Interconnection Facilities Study Report
GI-2007-13

250 MW Cedar Point Wind Energy
At the Proposed Missile Site Switching Station East of Deer Trail, Colorado

PSCo Transmission Planning
April 16, 2010

A. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) in GI-2007-13 to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect a 250 MW wind generation at a new Missile Site Switching Station. The Point of Interconnection (POI) will be the Missile Site Switching Station. For the purpose of this study, the Missile Site Switching Station (including the 230kV three breaker ring bus configuration) is assumed to be part of the "existing system". "Existing system" means that the cost for most of the PSCo-Owned; PSCo-Funded Interconnection Facilities is not considered to be a project cost because the Generation Provider would be interconnecting its transmission line to substation facilities that will be already existing when the interconnection is accomplished. The Missile Site 230kV Substation Project is a Senate Bill 100 Project[1] that is needed for building transmission facilities in renewable resource zones.

The Generation Provider's wind generation facility would be divided into two sites - one site that would connect to the POI with a 32.4-mile 230kV transmission line, and the second site that would connect to the first site with a 7.6-mile 230kV transmission line. The Generation Provider would construct both lines. The Generation Provider proposed an in-service date of September 2010; however, this in-service date has been changed to the first quarter of 2012.

[1] "Senate Bill 100: Energy Resource Zones Transmission Development" established a requirement of Colorado Investor-Owned Utilities (IOU's) to identify energy resource zones, develop plans for the construction or expansion of transmission facilities to deliver electric power, and file applications for Certificates of Public Convenience and Necessity (CPCN) with the Colorado Public Utilities Commission CPUC) every two years. The bill provides an incentive to invest in transmission by authorizing current cost recovery by utilities for building transmission to the renewable resource zones.

The GI-2007-13 System Impact Re-study #2 determined that the proposed 250-MW facility could be considered a Network Resource after resolving one reliability issue. A network upgrade may be needed to address the impact of the proposed generation addition on the following facility:

- The Beaver Creek 224 MVA 230-115kV transformer T3. The facility is owned by Tri-State Generation & Transmission, Inc. (Tri-State G&T).

The Generation Provider and the Transmission Provider (PSCo) will need to address this reliability concern with Tri-State G&T.

The GI-2007-13 Re-Study #2 also requires[2] the Generation Provider to do the following:

- Add 40 MVAR's of capacitance near the POI (please see Figure 1 below called the "Missile Site Capacitor Station", a Generation Provider-owned and constructed facility).
- Add 20 MVAR's of capacitance to each of the two 34.5-kV buses at the Generation Provider's wind generation facility for a total of 80 MVAR (all owned and constructed by the Generation Provider).
- Install dynamic reactive support for the 2012 to 2013 time period to keep the voltage at Missile Site within the 5% voltage criteria. **A more detailed study of the reactive requirements at the Generation Developer's site and at the Missile Site 230 kV POI is needed and is being conducted by the Generation Provider.**

The total estimated cost of the recommended system upgrades to interconnect the project is approximately **$ 0.856 million** and includes:

- $0.848 million for PSCo-Owned, Generation Provider-Funded Interconnection Facilities. This includes a 230kV gang switch, 230kV lightning arrestors, CT/PT's, revenue metering and enclosure, foundations, structures, communications, relaying, testing, etc.
- $0.008 million for PSCo-Owned, PSCo-Funded Network Upgrades for interconnection and substation upgrades required at PSCo's Pawnee Substation (relaying and testing) and PSCo's Daniels Park Substation (relaying and testing).
- $0.0 million for PSCo Network Upgrades for Delivery. PSCo and the Generation Provider will resolve the issues with Tri-State G&T.

A conceptual one-line of the proposed Interconnection is shown in Figure 1 below.

[2] The GI-2007-13 System Impact Re-study #2 recommends the addition of a 345-kV line from Pawnee to Smoky Hill to mitigate the observed criteria violations associated with the addition of the proposed 250-MW facility. This recommendation will be achieved with the construction of the Pawnee-Smoky Hill 345kV line. The Pawnee-Smoky Hill 345kV transmission line is a Senate Bill 100 Project that is scheduled to be in-service in June 2013.

