Interconnection System Impact Study Report
Request # GI-2007-12
Restudy 1

250 MW Wind Farm, Near Calhan, Colorado

Public Service Company of Colorado
Transmission Planning
June 15, 2009

This restudy is being issued at the request of the generator developer to include additional information and updates regarding the GI-2007-12 Feasibility Study results and associated cost estimates that were not included in the original March 19, 2009 SIS report.

Executive Summary

Public Service Company of Colorado received an interconnection request (GI-2007-12) for a System Impact Study to examine installation of a 250 MW wind turbine generator facility near Calhan, Colorado. The proposed interconnection point is the Jackson Fuller 230 kV Substation near Colorado Springs, Colorado (see Figure 1 below). This substation is jointly owned by Colorado Springs Utilities, Tri-State Generation & Transmission, and PSCo. The wind generating facilities are located approximately 24 miles from the interconnection point and would be connected via a developer owned radial 230 kV line. The requested in service date is December 31, 2010 with a projected backfeed date of June 30, 2010.

The generator output, equipment, and interconnection point did not change from the GI-2007-12 Feasibility Study. However, certain issues from the Feasibility Study required update and revision. First, the status of the Monument-Palmer Lake 115 kV circuit needed to be updated. Also, the delay of the Midway-Waterton 345 kV circuit needed to be assessed. In addition, the impact of CSU line rating changes needed to be evaluated. This System Impact Study addressed those issues and also the effects of modeling errors found in the CSU system. Updated load flow studies were performed. Also, the dynamic and transient stability of the transmission system with the proposed wind plant was evaluated. In addition, voltage performance at the POI was examined. Cost estimates for the required facilities were also updated and a project schedule was developed.

The request was studied as a stand-alone project only, with no evaluation made of other potential new generation requests that may exist in the Large Generator Interconnection

Request (LGIR) queue, other than the generation projects that are already approved and planned to be in service by December 2010.

In the Feasibility Study, the load flow results were dependent on the status of the Monument-Palmer Lake 115 kV circuit. At the time of the Feasibility Study, this circuit had been operated normally open at the request of CSU. This is no longer the case. Future operation in a normally open state is not preferred by TSG&T.

In the Feasibility Study load flow analyses, the Midway-Waterton 345 kV circuit was assumed to be in service. However, completion of that circuit has been delayed until May 2011. That is five months after the requested generator in service date. Therefore, in addition to the Monument-Palmer Lake 115 kV circuit, the impact of this delay needed to be quantified.

Based on these changes, and using updated ratings and other modeling data from CSU and TSG&T, updated load flow analyses were performed. The results of the evaluation indicate the following CSU circuits are overloaded both with and without installation of the Midway-Waterton 345 kV project:

- Monument-Palmer Lake 115 kV
- BRIARGAT-CTTNWD S 115 kV
- Cottonwood-Kettle Creek 115 kV
- Kettle Creek-Flying Horse 115 kV
- Flying Horse-Monument 115 kV

Some of these lines are also benchmark overloaded. The Developer should work with CSU to review these results and determine the most appropriate way to address them. Please note that PSCo also has facilities that are limiting on the Monument-Palmer Lake 115 kV circuit without installation of the Midway-Waterton 345 kV project. However, they are not limiting with the 345 kV project in service. Therefore, should the 345 kV project be delayed past the summer of 2011, the PSCo facility overloads will also need to be addressed.

In the updated load flow studies, TSG&T's Fuller 230/115 kV transformer is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. The overloads are 119.1% and 114.6% of the 100 MVA rating in the case before and after installation of Midway-Waterton. The Developer should work with TSG&T to review these results and determine the most appropriate way to address them.

In the Feasibility Study, with Monument-Palmer Lake 115 kV closed, other facilities reported as overloaded with the new generation included PSCo's two Wateron 230/115 kV 100 MVA transformers and PSCo's Daniels Park 230/115 kV 150 MVA transformer. However, these facilities are no longer overloaded both with and without installation of the Midway-Waterton 345 kV project. Therefore, they do not require replacement due to installation of the proposed generation. Regardless, PSCo plans to upgrade these transformers through its Five Year Capital Budget process.

The study shows that with the turbines specified, Clipper Liberty 2.5 MW (100 turbines), the transmission system with the proposed wind farm will be transiently stable and the wind farm will meet the low voltage ride through requirement. Also, all transient voltage swings are within WECC voltage dip criteria. Therefore, the dynamic and transient stability performance of the proposed wind plant is expected to be satisfactory.

This study examined the ability of the proposed wind plant to adhere to the power factor and reactive power requirements of the interconnection and other guidelines. Based on the results of the studies, the wind plant should be able to deliver the full 250 MW minus losses at the POI within the 0.95 leading to 0.95 lagging power factor criteria. The Rocky Mountain Area Voltage Guidelines for the Southeast Colorado Area Region 4 specify that the ideal voltage range for non-regulating buses is 1.0 – 1.03 pu. The proposed generation should be able to conform to the ideal voltage range when maintaining the power factor at the Jackson Fuller 230 kV POI near unity during peak system conditions.

The study showed that the wind farm could have a detrimental impact to area dynamic reactive resources. To alleviate this impact, the Developer will need to add reactive resources within the wind farm. In the Feasibility Study, 40 Mvars of capacitor banks was recommended. However, this study shows that 32 Mvar of capacitor banks located at the main 230/34.5 kV transformer low side buses will mitigate this problem when the wind farm is at maximum output. Additional reactive resources are also required to mitigate the effects of line charging from wind farm facilities when the wind turbines are not generating. The Developer will need to perform additional detailed studies to determine the optimum types and locations for the reactive correction equipment.

