SPP Southwest Power Pool

System Impact Study Report
PID 215 Generation
31 MW Plant
Spherelene 69kV Substation

Prepared by:

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Revision: 1

Rev	Issue Date	Description of Revision	Revised By	Project Manager
0	8/5/2008	Final for Review	BEF	JDH
1	8/7/2008	Minor Edits to Format and Figure References	BEF	JDH

Objective:

This System Impact Study is the second step of the interconnection process and is based on PID-215 request for interconnection on Entergy's transmission system at the Spherelene substation. This report is organized in two sections, namely, Section – A, Energy Resource Interconnection Service (ERIS) and when requested, Section – B, Network Resource Interconnection Service (NRIS – Section B).

Scope for the ERIS section (Section – A) includes load flow (steady state) analysis, transient stability analysis and short circuit analysis as defined in FERC orders 2003, 2003A and 2003B. If applicable, the NRIS section (Section – B) contains details of load flow (steady state) analysis only, however, transient stability analysis and short circuit analysis of Section – A are also applicable to Section – B. Additional information on scope for NRIS study would be found in Section – B.

Requestor for PID-215 did request ERIS, however it was determined that a load flow (steady state) analysis was not required because the generator would not be exporting power.

PID-215 intends to install (1) 15 MWe Gas Turbine Package with Heat Recovery Steam Generator capable of 64,000 lbs/hr steam in turbine exhaust mode; (2) 8.5 MWe Reciprocating Gas Engines with Heat Recovery Feedwater Economizers; and (2) 58,000 lbs/hr Natural Gas fired package boilers.

The proposed in-service date for this facility is September 1, 2009

TABLE OF CONTENTS FOR ERIS

I. Introduction

This Energy Resource Interconnection Service (ERIS) is based on PID-215 **(31 MW)** request for interconnection on Entergy's transmission system at the Spherelene substation. The objective of this study is to assess the reliability impact of the new facility on the Entergy transmission system with respect to the steady state and transient stability performance of the system as well as its effects on the system's existing short circuit current capability. It is also intended to determine whether the transmission system meets standards established by NERC Reliability Standards and Entergy's planning criteria and guidelines when the plant is connected to Entergy's transmission system. If not, transmission improvements will be identified.

A short circuit analysis is performed to determine whether the generation would cause the available fault current to surpass the fault duty of existing equipment within the Entergy transmission system. A transient stability analysis was conducted to determine whether the new units would cause a stability problem on the Entergy system.

This ERIS System Impact Study was based on information provided by PID-215 and assumptions made by Southwest Power Pool, Independent Coordinator of Transmission (SPP ICT). All supplied information and assumptions are documented in this report. If the actual equipment installed is different from the supplied information or the assumptions made, the results outlined in this report are subject to change.

The load flow results from the ERIS study are for information only. ERIS does not in and of itself convey any transmission service.

II. Short Circuit Analysis/ Breaker Rating Analysis

A. Model Information

The short circuit analysis was performed on the Entergy system short circuit model using ASPEN software. This model includes all generators interconnected to the Entergy system or interconnected to an adjacent system and having an impact on this interconnection request, IPP's with signed IOAs, and approved future transmission projects on the Entergy transmission system including the proposed PID-215 unit.

B. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID-215 generation is as follows:

1. Three phase and single phase to ground faults were simulated on the Entergy base case short circuit model and the worst case short circuit level was determined at each station. The PID-215 generator was then modeled in the base case to generate a revised short circuit model. The base case short circuit results were then compared with the results from the revised model to identify any breakers that were under-rated as a result of additional short circuit contribution from PID-215 generation. The breakers, if any, identified to be upgraded through this comparison are *mandatory* upgrades.

C. Analysis Results

The results of the short circuit analysis, including priors PID's 195, 197, 198, 203, 205, 207 and 208 indicates that the additional generation due to PID-215 generators does not cause an increase in short circuit current such that they exceed the fault interrupting capability of the high voltage circuit breakers within the vicinity of the proposed generation. Also, when studied with no generation interconnection queue priors in service, there were no breakers identified as being underrated due to the added fault current from the PID-215 generator.

D. Problem Resolution

There were no problems identified for this part of the study that were a result of the additional PID-215 generation.

The results of the short circuit analysis are subject to change. They are based upon the current configuration of the Entergy transmission system and Generation Interconnection Study Queue.

III. Transient Stability Analysis

A. Transient 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 Siemens-PTI's PSS/E^{TM} dynamics program V29.4.0. Three-phase (3PH) normally cleared and three-phase stuck breaker faults were simulated for the specified durations 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.

The stability analysis was performed using the PSS/E dynamics program, which only simulates the positive sequence network. Unbalanced faults involve the positive, negative, and zero sequence networks. For unbalanced faults, the equivalent fault admittance must be inserted in the PSS/E positive sequence model between the faulted bus and ground to simulate the effect of the negative and zero sequence networks. For a single-line-to-ground (SLG) fault, the fault admittance equals the inverse of the sum of the positive, negative and zero sequence Thevenin impedances at the faulted bus. Since PSS/E inherently models the positive sequence fault impedance, the sum of the negative and zero sequence Thevenin impedances needs to be added and entered as the fault impedance at the faulted bus.

The single-line-to-ground (SLG) fault impedance was computed to give a positive sequence voltage at the fault location of approximately 60% of pre-fault voltage, which is a typical value.

For three-phase faults, a fault admittance of –j2E9 is used (essentially infinite admittance or zero impedance).

B. Model Information

The study model consists of power flow cases and dynamics databases, developed as follows. ***Power Flow Case.*** A Powerflow case (2011-noupgr-uncov.sav) representing the 2011 Summer Peak conditions was provided by SPP/ Entergy.

The proposed PID-215 project will be connected to the 69-kV Spherelene bus (335053) with a 69/13.8 kV transformer. The proposed project was added to the pre-project cases and the generation was dispatched against the White Bluff Unit 1. A total 37 MW load at Extruder, Hercules, Flake, and Spherelene 69-kV buses is moved to Spherelene 13.8-kV bus. Table III-1 summarizes the dispatch. Thus a post-project power flow case with PID-215 was established (‘Post_PID-215.sav’).

Table III-1: PID-215 project details

System condition	MW	Point of Interconnection	Sink
Summer Peak	31	Spherelene 69 kV Substation (#335053)	White Bluff (#337653)

Figure III- 2b and Figure III-2c show the PSS/E one-line diagrams for the local area without and with the PID-215 project, respectively, for 2011 Summer Peak system conditions.

Stability Database

The pre-project stability database (red11S_newnum.dyr) was provided by SPP/Entergy.

The stability data for PID-215 was appended to the pre-project data. The data provided at the Interconnection Request of PID-215 is included in Appendix A. The PSS/E power flow and stability data for PID-215, used for this study, are included in Appendix B.

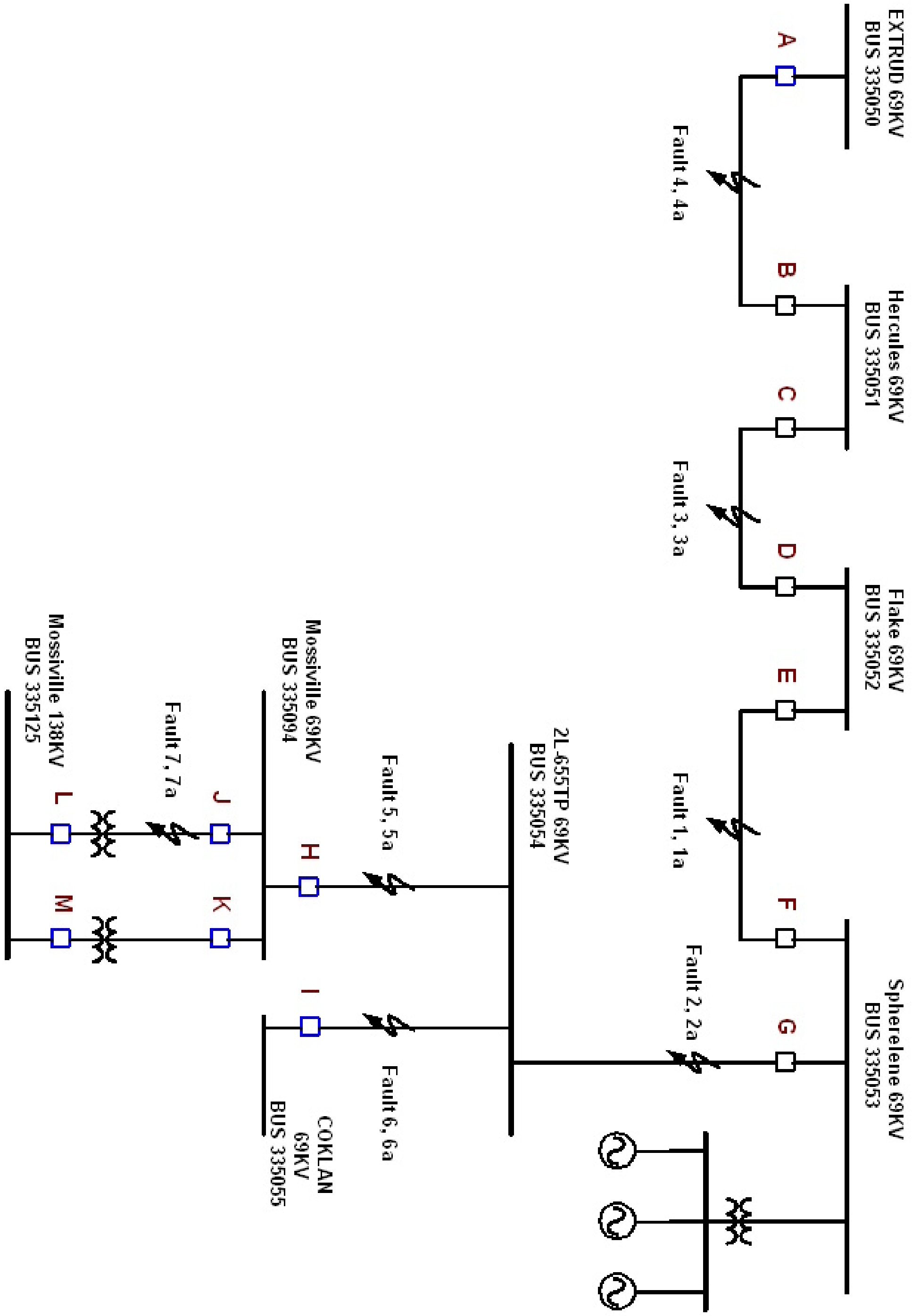


Figure III-2a. Single Line Diagram of the Stability Study Area of Focus with PID-215

