



## **Interconnection Facilities Study Report**

### **Request # GI-2006-1g**

Peetz Logan Interconnect, LLC.  
Facility Study

October 23, 2006

Xcel Energy Services, Inc.  
Transmission Planning – Denver, CO

## I. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect 400 MW<sup>1</sup> of new wind generation at the PSCo Pawnee Station in Morgan County, Colorado. The new wind generation facility would be located near Peetz, Colorado and would interconnect at Pawnee Station via the Customer's 70-mile 230 kV transmission line. The requested commercial in-service date is October 2007 and a requested back feed date of April 2007. This study indicates that the April 2007 back feed date is achievable to facilitate the commercial in-service date of October 2007. Subsequent to the back feed date, and prior to the commercial operation date, the PSCo system will accept test power and energy from the new wind generation facility, up to the facility's full output capacity.

The recommended Network Upgrades for Interconnection at Pawnee Station include a 230 kV circuit breaker, associated switches, metering and transmission line rearrangement.

The total estimated cost for the facilities required for interconnection is approximately **\$1.538 million**<sup>2</sup> including:

- \$0.593 million for Transmission Provider's Interconnection Facilities (Customer Funded)
- \$0.945 million for PSCo Network Upgrades for Interconnection

The estimated time required to engineer, permit, and construct the facilities described above is at least **12 months** from the date of notice to proceed from the Customer. PSCo anticipates they can meet the back feed date of April 2007<sup>3</sup>.

This wind project was evaluated as a Network Resource, with power directed to PSCo customer loads. During the modeling of the wind project, re-dispatch of other PSCo resources in the vicinity of the wind project were used to manage any potential transmission limitations. Therefore, the costs associated with the wind project only consist of those associated with the interconnection of the wind facility.

A simple diagram of the regional transmission system for this request is depicted in Figure 1, and a simple one-line diagram of the proposed interconnection facilities shown in Figure 2.

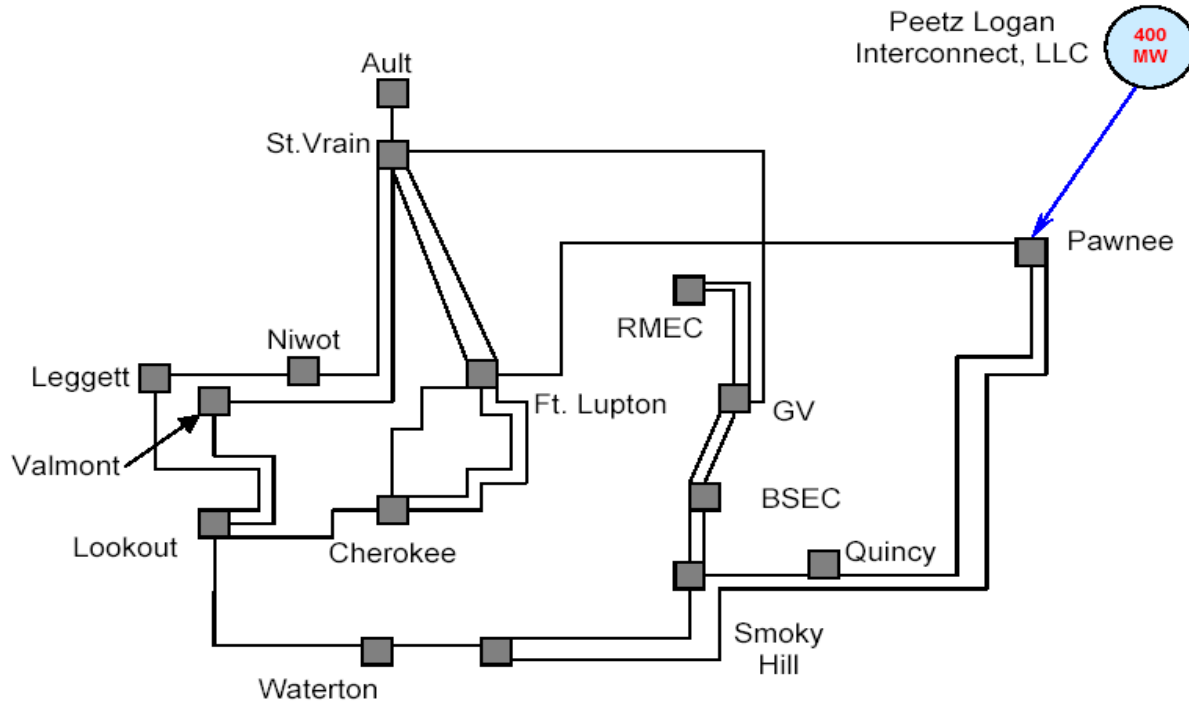
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<sup>1</sup> The 400 MW is split 200 MW each between two separate entities each with their own Power Purchase Agreements (PPA's) with Xcel Energy Markets.

