Southwest Power Pool

Impact Study for Generation Interconnection Request GEN–2008–006

SPP Tariff Studies
(#GEN-2008-006)

May 2008

Summary

<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 510MW (summer)/580MW (winter) of a 2-on-1 combined cycle generation within the control area of American Electric Power West (AEPW) located in Caddo Parish, Louisiana. The proposed point of interconnection is the Arsenal Hill 138kV substation. The proposed in-service date is June 1, 2010. Previously, the plant was studied at 455MW (summer)/550MW (winter) rating in the interconnection study for GEN-2006-008. The customer has requested an increase of capacity to 510 (summer)/580MW (winter) rating.

This study has determined there are no additional requirements for GEN-2008-006 from the costs given in the Facility Study for GEN-2006-008.

A stability study was conducted by ABB Consulting and is included in Attachment 1. The stability study shows that the interconnection of proposed project does not have any adverse impact on the system stability in SPP area.

The required interconnection costs listed in Table 2 do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer requests transmission service through Southwest Power Pool's OASIS.

Introduction

<OMITTED TEXT> (Customer) has requested an Impact Study for the purpose of interconnecting 510MW (summer)/580MW (winter) of a 2-on-1 combined cycle generation within the control area of American Electric Power West (AEPW) located in Caddo Parish, Louisiana. The proposed point of interconnection is the Arsenal Hill 138kV substation. The proposed in-service date is June 1, 2010. Previously, the plant was studied at 455MW (summer)/550MW (winter) rating for the interconnection study for GEN-2006-008. The customer has requested an increase in capacity of GEN-2006-008 to 510 (summer)/580MW (winter) rating.

Interconnection Facilities

No additional interconnection facilities are necessary for the interconnection of GEN-2008-006. For full interconnection costs of the facility, the Facility Study for GEN-2006-008 should be consulted.

Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2012 summer and winter peak, and 2017 summer peak models. The output of the Customer's facility was offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ER) Interconnection request. The proposed in-service date of the generation is June 1, 2010. The available seasonal models used were through the 2017 Summer Peak of which is the end of the current SPP planning horizon.

The analysis of the Customer's project indicates no overloaded elements for transmission systems under steady state and contingency conditions in the peak seasons. These network constraints are shown in Table 3.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

If any of these projects do not get constructed or if any prior queued generation interconnection request withdraws from the queue, this analysis will need to be re-evaluated.

Powerflow Analysis Methodology

The Southwest Power Pool (SPP) criteria states that: "The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable *NERC Planning Standards* for System Adequacy and Security – Transmission System Table I hereafter referred to as NERC Table I) and its applicable standards and measurements".

Using the created models and the ACCC function of PSS\E, single contingencies in portions or all of the modeled control areas of Sunflower Electric Power Corporation (SUNC), Missouri Public Service (MIPU), Westar (WESTAR), Kansas City Power & Light (KCPL), West Plains (WEPL), Midwest Energy (MIDW), Oklahoma Gas and Electric (OKGE), American Electric Power West (AEPW), Grand River Dam Authority (GRDA), Southwestern Public Service (SPS), Western Farmers Electric Cooperative (WFEC), Western Resources (WERE), and other control areas were applied and the resulting scenarios analyzed. This satisfies the 'more probable' contingency testing criteria mandated by NERC, and the SPP criteria.

Table 3: Network Constraints

AREA	OVERLOADED ELEMENT
	NO OVERLOADED ELEMENTS

Table 4: Contingency Analysis

SEASON	OVERLOADED ELEMENT	RATING (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
12SP	NONE				
12WP	NONE				
17SP	NONE				

Note: When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

Stability Analysis

A transient stability analysis was conducted for the facility by ABB Consulting (ABB). The study is attached to this report. The stability analysis indicated that the interconnection of proposed project does not have any adverse impact on the system stability in SPP area.

If any of these projects do not get constructed or if any prior queued generation interconnection request withdraws from the queue, this analysis will need to be re-evaluated.