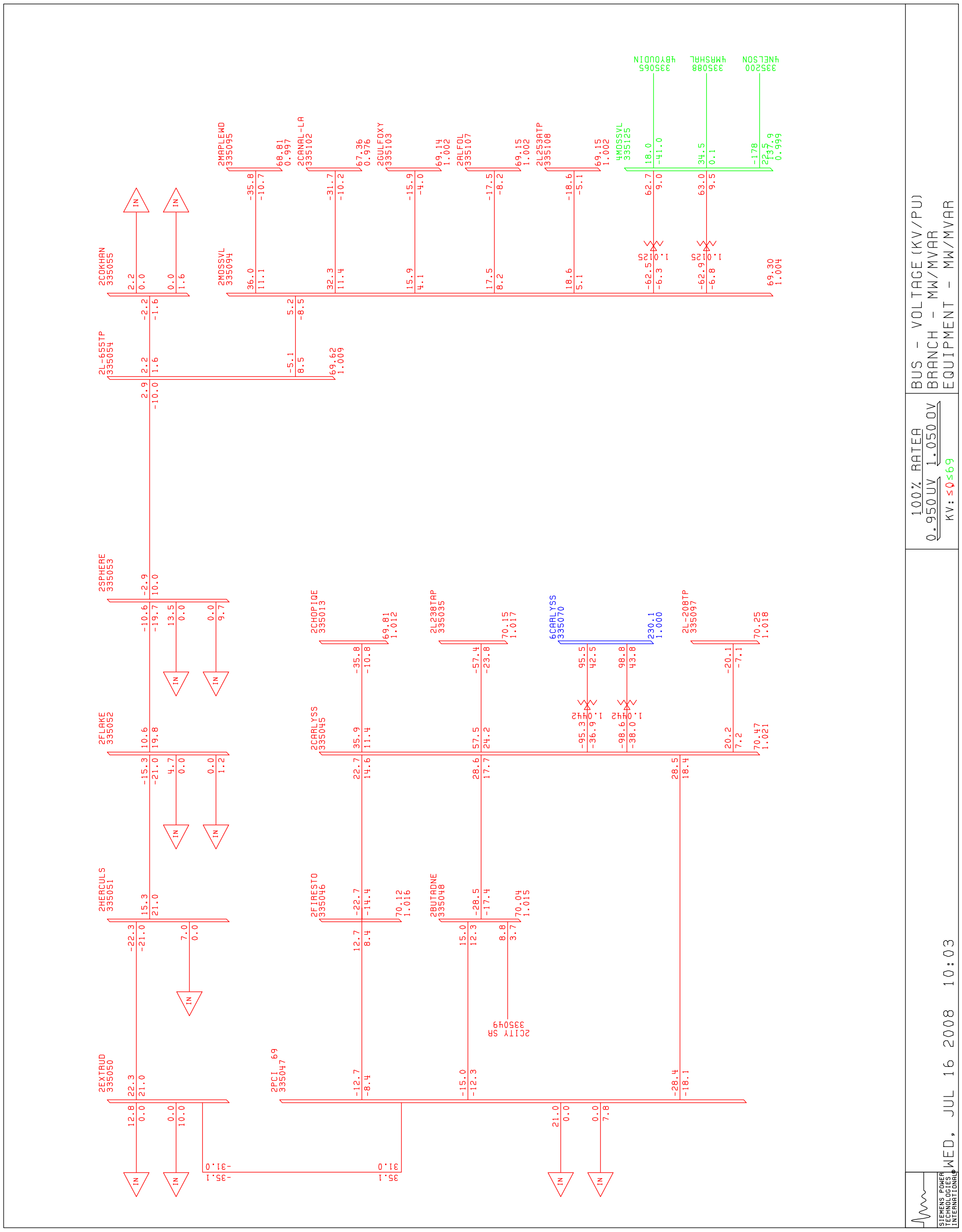


Figure III-2b 2011 Summer Peak Flows and Voltages without PID-215

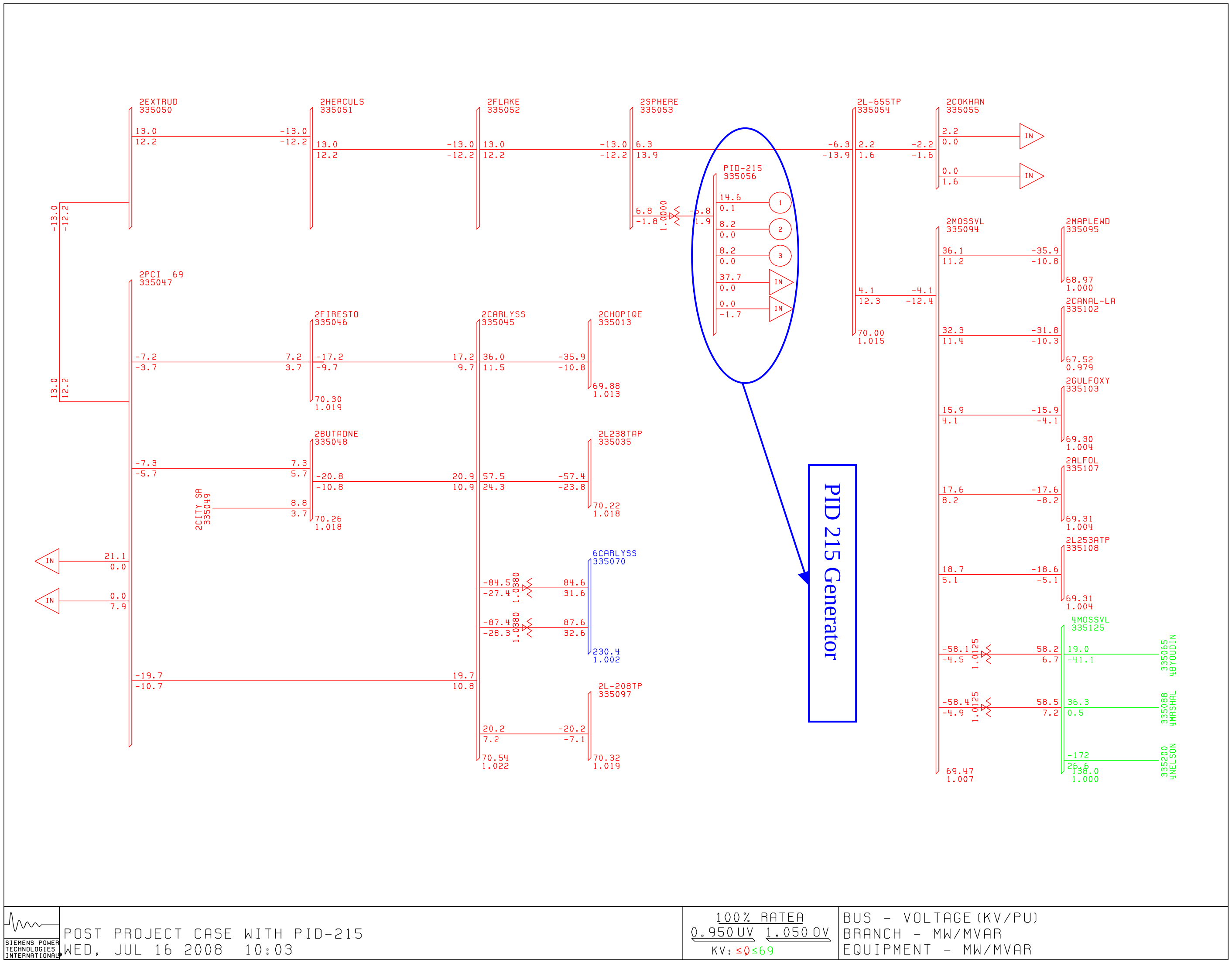


Figure III-2c 2011 Summer Peak Flows and Voltages with PID-215

C. Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID-215 generator and its impact on the Entergy system. Stability analysis was performed using the following procedure. First, three-phase faults with normal clearing were simulated. Next, the stuck breaker three phase fault were simulated. If a three-phase stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. This procedure is being followed since if the units are stable for a more severe fault (such as three phase fault with breaker failure) then the need to study stability for a less severe fault (such as SLG fault with breaker failure) does not arise. The fault clearing times used for the simulations are given in Table III-2.

Table III-2: Fault Clearing Times

Contingency at kV level	**Normal Clearing**	**Delayed Clearing**
69	6 cycles	6+9 cycles

The breaker failure scenario was simulated with the following sequence of events:

1) At the normal clearing time for the primary breakers, the faulted line is tripped at the far end from the fault by normal breaker opening.

2) The three-phase fault remains in place for three-phase stuck-breakers.

3) The fault is then cleared by back-up clearing. If the system was found to be unstable, then the fault was repeated without the proposed PID-215 plant.

All line trips are assumed to be permanent (i.e. no high speed re-closure).

Table III-3 to Table III-5 list all the fault cases that were simulated in this study. Fault scenarios were formulated by examining the system configuration shown in Figure III-2a.