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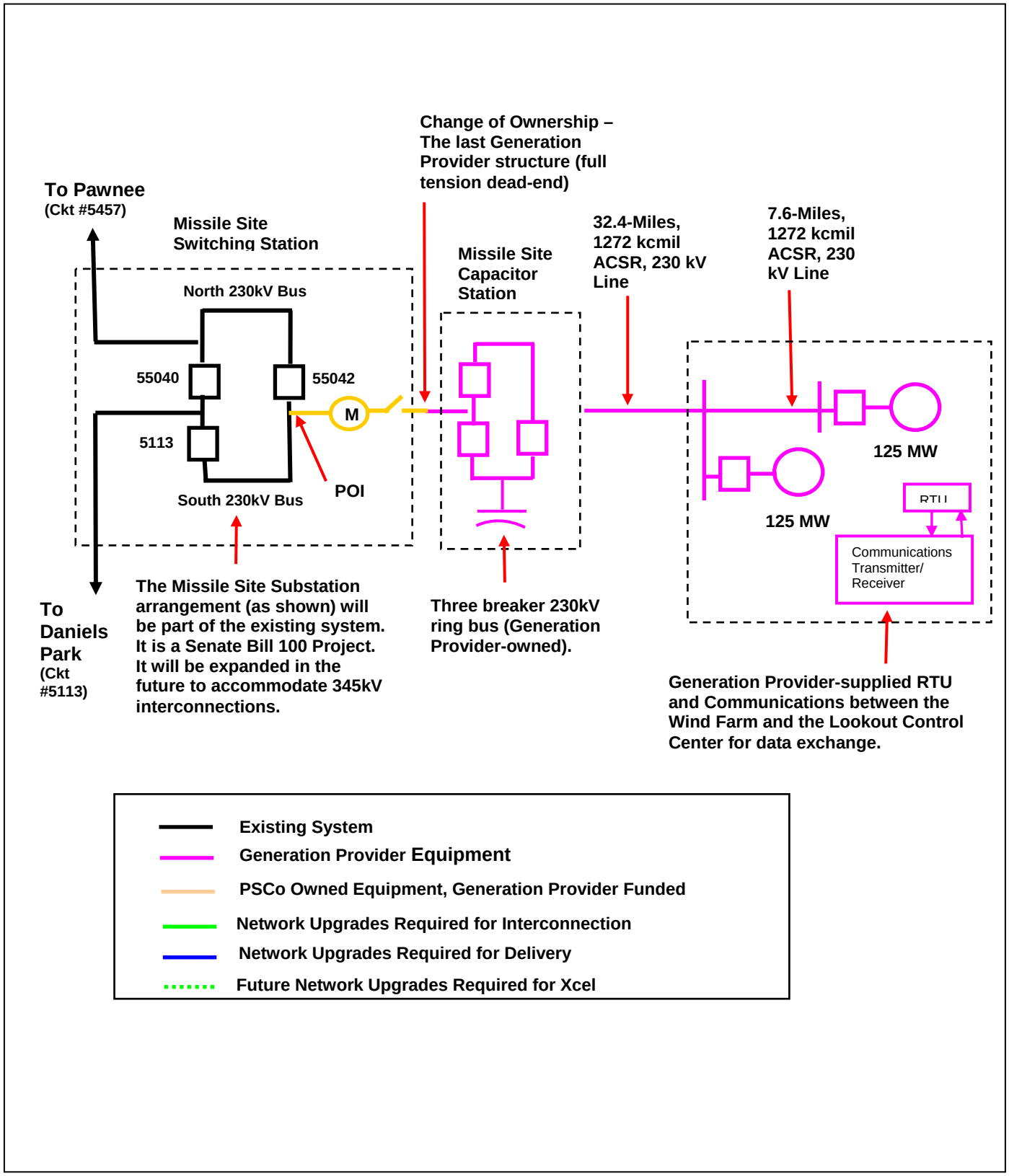
Figure 1. Diagram of the GI-2007-13 Interconnection at Missile Site 230 kV



B. Introduction

On January 28, 2008, Public Service Company of Colorado (PSCo) and a Generation Provider signed an Interconnection Feasibility/System Impact Study request to determine the potential impacts of interconnecting a 300 MW wind powered generation plant on the PSCo Pawnee-Daniels Park 230kV line. The Generation Provider initially proposed a 300 MW wind generation facility using 150 2.0-MW Gamesa Model G87-2.0 wind turbine generators. Subsequent to this interconnection study request, the Generation Provider changed the turbine generator manufacturer from Gamesa to General Electric using 200 GE-1.5 LVRT-II wind turbine generators. The Feasibility Study was completed on October 28, 2008. Subsequently, the Generation Provider elected to reduce the size of the GI-2007-13 Project from 300 MW to 250 MW using 167 1.5-MW GE wind turbines. The first re-study was completed on February 10, 2009.After the first re-study was completed, the Generation Developer elected to change the generating units to 139 Vestas V90 1.8-MW wind turbine generators necessitating the second re-study. The second re-study was completed on December 11, 2009.