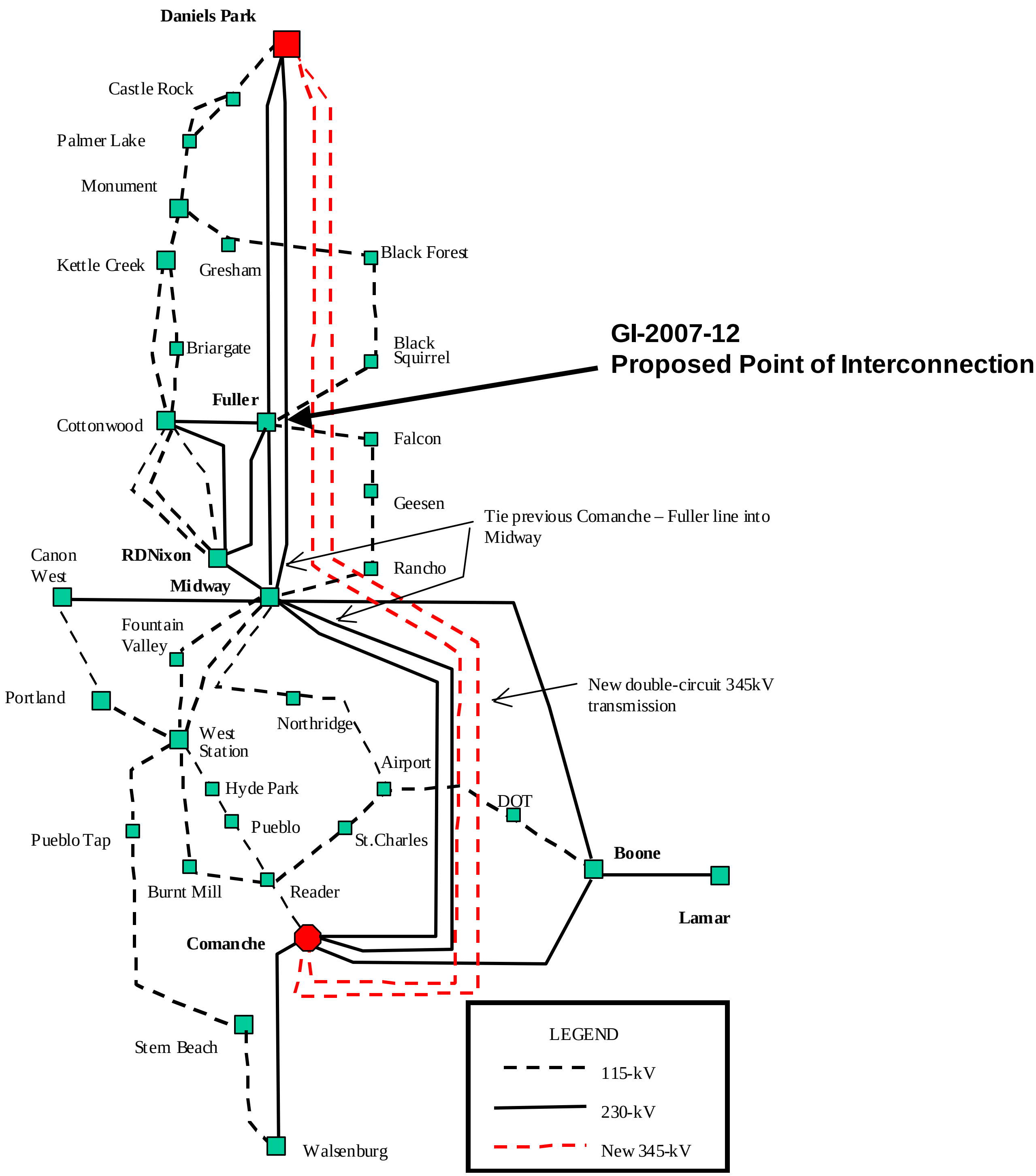
The cost for the transmission interconnection (in 2009 dollars):

Transmission Proposal
The total estimated cost of the recommended system improvements to interconnect the project is approximately **$1,870,000** and includes:

- $ 0.340 million for PSCo-Owned, Developer-Funded Attachment Facilities
- $ 1.530 million for PSCo-Owned, PSCo-Funded Attachment Facilities
- $ 0.000 million for PSCo Network Upgrades for Delivery to PSCo Loads

This work can be completed in 18 months following receipt of authorization to proceed.

Figure 1 Network Diagram with Proposed POI at Jackson Fuller



Introduction

Public Service Company of Colorado received a large generator interconnection request (GI-2007-12) to install a 250 MW generating facility near Calhan, Colorado. The project includes 100 Clipper 2.5 MW wind turbine generators (250 MW total). The proposed interconnection point is the Jackson Fuller 230 kV Substation near Colorado Springs, Colorado (see Figure 1). This substation is jointly owned by Colorado Springs Utilities, Tri-State Generation & Transmission, and PSCo. The wind generating facilities are located approximately 24 miles from the interconnection point and would be connected via a developer owned radial 230 kV line. The requested in service date is December 31, 2010 with a projected backfeed date of June 30, 2010.

The generator output, equipment, and interconnection point did not change from the GI-2007-12 Feasibility Study. However, certain issues from the Feasibility Study require update and revision. First, the status of the Monument-Palmer Lake 115 kV circuit needs to be updated. Also, the delay of the Midway-Waterton 345 kV circuit needs to be assessed. Finally, the impact of ratings changes and modeling errors identified in the CSU system model needs to be evaluated. This System Impact Study addressed those issues and re-evaluated the overloaded facilities and required network upgrades for delivery. It also evaluated the dynamic and transient stability of the transmission system with the proposed wind plant. In addition, voltage performance at the POI was examined. Cost estimates for the required facilities were also updated and a project schedule was developed. The schedule can be found in Section C of the Appendix.

Study Scope and Analysis

The System Impact Study evaluated the transmission impacts associated with the proposed generating station. It updated the Feasibility Study analysis conclusions based on the status of Monument-Palmer Lake 115 kV, the delay of Midway-Waterton 345 kV, and the impact of ratings changes and modeling errors identified in the CSU system model. It also included dynamic & transient stability analysis and some additional power flow analysis to assess voltage performance. The dynamic & transient analysis identified any dynamic or transient stability problems associated with the new generation. It also evaluated low voltage ride through. The power flow analysis addressed steady state voltage performance at the POI.

PSCo adheres to NERC and WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per unit of nominal, and steady-state power flows below the thermal ratings of all facilities. Per the Rocky Mountain Area Voltage Coordination Guidelines[1], Southeast Colorado Area Region 4,

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[1] The Voltage Coordination Guidelines Subcommittee of the Colorado Coordinated Planning Group developed these guidelines. The subcommittee consisted of representatives from major Colorado utilities including Colorado Springs Utilities, Platte River Power Authority, Tri-State Generation and Transmission, Public Service Company of Colorado, and Western Area Power Administration-Rocky Mountain Region. Other major utilities outside of Colorado were involved in the development of these guidelines.

PSCo tries to maintain a transmission system voltage profile ranging from 1.02 – 1.03 per unit at regulating buses and 1.0 – 1.03 per unit at non-regulating buses. Following a single contingency, transmission system steady state bus voltages must remain within 0.90 per unit to 1.10 per unit, and power flows within 100% of the facilities' continuous thermal ratings.

Transient stability criteria require that all generating machines remain in synchronism and all power swings should be well damped. Also, transient voltage performance should meet the following criteria:

- Following fault clearing for single contingencies, voltage may not dip more than 25% of the pre-fault voltage at load buses, more than 30% at non-load buses, or more than 20% for more than 20 cycles at any bus.
- Following fault clearing for double contingencies, voltage may not dip more than 30% of the pre-fault voltage at any bus or more than 20% for more than 40 cycles at any bus.

Wind plants are required to remain in service during a three-phase fault lasting up to 9 cycles. They should also remain in service following single line to ground faults with delayed clearing.

For this project, potential affected parties include Colorado Springs Utilities and Tri-State Generation & Transmission (TSG&T).

Feasibility Study Load Flow Results Re-evaluation

In the Feasibility Study, the load flow results were dependent on the status of the Monument-Palmer Lake 115 kV circuit. At the time of the Feasibility Study, this circuit had been operated normally open at the request of CSU. This mode of operation continued through the end of September 2008 until CSU indicated it would be okay to return to closed operation. Future operation in a normally open state is not preferred by TSG&T. Since Monument-Palmer Lake 115 kV is now normally closed, load flow results assuming this circuit is in service are applicable.