Faults 1 through 7 represent the normally cleared 3-phase faults. Faults 1a through 7a represent the 3-phase stuck breaker faults with the appropriate delayed back-up clearing times. Faults 3b and 4b represent the single-line-to-ground faults with appropriate delayed back-up clearing times.

For all cases analyzed, the initial disturbance was applied at t = 0.1 seconds. The breaker clearing was applied at the appropriate time following this fault inception.

The plots for all the simulated faults are included in Appendix A.D.

Table III-3: Fault Cases Simulated for Post-project Case: 3-phase faults with normal clearing

CASE	LOCATION	TYPE	CLEARING TIME (cycles)	PRIMARY BRK TRIP #	TRIPPED FACILITIES	Stable ?	Acceptable Voltages ?
			PRIMARY				
FAULT_1	Spherelene - Flake 69KV	3PH	6	E, F	Spherelene - Flake 69KV	YES	YES
FAULT_2	Spherelene - Mossiville 69KV	3PH	6	G, H, I	Spherelene - 2L-655TP 69 kV 2L-655TP - Mossiville 69 kV 2L-655TP - Coklan 69 kV	YES	YES
FAULT_3	Flake - Hercules 69 kV	3PH	6	C, D	Flake - Hercules 69 kV	YES	YES
FAULT_4	Hercules - Extrud 69 kV	3PH	6	A, B	Hercules - Extrud 69 kV	YES	YES
FAULT_5	Mossiville - Spherelene 69KV	3PH	6	G, H, I	Spherelene - 2L-655TP 69 kV 2L-655TP - Mossiville 69 kV 2L-655TP - Coklan 69 kV	YES	YES
FAULT_6	Coklan - Spherelene 69KV	3PH	6	G, H, I	Spherelene - 2L-655TP 69 kV 2L-655TP - Mossiville 69 kV 2L-655TP - Coklan 69 kV	YES	YES
FAULT_7	Mossiville 138/69 kV, ckt 1	3PH	6	J, L	Mossiville 138/69 kV, ckt 1	YES	YES

Table III-4: Fault Cases Simulated for Post-project Case: 3-PH faults with stuck breaker

CASE	LOCATION	TYPE	CLEARING TIME (cycles)		PRIMARY BRK TRIP #	SECONDARY BRK TRIP #	TRIPPED FACILITIES	Stable ?
			PRIMARY	Back-up				
FAULT_1a	Spherelene - Flake 69KV	3ph Stuck breaker	6	9	E	G	Spherelene - Flake 69KV Spherelene - 2L-655TP 69 kV PID-215 Plant (31 MW)	YES
FAULT_2a	Spherelene - Mossiville 69KV	3ph Stuck breaker	6	9	H, I	F	Spherelene - 2L-655TP 69 kV 2L-655TP - Mossiville 69 kV 2L-655TP - Coklan 69 Kv Spherelene - Flake 69KV PID-215 Plant (31 MW)	YES
FAULT_3a	Flake - Hercules 69 kV	3ph Stuck breaker	6	9	C	E	Flake - Hercules 69 kV Fake – Speherelen 69 kV	YES (PID-215 Unit 2 and 3 are Out of Step)
FAULT_4a	Hercules - Extrud 69 kV	3ph Stuck breaker	6	9	A	C	Hercules - Extrud 69 kV Flake - Hercules 69 kV	YES (PID-215 Unit 2 and 3 are Out of Step)
FAULT_5a	Mossiville - Spherelene 69KV	3ph Stuck breaker	6	9	G, I	J, K	Spherelene - 2L-655TP 69 kV 2L-655TP - Mossiville 69 kV 2L-655TP - Coklan 69 kV Mossiville 69 kV substation	YES
FAULT_7a	Mossiville 138/69 kV, ckt 1	3ph Stuck breaker	6	9	L	H, K	Mossiville 138/69 kV, ckt 1 Mossiville 69 kV substation	YES

Table III-5: Fault Cases Simulated for Post-project Case: Single-line-to-ground (SLG) faults with stuck breaker

CASE	LOCATION	TYPE	CLEARING TIME (cycles)		PRIMARY BRK TRIP #	SECONDARY BRK TRIP #	TRIPPED FACILITIES	Stable ?
			PRIMARY	Back-up				
FAULT_3b	Flake - Hercules 69 kV	SLG Stuck breaker	6	9	C	E	Flake - Hercules 69 kV Fake – Speherelen 69 kV	YES
FAULT_4b	Hercules - Extrud 69 kV	SLG Stuck breaker	6	9	A	C	Hercules - Extrud 69 kV Flake - Hercules 69 kV	YES

System was found to be stable following all simulated faults ***except*** for two three phase stuck breaker faults - Fault 3a and Fault 4a. These two faults are NERC Category D faults (Extreme contingencies); hence per NERC transmission planning criteria the instability following these two faults is not deemed to be a stability criteria violation.

Following three-phase stuck breaker Fault 3a and Fault 4a PID-215 Unit #2 and unit #3 were unstable. All other units in the Entergy system were stable. Figure III-3 and Figure III-4 show angle and speed of Unit 1 and Unit 2 during the simulation of Fault 3a. A large angle deviations were observed in Units #2 and #3 compared to Unit#1 Figure III-5 shows apparent impedance of Unit 2 during the simulation of Fault 3a. As Unit #3 is identical to Unit #2 the response of Unit #3 is same as Unit #2.

As shown in Figure III-3 the angle of Unit 2 slip two poles in Fault 3a, as evidenced by the approximate 2x360=720 degree movement of Unit 2 relative to Unit 1. Also as shown in Figure III-4 and Figure III-5 the speed of Unit 2 has large deviation and the apparent impedance of Units 2 has large excursions into the negative reactance region.

Single-line-to-ground (SLG) faults with stuck breaker Fault 3b and Fault 4b were also simulated. The system was found to be STABLE and PID-215 Unit 2 and Unit 3 maintained synchronization following faults. Figure III-6 shows angles of Unit 1 and Unit 2 during the simulation of Fault 3b.

The developer should consider an over speed and an out-of-step protection system to trip PID-215 Unit 1, 2 and 3 in order to prevent any damage to the PID-215 units following such conditions.