POWER SYSTEMS DIVISION
GRID SYSTEMS CONSULTING

IMPACT STUDY FOR GENERATION INTERCONNECTION REQUEST GEN-2008-006

FINAL REPORT

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ABB Inc – Grid Systems Consulting

Technical Report

Southwest Power Pool	**No.** 2008-11778-R0	
Impact Study for Generation Interconnection request GEN-2008-006	5/9/2008	# Pages 22

Author(s):	**Reviewed by:**	**Approved by:**
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Executive Summary

Southwest Power Pool (SPP) has commissioned ABB Inc to perform a generator interconnection study for an uprate to a previously studied 138 kV interconnection of a 2-on-1 combined cycle power plant in Caddo Parish, Louisiana. This combined cycle plant will be interconnected into the existing Arsenal Hill 138 kV substation in the control area of American Electric Power West (AEPW). Previously, the plant was studied at 455/550 MW (summer/winter) rating. The Customer has requested an uprate to 510/580 MW (summer/winter) rating.

This Combined Cycle Power Plant was studied under two different system loading scenarios - 2008 winter peak and 2012 summer peak. The generators are connected at existing Arsenal Hill 138 kV (Bus #507711) substation.

The SPP system, prior-queued generators, and the proposed project are stable following all simulated faults. Based on the results of the stability analysis, it is concluded that the proposed capacity uprate (510 MW for summer peak and 580 MW for winter peak) does not adversely impact the stability of the SPP system.

The results of this analysis are based on available data and assumptions made at the time of conducting this study. If any of the data and/or assumptions made in developing the study model change, the results provided in this report may not apply.

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0	Draft Report	05/09/08	Sunil Verma	Amit Kekare	Willie Wong
1	FINAL REPORT	05/14/08	Sunil Verma	Amit Kekare	Willie Wong
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1 INTRODUCTION

SPP has requested a generator interconnection study for a modification to a previously studied 138 kV interconnection for a 2-on-1 combined cycle power plant in Caddo Parish, Louisiana. This combined cycle plant will be interconnected into the existing Arsenal Hill power station substation (bus #507711) in the control area of American Electric Power West (AEPW). Previously, the plant was studied at 455/550 MW (summer/winter) rating. The customer has requested an uprate to 510/580 MW (summer/winter) rating.

The proposed uprate (GEN-2008-006) of the Combined Cycle Power Plant was studied under two different system loading scenarios - 2008 winter peak and 2012 summer peak. The feasibility (power flow) study was not performed as a part of this study.

The objective of the impact study is to evaluate the impact on system stability after uprating the combined cycle plant and its effect on the nearby transmission system and generating stations including prior queued projects (such as GEN-2006-010 coal plant at bus #509416). Figure 1-1 shows the combined cycle plant interconnecting station and Figure 1-2 shows the interconnection with the existing network.