In the Feasibility Study load flow analyses, the Midway-Waterton 345 kV project was assumed to be in service. However, completion of this project has been delayed until May 2011. That is five months after the requested generator in service date. Therefore, in addition to Monument-Palmer Lake 115 kV, the impact of this delay needed to be quantified. Also, specific modeling errors identified in the CSU system model also needed to be addressed. These load flow studies were based on the original load flow cases from the Feasibility Study representing 2010 HS conditions. The results are included in Tables 6 & 7.

The specific modeling errors in the CSU model that were uncovered in the original Feasibility Study case included a second KELKER N – RD NIXON 230 kV circuit that was erroneously included and needed to be removed. This error was found in an earlier study and confirmed for this study after requesting all required updates from CSU for the case. Also, the impedances of the KETTLECK – FLYHORSE 115 kV and MONUMENT – FLYHORSE 115 kV circuits had unexpected X/R ratios for high voltage circuits (0.6). They were also exactly the same. This was noticed during a review of initial voltage results that showed low voltages on the Tri-State system near Monument. CSU subsequently provided updated impedances for these circuits that had higher X/R ratios (3.2-3.6) and were 3.5 times lower. CSU also provided additional impedance updates to their system. Ratings were also provided but they were not labeled. Subsequent load flow studies using the revised impedances showed significantly higher flows on a number of CSU lines, including some base case overloads that had not been there previously. Subsequent comparison against a 2011HS case showed large variation in loads at multiple buses. After review with management, it was decided to send the results and the CSU model from the case to CSU for review and update. Revised data was subsequently received from CSU including updated loads, lines, and ratings. The case was modified to include this information. CSU generation was scaled to match the load change. With these changes, and an update received from TSG&T, new studies were performed. However, during assembly of the dynamics case, an additional error was found. A line connecting 73407 KELKER N 230 kV in CSU's system to 73466 RICHRDTP 115 kV in Platte River's system was found. This line was taken out of service and new studies performed.

In the revised load flow studies, the Monument-Palmer Lake 115 kV circuit is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. The rating in the case is 135 MVA. PSCo's facilities on this line are rated 691 A or 137.6 MVA. Prior to the installation of the Midway-Waterton 345 kV project, all of the facilities on this line are overloaded. However, after the 345 kV project installation, only non-PSCo facilities are overloaded. Since the wind plant in service date is specified as December 2010 and the Midway-Waterton project is planned to be in service prior to the summer, this overload is not expected to be a concern for PSCo facilities. However, the Developer should work with CSU to review the results and determine the most appropriate way to address the overload on this line. Should the Midway-Waterton project be delayed, then the overloaded PSCo facilities will need to be addressed.

In the updated load flow studies, CSU's BRIARGAT-CTTNWD S 115 kV circuit is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. However, this circuit is also overloaded in both benchmark cases. The benchmark overloads are 113.9% and 109.8% of the 150 MVA rating in the case before and after installation of Midway-Waterton. The Developer should work with CSU to review these results and determine the most appropriate way to address them.

In the updated load flow studies, CSU's Cottonwood-Kettle Creek 115 kV circuit is overloaded with the proposed generation both with and without installation of the

Midway-Waterton 345 kV project. However, this circuit is also overloaded in both benchmark cases. The benchmark overloads are 115.7% and 111.3% of the 159 MVA rating in the case before and after installation of Midway-Waterton. However, expected upgrades to this line to be completed in 2009 will increase the rating to 168 MVA, resulting in benchmark overloads of 109.5% and 105.3%, respectively. The Developer should work with CSU to review these results and determine the most appropriate way to address them.

In the updated load flow studies, CSU's Kettle Creek-Flying Horse 115 kV circuit is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. The overloads are 110.3% and 104.0% of the 159 MVA rating in the case before and after installation of Midway-Waterton. The Developer should work with CSU to review these results and determine the most appropriate way to address them.

In the updated load flow studies, CSU's Flying Horse-Monument 115 kV circuit is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. The overloads are 116.0% and 109.0% of the 142 MVA rating in the case before and after installation of Midway-Waterton. The Developer should work with CSU to review these results and determine the most appropriate way to address them.

In the updated load flow studies, TSG&T's Fuller 230/115 kV transformer is overloaded with the proposed generation both with and without installation of the Midway-Waterton 345 kV project. The overloads are 119.1% and 114.6% of the 100 MVA rating in the case before and after installation of Midway-Waterton. The Developer should work with TSG&T to review these results and determine the most appropriate way to address them.

In the Feasibility Study, with Monument-Palmer Lake 115 kV closed, other facilities reported as overloaded with the new generation included PSCo's two Wateron 230/115 kV 100 MVA transformers and PSCo's Daniels Park 230/115 kV 150 MVA transformer. However, these facilities are no longer overloaded both with and without installation of the Midway-Waterton 345 kV project. Therefore, they do not require replacement due to installation of the proposed generation. Regardless, PSCo plans to upgrade these transformers through its Five Year Capital Budget process.

Dynamic and Voltage Performance Power Flow and Transient Stability Models

The dynamic and voltage performance power flow studies in the System Impact Study were based on the WECC approved 11HS1BP base case. Load levels reflect 2011 heavy summer peak system conditions. The requested in service date of the wind plant is December 2010. Therefore, the case was modified to reflect the delayed 2011 in service date of the Midway-Waterton 345 kV line. The case was also modified to include the replacement of the Daniels Park 230/115 kV transformer with a 280 MVA unit. The CSU modeling updates were also included.

For the transient and dynamic studies, the Project's wind turbine generators were modeled as two equivalent machines, sized 122.5 MW and 127.5 MW, and connected to two 690 V buses. The machine sizes were based on the number of wind turbines in each part of the wind farm. The wind plant model includes equivalent 34.5/0.690 kV generator step-up transformers and equivalent collector system impedances. It also includes two main 230/34.5 kV 135 MVA transformers. This model is connected to the interconnection station through a 24-mile 230 kV overhead transmission line. The point of interconnection was the Jackson Fuller 230 kV Substation. The machines were set to operate at a fixed 0.98 pf (lag). This power factor resulted in near unity power factor at the POI.

For the low voltage ride through studies, two strings of 2.5 MW generators were modeled, one each on each side of the wind farm. They were set to operate at 0.98 pf (lag). Each had its own GSU transformer. The strings also included the 34.5 kV collector system cable impedances. The remaining generators were modeled as two equivalent machines, sized 100.0 MW and 102.5 MW and operating at 0.98 pf (lag). They were connected to equivalent GSU transformers and equivalent collector system impedances. Please note that these studies were conducted without the CSU updates. However, these updates would not have an appreciable impact on the results.

The Squirrel Creek generators in the power flow case were switched off due to their cancellation since the load flow case was developed. This generation was made up by dispatching power from Peetz Logan and the DC tie at Lamar. The balance of the power flow case models included a generation dispatch that simulated high flows from southern Colorado to the north. Generation that was redispatched to develop these dispatch scenarios included units at Fountain Valley, Comanche, and the DC tie at Lamar. The northern generators that were ramped back included units at Cherokee, Pawnee, Manchief, and Rawhide. The generation dispatch in the power flow case can be found in Table 8 in the Appendix.

PSCo control area (Area 70) wind generation facilities, other than those dispatched to offset the outage of the Squirrel Creek generation, were dispatched to approximately 12% of facility ratings, consistent with other similar planning study models.