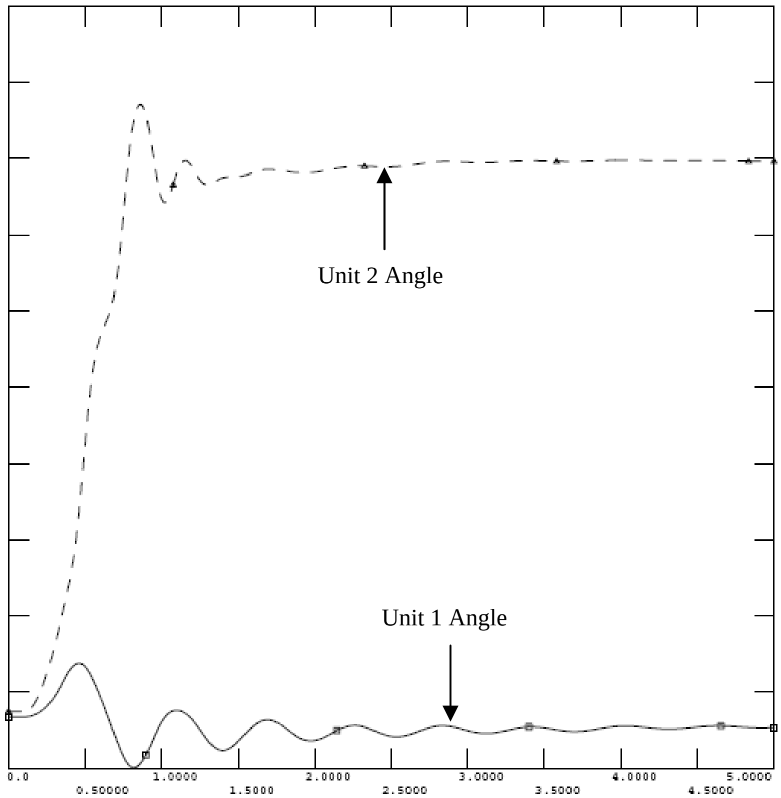


Figure III-3 PID-215 Units Angle during Simulation Fault 3a

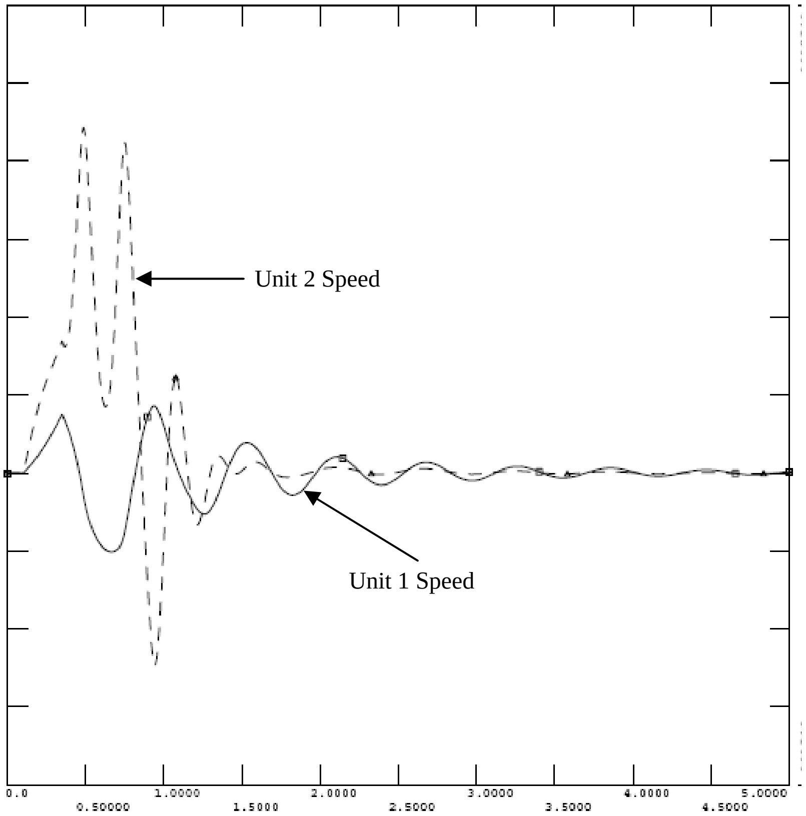


Figure III-4 PID-215 Units Speed during Simulation Fault 3a

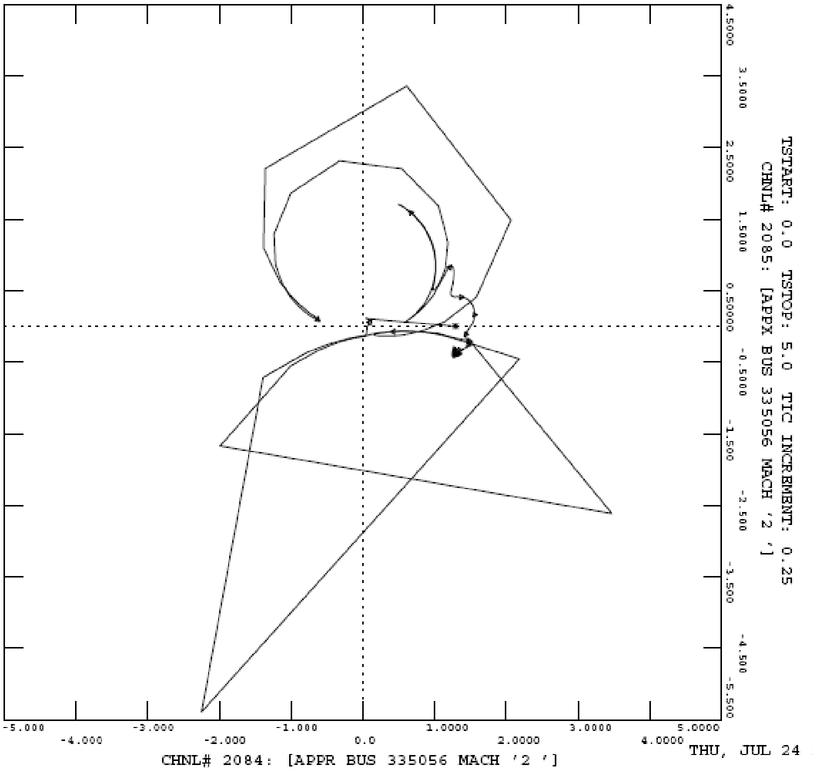


Figure III-5 PID-215 Unit 2 Apparent Impedance during Simulation Fault 3a

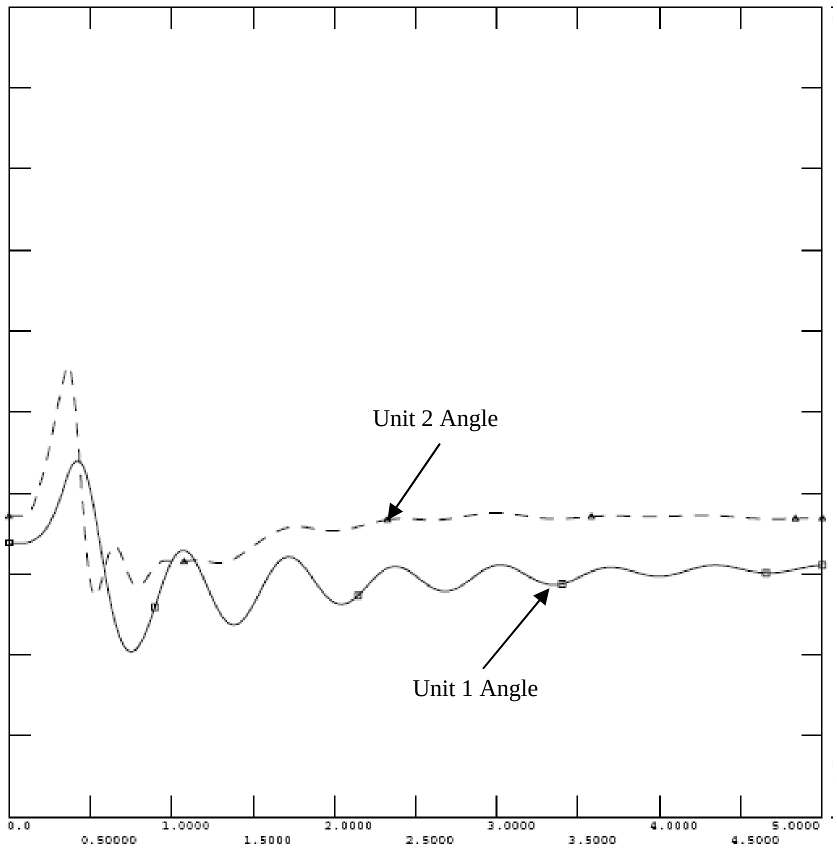


Figure III-6 PID-215 Units Angle during Simulation Fault 3b

Following two three-phase stuck breaker faults - Fault 5a and Fault 7a – two Mossiville 138/69-kV transformers and the 69-kV line from Mossiville to 2L-655TP is tripped. This results into islanding of 17 buses (including Mossiville 69-kV bus). During the dynamic simulations these buses are disconnected. Hence in plots of Fault 5a and 7a, the voltages of these buses drop to zero after fault clearing.

In addition to criteria for the stability of the machines, Entergy has evaluation criteria for the transient voltage dip as follows:

- 3-phase fault or single-line-ground fault with normal clearing resulting in the loss of a single component (generator, transmission circuit or transformer) or a loss of a single component without fault:

  Not to exceed 20% for more than 20 cycles at any bus

Not to exceed 25% at any load bus

Not to exceed 30% at any non-load bus

- 3-phase faults with normal clearing resulting in the loss of two or more components (generator, transmission circuit or transformer), and SLG fault with delayed clearing resulting in the loss of one or more components:

  Not to exceed 20% for more than 40 cycles at any bus

  Not to exceed 30% at any bus

The duration of the transient voltage dip excludes the duration of the fault. The transient voltage dip criteria will not be applied to three-phase faults followed by stuck breaker conditions unless the determined impact is extremely widespread.

The voltages at all buses in the Entergy system (115 kV and above) were monitored during each of the normally cleared three-phase fault cases as appropriate. No voltage criteria violations were observed.

D. Analysis Results

The objective of this study was to evaluate the impact of proposed PID-215 (31 MW) on system stability and the nearby transmission system and generating stations. The study was performed on 2012 Summer Peak case, provided by SPP/Entergy.

Selected three-phase normally cleared and three-phase stuck breaker faults were simulated in the vicinity of the proposed project. System was found to be stable following all simulated faults ***except*** for two three phase stuck breaker faults - Fault 3a and Fault 4a. These two faults are NERC Category D faults (Extreme contingencies); hence per NERC transmission planning criteria the instability following these two faults is not deemed to be a stability criteria violation.

Following three-phase stuck breaker Fault 3a and Fault 4a PID-215 Unit #2 and unit #3 were unstable. All other units in the Entergy system were stable. The developer should consider an over speed protection system and an out-of-step protection system to trip PID-215 Unit 1, 2 and 3 in order to prevent any damage to the PID-215 units following such conditions. The stuck-breaker single-line-to-ground (SLG) fault versions of these two faults were repeated. The results indicated that there are no stability criteria violations. Customer should consider detailed evaluation of internal plant distribution system.

Based on the results of stability analysis it can be concluded that interconnection of the proposed PID-215 (31 MW) generation at the Spherelene 69-kV substation does not adversely impact the stability of the Entergy System. This meets Entergy's performance criteria when the PID-215 plant is in-service.

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.

