System Impact Study for Interconnection of >Omitted Text< >Omitted Text< MW Generation Facility in >Omitted Text<, Texas

Southwest Transmission Planning
(#OAIS 02 001)

April 2002

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Executive Summary

>Omitted Text< has requested an Impact Study for the interconnection of a merchant facility in >Omitted Text<, Texas. The plant will have a maximum output of >Omitted Text< MW in the summer and >Omitted Text< MW in the winter. The projected in service date is 2003.

The principal objective of this study is to: 1) identify any system problems associated with the connection of the proposed plant, 2) determine potential system modifications that might be necessary to facilitate the installation of the plant while maintaining system reliability and stability, and 3) estimate the costs associated with those system modifications. The study includes a steady state contingency analysis, a transient stability analysis, and an analysis of the interrupting capabilities of the existing circuit breakers in the area and if the circuit breaker capabilities are exceeded with the addition of this new generation.

For the purposes of this study, two seasons were studied, the 2005 summer peak and the 2005 winter peak. In both cases the plant's output was exported as follows: >Omitted Text< MW to Southwestern Electric Power Company (SWEPCO).

The estimated directly assigned cost of interconnecting the new >Omitted Text< facility to the transmission system is $2,611,141. This cost includes interconnection costs on the American Electric Power (AEP) system.

The analysis in this document shows that to accommodate a transfer, upgrades will also be required on the AEP 69 kV transmission system to relieve certain criteria violations during contingency operation. These violations are listed in **Tables 1** and **2** of the Steady State Analysis section of this document.

Introduction

>Omitted Text< has requested an Impact Study for the interconnection of a merchant facility in >Omitted Text<, Texas, approximately >Omitted Text< miles west of the Southwestern Electric Power Company's (SWEPCO's) Perdue Station on the Perdue to North Mineola 138 kV circuit, see **Figure 1**. The plant will have a maximum output of >Omitted Text< MW in the summer and >Omitted Text< MW in the winter. The projected in service date is 2003.

The principal objective of this study is to: 1) identify any system problems associated with the connection of the proposed plant, 2) determine potential system modifications that might be necessary to facilitate the installation of the plant while maintaining system reliability and stability, and 3) estimate the costs associated with those system modifications. . The study includes a steady state contingency analysis, a transient stability analysis, and an analysis of the interrupting capabilities of the existing circuit breakers in the area and if the circuit breaker capabilities are exceeded with the addition of this new generation.

The steady-state analysis considers the impact of the new generation on transmission facility loading and transmission bus voltages for outages of single, double, and triple circuit transmission lines, as well as outages of autotransformers, and generators.

Stability analysis shows the effects of the new generation on the transient stability of the SWEPCO generators as well as the surrounding utility and IPP generators. Transient stability is concerned with recovery from faults on the transmission system that are in close proximity to generating facilities.

This study also includes a short circuit analysis that determines if the interrupting capabilities of existing circuit breakers are exceeded with the addition of the new generation.

Interconnection Facilities

>Omitted Text< Generation 138 kV Interconnection

The proposed >Omitted Text< merchant facility is to be interconnected at SWEPCO's new >Omitted Text< >Omitted Text< 138 kV station, which will be located ½ mile from the merchant facility. AEP will construct a new 138 kV station with a three circuit breaker ring bus that will accommodate three 138 kV terminals. The new construction will include all metering, digital fault recording, protection and SCADA systems. >Omitted Text< will construct and own the generating plant and maintain their equipment including the GSU high-side transformer disconnects at the ownership boundary. AEP will retain ownership and operating authority of the 138 kV interconnects up to the high-side GSU transformer disconnects.

The design and construction of the new 138 kV station will meet all AEP specifications for stations. Bus work and disconnect switches will be designed to accommodate the loading requirements, and circuit breakers will be rated to ensure adequate load and fault interrupting capability. Metering equipment will be installed to monitor the plant output and will meet the required accuracy specifications. The estimated cost of the new >Omitted Text< >Omitted Text< 138 kV station is $2,092,000.

>Omitted Text< merchant plant to new >Omitted Text< 138 kV Station 138 kV Circuit

AEP will build a ½ mile, 138 kV circuit connecting the >Omitted Text< merchant plant to the >Omitted Text< >Omitted Text< 138 kV interconnection station. The line shall be supported on single concrete pole structures. The phase conductors shall be >Omitted Text<7 ACSR with shield wire. The cost of the line construction is estimated to be $519,141.

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Interconnection Costs

Listed below are the directly assigned costs associated with interconnecting the >Omitted Text< >Omitted Text< MW generation facility to the transmission system.

AEP SYSTEM IMPROVEMENTS	COST (2002 DOLLARS)
>Omitted Text< 138 kV Interconnection-New >Omitted Text< >Omitted Text< 138 kV switching station located on the Perdue to North Mineola 138 kV circuit	$2,092,000
>Omitted Text< merchant plant to new >Omitted Text< station 138 kV ½ mile circuit	$519,141
TOTAL	**$2,611,141**

A. Steady State Analysis

Study Methodology

The AEP and Southwest Power Pool (SPP) criteria state that the following conditions be met in order to maintain a reliable and stable system.

1) More probable contingency testing.... must conclude that

   a) All facility loadings are within their emergency ratings and all voltages are within their emergency limits (0.90-1.05 per unit) and
   b) Facility loadings can be returned to their normal limits within four hours

2) Less probable contingency testing.... shall conclude that

   a) Neither uncontrolled islanding, nor uncontrolled loss of large amounts of load will result.

More probable contingency testing is defined as the outage of any single piece of equipment or multi-circuit transmission line. Less probable contingency testing involves the loss of any two critical pieces of equipment such as 345 kV autotransformers and generating units or the loss of critical transmission lines on different structures but in the same right-of-way.

The 2002 series Southwest Power Pool 2005 summer and winter peak base cases were used to model the transmission network and system loads. These cases were modified to reflect known firm point-to-point transmission requests that have been approved.

>Omitted Text< requested that the analysis be performed assuming that the point of receipt of the >Omitted Text< MW generated capacity output of the new plant is in the SWEPCO system.

Using the created 2005 summer peak model and PTI's PSS/E program, single and select double contingency outages on the SPP system were analyzed to determine the necessary facilities to interconnect the proposed plant to the transmission system. This load flow analysis is described on the following pages.

Next, using the two created models and the ACCC function of PTI's PSS/E program, single and select double contingency outages on the SPP system were analyzed. Facilities in the western AEP (AEPW) control area found to be overloaded in the transfer cases with the proposed plant addition and not overloaded in the base cases were flagged and listed in **Tables 1** and **2.**

Load Flow Analysis

The discussion below is not a summary of all outages or criteria violations. It lists certain key flow results most relevant to the discussion. These load flow analysis results do not include any additions or changes resulting from the stability analysis or the short circuit analysis. However, the dynamics modeling data for the stability study had to be estimated, due to certain data not being provided (see **B. Stability Analysis**). If this project does move forward, the actual generator stability data will need to be provided and some transmission system upgrade changes may result.

It should be noted that there are third party transmission lines in the vicinity of the >Omitted Text< generating plant. The transmission customer is responsible for coordinating system impact studies with the third party transmission owners and making arrangements for any necessary transmission upgrades to the third party's transmission system.

>Omitted Text< >Omitted Text< MW Plant

Summer Peak->Omitted Text< MW plant with one 138 kV interconnection line to new >Omitted Text< Station: For an outage of the Adora to Adora/West Mt. Pleasant 'T' 69 kV line, the 4/0 Cu bus and jumpers overload to 101% of their emergency ratings at Quitman 69 kV Station

Winter Peak->Omitted Text< MW plant with one 138 kV interconnection line to new >Omitted Text< Station: For an outage of the new >Omitted Text< Station to Lake >Omitted Text< Station 138 kV line, the 600 A switch overloads to 101% of its emergency rating at the Mineola 69 kV Station on the Mineola to Hoard REC 69 kV line.

Table 1 – Overloaded SPP Facilities for 05SP. >Omitted Text< MW transfer to SWEPCO. The upgrades (if available) are included.

Study Year	From -To Area(s)	Branch Over 100% Rate B	Rate B <MVA>	>Omitted Text<MW Transfer Case %Loading	Outaged Branch That Caused Overload	Upgrades Required to Relieve Overload
05SP	AEPW-AEPW	NMINEOL2 to QUITMAN2	59	101	ADORA to ADORA ‘T’	Replace 4/0 Cu bus and jumpers at Quitman

Table 2 – Overloaded SPP Facilities for 05WP. >Omitted Text< MW transfer to SWEPCO. The upgrades (if available) are included.