CSU provided updated dynamics data for their generators. However, it was in GE PSLF format. We obtained conversion software, but consultation with WECC staff indicated that experience with doing these conversions was essential in performing these conversions, which we do not have. Also, the conversion software was not able to find PSS/E analogs for some of the PSLF models. Therefore, the existing data was utilized. Please note that in the WECC base case, the Front Range Units 1 & 3 were in service but at 0 MW output. In order to more accurately stress the system for the dynamics studies, these two units were dispatched to full MW output, before scaling to account for the adjustment in CSU load. However, this resulted in dynamics initialization problems with each unit's governors. Rather than turning the units off, we disconnected each unit's governor model and evaluated the system stability. This was judged more conservative than turning them off.

Transient Stability Study Process

The transient stability studies were conducted using PTI's PSS/E Version 30.3.2 software. NERC Category B & C contingencies were considered as part of the analysis. The simulations considered three-phase faults with normal clearing and single line to ground faults with breaker failure and clearing by backup breakers. The analyses using three-phase faults assumed 5 cycle normal clearing time. The single line to ground breaker failure analyses used a backup clearing time of 17 cycles. The results were assessed for dynamic and transient stability performance, including wind turbine generator low voltage ride through. A listing of the buses that were monitored to evaluate transient voltage dip performance can be found in Table 10.

Transient Stability Study Results

The list of contingencies that were evaluated and associated results can be found in Table 11 in the Appendix. The range of contingencies evaluated was limited to that necessary to adequately assess the transient stability performance of the proposed wind turbine generator project. Plots of machine speed, relative angle, power, terminal voltage, terminal current, and system voltages for each contingency were produced to perform the assessment. The study shows that with the turbines specified, Clipper 2.5 MW (100 turbines), the transmission system with the proposed wind farm will be transiently stable and the wind farm will meet the low voltage ride through requirement.

All transient voltage swings were within WECC voltage dip criteria. The lowest observed voltage dip was to 0.9732 pu.

Voltage Performance at the Point of Interconnection

Wind developers are required to conform to NERC and WECC Reliability Criteria, Xcel Energy interconnection guidelines, and FERC Order 661-A, including:

- The wind plant shall maintain the power factor at the POI within the range of 0.95 leading to 0.95 lagging for the full MW operating range of the facility, if the System Impact Study demonstrates that this power factor requirement is necessary to ensure safety or reliability.
- During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per unit of nominal. Following a single contingency, transmission system steady state bus voltages must remain within 0.90 per unit to 1.10 per unit.

- To ensure reliable operation, the interconnecting generation should adhere to the Rocky Mountain Area Voltage Coordination Guidelines for the Southeast Colorado Area Region 4; per the guidelines, PSCo tries to maintain an ideal transmission system voltage profile ranging from 1.02 – 1.03 per unit at regulating buses and 1.0 – 1.03 per unit at non-regulating buses.
- The impact of the wind generating facility on the reactive power schedules of nearby generating units may need to be mitigated by the developer if system studies demonstrate that the proposed wind generating facility causes nearby generating units to generate or absorb reactive power for voltage control[2]. It is understood that reactive power reserve must be maintained on generating units to allow them to dynamically regulate voltage for extreme system conditions.
- The wind plant is required to demonstrate to the satisfaction of PSCo System Operations prior to the commercial in-service date that it can safely and reliably operate within required power factor and voltage ranges.
- It is the responsibility of the project developer to determine what type of equipment (DVAR, added switched capacitors, SVC, reactors, etc.), the ratings (MVAR, voltage--34.5 kV or 230 kV), and the locations of those facilities to meet the power factor and voltage range standards.
- PSCo requires the Developer to provide a single point of contact to coordinate compliance with the power factor and voltage regulation at the POI. The reactive flow at the end of the line near the POI will need to be controlled according to the Interconnection Guidelines.

This study examined the ability of the proposed wind plant to adhere to the power factor and reactive power requirements of the interconnection guidelines. The results are in Table 1 below. Based on the results of the studies, the wind plant should be able to deliver the full 250 MW minus losses at the POI within the 0.95 leading to 0.95 lagging power factor criteria. Also, the proposed generation should be able to conform to the ideal voltage range for non-regulating buses when maintaining the power factor at the Jackson Fuller 230 kV POI near unity during peak system conditions.

However, the studies also show that wind plant operation can have a detrimental impact on the voltage regulating capability of area generating units, including the Nixon, Front Range, Fountain Valley, and Comanche plants. To alleviate the detrimental impact, the Developer will need to add reactive support within the wind farm. In the Feasibility Study, 40 Mvars of capacitor banks was recommended. However, this study shows that 32 Mvar of capacitor banks located at the main 230/34.5 kV transformer low side buses will mitigate this problem. This will also maintain the POI voltage within the ideal voltage range for non-regulating buses. The Developer will need to perform additional

[2] The Rocky Mountain Area Voltage Coordination Guidelines (July 2006), page 8 of 34, Item 6, states that "Static VAR sources (switched shunt capacitors, reactors) should be operated to control the voltage profile before relying on LTC or generator VAR output, and should be used in such a manner to keep LTC transformers near their nominal tap range and to keep reactive margin on generating equipment. The rationale for this goal is that the generator is a dynamic reactive source that can provide high-speed reactive support to the transmission system after a disturbance that results in low voltages, or conversely are in a position to reduce voltages after a contingency that results in high voltages. Keeping transformers near their mid-tap range also allows for maximum response to either boost or reduce voltages following a disturbance."

detailed studies to determine the optimum types and locations for the reactive correction equipment.

When the proposed wind plant is off-line, the facilities deliver approximately 18.5 Mvar at the POI due to line charging from the developer's 230 kV transmission line and 34.5 kV collector system. The voltage is within the ideal range, but the reactive output of the generating units changes by 10 Mvars. Therefore, reactive correction located within the wind plant will be required to mitigate the line charging.

Table 1 Voltage & Reactive Power at the Point of Interconnection

	Benchmark w/o generator – Peak Summer Conditions	Benchmark w/ collector system, w/o generator – Peak Summer Conditions	GI 2007-12 @ 250 MW – Unity PF @ terminal 32 Mvar of Cap Banks @ 34.5 kV transformer buses – Peak Summer Conditions
Real Power Delivered at POI, MW	N/A	0	243.3
Reactive Power Delivered at POI, Mvar	N/A	18.5	-17.9
Power Factor at POI	N/A	0.00	1.00
Voltage at the POI, pu	1.004	1.006	1.005
Nixon Units Reactive Output (P=246.2 MW), Mvar	52.8	50.7	51.6
Front Range Units Reactive Output (P=454.4 MW), Mvar	99.1	95.2	96.7
Fountain Valley Units Reactive Output (P=228.0 MW), Mvar	39.0	37.8	38.4
Comanche Units Reactive Output (P=1475.0 MW), Mvar	331.7	328.6	336.3
Total Area Units Reactive Output, Mvar	522.6	512.3	523.0

Short Circuit Study Results

A review of the short circuit studies in the Feasibility Study indicates that they were performed using a case that reflected conditions earlier than December 2010. Among other differences, this case did not include the two Comanche-Daniels Park 345 kV circuits. Therefore, revised short circuit calculations were performed using the 2010 short circuit master database. Two scenarios were examined, one including the Midway-Waterton 345 kV project, and one without.