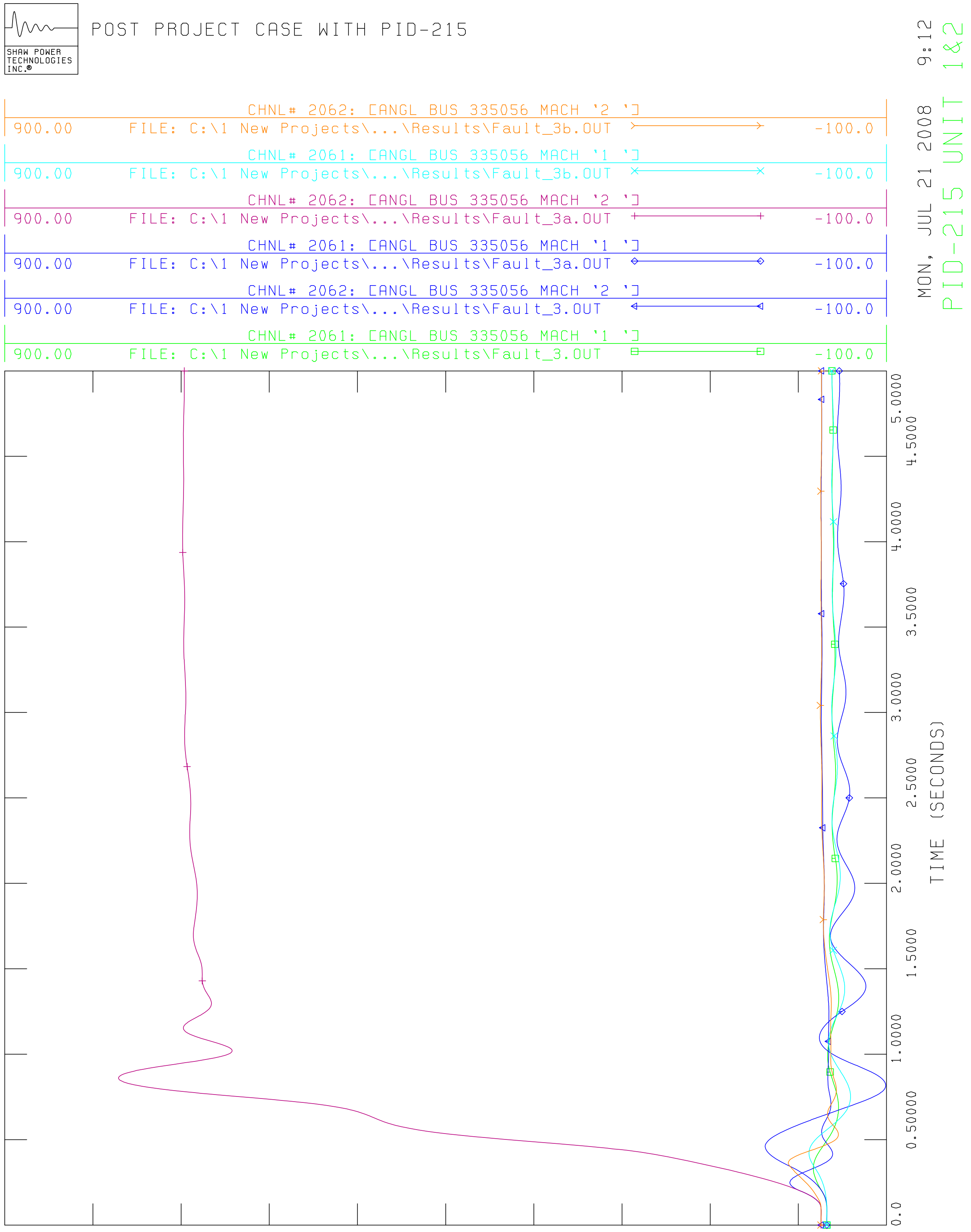


Figure III-4. Fault-3a WITH PID-215 Unit 1 & 2

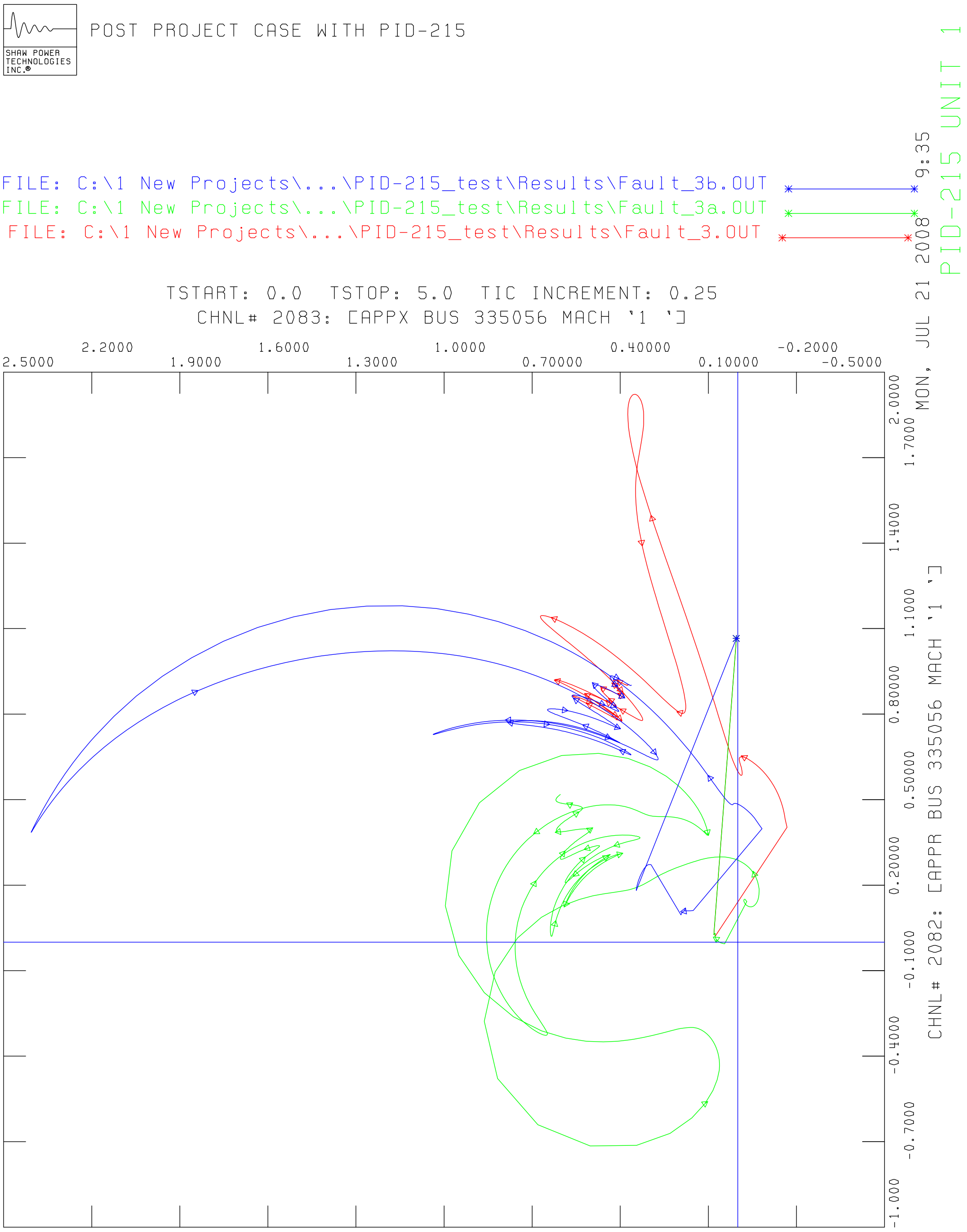
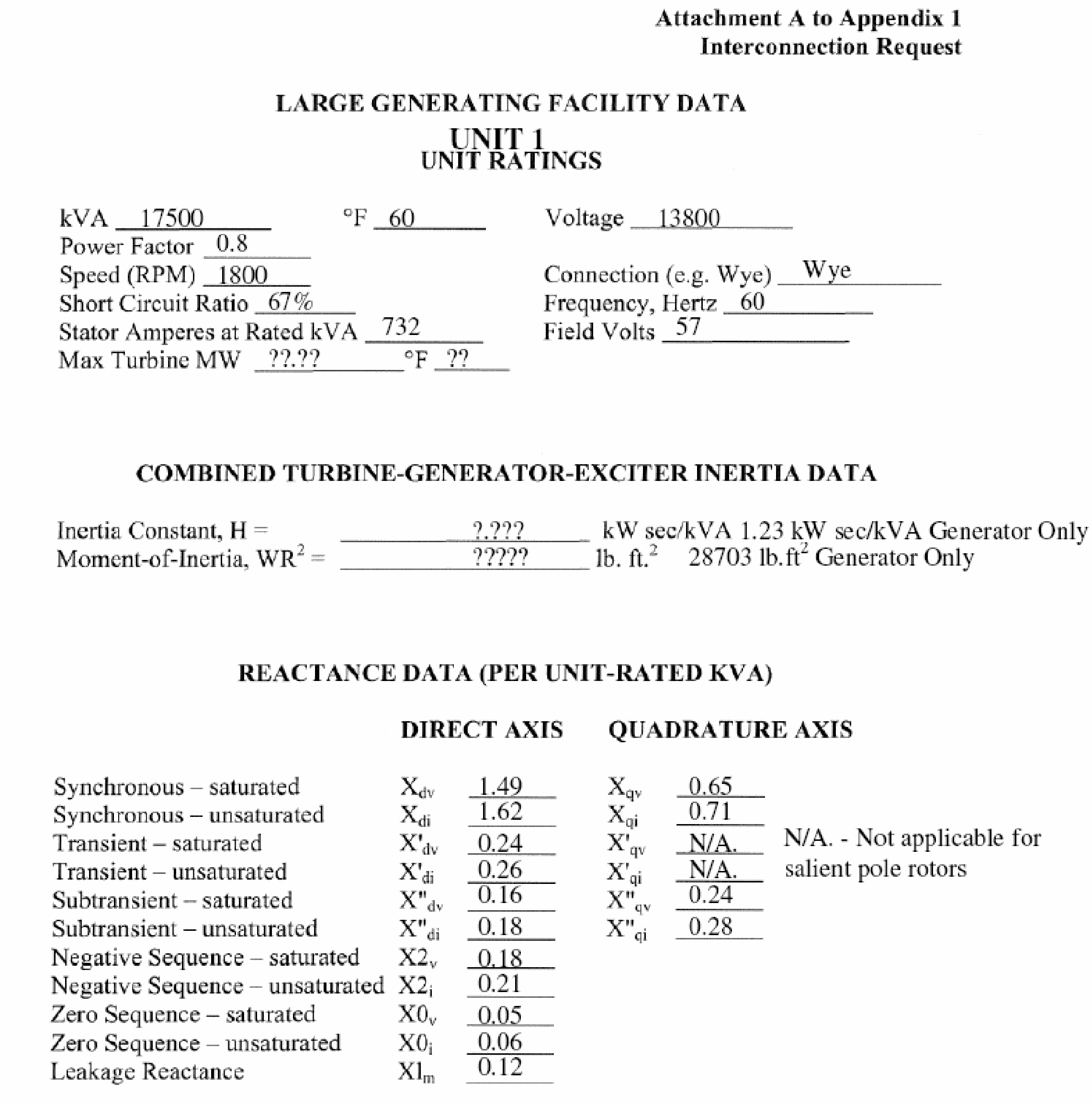


Figure III-6. Fault-6b-SLG WITH PID-205

APPENDIX A.A DATA SUPPLIED BY CUSTOMER



Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

UNIT 1

UNIT RATINGS

kVA 17500 °F 60 Voltage 13800
Power Factor 0.8
Speed (RPM) 1800 Connection (e.g. Wye) Wye
Short Circuit Ratio 67% Frequency, Hertz 60
Stator Amperes at Rated kVA 732 Field Volts 57
Max Turbine MW ??.?? °F ??

