Interconnection Customer shall coordinate relay, protection, control, and communication system configurations and schemes with the Transmission Owner.

¹ This approximate minimum reactor amount is needed for the current configuration of the wind farm as studied in the DISIS-2015-002 Analysis with generator lead parameter corrections and restudies.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer’s Interconnection Facilities.

Table 1 lists the Interconnection Customer’s estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Interconnection Customer TOIF and Non-Shared Network Upgrade(s)

| TOIF and Non-Shared Network Upgrades Description | Z2 Type² | Allocated Cost Estimate (\$) | Allocated Percent (%) | Total Cost Estimate (\$) | Estimated Lead Time |
|---|----------------------------|-------------------------------------|------------------------------|---------------------------------|----------------------------|
| <u>SPS Tule Creek Interconnection Substation - Transmission Owner Interconnection Facilities:</u> Construct one (1) 230 kV line terminal, line switches, dead end structure, line relaying, communications, revenue metering, line arrestor and all associated equipment and facilities necessary to accept transmission line from Interconnection Customer’s Generating Facility. | N/A | \$260,000 | 100% | \$260,000 | 24 Months |
| <u>SPS Tule Creek Interconnection Substation - Non-Shared Network Upgrades:</u> Construct three (3) 230 kV 3000 continuous ampacity breakers, cut in transmission line and re-terminate, acquire 20 acres of land, control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials. | Non-Creditable | \$7,307,148 | 100% | \$7,307,148 | |
| Total | | \$7,567,148 | 100% | \$7,567,148 | |

² Indicates the method used for calculating credit impacts under Attachment Z2 of the Tariff.

SHARED NETWORK UPGRADE(S)

The Interconnection Customer’s share of costs for Shared Network Upgrades is estimated in **Table 2** below.

Table 2: Interconnection Customer Shared Network Upgrades

| Shared Network Upgrades Description | Z2 Type | Allocated Cost Estimate (\$) | Allocated Percent (%) | Total Cost Estimate (\$) |
|---|----------------|-------------------------------------|------------------------------|---------------------------------|
| <p>Border – Chisholm 345 kV Circuit #1 and #2: Build thirty (30) miles of double 345 kV circuit from Border (OKGE) – Chisholm (AEP), convert Border 345 kV bus to breaker-and-a-half configuration for acceptance of the new line terminal and install seven (7) 345 kV 5000 continuous ampacity breakers, and expand Chisholm 345 kV bus for acceptance of the new line terminal by installing three (3) 345 kV 3000 continuous ampacity breakers. Border and Chisholm substations will require upgrades including: control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials.</p> | Creditable | \$6,888,625 | 8.15% | \$84,546,835 |
| <p>Crawfish Draw – Border 345 kV Circuit #2: Build one-hundred-ninety-four (194) miles of second 345 kV circuit from Crawfish Draw (SPS) – Border (OKGE), expand Crawfish Draw substation for acceptance of the new line terminal by installing one (1) 345 kV 3000 continuous ampacity breakers, and expand Crawfish Draw substation for acceptance of the new line terminal by installing one (1) 345 kV 5000 continuous ampacity breakers. Crawfish Drawn and Border substations will require upgrades including: control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials.</p> | Creditable | \$19,237,565 | 8.21% | \$234,229,687 |
| <p>Crawfish 345/230 kV Substation Upgrade: Tap Border – TUCO and Tap TUCO - Oklaunion approximately three (3) miles from TUCO, build Crawfish Draw 345 kV substation, add 345/230/13.2 kV transformer, and tie on TUCO – Swisher 230 kV.</p> | Creditable | \$6,923,962 | 27.96% | \$24,764,205 |
| <p>Potter County 345/230/13 kV Transformer Circuit #2: Build second 345/230/13 kV transformer at Potter County. Along with this new 560 MVA transformer, install two (2) 345 kV circuit breakers, one (1) 230 kV circuit breaker and associated substation terminal equipment.</p> | Creditable | \$1,700,338 | 25.46% | \$6,679,535 |
| Total | | \$34,750,490 | | \$350,220,262 |

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

PREVIOUS NETWORK UPGRADE(S)

Certain Previous Network Upgrades are currently not the cost responsibility of the Interconnection Customer but will be required for full Interconnection Service.