The GI-2007-13 System Impact Re-study #2 determined that the proposed 250-MW facility could be considered a Network Resource provided one reliability issue (due to the proposed generation facility) is resolved. Network upgrades may be needed to address the impact of the proposed generation addition on the following facility:

- The Beaver Creek 224 MVA 230-115kV transformer T3 experienced a contingency overload of 101.2% of its nominal rating after the addition of the wind generation facility. The facility is owned by Tri-State G&T.

The Generation Provider and the Transmission Provider (PSCo) will need to resolve this issue with Tri-State G&T.

The GI-2007-13 Re-Study #2 observed other criteria violations on the Tri-State G&T system; however, the re-study found that these criteria violations should be mitigated with the completion of the Erie-Henry Lake-Story 230/115kV double circuit line, a joint transmission project between Western Area Power Administration (WAPA) and Tri-State G&T. In addition, the re-study determined that PSCo's proposed Pawnee-Smoky Hill 345 kV transmission line (that has a scheduled in-service date of June 2013) should provide further benefits to the transmission system in the study area.

The transient stability study determined the following:

- The system remains stable during and after each contingency studied and all system oscillations display positive damping that decrease quickly.
- Criteria violations could occur when the 250-MW facility is at maximum capacity including high voltages at the wind farm 34.5kV bus (under specific contingencies) including voltage changes exceeding 5% at the POI, and voltage dips greater than 25% at the Pawnee 230kV bus for a fault at Pawnee and opening the Pawnee-Smoky Hill 230kV line to clear the fault.

- The GI-2007-13 System Impact Re-Study #2 recommends the addition of the 345-kV line from Pawnee to Smoky Hill to mitigate the observed criteria violations associated with the addition of the proposed 250-MW facility.
- The GI-2007-13 System Impact Re-Study #2 recommends the addition of 40 MVAR of capacitance near the POI and 20 MVAR of capacitance at each of the two 34.5-kV buses at the generation facility for a total of 80 MVAR.
- The Generation Developer will need to install some form of dynamic reactive support for operation in the 2012 to 2013 time period to keep the voltage at Missile Site within the 5% criteria.
- A more detailed study of the reactive requirements at the Generation Developer's site and at the Missile Site 230 kV POI is needed.

The Generation Provider and PSCo have entered into Interconnection Facilities Study Agreement. The purpose of the Interconnection Facilities Study[3] is to do the following:

- Specify and estimate the cost of the equipment, engineering, procurement and construction work needed to implement the conclusions of the Interconnection System Impact Study in accordance with Good Utility Practice to physically and electrically connect the Interconnection Facility to the Transmission System.
- Identify the electrical switching configuration of the connection equipment, including the transformer, switchgear, meters, and other station equipment
- Identify the nature and estimated cost of any Transmission Provider's Interconnection Facilities and Network Upgrades necessary to accomplish the interconnection
- Estimate of the time required to complete the construction and installation of the Transmission Provider's facilities.

C. 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 3.0[3], last revised in December 2006. Xcel Energy requires the Interconnection Generation Provider to construct the Interconnection Facilities in compliance with this document. The guidelines describe the technical and protection requirements for connecting new generation to the Xcel Energy Operating Company transmission system and also requires that the Interconnection Generation Provider be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Council, Public Utility Commission or their successor organizations.

[3] Information for the Facilities Study is taken from Appendix B of the Standard Large Generator Interconnection Procedures (LGIP) including Standard Large Generator Interconnection Agreement (LGIA)

[3] Guidelines can be found at www.xcelenergy.com.

a) Fault Current

A fault study was conducted on the existing system and on the future system with the proposed wind generation facility interconnected at the Missile Site 230kV bus. The study found that for the existing system, the three-phase fault and the single-line-to-ground fault currents are expected to be 6724 amps and 4159 amps respectively at the proposed Missile 230 kV bus. These fault current values increase as additional generators and transmission lines are added to the system.

The fault study considered the impact of adding the proposed 250 MW wind generation facility at the future Missile Site 230kV bus. Table 1 lists the results of the fault studies with the proposed wind generation facility added.