The results indicate that no new circuit breakers are expected to exceed their capabilities following installation of the new generation. The calculated short circuit parameters for the Point of Interconnection at Jackson Fuller are shown in Table 2 below. These calculations do not include the contribution from the proposed wind farm. From the documentation for the Liberty wind turbine PSSE dynamics model, the wind turbine generators should contribute no more than the 1.11 pu current limit imposed by the wind turbine generator inverters. This equates to 696.6 A at the 230 kV POI.

Table 2 Short Circuit Parameters at the Point of Interconnection

System Condition	Three-Phase Fault Level (Amps)	Single-Line-to-Ground Fault Level (Amps)	Thevenin System Equivalent Impedance (R +j X) (ohms)
With Midway-Waterton 345 kV project	16,154	12,720	Z1(pos)= 0.68723 +j 8.19154 Z2(neg)= 0.69117 +j 8.19230 Z0(zero)= 1.21295 +j 14.8265
Without Midway-Waterton 345 kV project	15,867	12,673	Z1(pos)= 0.69177 +j 8.34032 Z2(neg)= 0.69494 +j 8.34160 Z0(zero)= 1.55054 +j 14.7112

Costs Estimates and Assumptions

GI-2007-12 (System Impact Study Report)
June 8, 2009

The Customer has requested a 250 MW Wind Generation Project interconnecting on the 230kV bus at Jackson Fuller Substation. A 230kV radial transmission line will connect the Customer's collector site with the PSCo transmission system at the Point of Interconnection. The estimated total cost for the required upgrades is **$1,870,000.**

The estimated costs shown are (+/-30%) estimates in 2009 dollars and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the engineering, design, procurement and construction of these new PSCo facilities. This estimate did not include the cost for any other Customer owned equipment and associated design and engineering.

The following tables list the improvements required to accommodate the interconnection and the delivery of the Project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis.

Table 3 – PSCo Owned; Customer Funded Interconnection Facilities

Element	Description	Cost Est. Millions
Jackson Fuller 230kV Substation	Interconnect Customer to tap the bus at the Jackson Fuller 230kV substation. The new equipment includes: • 230kV bidirectional metering • Three 230kV combination CT/PT instrument transformers • Associated foundations and structures • Associated transmission line communications, relaying and testing	**$0.240**
	Transmission – labor to install slack span into Jackson Fuller. Materials furnished by Customer.	**$0.070**
	Customer Generator Communication to Lookout.	**$0.010**
	Customer Load Frequency/Automated Generator Control and Generator Witness Testing.	**$0.010**
	Siting and Land Rights support for required easements, reports, permits and licenses.	**$0.010**
	Total Cost Estimate for Customer Interconnection Facilities	**$0.340**
Time Frame	**To design, procure and construct**	**18 Months**

Table 4: PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost
Jackson Fuller 230kV Substation	Interconnect Customer to tap the bus at the Jackson Fuller 230kV substation. The new equipment includes: • Two 230kV, 3000 amp, gas circuit breakers • Four 230kV, 3000 amp gang switches • Associated communications and SCADA equipment • Line relaying and testing • Electrical bus work • Associated foundations and structures • Associated yard surfacing, landscaping, fencing and grounding	**$1.520**
Jackson Fuller 230kV Substation	Siting and Land Rights support for required easements, reports, permits and licenses	**$0.010**
	Total Estimated Cost for PSCo Interconnection Facilities	**$1.530**
Time Frame	**To design, procure and construct**	**18 Months**

Table 5 – PSCo Network Upgrades for Delivery Not Applicable

Element	Description	Cost Est. Millions

Assumptions

- The cost estimates provided are "scoping estimates" with an accuracy of +/- 30%.
- Estimates are based on 2009 dollars.
- There is no contingency added to the estimates. AFUDC is not included.
- Labor is estimated for straight time only – no overtime included.
- The Generator 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 (long lead time materials) and construct the interconnection facilities is at least 18 months, and is completely independent of other queued projects and their respective ISD's.
- A CPCN will not be required for interconnection facility construction.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- PSCo crews to perform checkout, relay panel construction and final commissioning.
- No new substation land required. Substation work to be completed within existing property boundaries.

Project Schedule

The project schedule for the work estimated above can be found in Section D of the Appendix.

Jackson Fuller Substation Proposed One-Line

The revised one-line from the Feasibility Study of the Jackson Fuller Substation with the addition of the proposed wind farm can be found in Section E of the Appendix.

Appendix

A. Load Flow Results Update

The results of the power flow studies are summarized in Table 6 below. The facilities identified in this study report as overloaded in the contingency analysis are limited to new or significantly increased overloads and do not address all of the facilities that may have been flagged as overloaded in the contingency runs. The other facilities that may be overloaded, independent of the new 250 MW generation injection at Jackson Fuller substation, will be addressed through other separate Transmission Planning project proposals or by other affected utilities.

Table 6 – Summary Listing of Differentially Overloaded Facilities without Midway-Waterton 345 kV Project[3]

				Branch N-1 Loading Without GI-2007-12			Branch N-1 Loading With GI-2007-12			
Monitored Facility (Line or Transformer) From Bus To Bus	**Type**	**Line Owner**	**Branch Rating MVA**	**N-1 Flow in MVA**	**N-1 Flow in % of Rating**	**Total # of Violations**	**N-1 Flow in MVA**	**N-1 Flow in % of Rating**	**Total # of Violations**	**N-1 Contingency Outage From Bus To Bus**
70308 PALMER 115 73414 MONUMENT 115 1	LN	PSCo/CSU	135	103.3	76.5	0	147.2	109.0	8	70139 DANIELPK 230 FULLER 230 1
73389 BRIARGAT 115 CTTNWD S 115 1	LN	CSU	150	170.8	113.9	1	193.2	128.8	1	73391 CTTNWD N 115 73410 KETTLECK 115 1
73391 CTTNWD N 115 73410 KETTLECK 115 1	LN	CSU	159	184.0	115.7	1	209.7	131.9	2	73389 BRIARGAT 115 73393 CTTNWD S 115 1
73410 KETTLECK 115 73576 FLYHORSE 115 1	LN	CSU	159	140.0	88.0	0	175.4	110.3	2	73460 BLK SQMV 115 73481 FULLER 115 1
73414 MONUMENT 115 73576 FLYHORSE 115 1	LN	CSU	142	129.2	91.0	0	164.7	116.0	6	73460 BLK SQMV 115 73481 FULLER 115 1
73477 FULLER 230 73481 FULLER 115 1	TR	TSG&T	100	96.0	96.0	0	119.1	119.1	3	73410 KETTLECK 115 73576 FLYHORSE 115 1

[3] **Newly overloaded elements, or delta overloads > 5% of rating, due to proposed 250 MW generation injection at POI.**

Table 7 – Summary Listing of Differentially Overloaded Facilities with Midway-Waterton 345 kV Project[4]