Study Year	From -To Area(s)	Branch Over 100% Rate B	Rate B <MVA>	>Omitted Text<MW Transfer Case %Loading	Outaged Branch That Caused Overload	Upgrades Required to Relieve Overload
05WP	AEPW-AEPW	HOARD R2 to MINEOLA2	72	101	EXONTAP4 to LHAWKNS4	Replace 600A switch at Mineola

B. Stability Analysis

INTRODUCTION

Per >Omitted Text< request, American Electric Power (AEP) has conducted a stability performance study to evaluate the feasibility of connecting >Omitted Text< MW (winter net) of generation to the Perdue-North Mineola 138 kV line near >Omitted Text<, Texas. This report documents the stability performance study.

OVERVIEW OF GENERATION FACILITIES

Figure A.1 of Appendix 1 shows the transmission system configuration in the vicinity of the proposed generaton. The proposed facility would be located a short distance from, and connected directly to the Perdue-North Mineola 138 kV line at a new station, >Omitted Text< 138 kV, as shown in Figure A.1.

The proposed facility would consist of a simple-cycle unit with a maximum winter generation capacity of >Omitted Text< MW. The generator would be connected to the >Omitted Text< 138 station through a two-winding step-up transformer with the breaker configuration as shown in Figure A.1.

The dynamic modeling data for the generating unit as provided by >Omitted Text< and its equipment suppliers, are given in Appendix 2. **It should be noted that in this study some of the dynamics modeling data had to be estimated because these data were not provided to AEP by >Omitted Text<. Specifically, typical values were used for the quadrature transient reactance X_q' and open circuit time constant T_{qo}'.**

The exciter model provided by the vendor was not a standard model in the model library of the Power Technologies, Inc. PSS/E package used for the dynamic simulation. A standard model available in the library, ESAC8B, was used to represent the exciter. Although this model type was judged to give the best approximation of the exciter from the available standard model types, the approximation is judged to be poor because the provided data was difficult to correlate. If the proposed project moves forward, the equipment vendor should supply a more accurate representation.

DYNAMICS BASE CASE

A western AEP dynamics base case representing 2002 summer peak load conditions for the SPP portion of the AEP System was used for this study. This dynamics case was assembled using data from the 2002 SPP Dynamics Database. The new >Omitted Text< generating facility totaling >Omitted Text< MW was added to the case based upon data and configuration information provided by >Omitted Text< and its equipment vendors as shown in Appendix 2.

TESTING CRITERIA

AEP transient stability criteria for 138 kV connected generation facilities shown in Table 4.1 are used in time domain simulations to evaluate the stability performance of a proposed generation facility.

The testing criteria described in Table 4.1 specify the conditions and events for which stable operation is required. In addition to transient stability performance, satisfactory damping of generating unit post-disturbance power oscillations is required. For each simulated disturbance, the resulting transmission system response is analyzed to assess the impact of the disturbance scenarios on the proposed generators and the surrounding system.

Table 4.1

AEP 138 kV Stability Disturbance Testing Criteria

Prefault System Condition	**Fault Disturbance Scenario**
All Facilities In Service	3A. Permanent single phase to ground fault with three-phase breaker failure. Fault cleared by backup breakers 3B. Permanent 3-phase fault with unsuccessful HSR (high speed reclosing), if applicable. Fault cleared by primary breakers. 3C. 3-phase line opening without fault.
One Facility Out of Service	3D. Permanent 3-phase fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers. 3E. 3-phase line opening without fault

STUDY SCOPE

The dynamic simulations were conducted for selected event scenarios and post-contingency network configurations described in Table 5.1. Note: First two characters of the case designation refer to the criterion listed in Table 4.1 (e.g., case 3A-1 represents criterion 3A of Table 4.1).

Table 5.1

Event Scenarios and Post-Contingency Network Configurations

Case	Prior Condition (Lines out of service)	Disturbance	Faulted Circuit	Fault Location	Comments
3A-1	All facilities in service	Perm SLG fault W/1 ph CB failure	Perdue-Diana 138 kV	Perdue	Primary breaker opens in 3.5 cycles. Breaker fails at Perdue 138 kV. Backup breaker opens 12 cycles following fault initiation clearing >Omitted Text< Switching Station-Perdue 138 kV line.
3A-2			North Mineola-Canton Tap 138 kV	North Mineola	Primary breaker opens in 3.5 cycles. Breaker fails at North Mineola 138 kV. Backup breaker opens 12 cycles following fault initiation clearing >Omitted Text< Switching Station –North Mineola 138 kV line.
3B-1		Perm 3 ph fault w/ no HSR	>Omitted>Switching Station-Perdue 138 kV	>Omitted< Switching Station	Fault time 3.5 cycles.
3B-2			>Omitted<Switching Station –North Mineola 138 kV		
3D-1	Perdue-Diana 138 kV		>Omitted<Switching Station –North Mineola 138 kV		
3D-2	North Mineola-Canton Tap 138 kV		>Omitted<Switching Station-Perdue 138 kV		
3D-3	Perdue-Harrison Rd. 138 kV		>Omitted<Switching Station –North Mineola 138 kV		

STABILITY SIMULATION RESULTS

The stability performance study results are presented in Appendix 3 and are summarized in Table 6.1. Appendix 3 contains the plots of:

- speed deviation and terminal voltage for the proposed ExxonMobil generating unit and
- speed deviation plots for nearby existing generators: Eastex, Knox Lee, Pirkey, Welsh, Lieberman, and Arsenal Hill.

The transient stability performance in all cases was found to be acceptable. The oscillatory stability performance was found to be marginally unsatisfactory in Case 3A-1, and marginally satisfactory in Cases 3B-1 and 3D-2. The exciter modeling will affect the damping of post-disturbance power swings. A re-evaluation should be made once a more accurate exciter model is made available by the equipment vendor. A power system stabilizer may be required depending upon the outcome of the re-evaluation.

Table 6.1

Stability Performance Study Results

Case	Transient Stability	Oscillatory Stability
3A-1	Stable	Marginally Unsatisfactory
3A-2	Stable	Satisfactory
3B-1	Stable	Marginally Satisfactory
3B-2	Stable	Satisfactory
3D-1	Stable	Satisfactory
3D-2	Stable	Marginally Satisfactory
3D-3	Stable	Satisfactory

SUMMARY

- **Some of the dynamics modeling data had to be estimated because these data were not provided to AEP by >Omitted Text<. Specifically, the quadrature transient reactance X_q' and open circuit time constant T_{qo}' used were typical values.**
- **The exciter model provided was not a standard model in the model library of the Power Technologies, Inc. PSS/E package used for the dynamic simulations. A standard model available in the library, ESAC8B, was used to represent the exciter. Although this model type was judged to give the best approximation of the exciter from the available standard model types, the approximation is judged to be poor because the provided data was difficult to correlate. If the proposed project moves forward, the >Omitted Text< must provide a standard PSS/E model that represents the excitation system equipment reasonably accurate.**

- The study results show that from a stability perspective, the proposed >Omitted Text< generation plant totaling >Omitted Text<MW (winter, net) can be accommodated at the proposed location.
- If the proposed generation project is built, follow-up stability studies by AEP will be required based on dynamics data and modeling for the proposed generating units that have been revised to reflect equipment commissioning tests and field settings.
- This study addresses the impact of the proposed generation independent of any other merchant generation additions to the AEP System in the vicinity with the exception of those that have executed an Interconnection Agreement or those that have requested an unexecuted Interconnection Agreement be filed with FERC. If an Interconnection Agreement for a new generation facility in the general vicinity is executed or significant transmission network changes occur within AEP or adjacent systems, prior to the execution of an Interconnection Agreement for this facility, then a new study would be required to reassess the impact of this generation addition, and the study results contained in this report would no longer be valid.

Appendix 1

>Omitted Text< Generation

Configuration of Proposed Facility

Appendix 2

>Omitted Text< Generation

Dynamics Data

Synchronous Generator

Table A.1 GENROU

Round Rotor Generator Model (Quadratic Saturation)

Value	Description
57.412	Base MVA
13.8	Base kV
6.08	T'_{do} (>0) (sec)
0.037	T''_{do} (>0) (sec)
1	T'_{qo} (>0) (sec)
0.058	T''_{qo} (>0) (sec)*
8.68	Inertia, H
0	Speed damping, D
1.537	X_d
1.48	X_q
0.224	X'_d
0.418	X'_q*
0.147	$X''_d=X''_q$
0.1175	X_l
0.2195	S(1.0)
0.7143	S(1.2)

X_d, X_q, X'_d, X'_q, X''_d, X''_q, X_l, H and D are in pu, machine MVA base

Generator Step-up Transformer Data

GSU Data:	
Voltage Ratio Generator Side/ System Side	13.8/138
Impedance: Z1	8 % (on 30 MVA)

Plant Load: 23 MW + j10.5 MVAR

* Typical value used because the data was not provided to AEP.