Table 1: Fault Current Information for the Missile Site 230kV Bus with Cedar Point Wind Contribution Represented

System Condition	Three-phase (amps)	Thevenin System Equivalent Impedance (R,X) in ohms	Single-line-to-ground (amps)	Thevenin System Equivalent Impedance (R,X) in ohms
System Intact	I_1=7,677.3 I_2=I_0=0.0 I_A=I_B=I_C=7,677.3	Z_1(pos)= 1.83079,17.1994 Z_2(neg)= 1.83611,17.2042 Z_0(zero)= 8.94664,38.7844	I_1=I_2=1,788.0 3I_0=5,364.1 I_A=5,364.1 I_B=I_C=0.0	Z_1(pos)= 1.83079,17.1994 Z_2(neg)= 1.83611,17.2042 Z_0(zero)= 8.94664,38.7844

PSCo Substation Engineering has studied the interconnection of the proposed wind generation facilities and has concluded that the proposed 250 MW wind farm should not necessitate the replacement of circuit breakers, switches or other substation equipment at neighboring substations due to the increased fault current levels. Please refer to the fault study included with Feasibility Study Report.

b) Right of Way

There will be adequate land and all appropriate easements and land use permits are in place. It is the Generation Provider's responsibility to obtain Right of Way for the interconnection transmission line into the Missile Site Switching Station.

c) High Voltage Electrical Installations

The Missile Site Switching Station will be arranged ultimately in a breaker-and-a-half (BHHB) configuration. Initially, it will be operated in as a 230kV three-breaker ring bus configuration. The initial build-out of the Missile Site Switching Station will already have the breakers and

switches in place to handle the interconnection from the new wind farm. Therefore no additional utility (PSCo) funded equipment will be required.

The Generation Provider is responsible for the costs of all equipment and material that carry the current contributions of the incoming interconnected transmission line. The items include the following:

- Slack span of the interconnection transmission line into the switching station
- A Switching Station dead-end structure and foundation for the new line
- Revenue metering transformers and a metering cabinet
- All associated foundations, steel, grounding, conduit, control cable, and relaying to tie this equipment into the switching station.

At the Lookout Control Center, the wind farm will have to be added to the EMS system, and appropriate Load Frequency/Automated Generation Control/Supervisory Control And Data Acquisition (LF/AGC/SCADA) systems will have to be implemented.

The step-up transformers at the Generation Provider facility shall be designed to meet the interconnection guidelines mentioned above. The configuration shall be grounded-wye on the 230 kV side. The Generation Provider must specify their transformer(s) to meet PSCo's requirements for an effectively grounded system.

d) AC & DC Systems

There will be sufficient room on both the AC and DC panels to tie in the new equipment.

e) Control Building

There will be sufficient room in the control building for the additional relay panel and metering.

f) Grounding

Additional grounding will be installed in the Missile Site Switching Station to effectively tie the new dead-end to the existing ground grid.

g) Lightning Protection

The Missile Site Switching Station static wire system will be tied to the new dead-end on the incoming transmission line.

h) Grading & Fencing

The proposed fence layout will provide the necessary security for the Missile Site Switching Station. Minimal grading will have to be performed.

j) Foundations & Structural

There will be new drilled pier foundations, and new dead-ends.

k) Removals & Relocations

None.

l) Control & Protection – Electrical Installations

Transmission line relaying will have to be installed on the Generation Provider's new 230kV interconnection. Both the primary and secondary protection schemes will utilize a pilot system. Both protection schemes will have non-pilot backup consisting of step-distance phase and ground function, with a directional ground time overcurrent function. For the purposes of the estimate, it was assumed that the Generation Provider will be installing optical ground wire (OPGW) on the transmission line, and that a line current differential scheme will be used for the primary protection.

Three terminal line configurations will not be permitted.

Additional interconnection requirements will need to be satisfied as stated in PSCo's Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW.

The existing RTU at Lookout control center has space to add the additional SCADA points for the additional wind turbines.

m) Outages

Short duration outages will be required on the south 230kV portion of the ring bus at the Missile Site Switching Station.

n) Project and Operating Concerns

There are no known projects or operating concerns at this time.

o) Wind Farm RTU

The Generation Provider will install a Remote Terminal Unit (RTU) at the proposed wind farm to provide real time data to the PSCo operations center including generation control using DNP protocol.

p) Related Substation & Transmission Projects

Refer to System Impact Study for required network upgrades, if any.

q) Assumptions for Generation Provider's Site

The Generation Provider 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. **Since voltage support equipment is required to meet the interconnection requirements, the Generation Provider will be required to construct a capacitor switching station adjacent to the Missile Site Switching Station. The switching station will be laid out as a 230kV ring bus**. The Transmission Provider (PSCo) has determined that tapping the transmission line in a three terminal application is not acceptable. The Generation Provider must install breakers at the tap point in such a configuration that will not create a three terminal scenario.