- None

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

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 150.53 MW can be granted. Interconnection Service will be delayed until the Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are completed. The Interconnection Customer’s estimated cost responsibility for Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are summarized in the table below.

Table 3: Cost Summary

| Description | Allocated Cost Estimate |
|---|--------------------------------|
| Transmission Owner Interconnection Facilities | \$260,000 |
| Network Upgrades | \$42,057,638 |
| Total | \$42,317,638 |

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).

APPENDICES

A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT

See next page for the Transmission Owner's Interconnection Facilities Study Report.



**Facilities Study For
Southwest Power Pool (SPP)**
Swisher County, Texas
GEN-2015-031
Total Output is 300 MW
Generation Facilities

January 25, 2016

Transmission Planning South
Xcel Energy Services

Executive Summary

Interconnection Customer (IC) requested an interconnection of a wind energy facility, located in Swisher County, Texas, to the Southwestern Public Service Company (SPS) transmission network. This facility has a net capacity of 300 MW. The Interconnection Customer's facility will connect to a new SPS 230 kV 3 breaker ring-bus substation (Tule Creek Substation) on the existing Swisher Interchange to Amarillo South Interchange K63 230 kV transmission line approximately 5.5 miles from Swisher Interchange towards Amarillo South. The IC's requested commercial operation date is 12/01/2017.

The Southwest Power Pool (SPP) evaluated the request (GEN-2015-031) to interconnect the wind generation facility to the SPS transmission system in a Definitive Interconnection System Impact Study (DISIS-2015-002), which was completed in January 2016. The interconnection request was studied using one-hundred eighteen (118) units of GE 2.3 MW each and sixteen units of GE 1.79 MW each for a total of $(271.4 + 28.64) = 300.04$ MW wind generation. The Interconnection Customer is required to build 230 kV transmission line from their wind farm substation to the SPS's new Tule Creek Substation. The IC 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 for SPS found in the Xcel Energy Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW at the following link:

<http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.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 costs of the Interconnection Facilities and Direct Assigned Transmission Owner Interconnection Facilities; inclusive of all construction required for the 230 kV to interconnect at SPS's Tule Creek Substation.

The shared network upgrades will be determined at a later date by SPP and may impact the total overall costs for interconnection for the Interconnection Customer.

It is anticipated that the entire process of building the new Tule Creek substation for the acceptance of the IC's Wind Farm facility output and the network upgrades allocated to this project will require approximately 24 months to complete after an Interconnection Agreement is signed and an authorization to proceed is received. The cost of these upgrades, inclusive of the IC'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

| | | |
|--|----|------------------|
| Shared Network Upgrades | \$ | TBD |
| Network Upgrades: | \$ | 7,307,148 |
| Transmission Owner Interconnection Facilities: | \$ | 260,000 |
| Total: | \$ | 7,567,148 |

^a The cost estimates are 2015 dollars with an accuracy level of ±20%.

General Description of SPS^b Facilities

1. **Construction of New Tule Creek Substation:** 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 Tule Creek Substation which includes three (3) 230 kV breakers. Appendix A, Figure A-2, shows a preliminary one-line of Tule Creek Substation, 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. **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 411L and an SEL 311C will be used as primary and secondary relays, respectively. The SEL 411L will be used for line/bus SCADA closing conditions for the 230 kV breakers. Also, a SEL 351S will be used for breaker failure.