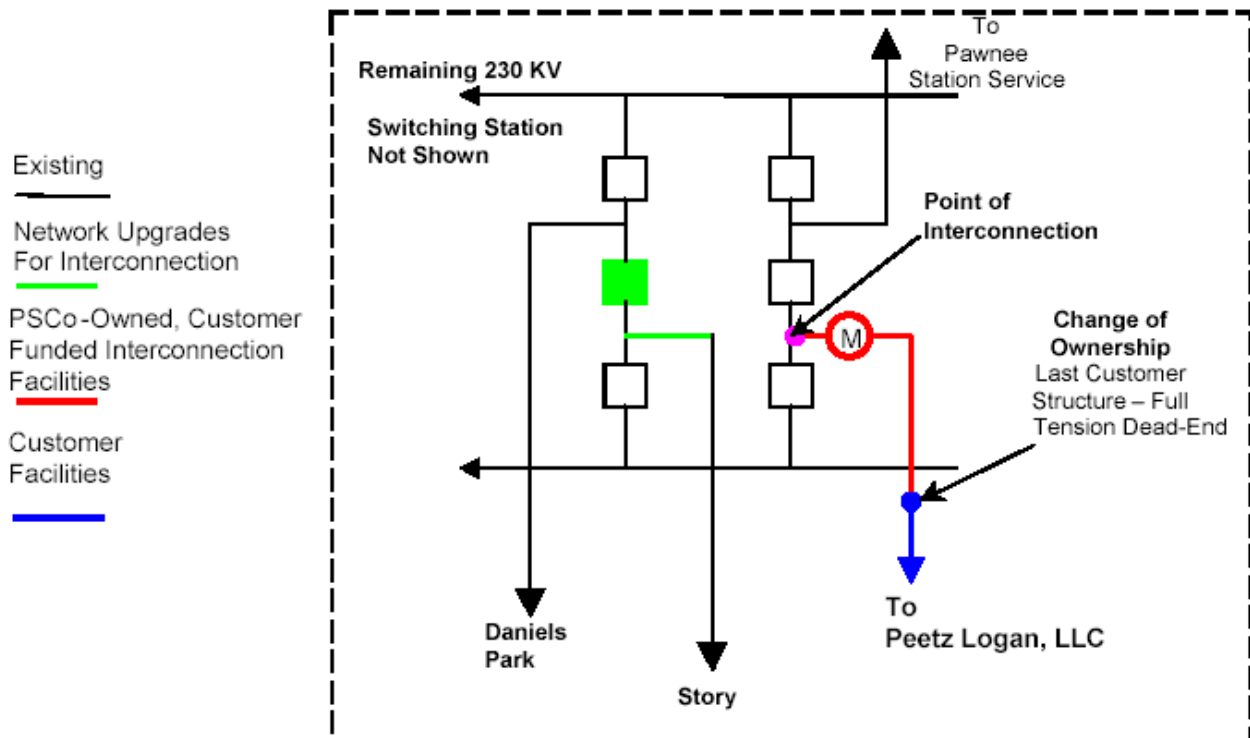
<sup>2</sup> Appropriation estimate considered to have an accuracy of +/- 20%.

<sup>3</sup> PSCo and the Customer executed an Engineer and Procure (E&P) Agreement in March 2006.