The Generation Provider will engineer, procure, and construct all equipment up to and including the Missile Site 230 kV Switching Station dead-end structure. The Generation Provider is responsible for transmission line relaying at their end of the line, and will coordinate protection design and settings with PSCo Substation Engineering.

The Generation Provider will need to arrange for station service power through the local utility/service provider, as the Generation Provider's site may not be in the PSCO service territory.

PSCo needs approximately four to six weeks to test requirements of Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW. Much of the testing can be performed in parallel with the construction schedule. A typical testing and commissioning procedure can be provided upon request.

The Generation Provider must comply with FERC Order 661-A and guidelines for Low Voltage Ride Through (LVRT) capability.

The Generation Provider is responsible for providing the following information, subject to change, to the PSCo Lookout Control Center via

a DNP-3 communication protocol.

- MW, & MVAR for each breaker in the Generation Provider's substation(s)
- Breaker Status for all breakers in the Generation Provider's substation(s).
- Wind speed.
- Wind direction.
- High wind cutout/cutoff.
- Generating generation.
- Available generation.

Via this same link, PSCo will supply raise and lower pulses to control the load on the wind generators, if generation curtailment is required by the PSCo Lookout Control Center.

r) Communications

The Generation Provider will need to supply a communication circuit from their site to the PSCo lookout Control Center for the information mentioned above.

D. Costs Estimates and Assumptions

Appropriation level cost estimates for Interconnection Facilities (+/- 20% accuracy) and scoping level cost estimates for Network Upgrades (+/- 30% accuracy) were developed by PSCo Engineering. The cost estimates are in 2009 dollars with escalation and contingencies applied (AFUDC not included) and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the siting support, engineering, design, and construction of these new PSCo facilities. This estimate does not include the cost for any other Generation Provider owned equipment and associated design and engineering.

The estimated total cost for the required upgrades for is **$ 856,000.** Figure 1 located previously in the report represents a conceptual one-line of the proposed interconnection at the Missile Site Switching Station. This estimate did not include the cost for any other Generation Provider-owned equipment and associated design and engineering. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon a more detailed and refined design.

Table 2: PSCo Owned; Generation Provider Funded Interconnection Facilities

Element	Description	Cost Est. (Millions)
Missile Site 230 kV Switching Station	Interconnect Generation Provider to tap at PSCo's New Missile Site 230 kV Switching Station. The new equipment includes: • One 230 kV, 2000 amp gang switch • Three 230 kV combination CT/PT metering units • Three 230 kV lightning arresters • One revenue meter and metering enclosure • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing.	**$0.502**
	Transmission line tap into the switching station. One double circuit steel pole, conductor, hardware and installation labor.	**$0.315**
	Generation Provider Load Frequency/Automated Generation Control and Generator Witness Testing. (Generation Provider generation telemetry equipment and witnessing the Generation Provider generator commissioning testing).	**$0.021**
	Siting and Land Rights support for required easements, reports, permits and licenses.	**$0.010**
	Total Cost Estimate for PSCo-Owned, Generation Provider-Funded Interconnection Facilities	**$0.848**
Time Frame	**Site, design, procure and construct**	**15 Months**

Table 3: PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost Estimate (Millions)
Pawnee 230 kV Substation	Interconnection and substation upgrades required at PSCo's Pawnee Substation (relaying and testing).	**$0.004**
Daniels Park 230 kV Substation	Interconnection and substation upgrades required at PSCo's Daniels Park Substation (relaying and testing).	**$0.004**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$0.008**
Time Frame	**Relaying and Testing**	**3 Months**

Table 4: PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
Tri-State G&T's Facilities	• Issues with the Beaver Creek 224 MVA 230-115kV transformer T3 need to be resolved.	**N/A**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**N/A**
Time Frame	**Network Upgrades for Delivery – to be constructed via the PSCo Capital Budget Construction Process.**	----------
	Total Cost of Project	**$0.0**