Exciter Model

Table A.2 ESAC8B

Basler Exciter

Value	Description
0	T_R (sec)
1	K_P
1	K_I
1	K_D
0	T_D (sec)
10	K_A
0	T_A (sec)
4.1320	V_{RMAX}
-3.5920	V_{RMIN}
0.1	T_E >0 (sec)
1	K_E or zero
1	E_1
0	$S_E(E_1)$
2.2550	E_2
0.3317	$S_E(E_2)$

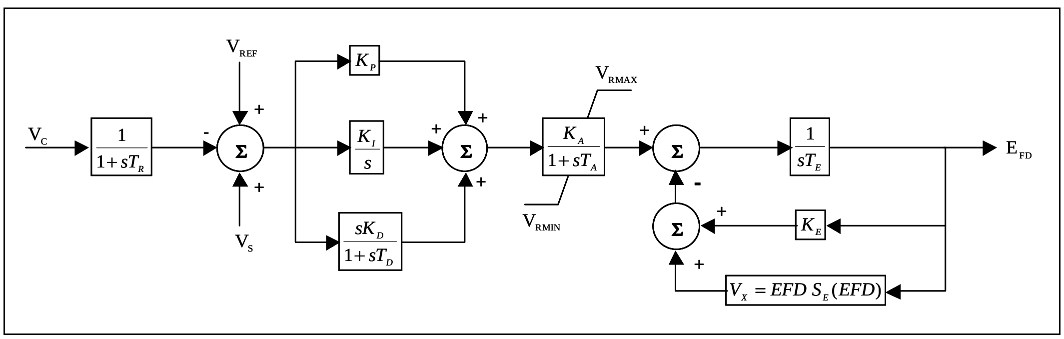


Figure A.2 ESAC8B

Note: This standard available in PSS/E library was used because the model provided to AEP was not a standard model in PSS/E library.

Turbine-Governor Model

Table A.3 GAST2A

Gas Turbine Model

Value	Description
25	W –governor gain (1/droop) (on turbine rating)
0	X (sec) governor lead time constant
0.05	Y (sec) (>0) governor lag time constant
1	Z –governor mode: 1 – droop 0 – ISO
0.02	E_{TD} (sec)
0.1	T_{CD} (sec)
48.8	T_{RATE} turbine rating (MW)
0.25	T (sec)
1.5	MAX (pu) limit (on turbine rating)
-0.1	MIN (pu) (on turbine rating)
0.01	E_{CR} (sec)
0.77	K_3
1	a (>0) valve positioner
0.05	b (sec) (>0) valve positioner
1	c valve positioner
0.4	τ_f (sec) (>0)
0	K_f
0.2	K_5
0.8	K_4
15	T_3 (sec) (>0)
2.5	T_4 (sec) (>0)
450	τ_t (sec) (>0)
3.3	T_5 (sec) (>0)
700	a_{f1}
550	b_{f1}
-0.299	a_{f2}
1.3	b_{f2}
0.5	c_{f2}
568	Rated temperature, T_R (0F)
0.23	Minimum fuel flow, K_6 (pu)
568	Temperature control, T_C (0F)