				Branch N-1 Loading Without GI-2007-12			Branch N-1 Loading With GI-2007-12			
Monitored Facility (Line or Transformer) From Bus To Bus	Type	Line Owner	Branch Rating MVA	N-1 Flow in MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Flow in MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Contingency Outage From Bus To Bus
70308 PALMER 115 73414 MONUMENT 115 1	LN	PSCo/CSU	135	102.6	76.0	0	137.1	101.5	3	70465 MIDWAYPS 345 WATERTON 345 1
73389 BRIARGAT 115 CTTNWD S 115 1	LN	CSU	150	164.7	109.8	1	186.2	124.1	1	73391 CTTNWD N 115 73410 KETTLECK 115 1
73391 CTTNWD N 115 73410 KETTLECK 115 1	LN	CSU	159	177.0	111.3	1	201.8	126.9	1	73389 BRIARGAT 115 73393 CTTNWD S 115 1
73410 KETTLECK 115 73576 FLYHORSE 115 1	LN	CSU	159	131.2	82.5	0	165.4	104.0	1	73460 BLK SQMV 115 73481 FULLER 115 1
73414 MONUMENT 115 FLYHORSE 115 1	LN	CSU	142	120.4	84.8	0	154.8	109.0	5	73460 BLK SQMV 115 73481 FULLER 115 1
73477 FULLER 230 73481 FULLER 115 1	TR	TSG&T	100	92.1	92.1	0	114.6	114.6	3	73410 KETTLECK 115 73576 FLYHORSE 115 1

[4] **Newly overloaded elements, or delta overloads > 5% of rating, due to proposed 250 MW generation injection at POI.**

B. Generation Dispatch

Table 8 – Generation Dispatch in Dynamics Case

GI-2007-12 System Impact Study				
Generation Dispatch - Dynamics				
Bus	Name	ID	Status	Pgen
90503	7-12_GEN 0.6900	1	1	122.5
90513	7-12_GEN 0.6900	1	1	127.5
70034	ARAP3 13.800	G3	1	44.0
70035	ARAP4 13.800	G4	1	115.0
70103	CHEROK1 15.500	G1	1	50.0
70104	CHEROK2 15.500	G2	1	50.0
70105	CHEROK3 20.000	G3	1	95.2
70106	CHEROK4 22.000	G4	1	180.0
70119	COMAN 1 24.000	G1	1	360.0
70120	COMAN 2 24.000	G2	1	365.0
70188	FTLUP1-2 13.800	1	0	0.0
70188	FTLUP1-2 13.800	2	0	0.0
70310	PAWNEE 22.000	G1	1	300.0
70314	MANCHEF1 16.000	G1	1	60.0
70315	MANCHEF2 16.000	G2	1	60.0
70350	RAWHIDE 24.000	1	1	95.0
70351	RAWHIDEA 13.800	1	1	60.0
70406	ST.VR 2 18.000	G2	1	130.0
70407	ST.VR 3 18.000	G3	1	130.0
70408	ST.VR 4 18.000	G4	1	130.0
70409	ST.VRAIN 22.000	G1	1	52.0
70446	VALMONT 20.000	G5	1	188.0
70448	VALMONT6 13.800	G6	1	50.0
70478	ZUNI1 13.800	G1	0	0.0
70479	ZUNI2 13.800	G2	0	0.0
70553	ARAP5-6 13.800	G5	1	37.0
70553	ARAP5-6 13.800	G6	1	37.0
70554	ARAP7 13.800	G7	1	45.0
70557	VALMNT7 13.800	G7	1	36.0
70558	VALMNT8 13.800	G8	1	36.0
70560	LAMAR DC 230.00	1	1	200.0
70561	RAWHIDEE 13.800	1	1	37.0
70562	SPRUCE1 18.000	G1	1	140.0
70563	SPRUCE2 18.000	G2	1	140.0

GI-2007-12 System Impact Study				
Generation Dispatch - Dynamics				
Bus	Name	ID	Status	Pgen
70567	RAWHIDED 13.800	1	1	55.0
70568	RAWHIDEB 13.800	1	1	60.0
70569	RAWHIDEC 13.800	1	1	56.0
70577	FTNVL1-2 13.800	G1	1	38.0
70577	FTNVL1-2 13.800	G2	1	38.0
70578	FTNVL3-4 13.800	G3	1	38.0
70578	FTNVL3-4 13.800	G4	1	38.0
70579	FTNVL5-6 13.800	G5	1	38.0
70579	FTNVL5-6 13.800	G6	1	38.0
70588	RMEC1 15.000	G1	1	140.0
70589	RMEC2 15.000	G2	1	140.0
70591	RMEC3 23.000	G3	1	322.0
70593	SPNDLE1 18.000	1	1	134.0
70594	SPNDLE2 18.000	2	1	134.0
70631	SQRRL01 24.000	1	0	0.0
70632	SQRRL02 24.000	1	0	0.0
70633	SQRRL03 24.000	1	0	0.0
70701	CO GRN E 34.500	1	1	8.0
70702	CO GRN W 34.500	1	1	8.0
70703	TWNBUTTE 34.500	1	1	8.0
70710	PTZLOGN1 34.500	1	1	146.6
70712	PTZLOGN2 34.500	1	1	146.6
70713	PTZLOGN3 34.500	1	1	36.6
70777	COMAN 3 24.000	1	1	750.0
70822	CEDARCK1 34.500	1	1	15.0
70823	CEDARCK2 34.500	1	1	15.0
73381	BIRDSAL1 13.800	1	1	14.2
73382	BIRDSAL2 13.800	1	1	14.2
73383	BIRDSAL3 13.800	1	1	18.9
73418	RD_NIXON 20.000	1	1	189.4
73424	TESLA1 13.800	1	1	23.2
73427	DRAKE 5 13.800	1	1	37.9
73428	DRAKE 6 13.800	1	1	66.3
73429	DRAKE 7 13.800	1	1	119.3
73434	NIXONCT2 12.500	1	1	28.4
73435	NIXONCT1 12.500	1	1	28.4
73507	FTRNG1CC 18.000	1	1	142.0
73508	FTRNG2CC 18.000	1	1	142.0

GI-2007-12 System Impact Study				
Generation Dispatch - Dynamics				
Bus	Name	ID	Status	Pgen
73509	FTRNG3CC 18.000	1	1	170.4
			(1=on)	

Table 9 – Generation Dispatch in Load Flow Case

GI-2007-12 System Impact Study				
Generation Dispatch – Load Flow				
Bus	Name	ID	Status	Pgen
70572	GI-2007-12J 0.6900	1	1	125.0
70573	GI-2007-12N 0.6900	1	1	125.0
70034	ARAP3 13.800	G3	1	44.0
70035	ARAP4 13.800	G4	1	115.0
70103	CHEROK1 15.500	G1	1	110.0
70104	CHEROK2 15.500	G2	1	110.0
70105	CHEROK3 20.000	G3	1	165.0
70106	CHEROK4 22.000	G4	1	350.0
70119	COMAN 1 24.000	G1	1	304.8
70120	COMAN 2 24.000	G2	1	320.0
70188	FTLUP1-2 13.800	1	0	0.0
70188	FTLUP1-2 13.800	2	0	0.0
70310	PAWNEE 22.000	G1	1	505.0
70314	MANCHEF1 16.000	G1	1	70.0
70315	MANCHEF2 16.000	G2	1	70.0
70350	RAWHIDE 24.000	1	1	290.0
70351	RAWHIDEA 13.800	1	1	57.0
70406	ST.VR 2 18.000	G2	0	50.0
70407	ST.VR 3 18.000	G3	0	50.0
70408	ST.VR 4 18.000	G4	0	50.0
70409	ST.VRAIN 22.000	G1	0	150.0
70446	VALMONT 20.000	G5	1	100.0
70448	VALMONT6 13.800	G6	1	50.0
70478	ZUNI1 13.800	G1	0	0.0
70479	ZUNI2 13.800	G2	0	0.0
70553	ARAP5-6 13.800	G5	1	37.0
70553	ARAP5-6 13.800	G6	1	37.0
70554	ARAP7 13.800	G7	1	40.0

