Interconnection System Impact Study Report
Request # GI-2007-11, (Winter 2009-2010)

CTG #'s 5 & 6 (331 MW total - winter) Additions at Fort St. Vrain Generation Plant in Winter 2009-2010

PSCo Transmission Planning
July 10, 2008

Executive Summary

On or about October 24, 2007 Public Service Company of Colorado (PSCo) Transmission Planning received a generation interconnection request to perform an Interconnection System Impact Study (SIS, or "Study") to assess the impact of interconnecting two simple-cycle gas-fired combustion turbine generators (CTG 5 & CTG 6) at its Fort St. Vrain (FSV) generation plant located north of Denver in Weld County, Colorado. Based upon information provided by the Customer (PSCo – Energy Supply Function), the total net output of the two General Electric CTGs is 331 MW (winter net), with a planned back-feed date of January 15, 2009, and a commercial operation in-service date of no later than May 31, 2009. This Study was performed first for the summer 2009 (269 MW total) ratings, and included short-circuit and dynamic stability studies. The details of these summer studies were reported in GI-2007-11, issued 3/4/2008. An additional study was commissioned for the winter 2009-2010 (331 MW total) ratings, and included steady state and dynamic stability studies. The winter analysis evaluated all the same faults as in the summer analysis, and the results were similar. All studied contingencies showed a stable system with all voltages within criteria and all oscillations well damped. The details of these studies are identified in the Dynamic Stability Analysis Study Results section of this report. Steady-state power flow studies were also performed in this SIS, as these were performed for a for a winter peaking case for the 2009/2010 winter period. The output of the 2 CT's was set at 331 MW. The line ratings in the power flow case were left as is (from the summer case) for the initial steps of the Ft. St. Vrain analysis. The results obtained from the contingency analysis (Table 1 steady state analysis results), indicated there were several circuits and two transformers identified as potentially impacted. No voltage violations associated with the addition of GI-2007-11 during the winter peak period were observed.

The summer 2009 study (GI-2007-11) previously determined the scope of work and costs associated with the installation and interconnection of the two new generator step-up transformers (GSU, one each per CTG 5 & 6) into the existing 230 kV switchyard at FSV, and identified additional transmission network upgrades and costs that were not identified in the initial NQ-2007-2 study. Therefore, similar work was not duplicated in this study, as it was previously reported in GI-2007-11 (SIS) dated March 4, 2008. No additional Interconnection costs or Network upgrades are required as a result of the GI-2007-11 winter analysis.

Steady State Analysis Study Results (performed by Siemens / PTI)

Steady-state power flow studies were also performed in this SIS, as these were performed for a for a winter peaking case for the 2009/2010 winter period. The output of the 2 CT's was set at 331 MW. The line ratings in the power flow case were left as is (from the summer case) for the initial steps of the Ft. St. Vrain analysis. The results obtained from the contingency analysis (Table 1 steady state analysis results), indicated there were several circuits and two transformers identified as potentially impacted. The two transformers are the Valmont 230/115 kV and the Weld PS 230/115 kV. The power flow case shows only one transformer at Valmont and with a planned addition of a second transformer, this issue would be resolved. The Weld transformer overload under contingency conditions can be alleviated with increased generation to 30 MW at Montfort (which was offline in the starting power flow case, although the 3 UNC units were on line). Additionally there are ongoing studies between PSCo and WAPA to alleviate the existing overload conditions at Weld. In reviewing the potentially overloaded circuits, the winter ratings taken from the latest FAC-009 report (revision 5 dated 5/7/08) are included as a separate column on the attached report.(Table 1) Using these ratings, none of these circuits would be overloaded under contingency conditions with the addition of GI-2007-11. No voltage violations associated with the addition of GI-2007-11 during the winter peak period were observed.

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Table 1: Steady State Analysis Result

			With GI-2007-11				Without GI-2007-11	
** From bus ** ** To bus ** CKT	Branch Rating in Case	FAC009 Rev 5 Winter Branch Rating	Cont MVA	Loading %	Loading % - Revised Rating	Contingency	Cont MVA	Loading %
70139 DANIELPK 230 70311 PAWNEE 230 1	340.0	580.0	407.9	119.5	**70.3**	70311 PAWNEE 230 70545 BRICKCTR 230 1	388.1	114.1
70192 FTLUPTON 230 70410 ST.VRAIN 230 1	435.0	506.0	502.8	113.3	**99.4**	70192 FTLUPTON 230 70410 ST.VRAIN 230 2	395.7	91.0
70192 FTLUPTON 230 70410 ST.VRAIN 230 2	435.0	506.0	502.8	113.3	**99.4**	70192 FTLUPTON 230 70410 ST.VRAIN 230 1	395.7	91.0
70266 LOOKOUT 230 70570 PLNENDSS 230 1	336.0	527.0	439.2	129.3	**83.3**	70266 LOOKOUT 230 70570 PLNENDSS 230 2	386.8	115.1
70266 LOOKOUT 230 70570 PLNENDSS 230 2	336.0	527.0	439.1	129.2	**83.3**	70266 LOOKOUT 230 70570 PLNENDSS 230 1	386.7	115.1
70444 VALMONT 115 70447 VALMONT 230 T	280.0	280.0	316.3	112.1	113.0	70447 VALMONT 230 70543 SIMMS 230 1	289.4	103.4
70470 WELD PS 115 70471 WELD PS 230 T1	150.0	150.0	186.6	124.2	124.2	73211 WELD LM 115 73212 WELD LM 230 1	184.1	122.7
70609 SILVSADL 230 70610 REUNION 230 1	326.0	744.0	331.7	101.3	**44.6**	70192 FTLUPTON 230 70529 JLGREEN 230 1	314.7	96.5
QF UNC generation in both cases at 66.9 MW. Placing Montfort on line at 30 MW will reduce Weld PS transformer loading to 167.9 MVA (111.9% of rating).								