Figure 1-1 GEN-2008-006 Combined Cycle Plant Location

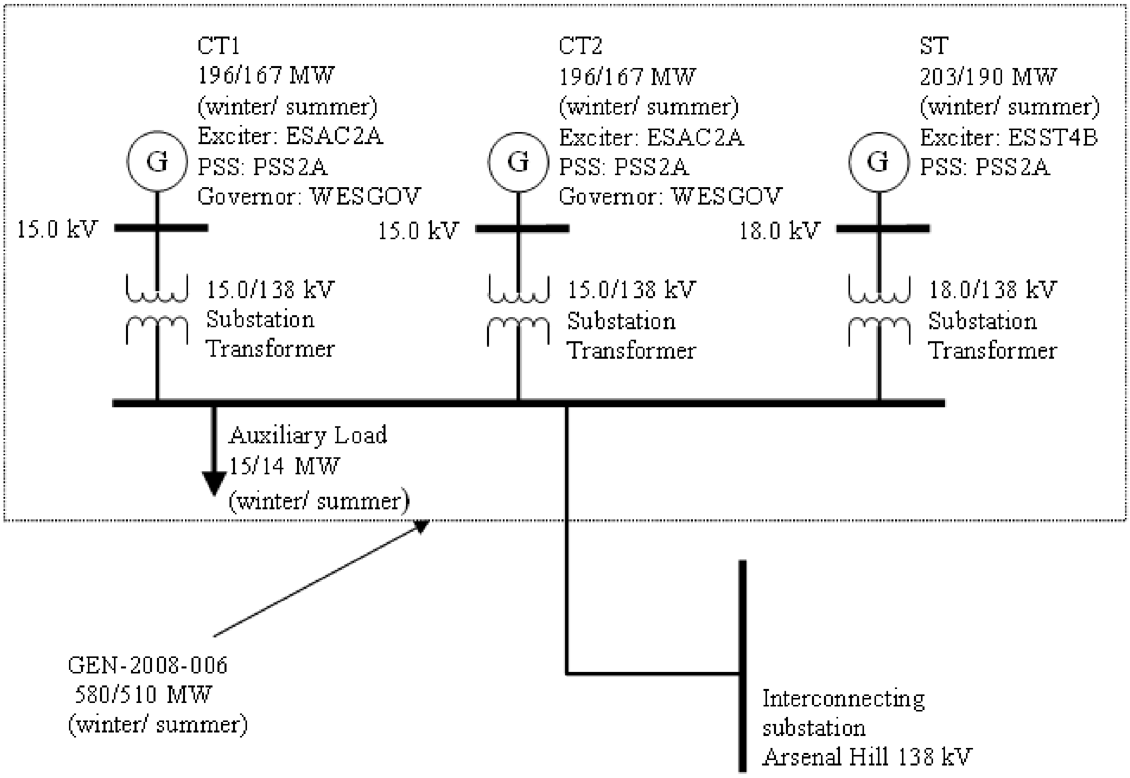

Figure 1-2 Combined Cycle Plant One-line

2 STABILITY ANALYSIS

In this stability study, ABB investigated the stability of the system for a series of faults specified by SPP, which are in the vicinity of the proposed project. All of the simulations, except FLT_7_3PH, FLT_8_1PH, FLT_9_3PH and FLT_10_1PH, represent three-phase or single-phase faults cleared by primary protection in 3.5 cycles, re-closing after 30 more cycles with the fault still on, and then permanently clearing of the fault 3.5 cycles later with primary protection.

Faults FLT_7_3PH and FLT_8_1PH are with double re-closing. First fault cleared by primary protection in 3.5 cycles, re-closing after 30 more cycles with the fault still on. Again clearing fault after 3.5 cycles more and then re-closing after 180 more cycles with fault still on, and then permanently clearing of fault in next 3.5 cycles. Faults FLT_9_3PH and FLT_10_1PH are without re-closing operation clearing permanently in 3.5 cycles.

2.1 STABILITY ANALYSIS METHODOLOGY

Using Planning Standards approved by NERC, the following stability definition was applied in the Transient Stability Analysis:

"Power system stability is defined as that condition in which the differences of the angular positions of synchronous machine rotors become constant following an aperiodic system disturbance."

Stability analysis was performed using the PSS/E™ dynamics program V30.2.1. Three-phase and single-phase line faults were simulated for the specified durations, including re-closing, and the synchronous machine rotor angles were monitored to make sure they maintained synchronism following the fault removal. Stability of asynchronous machines was monitored as well.

Single-phase faults were simulated with the standard method of applying fault impedance to the positive sequence network to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was estimated to give a positive sequence voltage at the fault location of approximately 60% of pre-fault voltage, which is a typical value.

2.2 STUDY MODEL DEVELOPMENT

The study model consists of power flow cases and dynamics databases, developed as follows.

Base Power Flow Cases

SPP supplied the following two (2) pre-project PSS/E power flow cases:

- *"gen-2008-006_08wp.sav"* representing the Winter Peak conditions of the SPP system for the year 2008
- *"gen-2008-006_12sp.sav"* representing Summer Peak conditions of the SPP system for the year 2012

The power flows in Pre-project conditions are shown in Figure 2-1 and Figure 2-2.