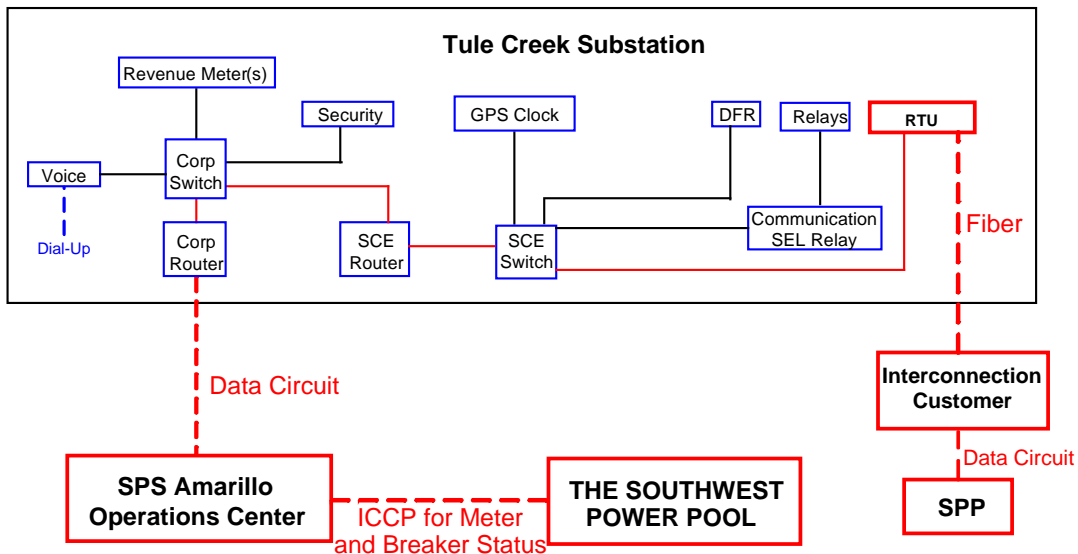
An SEL 411L will display the bus voltage, GCB amps, MW, MVAR, and fault location. A communication relay will be installed and for other functions as required.
 - 1.4. **Revenue Metering:** An individual billing meter will be installed at Tule Creek Substation on the 230 kV line terminal from the IC's 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.
 - 1.5. **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 syncing clock. This equipment will have communication capability with a dedicated communication circuit. The disturbance equipment will have its own dedicated communications circuit.
 - 1.6. **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; these costs will be directly assigned to the IC. The IC will provide and install an RTU for metering and telemetry at the IC's facility as required by the latest Xcel Energy Interconnection Guidelines.

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

1.7 Communications: To meet its Communications obligations, the Interconnection Customer shall be responsible for making arrangements with the local phone company to provide a communication circuit 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 at Tule Creek Substation. Prior to any construction, the IC is required to contact the Transmission Owner substation-engineering department for all communication details and provide detail of the method to be used in communication.

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

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 from the customer substation to Tule Creek Substation for protective relaying and for transmitting metering and status data to SPS. Utilizing this fiber optic connection, SPS will establish a direct connection to the IC's RTU.

SPS will not serve as a proxy for communication from the IC to SPP.

2. Transmission Work:

- 2.1 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 Tule Creek Substation. This line is shown in Appendix A, Figure A-1 and is approximately 2.0 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.**

3. Right-Of-Way:

- 3.1 **Permitting:** The IC 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 the new Tule Creek Substation.

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 solar 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 using the 2015 MDWG 2020S with MMWG 2019S on the 230 kV at Tule Creek Substation located approximately 5.5 miles north of the Swisher Interchange on circuit K-63, 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 2015-031) | | | | |
|---|----------------------|---------|------------------------|-----------------|
| Fault Location | Fault Current (Amps) | | Impedance (Ω) | |
| | Line-to-Ground | 3-Phase | Z^+ | Z^0 |
| 230 kV Bus | 6,285 | 8,686 | $2.53 + j14.97$ | $6.71 + j31.96$ |

Estimated Construction Costs

The projects required for the interconnection of 300 MW Wind Generation facilities consist of the projects summarized in the table below.

Table 3, Required Interconnection Projects^c

| Project | Description | Estimated Cost |
|---------|--|---------------------|
| | Shared Network Upgrades: | |
| 1 | Shared Network Upgrades | TBD |
| | Subtotal: | \$ TBD |
| | Network Upgrades (funded by IC). Stand Alone: | |
| 2 | Communication Equipment (DFR, RTU and other related items) | \$ 371,935 |
| 3 | Land Approximately 20 acre | \$ 133,170 |
| 4 | Build new 3-ring bus for new Tule Creek Substation with three new 230 kV breakers. | \$ 5,643,191 |
| 5 | Tap Swisher to Amarillo South 230 kV "In and Out". | \$ 904,816 |
| | Replace Relaying at Swisher and Amarillo South | \$ 254,036 |
| | | |
| | Subtotal Network Upgrades Constructed by Owner: | \$ 7,307,148 |
| | | |
| | Transmission Owner Interconnection Facilities (direct assigned to IC) | |
| 6 | Communications ^d | \$ See footnote |
| 7 | Revenue metering | \$ 230,000 |
| 8 | 230 kV Line arrestors | \$ 30,000 |
| | Subtotal: | \$ 260,000 |
| | | |
| | Total Cost | \$ 7,567,148 |

Engineering and Construction:

An engineering and construction schedule for this project is estimated at approximately 24 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 1.6.