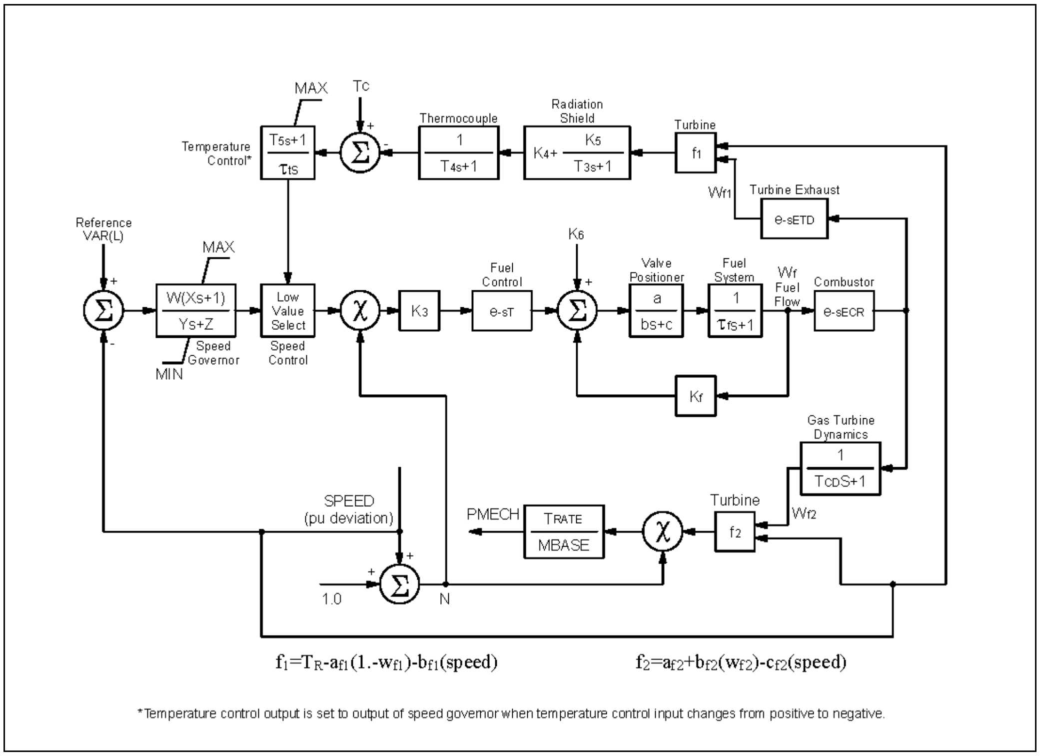


Figure A.3

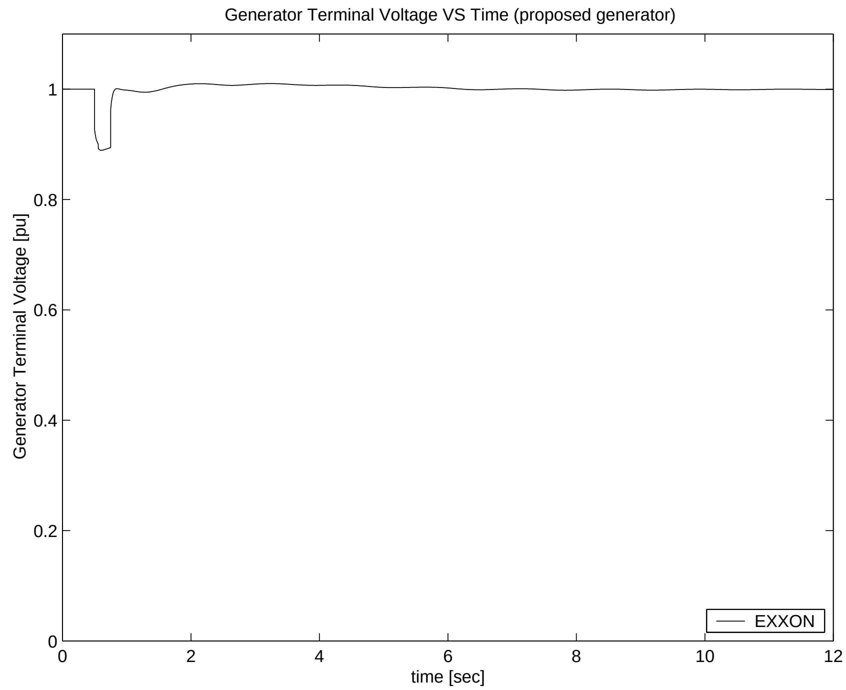
Gas Turbine Model

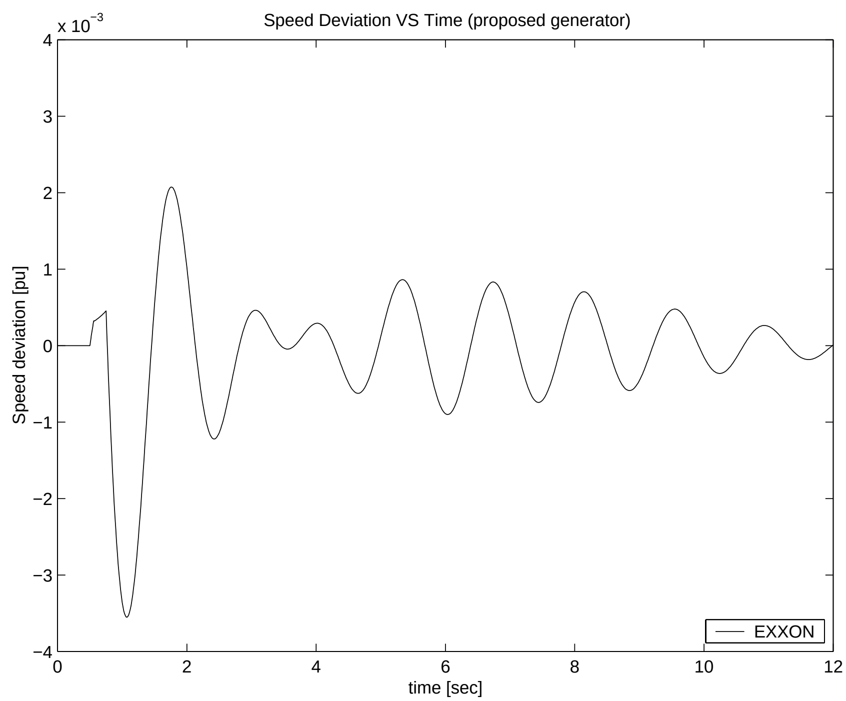
Appendix 3

Results –

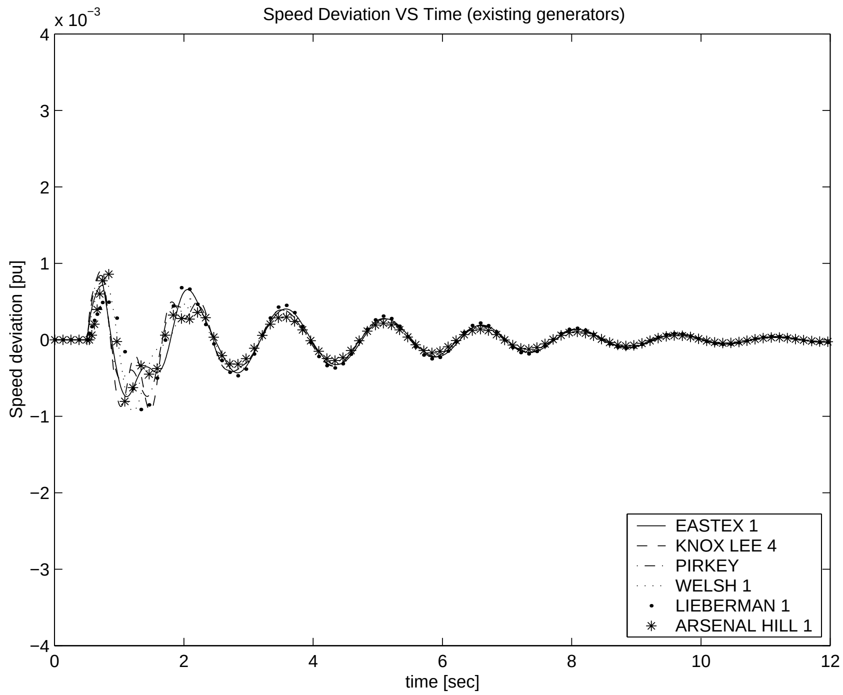
Individual Case Plots

Case 3A-1

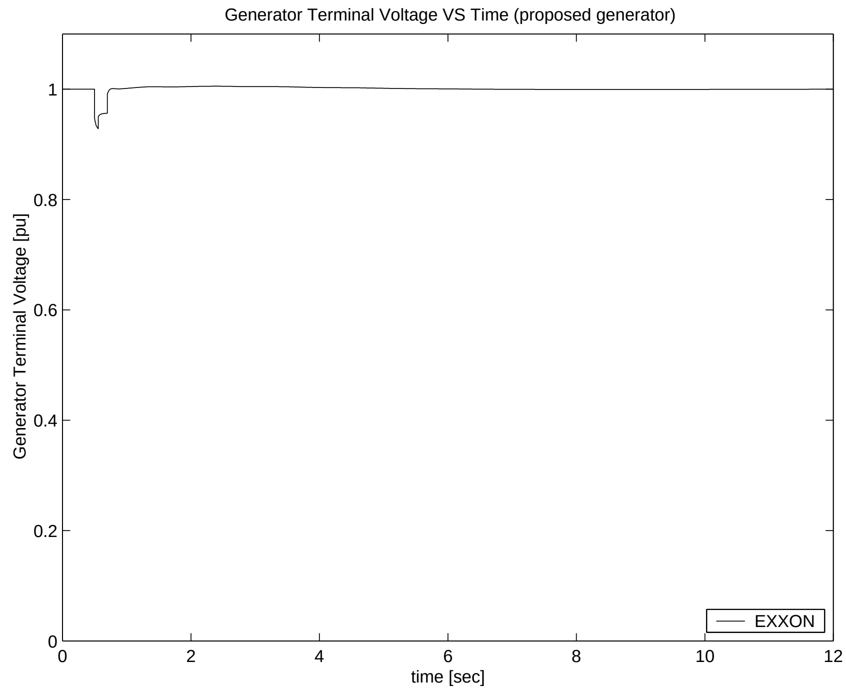

Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
time [sec]
EXXON
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10
12

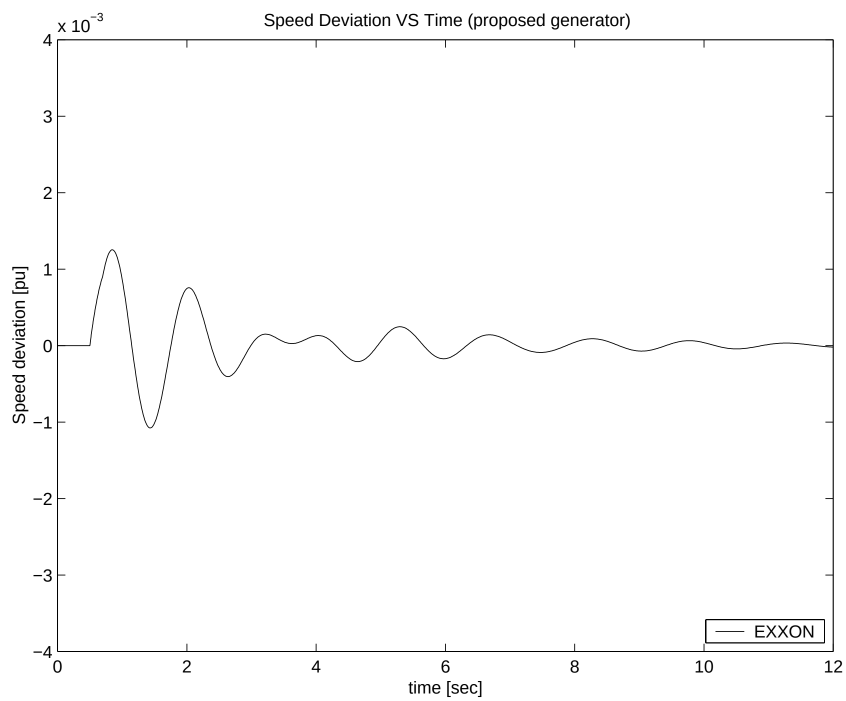

Speed Deviation VS Time (proposed generator)
x 10^-3
Speed deviation [pu]
time [sec]
EXXON
4
3
2
1
0
−1
−2
−3
−4
0
2
4
6
8
10
12

Case 3A-1

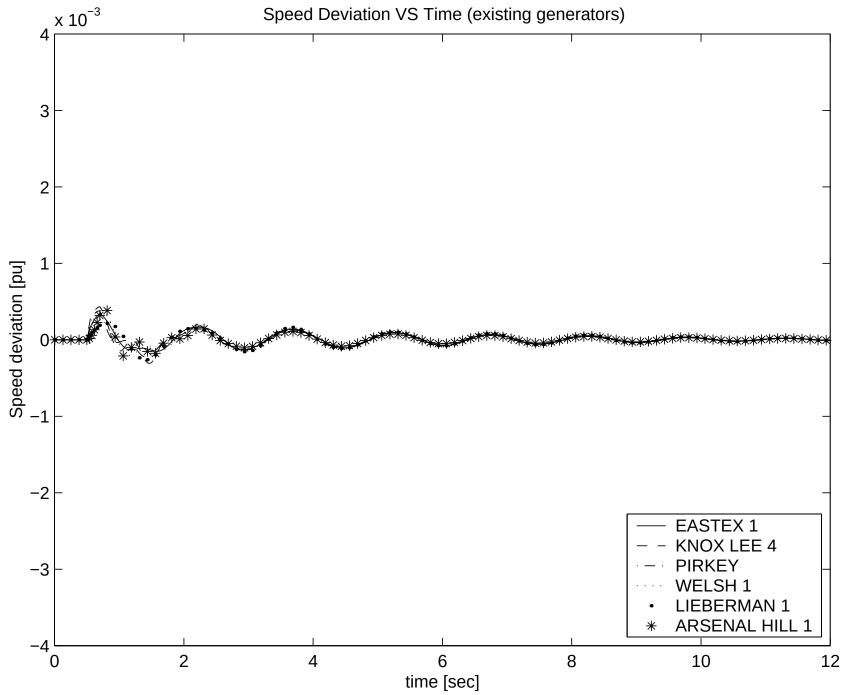

Speed Deviation VS Time (existing generators)
x 10^-3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3A-2