**Figure 1: PSCo's Regional 230 kV Transmission System One-Line Diagram**



**Figure 2: Interconnection One-Line Diagram**



## II. Introduction

On February 10, 2006 Xcel Energy Transmission received a request to conduct a System Impact study that would evaluate the integration of a “cluster” of potential generation resources. The Peetz Logan Interconnect Project was one of the resources considered in the “cluster-study”. The System Impact Study report was issued and posted on the Rocky Mountain Area OASIS (RMAO) web site on May 25, 2006 and June 21, 2006 at which date the Peetz Logan Interconnect Project was identified as a project that would proceed with the Facility Study process. An Interconnection Facilities Study Agreement was executed with the Customer on July 21, 2006.

## III. General Interconnection Facilities Description

### 1. Project Purpose & Scope

The purpose of this project is to interconnect a wind generation facility of 400 MW into PSCo’s existing Pawnee 230 kV Station. The Customer intends to build a 70-mile 230 kV transmission line from their site to the station. The wind generation project will be located in Peetz, Colorado. The additional equipment at Pawnee due to the Customer’s new transmission will have little effect on the size of the switchyard. The new transmission line from the Customer’s wind site will terminate into an existing bay that will be vacated by moving an existing termination over one bay to accommodate the new transmission line. Figure 6 shows a preliminary one-line diagram of the interconnection to Pawnee Station. Figure 7 shows a general location overview of all facilities.

### 2. Background

Pawnee substation is a 5 bay breaker and half transmission switching station, which sits adjacent to the Pawnee Generating Station. Presently the Pawnee Generating Station and other nearby generators inject over 1000 MW into the local area.

### 3. Other Considerations

None.

### 4. Interconnection & Network Upgrades for Interconnection

Requirements for interconnection can be found in the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW – Version 2.0<sup>4</sup>, last revised in January 2004. Xcel Energy requires the Interconnection

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<sup>4</sup> Guidelines can be found at [www.xcelenergy.com](http://www.xcelenergy.com)

Customer to construct the Interconnection Facilities in compliance with this document. 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 also requires 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, Western Electricity Coordinating Council, and Federal Energy Regulatory Commission or their successor organizations.

a) Removals and Relocations

The Story 230 kV Transmission line will be moved one bay to the West.

b) Fault Current

The present day maximum fault current at the Pawnee Substation is 20 kA for a 3-phase short circuit fault current and 22 kA for a single-phase to ground fault. These values have been modeled prior to the new generation being installed.

c) Right of Way

The Pawnee 230 kV Switchyard will not need to acquire additional land.

d) Pawnee Substation 230 kV bays and bus:

The new bay will be constructed to match the existing 2.5" Aluminum tubing rated at 1,550 Amps.

The existing 230 kV North and South slack buses are constructed with 2-1272 kCMIL Aluminum conductors rated at 2,200 Amps.

e) High Voltage Electrical Installations

The installation at Pawnee substation will consist of adding one 230 kV SF6 circuit breaker, three 230 kV gang switches, one line CCVT, one 230 kV revenue metering package, three 230 kV arresters and various structures will be installed to accommodate the Customer's interconnection

The interconnection guidelines mentioned above require the Customer to install 230 kV circuit breaker protection on the Customer's end of the 70-mile transmission line to isolate PSCo equipment from the generating facility.

The step-up transformers at the customer facility shall be designed to meet the interconnection guidelines mentioned above. The configuration shall be grounded-wye on the 230kV primary side, wye on the 34.5kV secondary side, and delta on the tertiary. The Customer must specify their transformer(s) to meet PSCo's requirements for an effectively grounded system.

f) AC & DC Systems

Existing AC and DC panels are adequate in the Electrical Enclosure Equipment (EEE).

g) Grounding

All standard grounding practices in the substation will be observed. Grounding system is designed according to soil resistivity and fault current levels at the site.

h) Lightning Protection

The substation will be shielded with static wire.