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = ?.??? kW sec/kVA 1.23 kW sec/kVA Generator Only
Moment-of-Inertia, WR^2 = ????? lb. $ft.^2$ 28703 lb.ft^2 Generator Only

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		**QUADRATURE AXIS**		
Synchronous – saturated	X_{dv}	1.49	X_{qv}	0.65	
Synchronous – unsaturated	X_{di}	1.62	X_{qi}	0.71	
Transient – saturated	X'_{dv}	0.24	X'_{qv}	N/A.	N/A. - Not applicable for
Transient – unsaturated	X'_{di}	0.26	X'_{qi}	N/A.	salient pole rotors
Subtransient – saturated	X''_{dv}	0.16	X''_{qv}	0.24	
Subtransient – unsaturated	X''_{di}	0.18	X''_{qi}	0.28	
Negative Sequence – saturated	$X2_v$	0.18			
Negative Sequence – unsaturated	$X2_i$	0.21			
Zero Sequence – saturated	$X0_v$	0.05			
Zero Sequence – unsaturated	$X0_i$	0.06			
Leakage Reactance	Xl_m	0.12			

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	7.63	T'_{qo}	N/A.	N/A. - Not applicable for salient pole rotors
Three-Phase Short Circuit Transient	T'_{d3}	0.869	T'_{q}	N/A.	
Line to Line Short Circuit Transient	T'_{d2}	1.278			
Line to Neutral Short Circuit Transient	T'_{d1}	0.895			
Short Circuit Subtransient	T''_{d}	0.026	T''_{q}	0.038	
Open Circuit Subtransient	T''_{do}	0.037	T''_{qo}	0.099	

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.191
Line to Line Short Circuit	T_{a2}	0.263
Line to Neutral Short Circuit	T_{a1}	0.191

NOTE: If requested information is not applicable, indicate by marking "N/A."

MW CAPABILITY AND PLANT CONFIGURATION
LARGE GENERATING FACILITY DATA

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Positive	R_1	0.0033
Negative	R_2	0.0044
Zero	R_0	0.0016

Rotor Short Time Thermal Capacity I_2^2t = 40
Field Current at Rated kVA, Armature Voltage and PF = 655 amps
Field Current at Rated kVA and Armature Voltage, 0 PF = 280 amps
Three Phase Armature Winding Capacitance = 0.299 microfarad
Field Winding Resistance = 0.0667 ohms 20 °C
Armature Winding Resistance (Per Phase) = 0.025 ohms 20 °C

CURVES

Provide Saturation, Vee, Reactive Capability, Capacity Temperature Correction curves.
~~Designate normal and emergency Hydrogen Pressure operating range for multiple curves.~~

See attached curves. C1, C2, C3 and C4.

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Only one transformer is used to step-up the three units.

Capacity	Self-cooled/ Maximum Nameplate		
30000 /	40000 (future)	kVA	@ 55 °C
33600 /	44800 (future)	.kVA	@ 65 °C

Voltage Ratio(Generator Side/System side/Tertiary)
13800 / 69000 / N/A. kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
Wye / Delta / N/A.

Fixed Taps Available 70725, 69000, 67275, 65550, 63825

Present Tap Setting 69000 Dial Position 2

IMPEDANCE

Positive	Z_1 (on self-cooled kVA rating)	7.55	%	25	X/R	@ 55 °C
Zero	Z_0 (on self-cooled kVA rating)	7.70	%	25 est.	X/R	

EXCITATION SYSTEM DATA

Identify appropriate IEEE model block diagram of excitation system and power system stabilizer (PSS) for computer representation in power system stability simulations and the corresponding excitation system and PSS constants for use in the model.

See attached diagrams and data, D1.

GOVERNOR SYSTEM DATA

Identify appropriate IEEE model block diagram of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

IEEE model block diagram with corresponding constants was not provided by Solar Turbines as requested. Solar provided data and diagrams located in attachment D2 as substitute.

WIND GENERATORS (N/A.)

Number of generators to be interconnected pursuant to this Interconnection Request: ____________

Elevation: ____________ _____ Single Phase _____ Three Phase

Inverter manufacturer, model name, number, and version:
____

List of adjustable setpoints for the protective equipment or software:
____

Note: A completed General Electric Company Power Systems Load Flow (PSLF) data sheet or other compatible formats, such as IEEE and PTI power flow models, must be supplied with the Interconnection Request. If other data sheets are more appropriate to the proposed device, then they shall be provided and discussed at Scoping Meeting.

Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

IDENTICAL UNITS 2 & 3

UNIT RATINGS

kVA 11000 °F 104 Voltage 13800
Power Factor 0.8
Speed (RPM) 720 Connection (e.g. Wye) Wye
Short Circuit Ratio 0.537 Frequency, Hertz 60
Stator Amperes at Rated kVA 460 Field Volts ?
Max ~~Turbine~~ MW 8400 (MECH) °F 77 ISO 8528-1 & ISO3046-1
Engine No change in rating from 41 to 95 °F.

Engine
COMBINED ~~TURBINE~~-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 0.632 kW sec/kVA 0.632 kW sec/kVA Generator Only
Moment-of-Inertia, WR^2 = 63597 lb. ft.^{2} 63597 lb.ft^2 Generator Only

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	1.863	X_{qv}	1.014
Synchronous – unsaturated	X_{di}	2.070	X_{qi}	1.035
Transient – saturated	X'_{dv}	0.419	X'_{qv}	1.014.
Transient – unsaturated	X'_{di}	0.419	X'_{qi}	1.035
Subtransient – saturated	X''_{dv}	0.219	X''_{qv}	0.241
Subtransient – unsaturated	X''_{di}	0.241	X''_{qi}	0.241
Negative Sequence – saturated	$X2_v$	0.230		
Negative Sequence – unsaturated	$X2_i$	0.253		
Zero Sequence – saturated	$X0_v$	0.066		
Zero Sequence – unsaturated	$X0_i$	0.072		
Leakage Reactance	Xl_m	0.??	According to AVK, Xpotier (Xlm) is n.a.	

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	3.230	T'_{qo}	0.400
Three-Phase Short Circuit Transient	T'_{d3}	0.654	T'_{q}	0.400
Line to Line Short Circuit Transient	T'_{d2}	?.??		
Line to Neutral Short Circuit Transient	T'_{d1}	?.??		
Short Circuit Subtransient	T''_{d}	0.020	T''_{q}	0.040
Open Circuit Subtransient	T''_{do}	0.038	T''_{qo}	0.172

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.110
Line to Line Short Circuit	T_{a2}	0.11
Line to Neutral Short Circuit	T_{a1}	0.09

NOTE: If requested information is not applicable, indicate by marking "N/A."

MW CAPABILITY AND PLANT CONFIGURATION
LARGE GENERATING FACILITY DATA

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Resistances provided at 20 °C

Positive	R_1	0.00944	Ra	0.00594
Negative	R_2	0.00950		
Zero	R_0	0.00594		

Rotor Short Time Thermal Capacity I_2^2t = 40 per NEMA MG-1 (20 per IEC60034-1)
Field Current at Rated kVA, Armature Voltage and PF = 260 amps
Field Current at Rated kVA and Armature Voltage, 0 PF = 305 amps
Three Phase Armature Winding Capacitance = 0.41 microfarad
Field Winding Resistance = 0.66 ohms 20 °C
Armature Winding Resistance (Per Phase) = 0.10 ohms 20 °C

CURVES

Per manufacturer all information is provided capability chart.

Provide Saturation, [✓ Vee], Reactive Capability, Capacity Temperature Correction curves.
~~Designate normal and emergency Hydrogen Pressure operating range for multiple curves.~~

See attached curves. C5, C6, C7 and C8.

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Only one transformer is used to step-up the three units.

Capacity Self-cooled/ Maximum Nameplate
______________/________________kVA

Voltage Ratio(Generator Side/System side/Tertiary)
______________/________________/______________kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
______________/______________/______________

Fixed Taps Available ____

Present Tap Setting ____

IMPEDANCE

Positive Z$_1$ (on self-cooled kVA rating)______________ % ________ X/R

Zero Z$_0$ (on self-cooled kVA rating)______________ % ________ X/R

EXCITATION SYSTEM DATA

Identify appropriate IEEE model block diagram of excitation system and power system stabilizer (PSS) for computer representation in power system stability simulations and the corresponding excitation system and PSS constants for use in the model.

See attached diagrams and data, D3.

GOVERNOR SYSTEM DATA

Identify appropriate IEEE model block diagram of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

See attached diagrams and data, D4

WIND GENERATORS (N/A.)

Number of generators to be interconnected pursuant to this Interconnection Request:

____

Elevation: ______________ _____ Single Phase _____ Three Phase

Inverter manufacturer, model name, number, and version:

____

List of adjustable setpoints for the protective equipment or software:

____

Note: A completed General Electric Company Power Systems Load Flow (PSLF) data sheet or other compatible formats, such as IEEE and PTI power flow models, must be supplied with the Interconnection Request. If other data sheets are more appropriate to the proposed device, then they shall be provided and discussed at Scoping Meeting.

APPENDIX A.B Stability Issues in the Western Region of the Entergy System Due to Independent Power Generation

Introduction

The WOTAB (West of the Atchafalaya Basin) Area in defined as Entergy's systems in Southwestern Louisiana, and Southeastern Texas. The WOTAB area is a major load center for the Entergy System. The load to generation ratio requires a significant amount of power to be imported into the WOTAB area. However, because of the influx of new generating projects proposed for the area, it is likely that by the year 2003 this area may turn into a significant exporter of power. There have been a significant number of requests for interconnection studies to evaluate the potential interconnection of new generating facilities in the WOTAB area. It is anticipated that by 2003 there may be approximately 4000 – 6000 MW of new merchant generation within the WOTAB area.