Cost Estimate Assumptions

- Appropriation level cost estimates for Interconnection Facilities (+/- 20% accuracy) and scoping level cost estimates for Network Upgrades (+/- 30% accuracy) were developed by PSCo Engineering.
- Estimates are based on 2010 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- PSCo funded and owned interconnection facilities will be constructed and completed by 11/1/10.
- Lead times for materials were considered for the schedule.
- The Wind Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates.
- PSCo (or it's Contractor) crews will perform all construction and wiring associated with PSCo owned and maintained facilities.
- The estimated time to site, design, procure and construct the interconnection facilities is at least 15 months, The estimated time for PSCo to site, design, procure and construct the scope of work identified in Table 2 is 15 months after authorization to proceed has be obtained. This is completely independent of other queued projects and their respective ISD's.
- A CPCN will not be required for interconnection facility construction.
- Generation Provider will string OPGW fiber into the switching station as part of the transmission line construction scope.
- Contractor to construct the new switching station, PSCo crews to perform checkout, relay panel construction and final commissioning.
- Acquisition of a new site this size eliminates the subdivision process.
- The Missile Site Switching Station is located at 82701 E. County Rd. 18, Deer Trail, CO in Arapahoe County. The site is adjacent to the existing transmission line corridor on the west side of the existing 230 kV double-circuit transmission lines at this location. The Generation Provider's

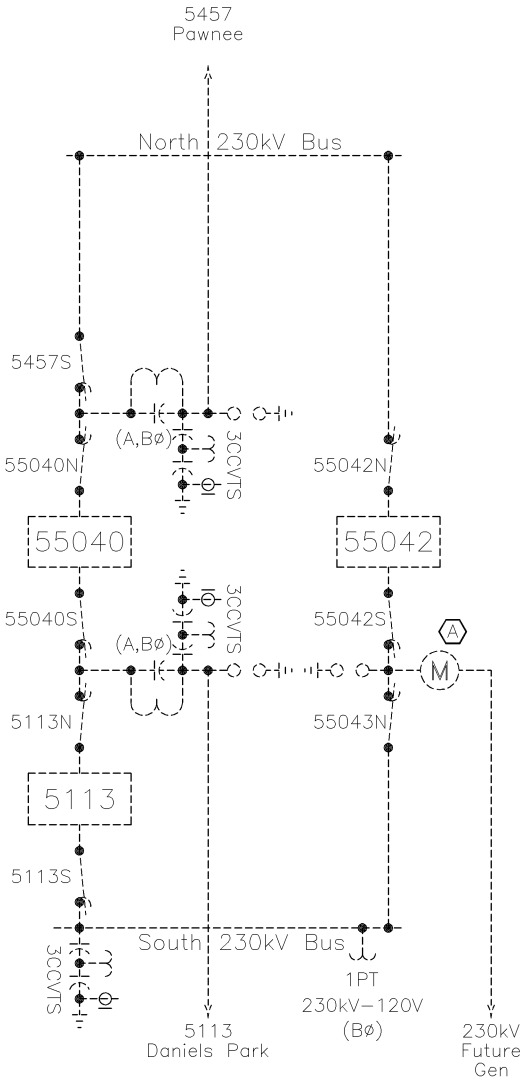
transmission line will come in from the south (heading north) and terminate into the southeast section of the yard.

E. Appendix Items

The Appendix has three sections – Section A that includes the “Project One-Line”, Section B that includes the “Project Schedule”, and Section C that includes sample results from a “Generic Testing Procedure”. The “Generic Testing Procedure” has been supplied to the Generation Provider to make it aware of acceptance tests that would be required for commissioning.

Appendix

A. Project One-Line



Notes:

(A) *The Future Generation Line & Metering Units Are Not Being Installed At this Time. Shown For Clarity Reasons Only.*

REV	DATE	PROJ. No.	REVISION DESCRIPTION	DWN	DSN	ENG	CHK	FILM
C	02-22-10		Changed Bkr & Sw Numbers.	CO				
B	01-19-10		Moved Gen Line To South Bkr Removed Bkr 5457 & Sw 5457N Added Bkr 5113 & Sw 5113S	CO				
A	01-06-10		New 230kV Sub.	CO		JT		