Appendix A

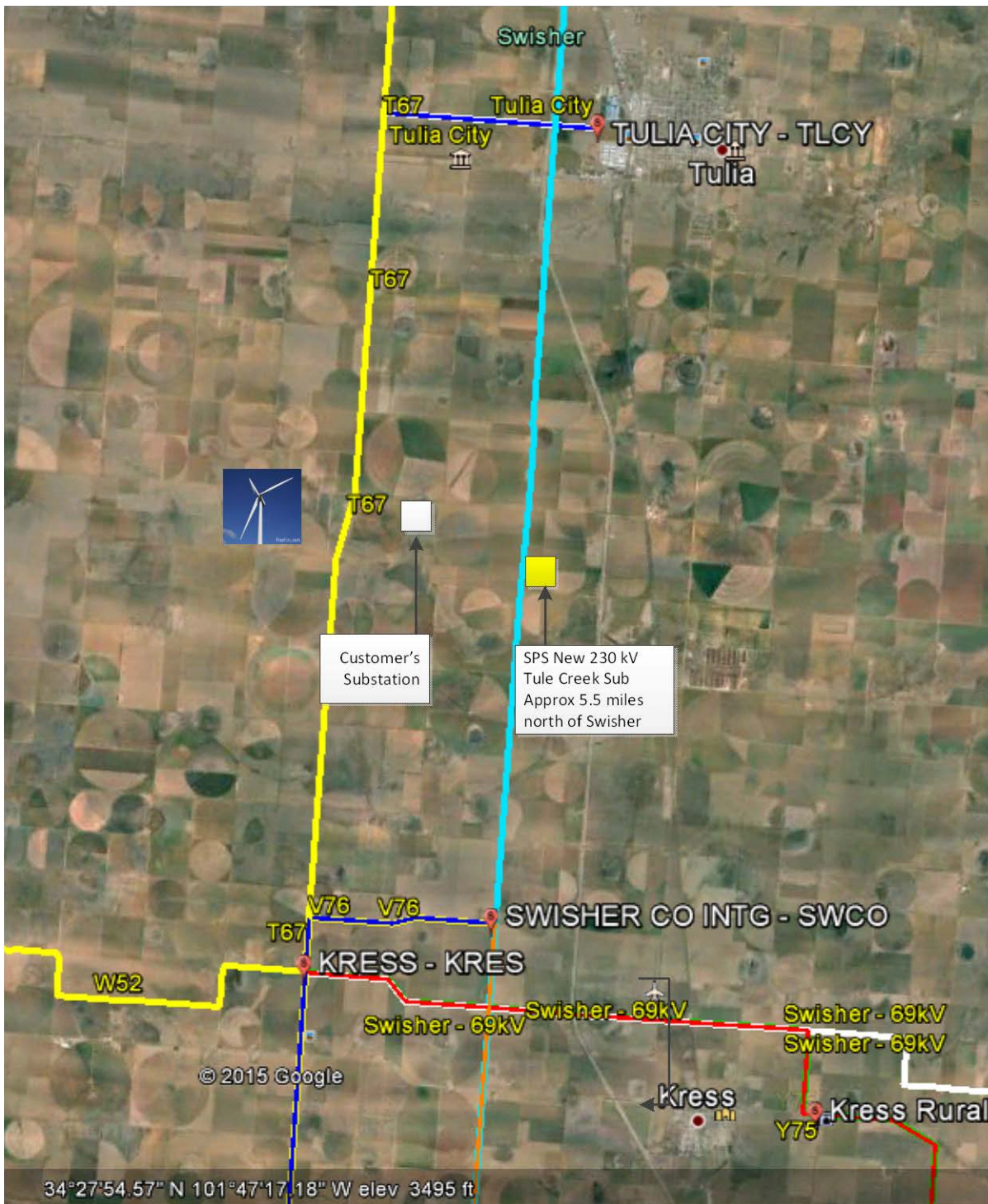


Figure A-1. Approximate location of Tule Creek Substation and Wind Farm