Dynamics Stability Analysis Study Results (performed by Siemens / PTI)

Input Data

Stability analysis was also performed for the winter period using the area 70 and 73 system representation for the 2009/10 winter superimposed on a 2011 HS power flow model with updated machine data (the same process used for the summer stability analysis). The analysis evaluated all of the same faults as in the summer analysis, and the results were similar. In conclusion, the results for all studied contingencies showed a stable system with all voltages within criteria and all oscillations well damped.

Methodology

The stability analysis was performed using PSS™E version 30.2. After reviewing the data for reasonableness and obtaining a flat start with the benchmark case, dynamic simulations were performed for both the benchmark case and the case with the new FSV CTG5 & CTG6 generators (GI-2007-11) for a common set of system disturbances to determine if the addition of the new FSV generation would have any adverse impacts on the system.

Rotor angles, mechanical and electrical power, generator terminal voltages, and frequency were monitored for representative generating units throughout control areas 70 and 73. In addition, voltages at the 115-, 230-, and 345-kV buses in areas 70 and 73 were also monitored.

WECC planning criteria including voltage deviation criteria for system response after disturbances was used in the analysis. Specifically, WECC requires that for a single contingency, transient voltage dips cannot exceed 25% at load buses, or 30% at non-load buses, cannot exceed 20% for more than 20 cycles at any load bus, cannot have a post-transient voltage deviation exceed 5% at any bus, and the frequency cannot dip below 59.6 Hz for 6 cycles or more at a load bus. For multiple contingencies, transient voltage dips cannot exceed 30% at any bus and cannot exceed 20% for more than 40 cycles at any load bus, cannot have a post-transient voltage deviation exceed 10% at any bus, and frequency cannot dip below 59.0 Hz for 6 cycles or more at a load bus. The addition of any new generation cannot produce system performance that is out of compliance with the values stated above.

Contingencies Studied

A list of faults near the proposed GI-2007-11 project were developed that should provide a reasonably thorough evaluation of system performance (see Table 2). Twelve three-phase faults on single 230-kV circuits were studied, with fault clearing in 5 cycles. In addition, four three-phase faults were studied that required the tripping of two circuits in 5 cycles. Finally three contingencies were studied that consisted of single-line-to-ground faults with delayed clearing, at 23 cycles.

Results

For all contingencies that were studied, the results of the stability analysis indicates that the addition of GI-2007-11 (FSV CTG5 and CTG6) does not have an adverse impact on the response of the system to severe system disturbances. All generation remained on line, except where disconnected from the system. All oscillations were positively damped and voltage deviations on nearby 115 kV and 230 kV buses were well within criteria. The contingencies consisting of delayed clearing were similarly behaved with no undamped oscillations and voltage response within criteria as well. Results of system behavior in the benchmark case were similar to those observed for the case with GI-2007-11 generation.

Table 2: Dynamic stability Results

Fault				Cleared Circuit 1							Cleared Circuit 2 (N - 2 and Breaker Failure)						
Location			Duration	Bus 1			Bus 2			Circuit	Bus 1			Bus 2			Ckt
Name	kV	Number	(Cycles)	Name	kV	Number	Name	kV	Number		Name	kV	Number	Name	kV	Number	
St.Vrain	230	70410	5	St.Vrain	230	70410	FtLupton	230	70192	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	Isabelle	230	70544	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	Weld PS	230	70471	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	*Fordham*	*230*	*73562*	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	GreenVal	230	70048	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	LongPeak	230	73116	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	Spndle	230	70592	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	Windsor	230	70474	1	None						
FtLupton	230	70192	5	St.Vrain	230	70410	FtLupton	230	70192	1	None						
Spndle	230	70592	5	St.Vrain	230	70410	Spndle	230	70592	1	None						
Niwot	230	70297	5	Isabelle	230	70544	Niwot	230	70297	1	None						
St.Vrain	230	70410	5	St.Vrain	230	70410	Spndle	230	70592	1	St.Vrain	230	70410	Isabelle	230	70544	1
St.Vrain	230	70410	5	St.Vrain	230	70410	GreenVal	230	70048	1	Keenesbg	230	70820	GreenVal	230	70048	1
St.Vrain	230	70410	5	St.Vrain	230	70410	FtLupton	230	70192	1	St.Vrain	230	70410	FtLupton	230	70192	2
St.Vrain	230	70410	5	St.Vrain	230	70410	Isabelle	230	70544	1	Spndle	230	70592	Valmont	230	70447	1
St.Vrain	230	70410	23	St.Vrain	230	70410	LongPeak	230	73116	1	St.Vrain	230	70410	Isabelle	230	70544	1
St.Vrain	230	70410	23	St.Vrain	230	70410	Weld PS	230	70471	1	St.Vrain	230	70410	*Fordham*	*230*	*73562*	1
St.Vrain	230	70410	23	St.Vrain	230	70410	Windsor	230	70474	1	St.Vrain	230	70410	*Fordham*	*230*	*73562*	1

Note: If the N - 2 breaker failure simulations meet criteria with a clearing time of 23 cycles, no further simulations for that scenario will be run. If the N - 2 simulations do not meet criteria with a clearing time of 23 cycles, the critical clearing time for that scenario will be determined.

All studied contingencies showed a stable system with all voltages within criteria and all oscillations well damped.