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
time [sec]
EXXON

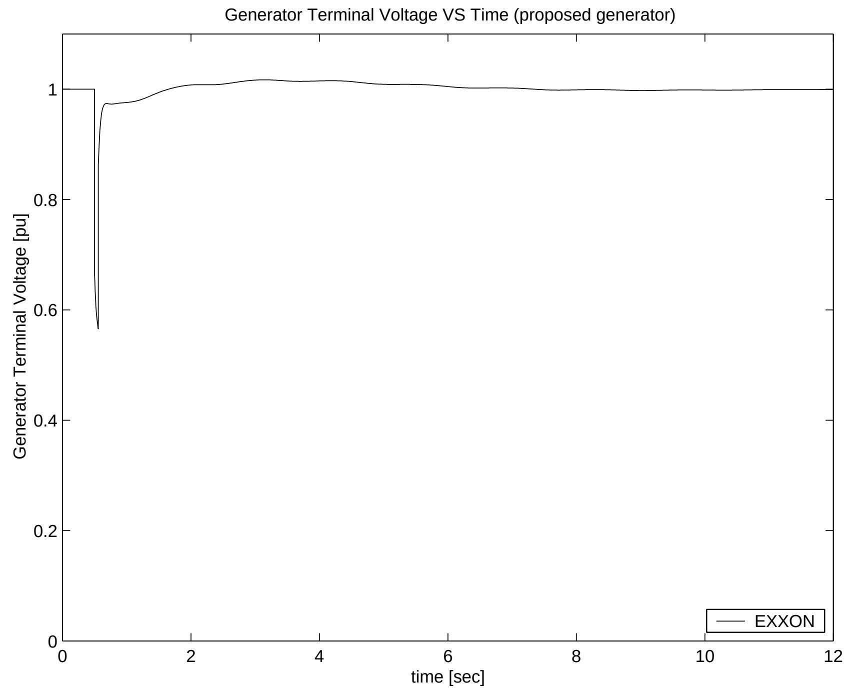

Speed Deviation VS Time (proposed generator)
x 10^-3
Speed deviation [pu]
time [sec]
EXXON

Case 3A-2



Speed Deviation VS Time (existing generators)
x 10^-3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3B-1


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
time [sec]
EXXON
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0.4
0.6
0.8
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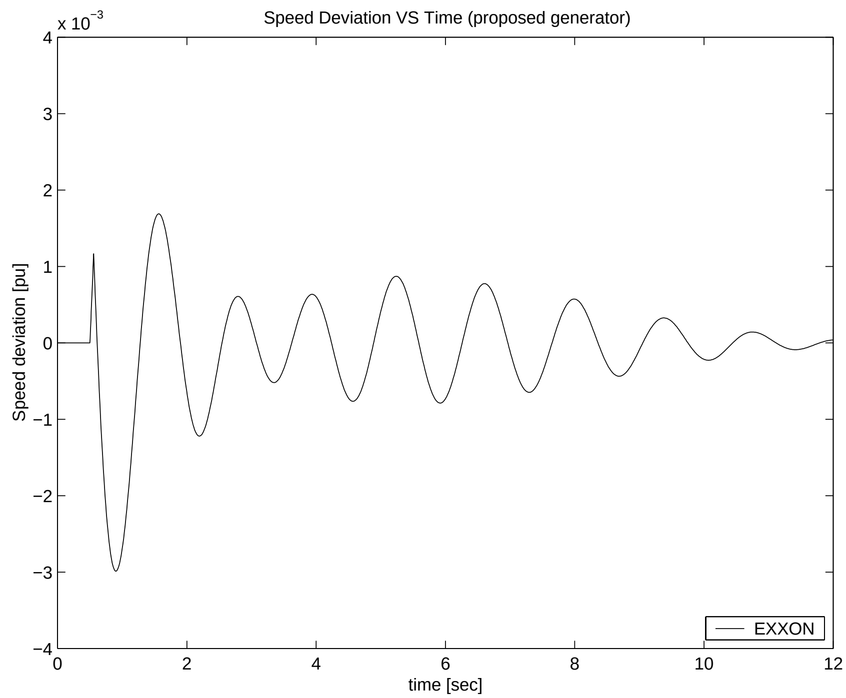
4
6
8
10
12


Speed Deviation VS Time (proposed generator)
x 10−3
Speed deviation [pu]
time [sec]
EXXON
−4
−3
−2
−1
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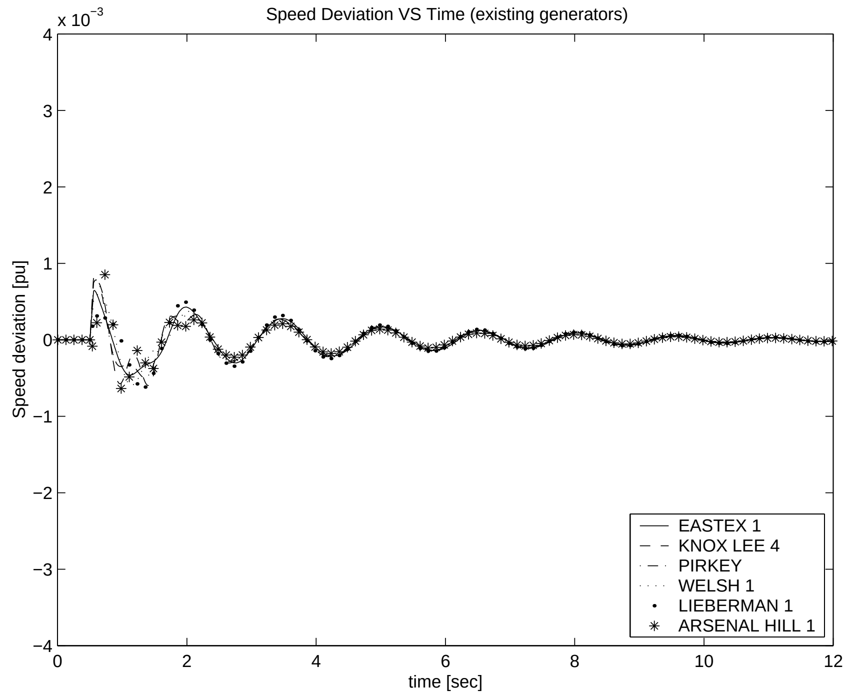
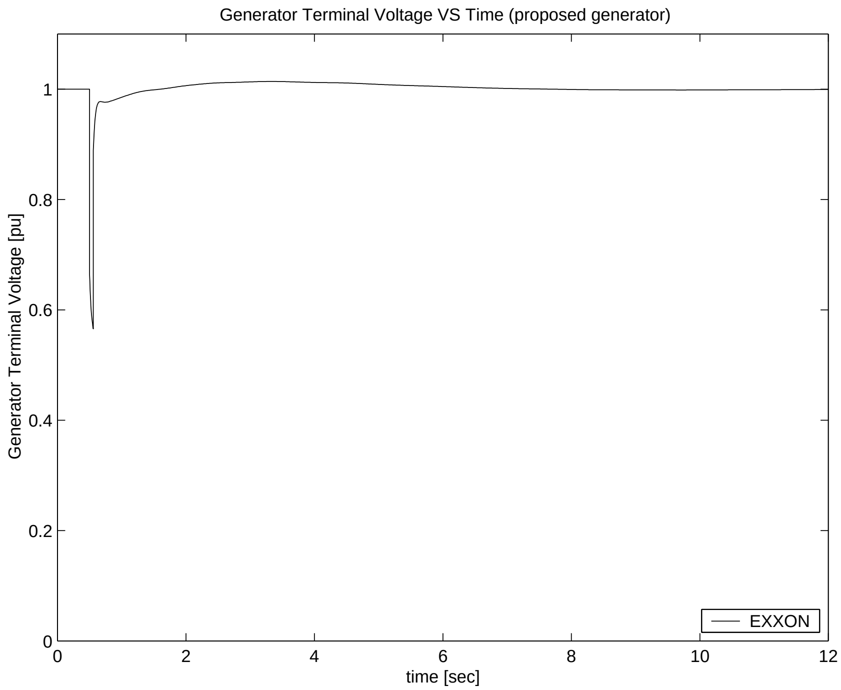
1
2
3
4
0
2
4
6
8
10
12