Entergy's transmission system was planned, designed and built to serve approximately 5000 – 6000 MW of native and network loads in the WOTAB area. The addition of a significant amount of merchant generation will result in the export of power out of the WOTAB area. A high level of export power has the potential to create major problems, such as voltage and dynamic stability. The main objective of this study is to establish an estimated power export limit for the WOTAB area based on stability criteria.

Signing an interconnection agreement provides the generator the right to interconnection to the transmission system, but does not provide it any right to move its power onto or over the transmission system. The right to use the transmission system to transmit power can only be obtained by submitting a transmission request for service pursuant to Entergy's FERC-approved transmission tariff. Solutions to stability problems to increase export limits, such as construction of 500 kV line, have very long lead-times and tend to be very expensive.

Entergy believes that it is important to post this study publicly on its OASIS site so that entities that have already executed interconnection agreements, as well as entities that are proposing to site new generation within the WOTAB area, can incorporate this information into their decision-making process.

Analysis

In order to establish stability limits from the WOTAB area, all merchant generating***]***that have signed an interconnection agreement were dispatched at their maximum capability along with the native generation in the area. In order to accommodate this export and simulate a worst case scenario, generation was reduced in the northern part of the Entergy System.

In this analysis the export limits were determined without the addition of any Power System Stabilizers (PSSs). However, sensitivity studies were conducted to determine the impact of stabilizers. If voltage stability limits were found to be lower than the dynamic stability limits, they were captured in this analysis.

One important assumption made in this study was to ignore thermal limitations. Thermal issues will be addressed as part of Transmission Service Request as they are based on source to sink information and generation dispatch within the WOTAB area.

The two cases analyzed in this study are as follows:

1. Base case with no merchant generation
2. Base case with merchant generation

Voltage stability analysis was performed for the pre-contingency condition and contingencies on four critical lines: Hartburg-Mt. Olive 500 kV, Richard–Webre 500 kV, Nelson–Richard 500 kV, and Grimes–Crockett 345 kV lines. As part of the voltage stability analysis, PV curves were developed in order to determine the maximum power that can be exported from the WOTAB area without experiencing voltage decline or voltage collapse. Entergy's guideline on voltage decline states that voltage at any station should not fall below 0.92 pu of nominal system voltage on single contingency.

Transient stability analysis was performed by applying a 3 phase to ground fault on the lines mentioned earlier. The fault clearing time was assumed to be 5 cycles for 500 kV and 345 kV lines and 6 cycles for the 230 kV lines. The transient stability plots show the machine angle as a function of time and indicate whether machine is stable and well damped, transiently unstable or dynamically unstable. A three percent damping criteria was used to screen the damping problem.

Results

Case 1 – Base Case with no Merchant Generation

No voltage stability problems were identified in this case. The transient stability plots in Figures 1 and 2 for a three-phase fault on the Hartburg – Mt.Olive 500 kV and Richard – Webre 500 kV lines show that the machines are stable and well damped.

Case 2 – Base case with Merchant Generation

A. Voltage Stability Analysis

The voltage stability plot or PV Curve for this case is shown in Figure 3. The X-axis of this plot is the power export level from the WOTAB area corresponding to the pre-contingency condition and the contingency of the four critical lines described earlier. The Y-axis represents the voltage at the Cane River 115 kV bus in the North Louisiana area. This station is representative of the voltage collapse occurring in that area. From the PV plot it can be observed that the most limiting contingency from the point of view of export from the area is the Hartburg – Mt. Olive 500 kV line. Based on the voltage decline guideline, the export limit from the area on the contingency of Hartburg-Mt. Olive line is 2100 MW. Figure 3 also shows that voltage collapse will eventually occur at about 3300 MW.

B. Transient/Dynamic Stability Analysis

The transient stability simulations were performed with the assumption that there are no Power System Stabilizers (PSS) installed on the proposed merchant generating units. The maximum export under this condition where the units are marginally damped was determined to be approximately 2700 MW. The stability plot for this simulation is shown in Figure 4. It was determined that export limits can be improved by adding PSS to the merchant generation. Henceforth, it will be a requirement that all new units in the area be equipped with stabilizers.

Conclusions:

The West of the Atchafalaya Basin (WOTAB) area can experience a voltage and dynamic stability problem if a significant amount of new merchant generation is operating in the area by year 2003. The export limit from this area is determined to be 2700 MW based on dynamic stability and 2100 MW based on voltage decline. As this area can experience dynamic problems beyond a certain export limit it will be mandatory for all IPPs in the area to install PSS on their units. Any *further* increase in the export level may require major upgrades, such as construction of 500 kV transmission lines.

The thermal limits were not evaluated in this study because they are source and sink specific and based on the generation dispatch. These limits will be evaluated when transmission service is requested and a System Impact Study is conducted.

APPENDIX A.C POLICY STATEMENT/GUIDELINES FOR POWER SYSTEM STABILIZER ON THE ENTERGY SYSTEM

Background:

A Power System Stabilizer (PSS) is an electronic feedback control that is a part of the excitation system control for generating units. The PSS acts to modulate the generator field voltage to damp the Power System oscillation.

Due to restructuring of the utility industry, there has been a significant amount of merchant generation activity on the Entergy system. These generators are typically equipped with modern exciters that have a high gain and a fast response to enhance transient stability. However, these fast response exciters, if used without stabilizers, can lead to oscillatory instability affecting local or regional reliability. This problem is exacerbated particularly in areas where there is a large amount of generation with limited transmission available for exporting power.

Stability studies carried out at Entergy have validated this concern. Furthermore, based on the understanding of operational problems experienced in the WSCC area over the last several years and the opinion of leading experts in the stability area, PSS are an effective and a low cost means of mitigating dynamic stability problems. In particular, PSS cost can be low if it is included in power plant procurement specifications.

Therefore, as a pre-emptive measure, Entergy requires all new generation (including affiliates and qualifying facilities) intending to interconnect to its transmission system to install PSS on their respective units.

The following guidelines shall be followed for PSS installation:

- PSS shall be installed on all new synchronous generators (50 MVA and larger) connecting to the transmission system that were put into service after January 1, 2000.

- PSS shall be installed on synchronous generators (50 MVA and larger) installed before January 1, 2000 subject to confirmation by Entergy that these units are good candidates for PSS and installing PSS on these units will enhance stability in the region. The decision to install PSS on a specific unit will be based on the effectiveness of the PSS in controlling oscillations, the suitability of the excitation system, and cost of retrofitting.

- In areas where a dynamic stability problem has not been explicitly identified, all synchronous generators (50 MVA and larger) will still be required to install stabilizers. However, in such cases the tuning will not be required and the stabilizer may remain disconnected until further advised by Entergy.

- Need for testing and tuning of PSS on units requesting transmission service from areas where stability problem has not been explicitly identified will be determined on an as-needed basis as part of transmission service study.

- The plants are responsible for testing and tuning of exciter and stabilizer controls for optimum performance and providing PSS model and data for use with PSS/E stability program.

- PSS equipment shall be tested and calibrated in conjunction with automatic voltage regulation (AVR) testing and calibration at-least every five years in accordance with the NERC Compliance Criteria on Generator Testing. PSS re-calibration must be performed if AVR parameters are modified.

- The PSS equipment to be installed is required to be of the Delta-P-omega type.

References:

WOTAB Area Stability Study for the Entergy System
WSCC Draft Policy Statement on Power System Stabilizers
PSEC Application Notes: Power System Stabilizer helps need plant stability margins for Simple Cycle and Combined Cycle Power Plants

APPENDIX A.D Transient Stability Data and Plots

Plots illustrating the results from the simulated cases have been provided. For all cases, bus voltages and angles of the nearby generators in the vicinity of the proposed PID 215 unit are included in the plots.