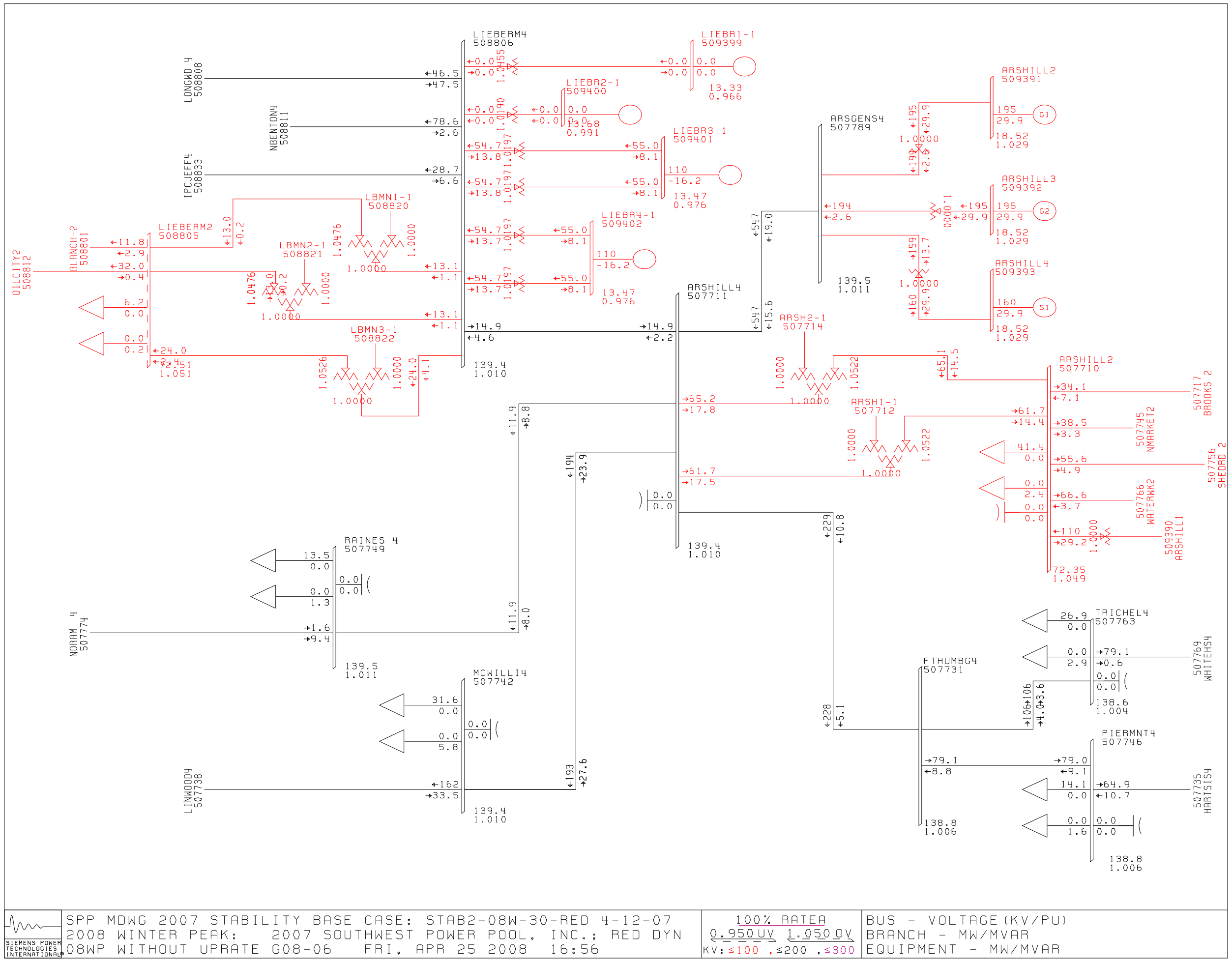

Figure 2-1 2008 Winter Peak case without uprating of GEN-2008-006

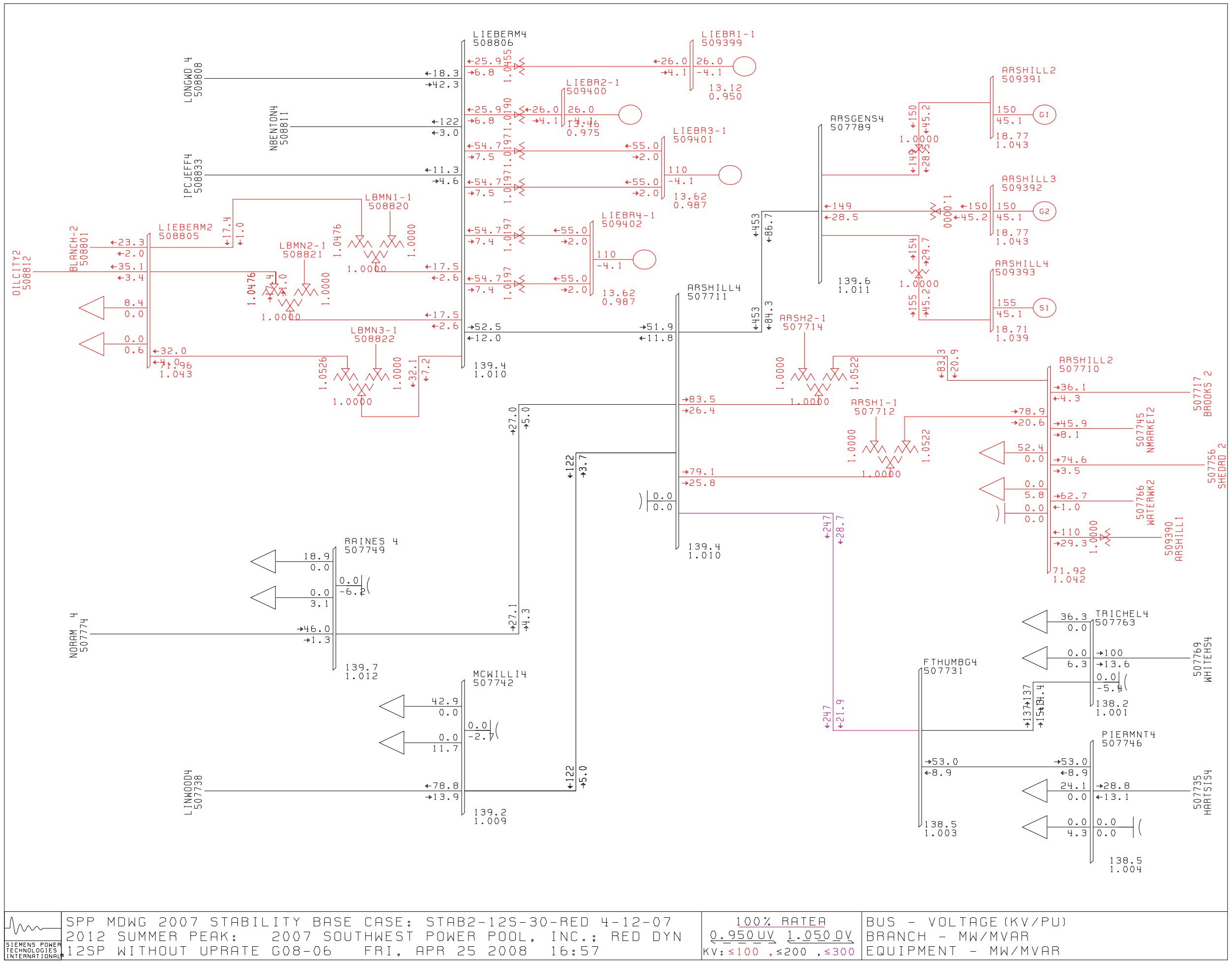

Figure 2-2 2012 Summer Peak case without uprating of GEN-2008-006

GEN-2008-006 Power Flow Cases

The proposed GEN-2008-006 project is comprised of two Combustion Turbines (CTs) and one Steam Turbine (ST). This combined cycle plant is connected to the Arsenal Hill 138 kV substation (bus #507711). Each CT is connected to the 138 kV bus with a 15/138 kV step-up transformer and the ST is connected to 138 kV bus with an 18/138 kV step-up transformer. The proposed project was dispatched against the generation in AEP (Area 520). The details of model development are described in Appendix A.

Thus two Post-project power flow cases were established:

- *WP08_GEN-2008-006.SAV – 2008 winter peak case*
- *SP12_GEN-2008-006.SAV – 2012 summer peak case*

Figure 2-3 and Figure 2-4 show a power flow one-line diagram with the GEN-2008-006 project for 2008 winter peak and 2012 summer peak system conditions respectively.