5. Civil Features

a) Grading and Fencing

The 230 kV switchyard will not be expanded.  
The fence will not be modified.

b) Foundation and Structural

Standard foundations will be used along with standard steel structures.

c) Removals and Relocations:

No foundations are required to be removed or relocated.

d) Installations

The following equipment will be installed at the Pawnee Switchyard:

- One (1) 230 kV dead end tower
- One (1) 230 kV circuit breaker
- Three (3) 230 kV gang switches
- One (1) 230 kV CCVT
- Revenue metering packages including structures
- Associated bus work

## 6. Protection and Control Features

A new relay panel will be installed in the control building. Line protection will consist of a primary relay with pilot communication over fiber in a differential scheme with step distance protection elements utilized as a backup feature, a secondary relay also using fiber in a blocking scheme with step distance protection elements used as a backup feature, and a breaker-failure relay. Since this is a radial line owned by the Customer, no automatic high-speed re-closing will be utilized. Transmission line relay settings and coordination will be performed in conjunction with the Customer. Transmission line relay design by the Customer shall be subject to review by PSCo.

a) Transmission Line protection

A new relay panel will be installed in the control building. Line protection will consist of a primary distance relay using pilot communication over fiber in a DCB scheme and a step distance protection scheme without communication -, a secondary relay –using step distance protection elements, and a breaker-failure relay. Since this is a radial line owned by the Customer, no automatic high-speed re-closing will be utilized. Transmission line relay settings and coordination will be performed in conjunction with the Customer. Transmission line relay design by the Customer shall be subject to review by PSCo.

Reclosing will be included in the SEL 321 protection package. There will not be high speed reclosing. Reclosing will be for a dead line condition after a delay of 1.5 seconds. Reclosing will be selective for single-line to ground faults only with permission from the primary relay package.

Sync Check will use the existing PLC sync check system in place.

The existing RTU at the Pawnee Substation will be utilized and if necessary expanded for Local SCADA information

## 7. **Disturbance Monitoring Device**

The existing Digital Fault Recorder in the Pawnee Switchyard will be expanded.

## 8. **Communications**

A new RTU<sup>5</sup> for LF/AGC (Load Frequency Control/Automatic Generator Control) will be required at the Customer's substation, that will provide information to a new RTU to be installed at the PSCo Control Center. Customer will supply all necessary AC and DC station service and space for the required equipment. Customer will need to supply a communication circuit for the RTU located at the Customer's facility and to the PSCo Control Center. Typical data required, *subject to change*, will be:

- Breaker Status for all breakers in the Customer's substation.
- MW and MVAR information for all lines coming into or leaving the Customer's substation.
- Voltage values for each phase.

The Customer will need to supply two-communication circuits; One from the RTU located at their substation to PSCo Control Center. The second circuit will need to go from the RTU located at their substation to the PSCo Pawnee substation.

Customer will need to supply protective relaying communication circuits going from their substation to the PSCo Pawnee substation.

## 9. **Outages**

The outages will be kept to a minimum during the expansion of the 230 kV bus at Pawnee Switchyard.

## 10. **Project and Operating Concerns**

There appears to be no significant Project or Operating Concerns at this time.

## 11. **Assumptions for Peetz Logan Interconnect Facility**

Customer will comply with FERC Order 661-A<sup>6</sup> and guidelines for Low Voltage Ride Through (LVRT) capability. PSCo modeled the GE 1.5 SLE turbines with LVRT of

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<sup>5</sup> Xcel Energy's Policy on Load Frequency Control for Wind Powered Generation is currently under review and subject to change.

<sup>6</sup> This can be found at [www.ferc.gov](http://www.ferc.gov).



0.15 per unit voltage as provided by the Customer. Any change in turbines will requires a re-study of the System Impact Study.

Customer will provide reactive support equipment to meet voltage tolerances and power factor at the point of interconnection as required by Xcel Energy and FERC interconnection guidelines.

Customer will engineer, procure, and construct all equipment up to their last 230 kV full-tension transmission structure just outside PSCo's Pawnee Station. PSCo will install the last span into the substation with Customer provided material.

The Customer will arrange for station service power through the local utility/service provider, as Customer's site is not in PSCo service territory.

Customer has proposed to construct the transmission line with fiber optic ground wire built into the static wire for relay communication.

PSCo needs approximately 4-6 weeks to test. Much of the testing can be performed in parallel with the construction schedule.

## **12. Assumptions for Pawnee Facility**

PSCo meters will be 4-quadrant, bi-directional meters with recorders.

Meters/recorders will be equipped such that they can be accessed remotely through a phone circuit. PSCo will own and operate the metering equipment. PSCo will engineer, procure, construct, own, and maintain all 230 kV facilities associated with the substation expansion.

Equipment lead times will dictate the time needed to build facilities. Current lead times are 9 months.