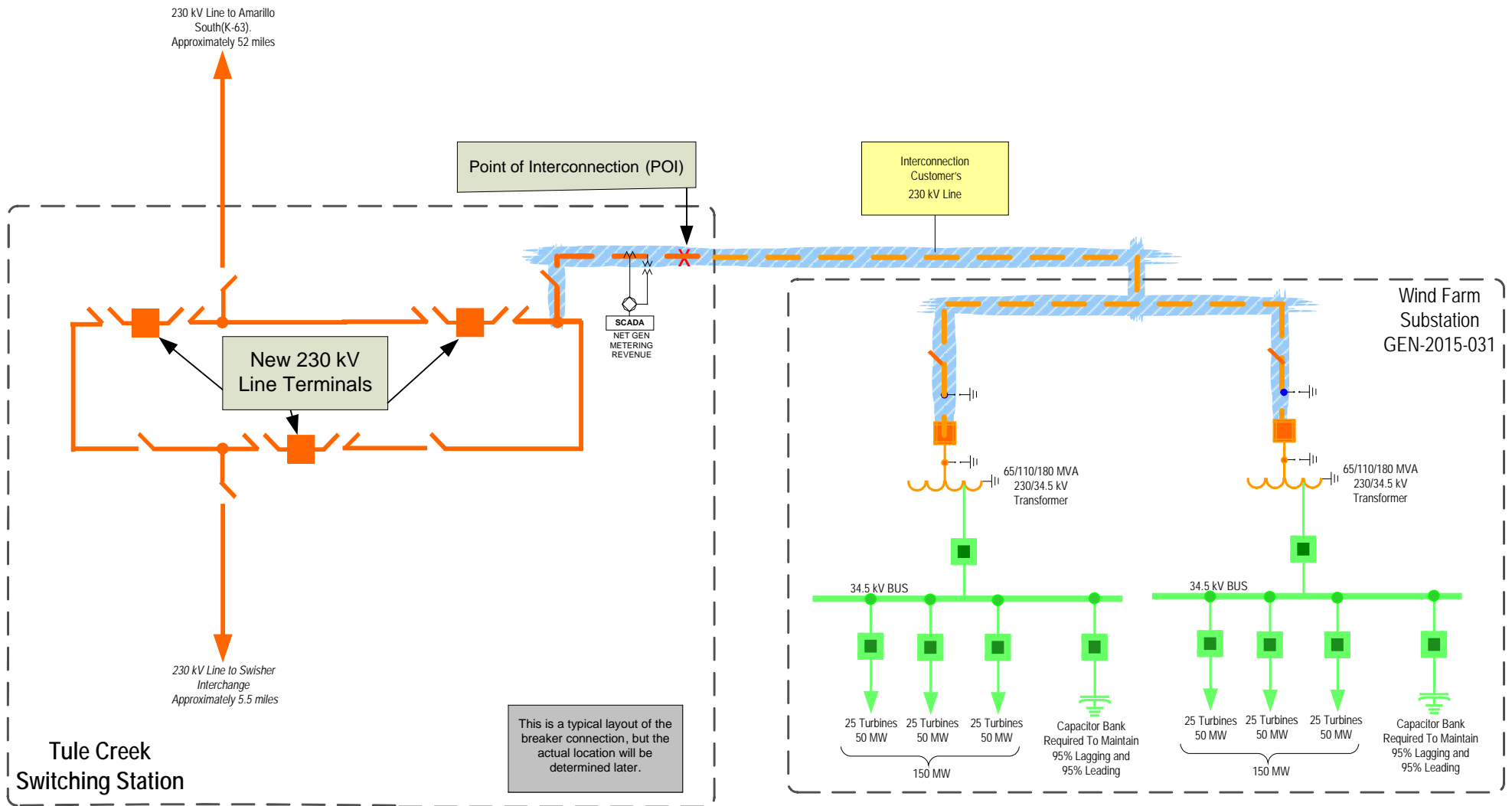


Figure A-2. One-line Diagram of New Tule Creek Substation.