Xcel Energy SUBSTATION ENGINEERING & DESIGN

Missile Site
82701 E. County Road 18,
Deer Trail, CO 80105

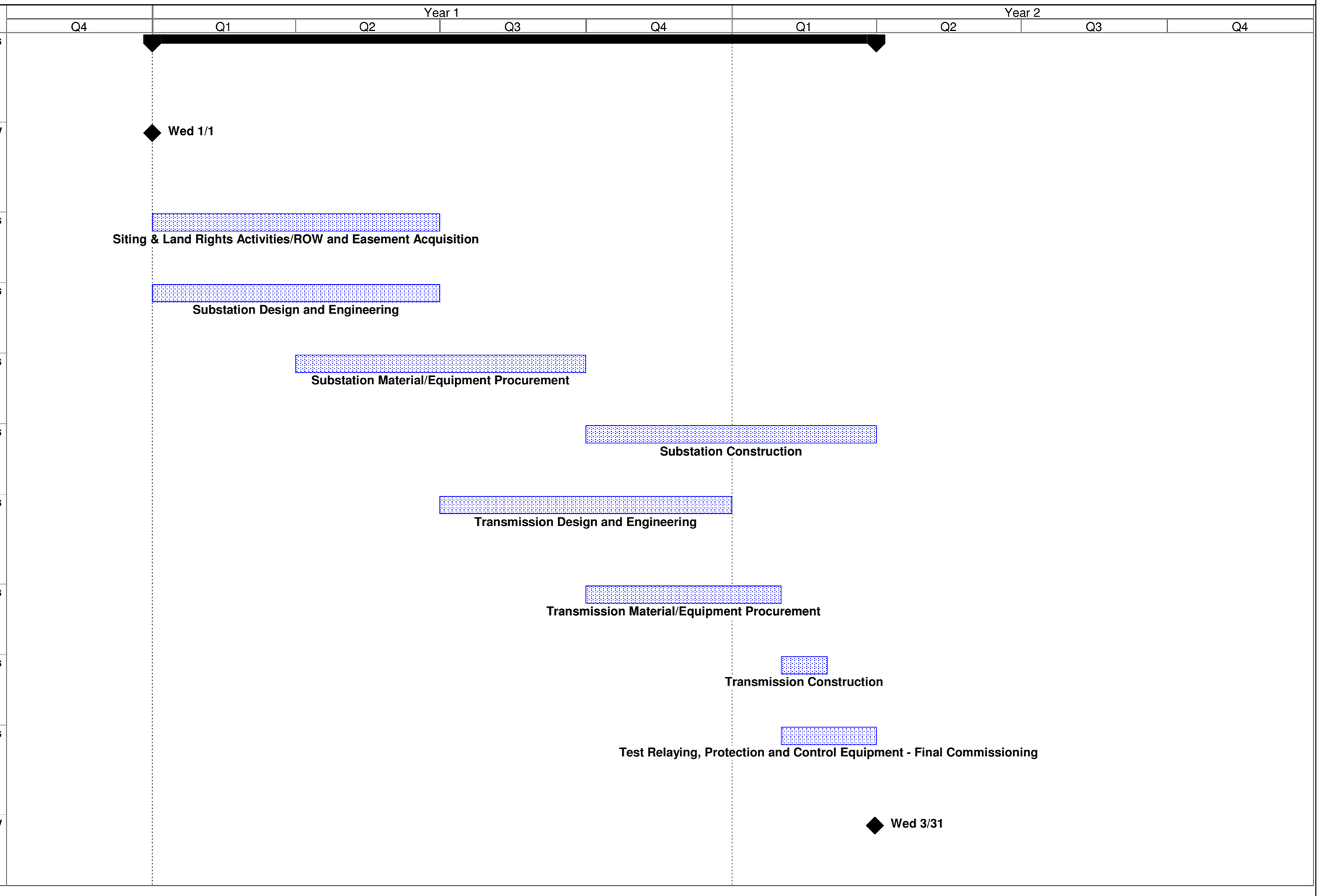
SIZE	DWG. No.		REV.
B	PRELIMINARY	MSST	C

SCALE	FILE NAME	SHEET
N.T.S.	Budget/MsstPl.dwg	1

B. Project Schedule

GI-2007-13 (Facilities Study Report)
250 MW Wind Interconnection Project

ID	Task Name	Duration
1	**GI-2007-13 (Facilities Study Report) 250 MW Wind Interconnection Project**	**456 days**
2	**Authorization to Proceed**	**1 day**
3	**Siting & Land Rights Activities/ROW and Easement Acquisition**	**181 days**
4	**Substation Design and Engineering**	**181 days**
5	**Substation Material/Equipment Procurement**	**183 days**
6	**Substation Construction**	**183 days**
7	**Transmission Design and Engineering**	**184 days**
8	**Transmission Material/Equipment Procurement**	**123 days**
9	**Transmission Construction**	**29 days**
10	**Test Relaying, Protection and Control Equipment - Final Commissioning**	**60 days**
11	**Completion Date**	**1 day**