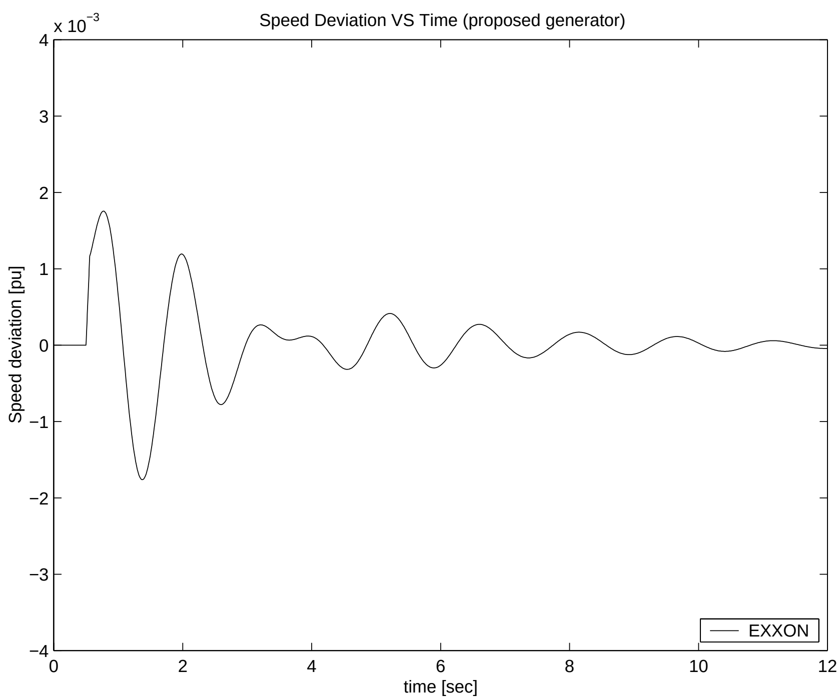
Case 3B-1


Speed Deviation VS Time (existing generators)
x 10^−3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3B-2

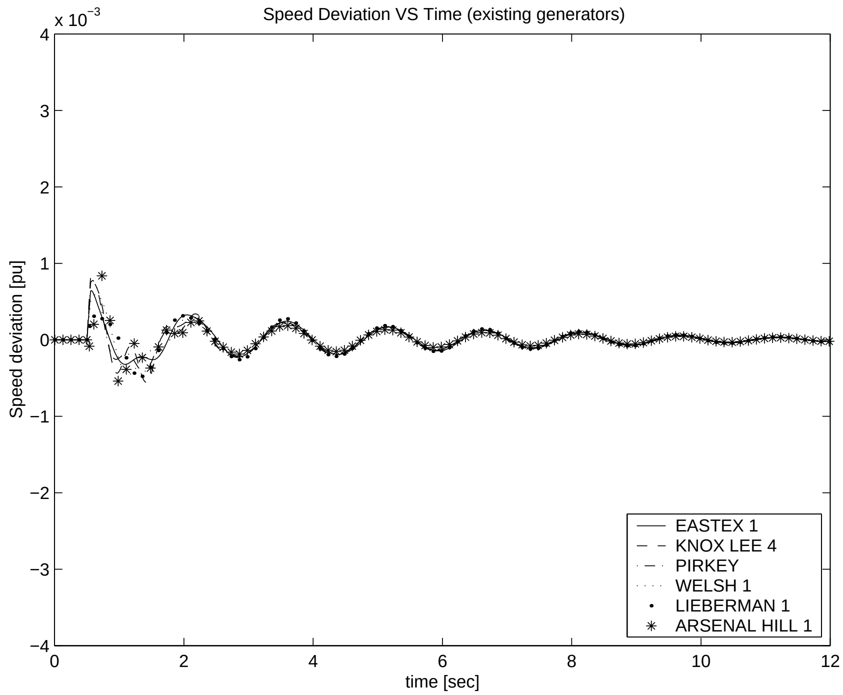


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
time [sec]
EXXON



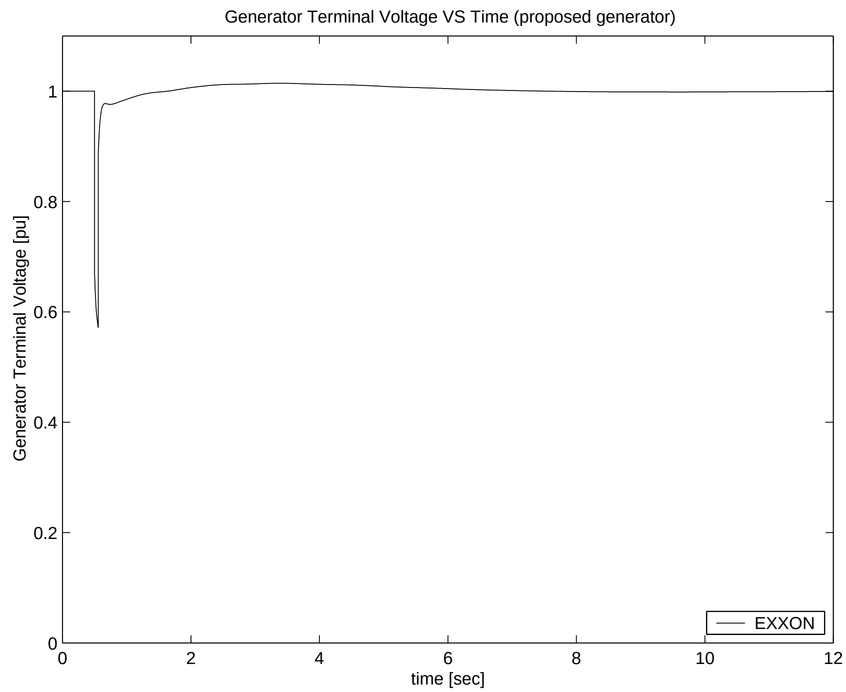
Speed Deviation VS Time (proposed generator)
x 10⁻³
Speed deviation [pu]
4
3
2
1
0
−1
−2
−3
−4
0
2
4
6
8
10
12
time [sec]
EXXON