**IV. Costs Estimates and Assumptions:**

**A. Interconnection**

Table 1 describes the costs assumed for work to be performed by PSCo, and funded by the Customer, for the dedicated “sole-use” interconnection facilities installed between the 230 kV Point of Interconnection located at Pawnee Substation, and the Customer Wind Facility. The estimated non-binding good faith total cost for the PSCo Interconnection Facilities and Network Upgrades to provide an Interconnection for the Customer requested generation is:

- **\$0.593 million for Transmission Providers’ Interconnection Facilities at Pawnee Substation (Customer funded).**
- **\$0.945 million for PSCo Network Upgrades for Interconnection at Pawnee Substation (PSCo funded).**
- **Total Estimated cost of Interconnection = \$1.538 million**

The estimated costs shown above are “appropriation estimates” with an accuracy of  $\pm$  20%. These estimates are in 2006 dollars, do not include escalation, and are based upon typical construction costs for previously performed similar construction. These estimates do not include any costs for any Customer-owned, supplied, and installed equipment and associated design and engineering for the Customer’s facilities.

**Table 1: Transmission Providers Interconnection Facilities (Customer funded):**

Element	Description	Cost (\$Million)
<b>PSCo Pawnee Switchyard</b>	Interconnect 230 kV line from Customer’s Facility to the existing Pawnee 230 kV PSCo switchyard. The major equipment required includes: <ul style="list-style-type: none"> <li>• One 230kV dead-end structure, insulators and hardware</li> <li>• One 230kV transmission line relaying panel</li> <li>• Three 230kV metering units</li> <li>• One (1) RTU and associated equipment at Customers Substation</li> <li>• One (1) JEM-10 metering unit</li> </ul>	<b>\$0.593</b>
<b>Time Frame</b>	<b>Months - Substation</b>	<b>9 months</b>
<b>Total</b>	<b>Customer Interconnection Facilities</b>	<b>\$0.593</b>

Table 2 describes the estimated costs for PSCo Transmission Network Upgrades associated with providing an interconnection to PSCo’s Transmission System.

**Table 2: PSCo Transmission Network Upgrades Required for Interconnection:**

<b>Element</b>	<b>Description</b>	<b>Cost (\$Million)</b>
<b>PSCo Pawnee Substation</b>	Modify the existing Pawnee 230 kV Switchyard to accommodate the Customer's 230 kV transmission. The new equipment required includes: <ul style="list-style-type: none"> <li>• One (1) 230 kV 3000 amp 40 kA circuit breaker</li> <li>• Three (3) 230 kV gang switches</li> <li>• Foundations and structures</li> <li>• Transmission line relaying and control upgrades</li> </ul>	<b>\$0.825</b>
	<b>Transmission Line tap structures and tap</b>	<b>\$0.100</b>
	<b>Siting &amp; Land Rights</b>	<b>\$0.020</b>
<b>Total Cost</b>	<b>Estimated Costs for Network Upgrades for Interconnection</b>	<b>\$0.945</b>
<b>Time Frame</b>	<b>Months - Substation</b>	<b>10-12 months</b>

**B. Major Assumptions for Costs Estimates**

- The estimated costs provided are “Appropriation Estimates” with an accuracy of ± 20%.
- All applicable overheads are included. AFUDC has been included with the PSCo Network Upgrades and removed from the Customer Interconnection Facilities.
- There is no contingency added to the estimates.
- Estimates have not been escalated. All estimates are in 2006 dollars.
- Generation is not in PSCo’s retail service territory, and if the Customer requests PSCo to provide retail load service, the requirements to meet this are not known at this time. Therefore no costs for retail load metering are included in these estimates.
- PSCo (or its contractor) crews will perform all construction and wiring associated with PSCo-owned and maintained equipment.
- A Certificate of Public Convenience and Necessity (CPCN) will not be required from Colorado Public Utility Commission (CPUC) for the PSCo interconnection facilities.
- The total estimated time for design, procurement and construction for the PSCo facilities required for the interconnection is at least 12 months.
- All required transmission outages necessary to support construction will be obtained as needed.

- RTU equipment will be required at the Customer's switching station to provide information to and from PSCo's Operations Center.