GI-2007-12 System Impact Study				
Generation Dispatch – Load Flow				
Bus	Name	ID	Status	Pgen
70557	VALMNT7 13.800	G7	1	30.0
70558	VALMNT8 13.800	G8	1	30.0
70560	LAMAR DC 230.00	1	1	200.0
70561	RAWHIDEF 18.000	1	1	70.0
70562	SPRUCE1 18.000	G1	1	100.0
70563	SPRUCE2 18.000	G2	0	0.0
70567	RAWHIDED 13.800	1	1	58.0
70568	RAWHIDEB 13.800	1	1	57.0
70569	RAWHIDEC 13.800	1	1	57.0
70577	FTNVL1-2 13.800	G1	1	38.0
70577	FTNVL1-2 13.800	G2	1	38.0
70578	FTNVL3-4 13.800	G3	1	38.0
70578	FTNVL3-4 13.800	G4	1	38.0
70579	FTNVL5-6 13.800	G5	1	38.0
70579	FTNVL5-6 13.800	G6	1	38.0
70588	RMEC1 15.000	G1	1	10.0
70589	RMEC2 15.000	G2	1	10.0
70591	RMEC3 23.000	G3	1	199.0
70593	SPNDLE1 18.000	1	1	110.0
70594	SPNDLE2 18.000	2	1	110.0
70701	CO GRN E 34.500	1	1	10.0
70702	CO GRN W 34.500	1	1	10.0
70703	TWNBUTTE 34.500	1	1	9.4
70710	PTZLOGN1 34.500	1	1	25.0
70712	PTZLOGN2 34.500	1	1	12.5
70713	PTZLOGN3 34.500	1	1	12.5
70777	COMAN 3 24.000	1	1	750.0
70822	CEDARCK1 34.500	1	1	18.8
70823	CEDARCK2 34.500	1	1	18.8
70950	ST.VR_5 18.000	G5	1	90.0
70951	ST.VR_6 18.000	G6	1	52.0
73381	BIRDSAL1 13.800	1	1	12.8
73382	BIRDSAL2 13.800	1	1	12.8
73383	BIRDSAL3 13.800	1	1	20.2
73418	RD_NIXON 20.000	1	1	183.4
73424	TESLA1 13.800	1	1	22.5
73427	DRAKE 5 13.800	1	1	42.2
73428	DRAKE 6 13.800	1	1	69.7

GI-2007-12 System Impact Study				
Generation Dispatch – Load Flow				
Bus	Name	ID	Status	Pgen
73429	DRAKE 7 13.800	1	1	119.2
73434	NIXONCT2 12.500	1	1	27.5
73435	NIXONCT1 12.500	1	1	27.5
73507	FTRNG1CC 18.000	1	1	142.0
73508	FTRNG2CC 18.000	1	1	142.0
73509	FTRNG3CC 18.000	1	1	170.4
			(1=on)	

C. Dynamic and Transient Stability Study Data & Results

Table 10 – Monitored Buses for Transient Voltage Dip Evaluation

Bus #	Bus Name	Nominal Bus Voltage	Bus #	Bus Name	Nominal Bus Voltage
73477	FULLER	230.0	73419	RD_NIXON	230.0
70139	DANIELPK	230.0	73394	CTTNWD S	230.0
70138	DANIELPK	115.0	73391	CTTNWD N	115.0
70278	MARCY	230.0	73393	CTTNWD S	115.0
70284	SURREYRG	230.0	73410	KETTLECK	115.0
70286	MIDWAYPS	230.0	73576	FLYHORSE	115.0
70311	PAWNEE	230.0	73389	BRIARGAT	115.0
70427	TARRYALL	230.0	73414	MONUMENT	115.0
70527	SANTEFE	230.0	70308	PALMER	115.0
70601	DANIELPK	345.0	73445	GRESHAM	115.0
70464	WATERTON	230.0	73400	EMIL AND	115.0
70038	ARAPAHOE	230.0	73422	TEMPLTON	115.0
70212	GREENWD	230.0	73490	RAMPART	115.0
70533	LEMON	230.0	73384	BIRDSALE	115.0
70524	SULPHUR	230.0	73408	KELKER E	115.0
70061	BOONE	230.0	73420	ROCKISLD	115.0
70122	COMANCHE	230.0	73409	KELKER W	115.0
70654	COMAN 3	345.0	73387	BIRDSALW	115.0
70121	COMANCHE	115.0	73407	KELKER N	230.0
70285	MIDWAYPS	115.0	73446	KELKER S	230.0
73413	MIDWAYBR	230.0	73380	ARIES	230.0
73551	W CANON	230.0	73421	STETSON	230.0
73531	LINCOLNT	230.0	73559	FRTRANGE	230.0
73392	CTTNWD N	230.0			

Table 11 – Summary Listing of Dynamic & Transient Stability Study Contingencies & Results

Case #	Fault Type	Fault Location	Tripped Facility	Additional Tripped Facility	Stability Results	Transient Voltage Dip Criteria	
						Bus	Lowest Voltage Dip (pu)
100	3ph	FULLER 230.0 kV	Jackson Fuller-Midway 230 kV	N/A	Stable	PALMER 115.0 kV	0.9807
101	3ph	FULLER 230.0 kV	Jackson Fuller-Daniels Park 230 kV	N/A	Stable	PALMER 115.0 kV	0.9737
102	3ph	FULLER 230.0 kV	Jackson Fuller-Cottonwood 230 kV	N/A	Stable	PALMER 115.0 kV	0.9816
103	3ph	FULLER 230.0 kV	Jackson Fuller-Nixon 230 kV	N/A	Stable	PALMER 115.0 kV	0.9801
104	3ph	FULLER 230.0 kV	Jackson Fuller 230/115 kV #1	N/A	Stable	PALMER 115.0 kV	0.9821
110	3ph	MIDWAYPS 230.0 kV	Midway-Jackson Fuller 230 kV	N/A	Stable	PALMER 115.0 kV	0.9785
112	3ph	MIDWAYPS 230.0 kV	Midway-Comanche 230 kV #1	N/A	Stable	PALMER 115.0 kV	0.9794
113	3ph	MIDWAYPS 230.0 kV	Midway-Comanche 230 kV #2	N/A	Stable	PALMER 115.0 kV	0.9794
116	3ph	MIDWAYBR 230.0 kV	Midway-Nixon 230 kV	N/A	Stable	PALMER 115.0 kV	0.9800
11A	3ph	MIDWAYPS 230.0 kV	Midway-Fountain Valley 230 kV	N/A	Stable	PALMER 115.0 kV	0.9811
133	3ph	RD_NIXON 230.0 kV	Nixon-Jackson Fuller 230 kV	N/A	Stable	PALMER 115.0 kV	0.9782
134	3ph	RD_NIXON 230.0 kV	Nixon-Midway 230 kV	N/A	Stable	PALMER 115.0 kV	0.9800
136	3ph	RD_NIXON 230.0 kV	Nixon Unit 1	N/A	Stable	PALMER 115.0 kV	0.9812
137	3ph	RD_NIXON 230.0 kV	Nixon Unit 2	N/A	Stable	PALMER 115.0 kV	0.9799
138	3ph	RD_NIXON 230.0 kV	Nixon Unit 3	N/A	Stable	PALMER 115.0 kV	0.9801
139	3ph	RD_NIXON 230.0 kV	Nixon-Front Range 230 kV	N/A	Stable	PALMER 115.0 kV	0.9775