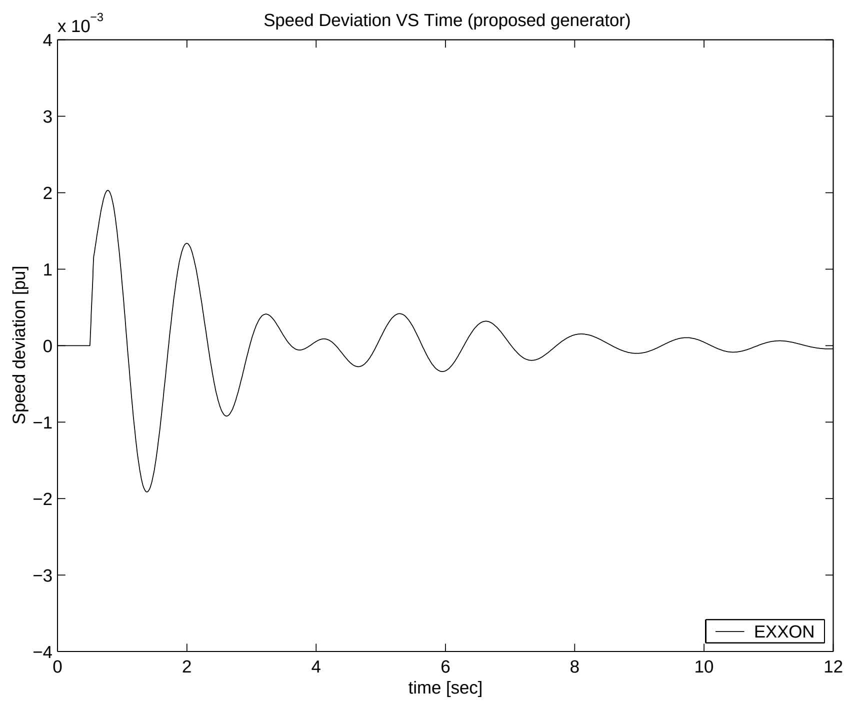
Case 3B-2



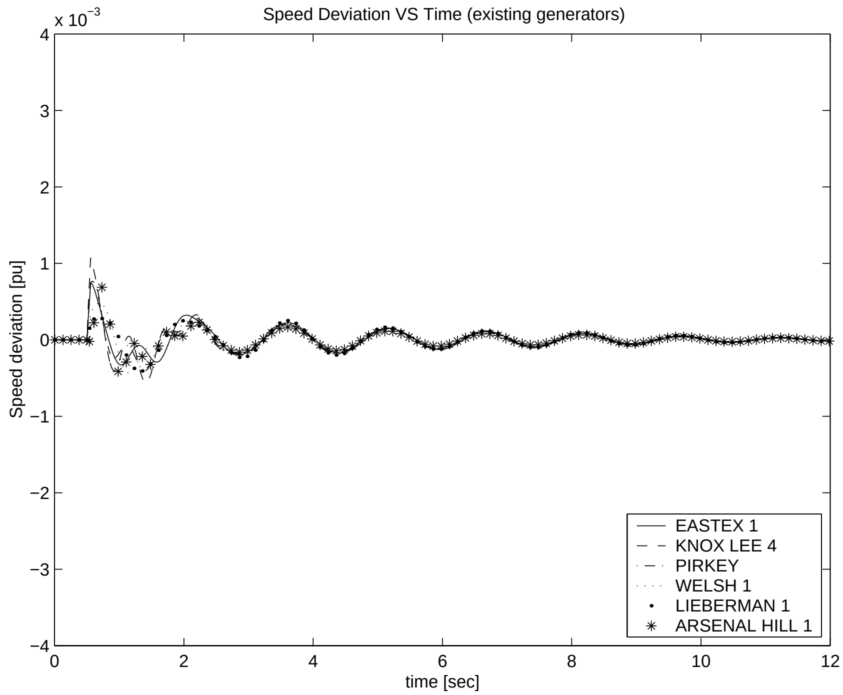
Speed Deviation VS Time (existing generators)
x 10^−3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3D-1


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
time [sec]
EXXON

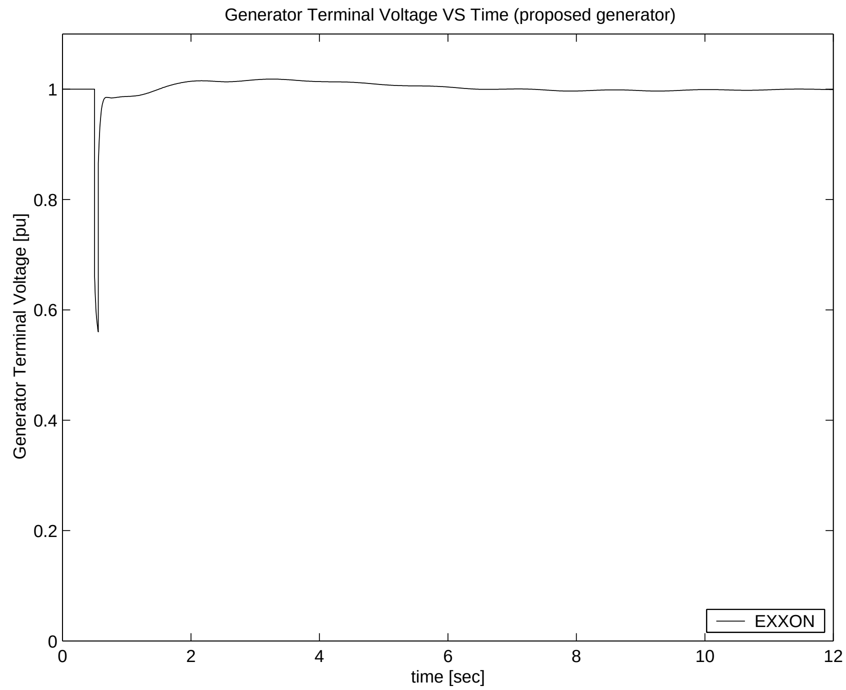

Speed Deviation VS Time (proposed generator)
x 10^-3
Speed deviation [pu]
4
3
2
1
0
−1
−2
−3
−4
0
2
4
6
8
10
12
time [sec]
EXXON

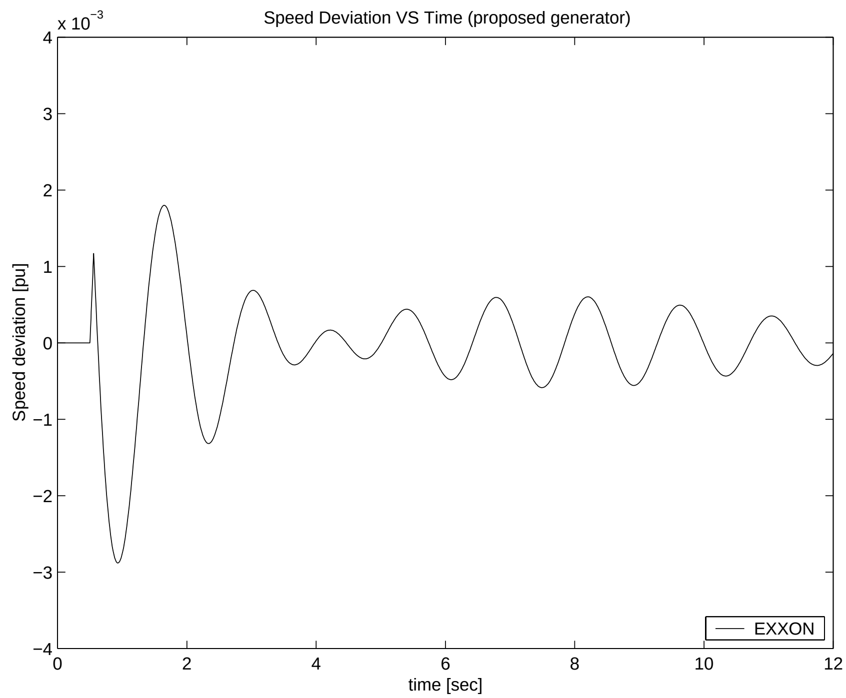
Case 3D-1



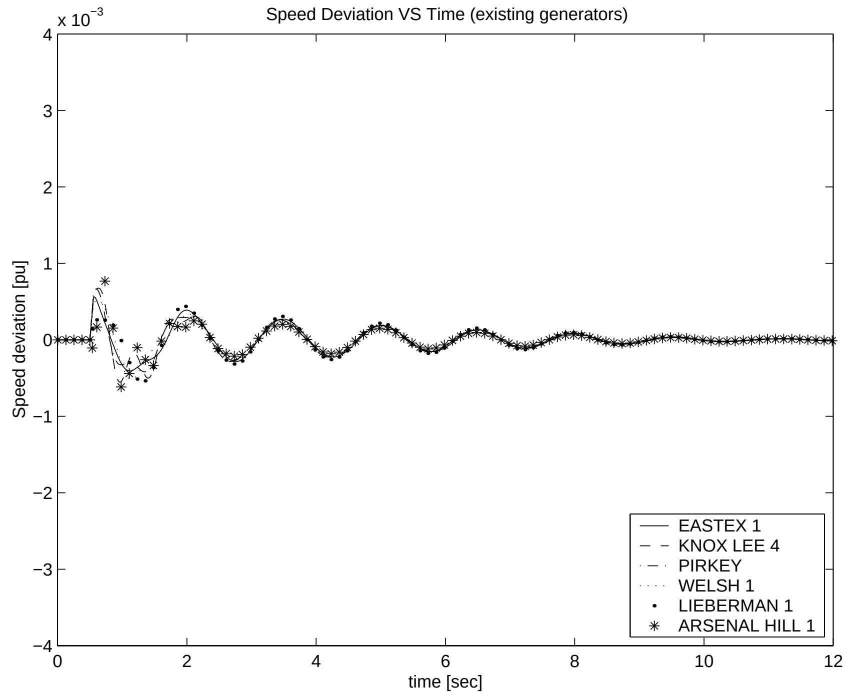
Speed Deviation VS Time (existing generators)
x 10^-3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3D-2


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
time [sec]
EXXON
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10
12