#### **V. Engineering, Procurement & Construction Schedule**

The following schedule identifies milestones needed to complete the interconnection of the proposed 400 MW wind generation facility.

The following schedule identifies project milestones for three separate phases of work needed to complete the proposed interconnection: Siting, Permitting & Land Acquisition, Substation Design & Construction and Transmission Line Design & Construction. The total estimated duration to complete all of the required activities and tasks is 12 months.

**Figure 5: Engineering, Procurement & Construction Schedule**

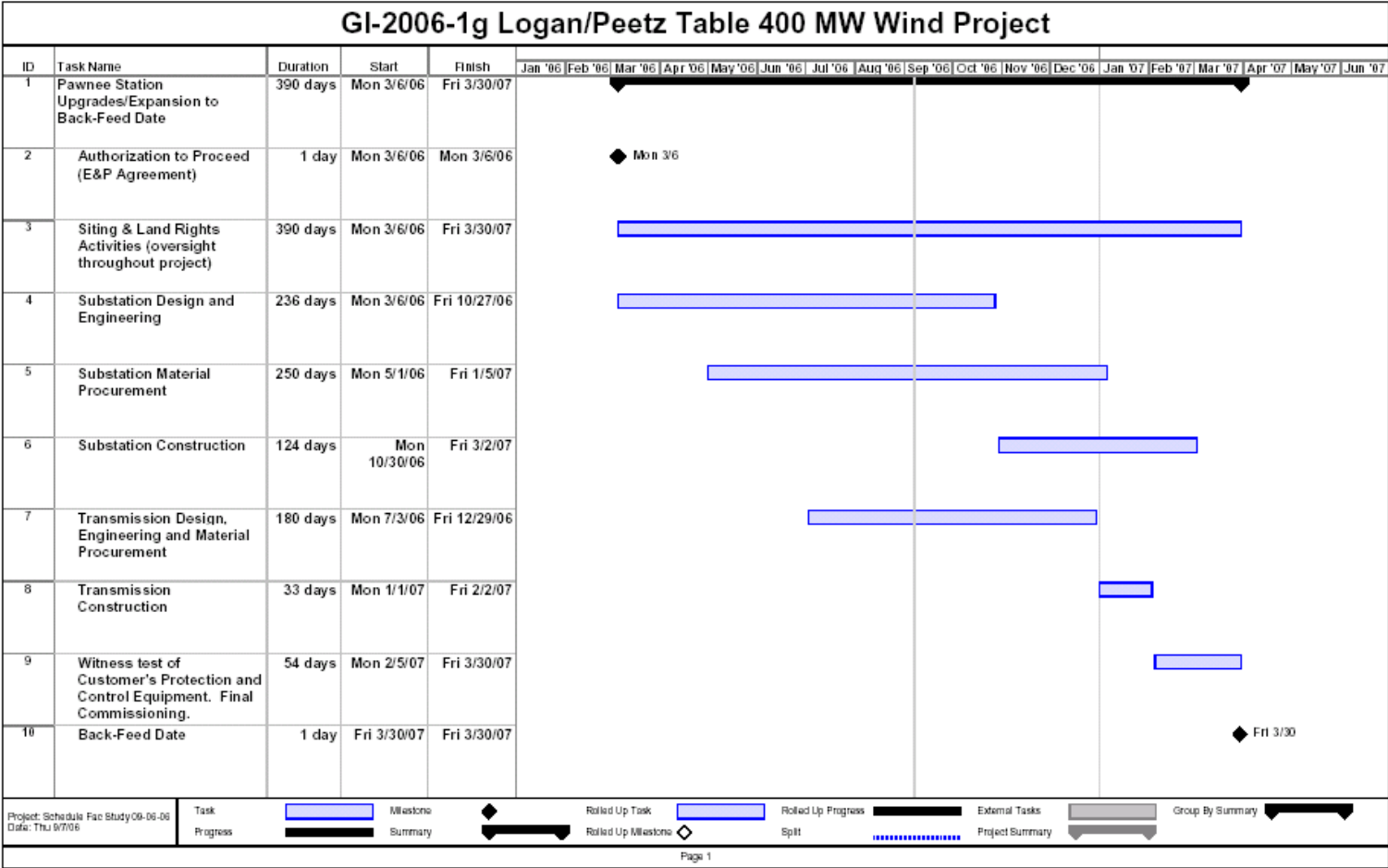


Figure 6: Pawnee Substation: One-Line Diagram

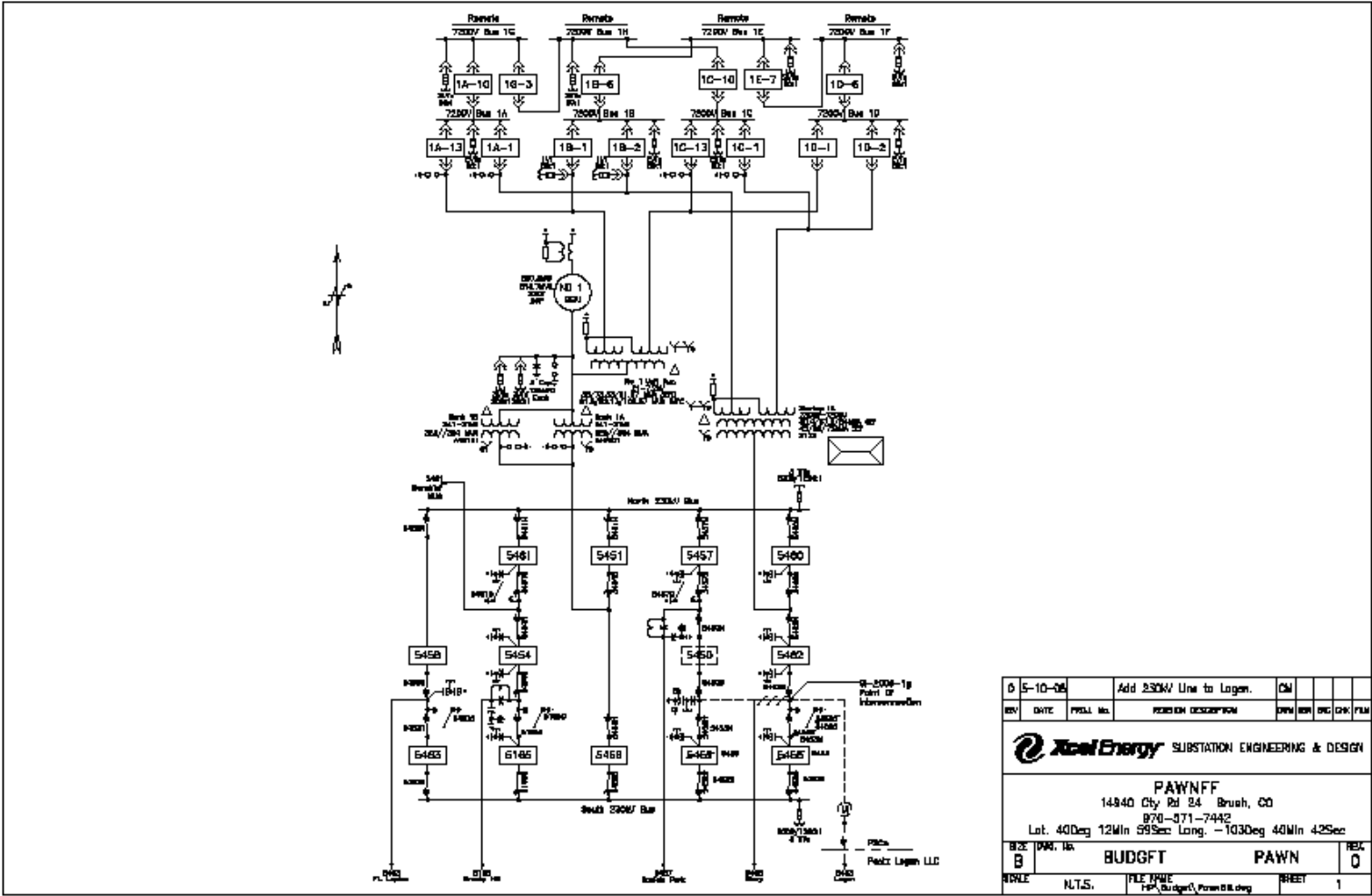


Figure 7: General Location Overview