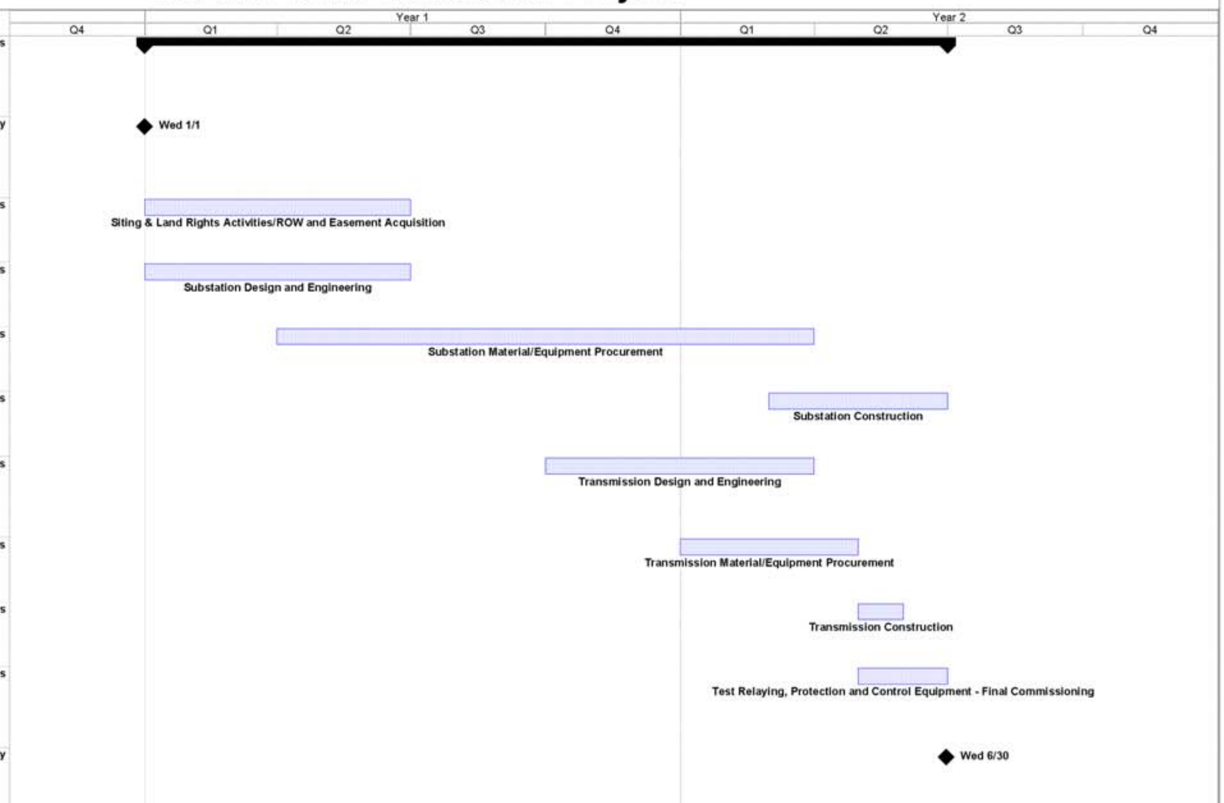
Case #	Fault Type	Fault Location	Tripped Facility	Additional Tripped Facility	Stability Results	Transient Voltage Dip Criteria	
						Bus	Lowest Voltage Dip (pu)
200	slg w/ BF	FULLER 230.0 kV	Jackson Fuller-Midway 230 kV	Jackson Fuller-Daniels Park 230 kV	Stable	PALMER 115.0 kV	0.9732
201	slg w/ BF	FULLER 230.0 kV	Jackson Fuller-Cottonwood 230 kV	Jackson Fuller-Nixon 230 kV	Stable	PALMER 115.0 kV	0.9804
210	slg w/ BF	MIDWAYPS 230.0 kV	Midway-Comanche 230 kV	Fountain Valley Generation	Stable	PALMER 115.0 kV	0.9791
211	slg w/ BF	MIDWAYPS 230.0 kV	Midway-Daniels Park 230 kV	Midway-Comanche 230 kV	Stable	PALMER 115.0 kV	0.9722
212	slg w/ BF	MIDWAYPS 230.0 kV	Midway-Jackson Fuller 230 kV	Midway PS-Midway WAPA 230 kV	Stable	PALMER 115.0 kV	0.9782
213	slg w/ BF	MIDWAYBR 230.0 kV	Midway-Nixon 230 kV	Midway PS-Midway WAPA 230 kV Midway-Lincoln 230 kV Midway-Canon W 230 kV Midway 230/115 kV #2	Stable	PALMER 115.0 kV	0.9794
230	slg w/ BF	RD_NIXON 230.0 kV	Nixon-Kelker N 230 kV	Nixon Unit 1	Stable	PALMER 115.0 kV	0.9798
232	slg w/ BF	RD_NIXON 230.0 kV	Nixon-Jackson Fuller 230 kV	Nixon Unit 2 Nixon Unit 3	Stable	PALMER 115.0 kV	0.9770
233	slg w/ BF	RD_NIXON 230.0 kV	Nixon-Midway 230 kV	Frontrange Generation	Stable	PALMER 115.0 kV	0.9752

Xcel Energy

D. Project Schedule

GI-2007-12 (System Impact Study Report)
250 MW Wind Generation Project

ID	Task Name	Duration
1	GI-2007-12 (System Impact Study Report) 250 MW Wind Generation Project	547 days
2	Authorization to Proceed - Day One Execution of Interconnection Agreement	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	366 days
6	Substation Construction	122 days
7	Transmission Design and Engineering	183 days
8	Transmission Material/Equipment Procurement	121 days
9	Transmission Construction	31 days
10	Test Relaying, Protection and Control Equipment - Final Commissioning	61 days
11	Completion Date	1 day



Project: Schedule 6-8-09.mpp
Date: Mon 6/8/09

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

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E. Jackson Fuller Substation Proposed One-Line with Wind Farm Attachment (from Feasibility Study)