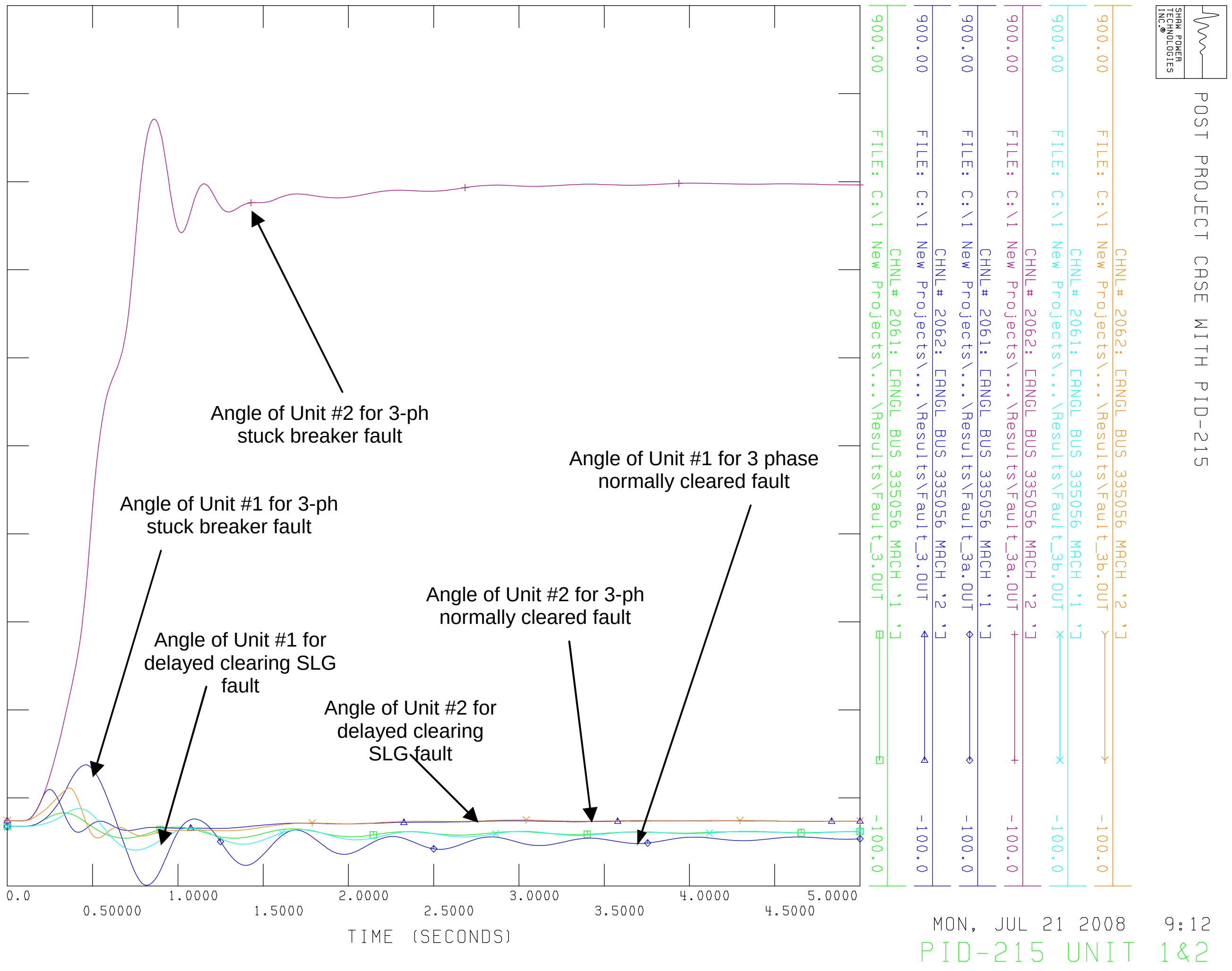


Figure 1a: Comparison of Angle of Unit #1 and #2 for 3 Phase normally cleared, stuck breaker and SLG delayed clearing fault

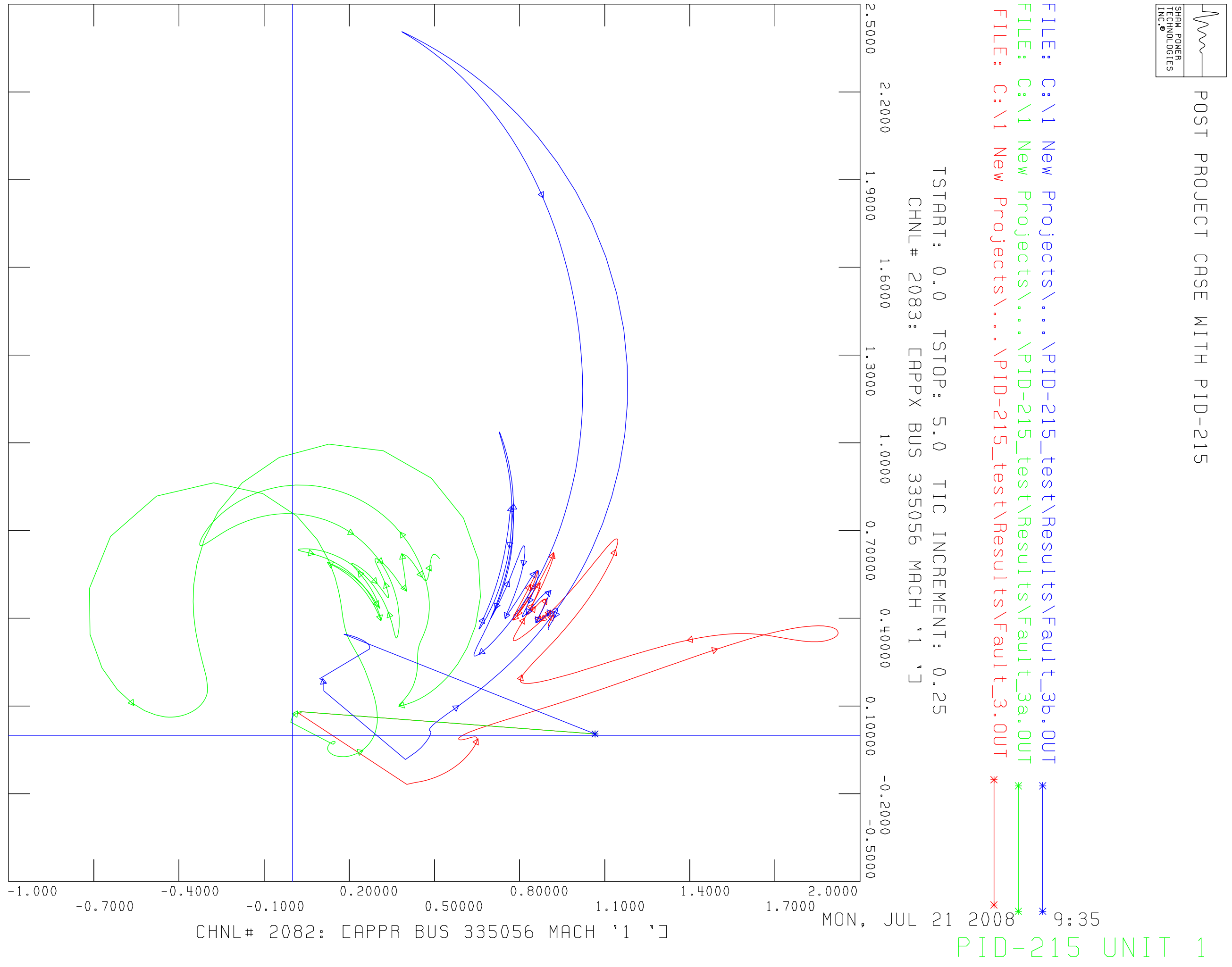


Figure 2b: Comparison of Angle of Unit #1 and #2 for 3 Phase normally cleared, stuck breaker and SLG delayed clearing fault

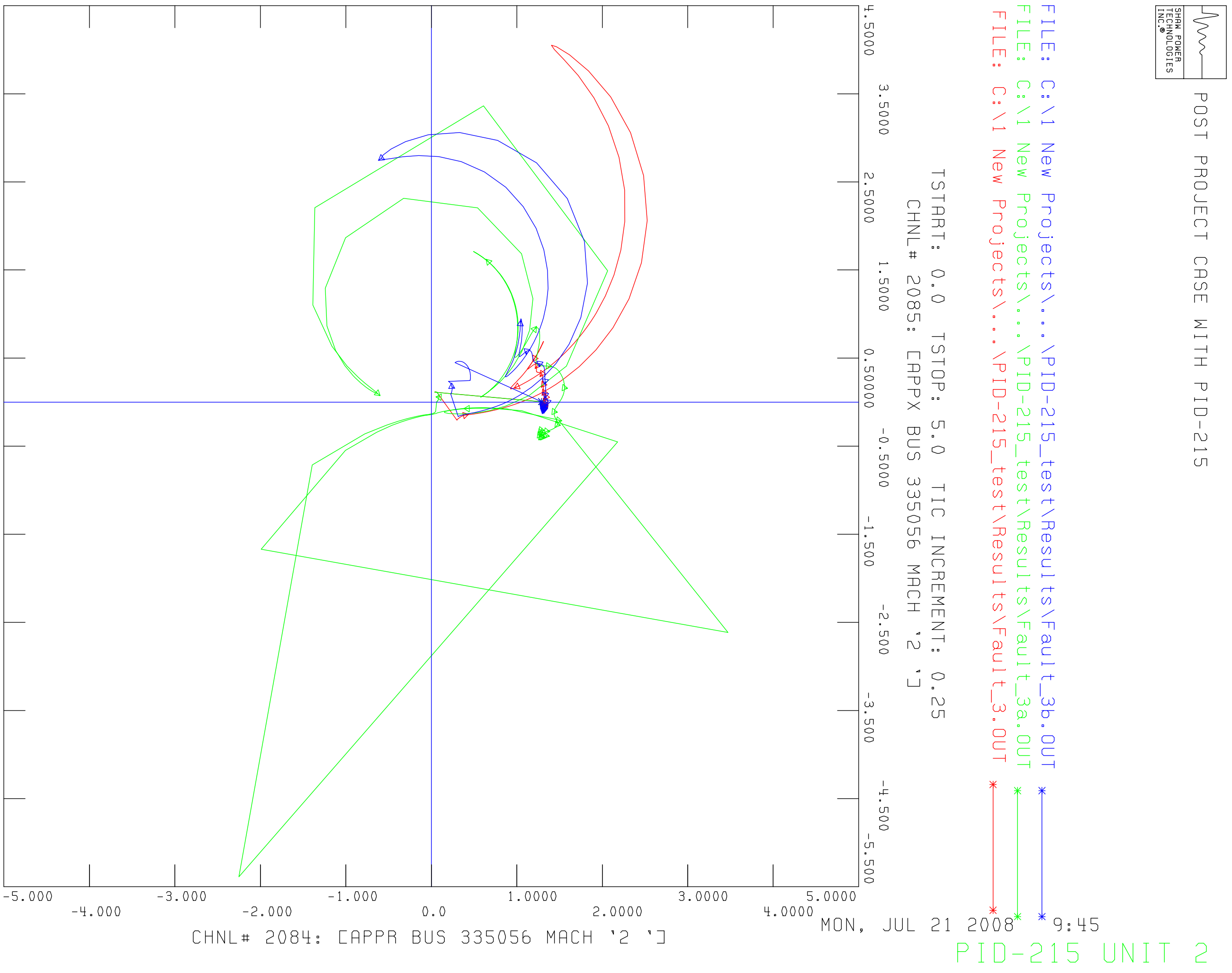


Figure 3c: Comparison of Angle of Unit #1 and #2 for 3 Phase normally cleared, stuck breaker and SLG delayed clearing fault