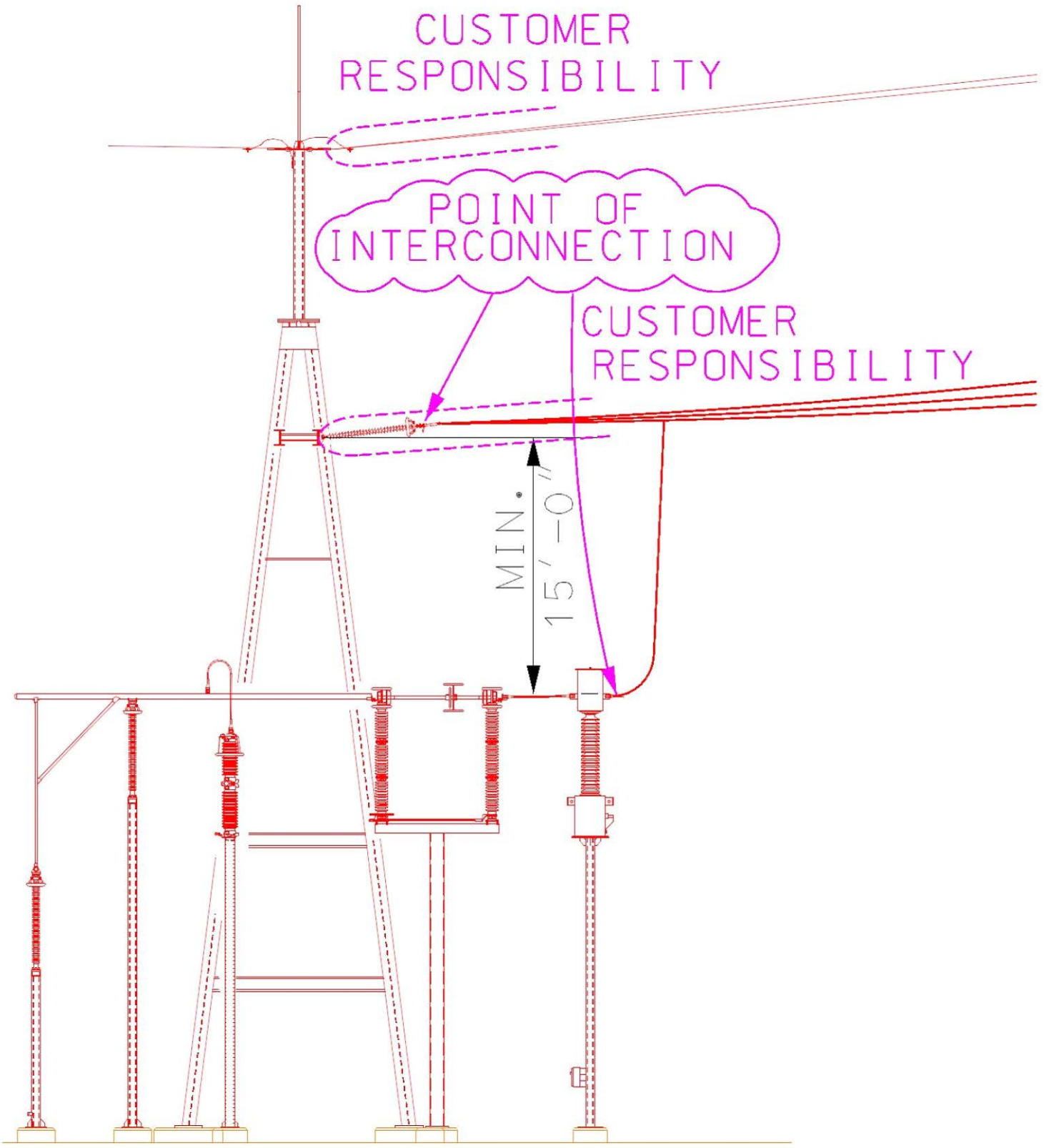


Figure A-3 Point of Interconnection & Change of Ownership (Typical)

– END OF REPORT –