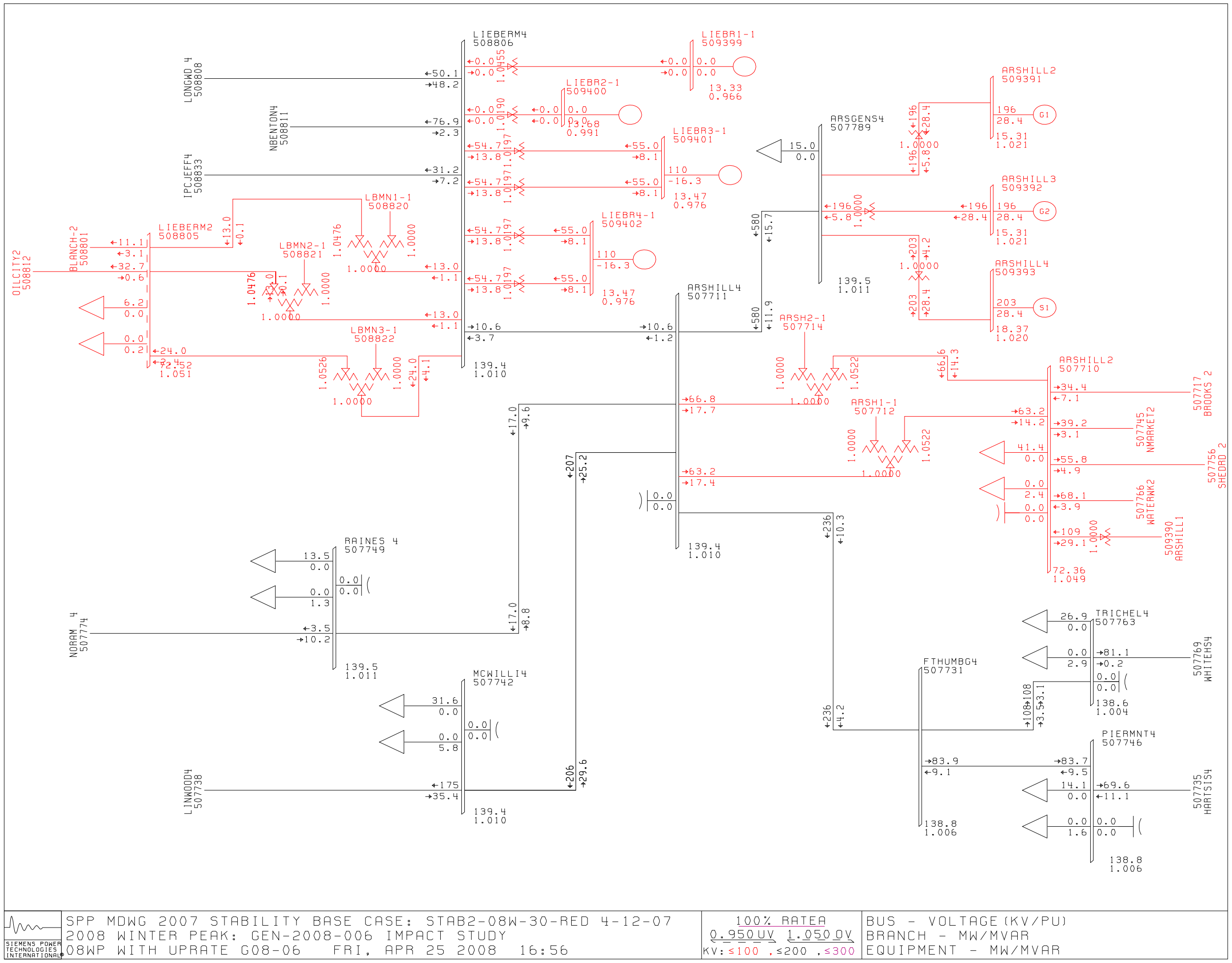

Figure 2-3 2008 Winter Peak case with uprating of GEN-2008-006

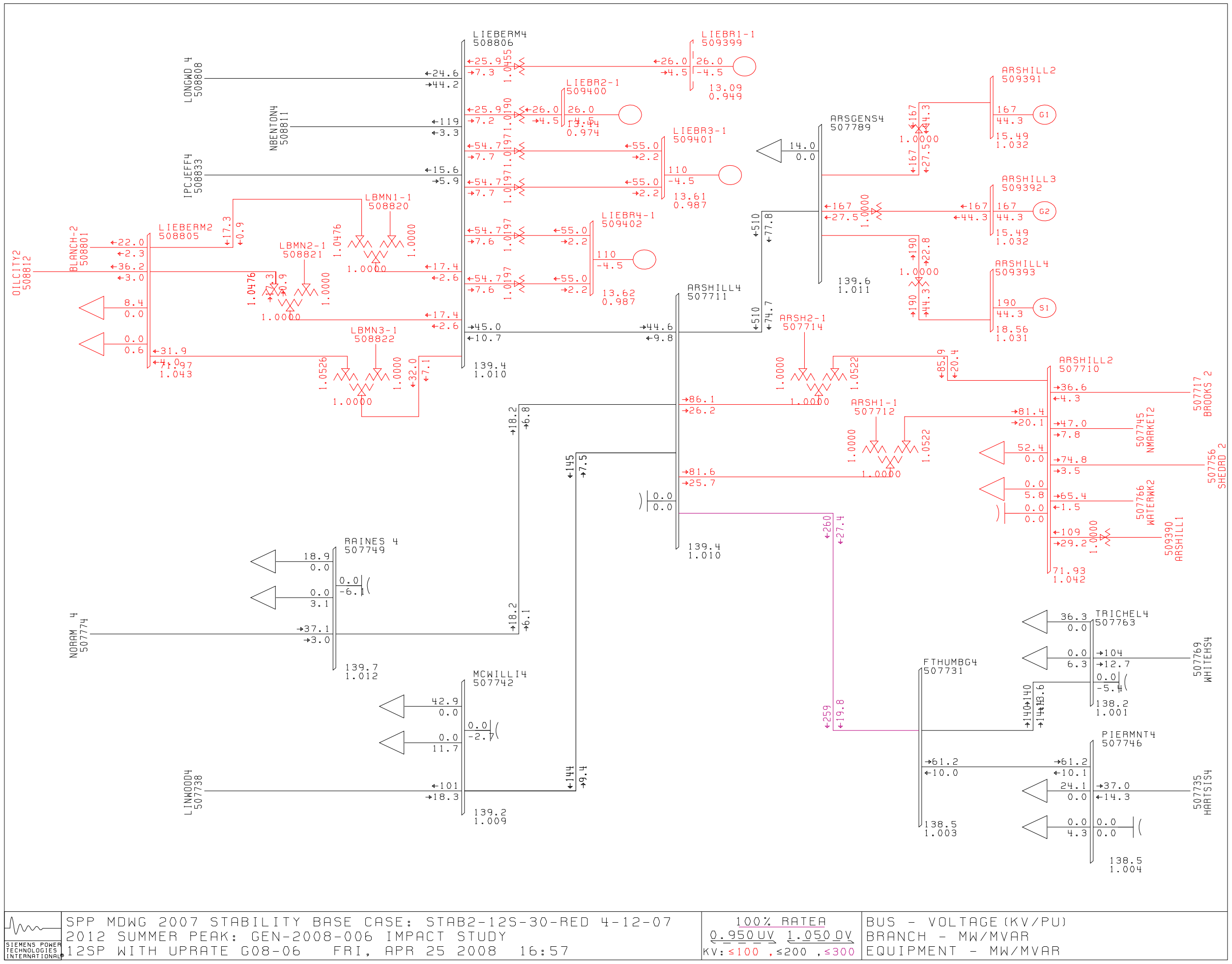

Figure 2-4 2012 Summer Peak case with uprating of GEN-2008-006

<u>Stability Model</u>

SPP provided the stability databases in the form of PSS/E dynamic data files - "*gen-2008-006_08wp.dyr*" to model the 2008 Winter Peak, and "*gen-2008-006_12sp.dyr*" to model the 2012 Summer Peak configuration. Command files were also provided to compile and link user-written models. These files are compatible with PSS/E version 30.2.1.

SPP provided the dynamic data for the proposed GEN-2008-006 project. The round rotor generator model, "GENROU", was used for both CTs and the ST. The "WESGOV" governor model, "ESAC2A" exciter model and "PSS2A" stabilizer model were used to represent the proposed CTs. The "ESST4B" exciter model and "PSS2A" stabilizer were used to represent the proposed ST.

The details of power flow and stability model representations for GEN-2008-006 are included in Appendix B.

<u>Simulated Faults</u>

Table 2-1 lists the disturbances simulated for stability analysis.

Table 2-1 List of Faults for Stability Analysis

Fault Name	*Description*
FLT_1_3PH	Three phase fault on the Arsenal Hill (#507711) to Lieberman (#508806) 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_2_1PH	Single phase fault on the Arsenal Hill (#507711) to Lieberman (#508806) 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_3_3PH	Three phase fault on the Arsenal Hill (#507711) to Longwood (#508808) (via Raines and Noram), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (507711). b) Clear Fault after 3.5 cycles by removing the line from #507711-#507749 -#507774-#508808. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_4_1PH	Single phase fault on the Arsenal Hill (#507711) to Longwood (#508808) (via Raines and Noram), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (507711). b) Clear Fault after 3.5 cycles by removing the line from #507711-#507749 -#507774-#508808. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_5_3PH	Three phase fault on the Arsenal Hill (#507711) to Linwood (#507738)(via McWillie), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from #507711-#507742 -#507738. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_6_1PH	Single phase fault on the Arsenal Hill (#507711) to Linwood (#507738)(via McWillie), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from #507711-#507742 -#507738. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.