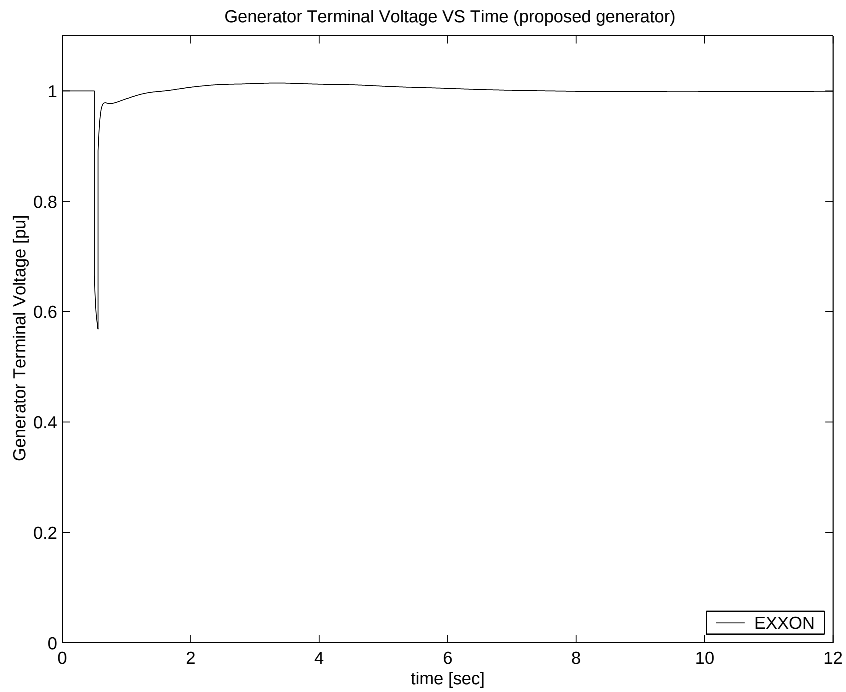

Speed Deviation VS Time (proposed generator)
x 10^−3
Speed deviation [pu]
time [sec]
EXXON
−4
−3
−2
−1
0
1
2
3
4
0
2
4
6
8
10
12

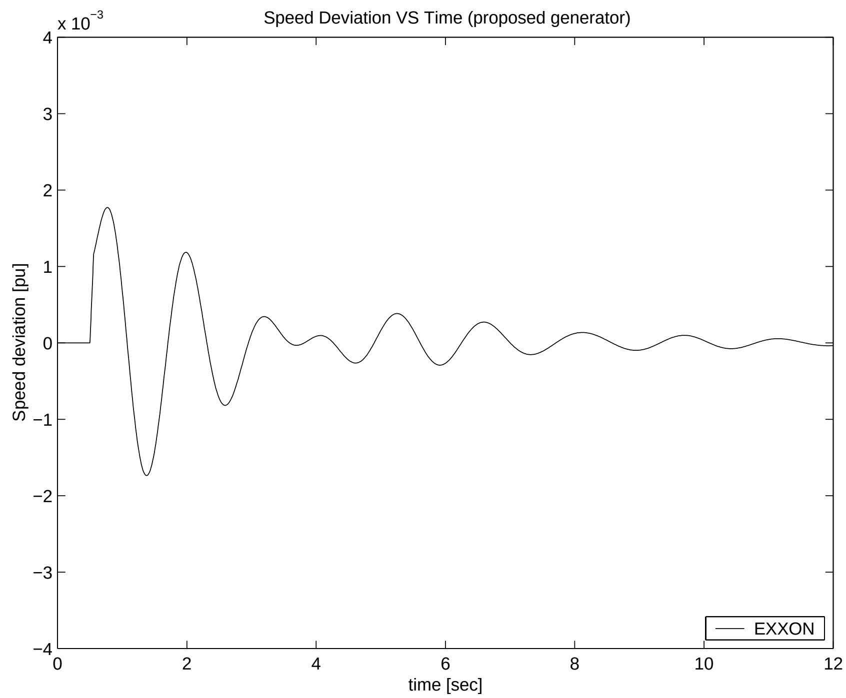
Case 3D-2



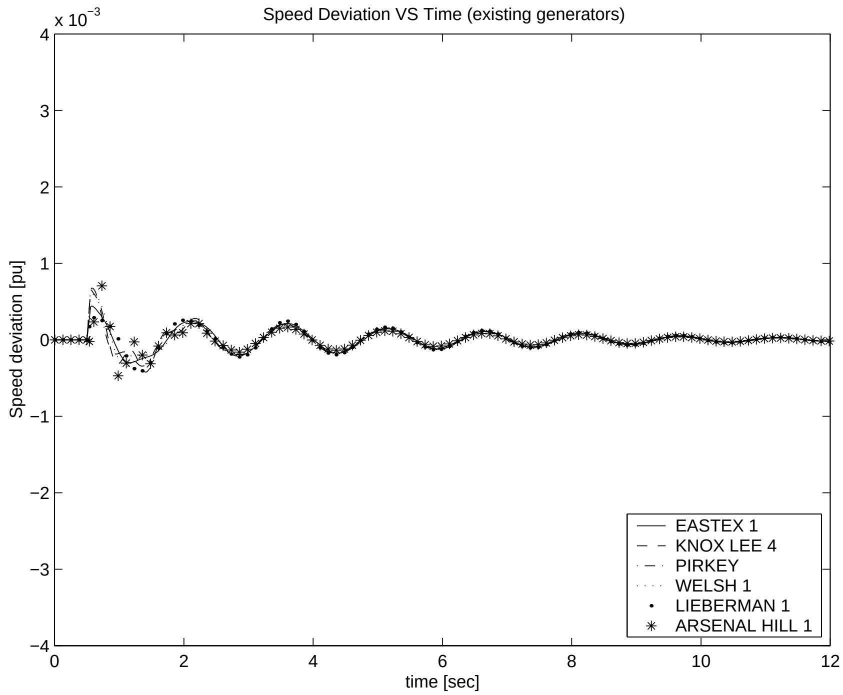
Speed Deviation VS Time (existing generators)
x 10^-3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

Case 3D-3


Generator Terminal Voltage VS Time (proposed generator)
Generator Terminal Voltage [pu]
time [sec]
EXXON
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10
12


Speed Deviation VS Time (proposed generator)
x 10−3
Speed deviation [pu]
time [sec]
EXXON
−4
−3
−2
−1
0
1
2
3
4
0
2
4
6
8
10
12

Case 3D-3


Speed Deviation VS Time (existing generators)
x 10^-3
4
3
2
1
0
−1
−2
−3
−4
Speed deviation [pu]
0
2
4
6
8
10
12
time [sec]
EASTEX 1
KNOX LEE 4
PIRKEY
WELSH 1
LIEBERMAN 1
ARSENAL HILL 1

C. Short Circuit Analysis

Scope

The subject of this study is the >Omitted Text< proposed >Omitted Text< MW facilities near >Omitted Text<, Texas. >Omitted Text< will be tapped off the Southwestern Electric Power Company (SWEPCO) Perdue – North Mineola 138 kV line near >Omitted Text< and construct a substation (named >Omitted Text< >Omitted Text< Switching Station) with a three circuit breaker ring bus arrangement. Approximately a half-mile of 138kV line from the Exxon generating facility to the above-proposed facility will have to be constructed. The purpose of this study is to assess the impact of the addition of the proposed generation on the available fault current in the SWEPCO system, and to determine whether the interrupting rating of SWEPCO circuit breakers, circuit switchers, and power fuses would be exceeded as a result of the addition.

The software used to study the >Omitted Text< proposed plant near >Omitted Text< has the ability to calculate ANSI X/R ratios for bus and close in faults and to perform breaker rating study in batch mode for determining the short-circuit duty imposed on circuit-interrupting devices. The base short-circuit case used was a Southwest Power Pool (SPP) 2005 case. This case includes prior IPP generation and related system improvements. This case was modified for the injection of >Omitted Text< MW of >Omitted Text< generation, into the SWEPCO transmission system.

>Omitted Text< 47 MW Case Model Data

The following facilities were modeled in the short circuit case to determine the impact of >Omitted Text< MW on available short circuit levels:

- The >Omitted Text< 138 kV generating facility consists of a single >Omitted Text< MW generator.
- Approximately half a mile of 138 kV line from the >Omitted Text< substation to a new >Omitted Text< Switching station located on the SWEPCO Perdue – North Mineola 138 kV line near >Omitted Text<.

Method

The batch short-circuit and circuit breaker rating program was used to place a three-phase-to-ground and a single-phase-to-ground close in fault on each transmission line connected to each circuit breaker modeled in the short-circuit case. For each circuit breaker, the worst-case fault current level was compared to the circuit breaker rating. This was performed with the above facilities excluded and then performed again with the above facilities included for comparative purposes.

Conclusion

It is AEP’s standard practice to recommend replacing a circuit breaker when the fault current to be interrupted by the breaker exceeds 100% of its interrupting rating with recloser de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

In the SWEPCO system, no equipment was found to exceed their interrupting capability after the addition of the >Omitted Text< 47 MW generation and related facilities.