Project: Schedule 2-26-10.mpp
Date: Mon 3/1/10

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary

C. Generic Testing Procedure

	"Example" Wind Project, Full Rated 300 MW					
	Test Sheet	DRAFT-Based on Power Factor Control as Primary Operating Mode (PSCo may decide on voltage control as primary)				
	*NOTE** Performance test period begins upon 1) successful commissioning of all turbines to be connected to the "Example" Wind Interconnection (300MW) and 2) SCADA in place, with all points available and active, including Lookout to the "Example" Wind Plant and "Example" Wind Plant to the Wind Project Remote Operations*					
	Requirement	**Specific Req.**	**Test**	**Pass**	**Conditions**	
1	Power Factor control at Point of Interconnection (POI)	Normal Plant Operation over full plant output range using primary (power factor)	Set to 1.00 p.f.	Variability recorded and noted	0-P(rated): 0--->300-->0 twice, not curtailed to achieve zero.	Demonstrates normal plant operation over full range using normal reactive power control
2		Plant may not have leading power factor at less than 50% load levels. Within Lead/Lag 0.98 p.f. required at 50+% customer load.	Operate plant at negative VAR input at POI (net inductive)	Mvar <=0, report reactive shunts in use, or other source(s) of reactive compensation	0 MW output (or negative), no turbines generating, 2+ hours, not curtailed to achieve zero.	Demonstrates compliance with TICL II.I (ref. LGIG III.F), requiring plant to not have leading power factor at less than 50% load levels. Lead/Lag 0.98 p.f. required at 50+% customer load. (ref. also NERC Std. VAR-001-1 R2)
3		Lead/Lag limits demonstrated and recorded	Set to 0.950 p.f. Lead	Capability measured and recorded	>92.5% P(rated)=277.5 MW	Demonstrates plant reactive power capability at high output (ref. NERC Standard TOP-002 R13, VAR-001-1 R6)
4			Set to 0.950 p.f. Lag	Capability measured and recorded	>92.5% P(rated)=277.5 MW	
5		Lead/Lag limits demonstrated and recorded	Set to 0.990 p.f. Lead	Measured and recorded	>50% P(rated)=150 MW	Demonstrate plant reactive control at lower output levels (ref. NERC Standard TOP-002 R13,VAR-001-1 R6)
6			Set to 0.970 p.f. Lead	Measured and recorded	>50% P(rated)=150 MW	
7			Set to 0.990 p.f. Lag	Measured and recorded	>50% P(rated)=150 MW	
8			Set to 0.970 p.f. Lag	Measured and recorded	>50% P(rated)=150MW	
9	Voltage control at POI	Raise/lower setpoint	Series selected at time of test, e.g., "raise 2 kV"	Correct direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)=150 MW	Demonstrate voltage control functionality (ref. NERC Standard TOP-002 R13,VAR-001-1 R6)
10			Volt raise 2, as above	Correct direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)=150 MW	
11			Volt lower 1, as above	Correct direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)=150 MW	
12			Volt lower 2, as above	Correct direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)=150 MW	
13		Hold voltage setpoint	Setpoint selected at time of test, e.g., 1.01 p.u.	Voltage held within +/- 1% as plant is capable, variability recorded and noted	>50% P(rated)=150 MW at start of test period, 6+ hours duration	
14	Communication	Responsiveness	Series of reasonable requests, e.g., "switch to voltage control mode", "report # turbines online", "report status of shunt caps & reactors, curtail plant to 120 MW total output.	Professional, prompt (within one minute) response, accurate and complete. 100% compliance for one week.	0-P(rated)=300 MW, full range at least once during test period.	Demonstrates responsiveness of operator and ability to view and control plant. (ref. LGIG VI.J)
15		Physical link	Documented dedicated circuit, Lookout-wind op center	Documentation submitted prior to operational testing.	No operational requirement	NOTE: I think the line has been completed. I do not have the documentation.
16			Site visit to observe wind operations center (most likely RTP or Op engineer or manager)	Written summary of how control center works, and first hand validation.	No operational requirement	Demonstrate compliance with operator requirements LGIG VI.J
17	LVRT	Physical Equipment installed	Substation configured according to requirements of study.	As-built one-lines provided	No operational requirement	LGIA LVRT requirements, based on the Latest Interconnection Study for 300 MW. A revised study is expected, and may change, add, or remove test requirements.
18		Operational Criteria met	Voltage at 34.5 kV buses maintained at 1.035--1.045 p.u.	Recordings made by mutually acceptable recording device (logger) indicate that voltage never deviates while plant is generating during test period	Entire test period	
20			Vendor turbines operated with minimal reactive power output	Vender machines do not contribute reactive power during plant operation	Entire test period	