Fault Name	Description
FLT_7_3PH	Three phase fault on the Arsenal Hill (#507711) to Fort Humbug (#507731), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service. e) Wait 180 cycles; and reclose into the fault a second time f) Clear fault after 3.5 cycles
FLT_8_1PH	Single phase fault on the Arsenal Hill (#507711) to Fort Humbug (#507731), 138kV line, near Arsenal Hill. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service. e) Wait 180 cycles; and reclose into the fault a second time f) Clear fault after 3.5 cycles
FLT_9_3PH	Three phase fault on the Arsenal Hill 138/69kV autotransformer on the 138kV bus. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the autotransformer from service.
FLT_10_1PH	Single phase fault on the Arsenal Hill 138/69kV autotransformer on the 138kV bus. a) Apply Fault at Arsenal Hill (#507711). b) Clear Fault after 3.5 cycles by removing the autotransformer from service.
FLT_11_3PH	Three phase fault on the Longwood (#508809) to El Dorado (#99294) 345kV line near Longwood. a) Apply Fault at Longwood (53424). b) Clear Fault after 3.5 cycles by removing the line from #508809 - #99294. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_12_1PH	Single phase fault on the Longwood (#508809) to El Dorado (#99294) 345kV line near Longwood. a) Apply Fault at Longwood (53424). b) Clear Fault after 3.5 cycles by removing the line from #508809 - #99294. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.

Fault Name	***Description***
FLT_13_3PH	Three phase fault on the Southwest Shreveport (#507760) to Diana (#508832) 345kV line near SW Shreveport. a) Apply Fault at SW Shreveport (#507760). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_14_1PH	Single phase fault on the Southwest Shreveport (#507760) to Diana (#508832) 345kV line near SW Shreveport. a) Apply Fault at SW Shreveport (#507760). b) Clear Fault after 3.5 cycles by removing the line from service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_15_3PH	Three phase fault on the Southwest Shreveport (#507760) to Dolet Hills (#500250) 345kV line near SW Shreveport. a) Apply Fault at SW Shreveport (#507760). b) Clear Fault after 3.5 cycles by removing the line form service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.
FLT_16_1PH	Single phase fault on the Southwest Shreveport (#507760) to Dolet Hills (#500250) 345kV line near SW Shreveport. a) Apply Fault at SW Shreveport (#507760). b) Clear Fault after 3.5 cycles by removing the line form service. c) Wait 30 cycles; and reclose into the fault d) Clear fault after 3.5 cycles by removing the line from service.

2.3 STUDY RESULTS

All the three phase and single phase faults listed above were simulated. Responses of the combined cycle plant, nearby prior-queued project (GEN-2006-010), and other nearby generators were monitored. The results for the simulated disturbances are summarized in Table 2-2. Plots showing the simulation results are included in Appendix C.

The results of the simulations indicate that GEN-2008-006 and all other generators in the vicinity of the project will be stable following all simulated faults. Hence, the interconnection of proposed project does not have any adverse impact on the system stability in SPP area.

Table 2-2: Results of Stability Simulations

FAULT	Winter Peak 2008	Summer Peak 2012
FLT_1_3PH	STABLE	STABLE
FLT_2_1PH	STABLE	STABLE
FLT_3_3PH	STABLE	STABLE
FLT_4_1PH	STABLE	STABLE
FLT_5_3PH	STABLE	STABLE
FLT_6_1PH	STABLE	STABLE
FLT_7_3PH	STABLE	STABLE
FLT_8_1PH	STABLE	STABLE
FLT_9_3PH	STABLE	STABLE
FLT_10_1PH	STABLE	STABLE
FLT_11_3PH	STABLE	STABLE
FLT_12_1PH	STABLE	STABLE
FLT_13_3PH	STABLE	STABLE
FLT_14_1PH	STABLE	STABLE
FLT_15_3PH	STABLE	STABLE
FLT_16_1PH	STABLE	STABLE

3 CONCLUSIONS

The objective of this study is to evaluate the power system stability after uprating the GEN-2008-006 combined cycle plant. The study is performed for two system scenarios: 2008 Winter Peak and 2012 Summer Peak.

The results indicated that following simulated faults the interconnection of proposed project does not have any adverse impact on the system stability in SPP area.

The results of this analysis are based on available data and assumptions made at the time of conducting this study. If any of the data and/or assumptions made in developing the study model change, the results provided in this report may not apply.

APPENDIX A - Combined Cycle Plant Model Development

APPENDIX B - Load Flow and Stability Data

APPENDIX C - Plots for Stability Simulations with Gen-2007-002