System Impact Study Report
PID 226
206MW Generation Uprate

Prepared by:

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0	5/13/2009	Posting for Review	BEF	JDH

Executive Summary:

This System Impact Study is the second step of the interconnection process and is based on the PID-226 request for an uprate of 206 MW onto the Entergy Transmission Grid from the Grand Gulf Unit #1 Power Station. This report is organized into two sections, namely, Section – A, Energy Resource Interconnection Service (ERIS) and Section – B, Network Resource Interconnection Service (NRIS – Section B).

The 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. 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 can be found in Section – B.

Requestor for PID-226 did request NRIS, but did not request ERIS, therefore, under Section - A (ERIS) a load flow analysis was not performed. PID 226 is an up-rate to an existing facility. The study evaluates an infusion of 206 MW to the Entergy Transmission System. The load flow study was performed on the latest available 2012 Summer Peak case, using PSS/E and MUST software by Siemens Power Technologies International (Siemens-PTI). The proposed in-service date for NRIS is June 1, 2012.

Results of the System Impact Study contend that under NRIS, the estimated upgrade cost With Priors is $7,160,000 + TBD and Without Priors is $7,160,000 + TBD

Estimated Project Planning Upgrades for PID 226

Study	Estimated cost With Priors ($)	Estimated cost Without Priors ($)
NRIS	$7,160,000 + TBD	$7,160,000 + TBD

The costs of the upgrades are planning estimates only. Detailed cost estimates, accelerated costs and solutions for the limiting elements will be provided in the facilities study.

Section – A

Energy Resource Interconnection Service

TABLE OF CONTENTS FOR SECTION –A (ERIS)

I. Introduction

This Energy Resource Interconnection Service (ERIS) is based on a request for interconnection onto Entergy's transmission system. PID 226 did not request ERIS. 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 guidelines when the plant is connected to Entergy's transmission system. If not, transmission improvements will be identified.

The System Impact Study process required a load flow analysis to determine if the existing transmission lines are adequate to handle the full output from the plant for simulated transfers to adjacent control areas. A short circuit analysis would be performed to determine if 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 if the new units would cause a stability problem on the Entergy system.

II. Short Circuit Analysis / Breaker Rating Analysis

No Short Circuit analysis was performed due to generator having a signed IA and the generator characteristics remain unchanged.

III. Load Flow Analysis

No load flow analysis performed due to generator not requesting ERIS.

IV. Stability Analysis

INTRODUCTION

Southwest Power Pool (SPP) had performed a stability analysis for System Impact Study of PID-226, which is a request for 206 MW uprate of the existing Grand Gulf Unit #1 in the Entergy transmission system.

The objective of the impact study is to evaluate the impact of the proposed 206 MW uprate (PID-226) on system stability and nearby transmission system. The study is performed on 2012 Summer Peak case, provided by Entergy. Figure 0-1 shows the location of the G. Gulf Unit with proposed 206 MW increase of generation

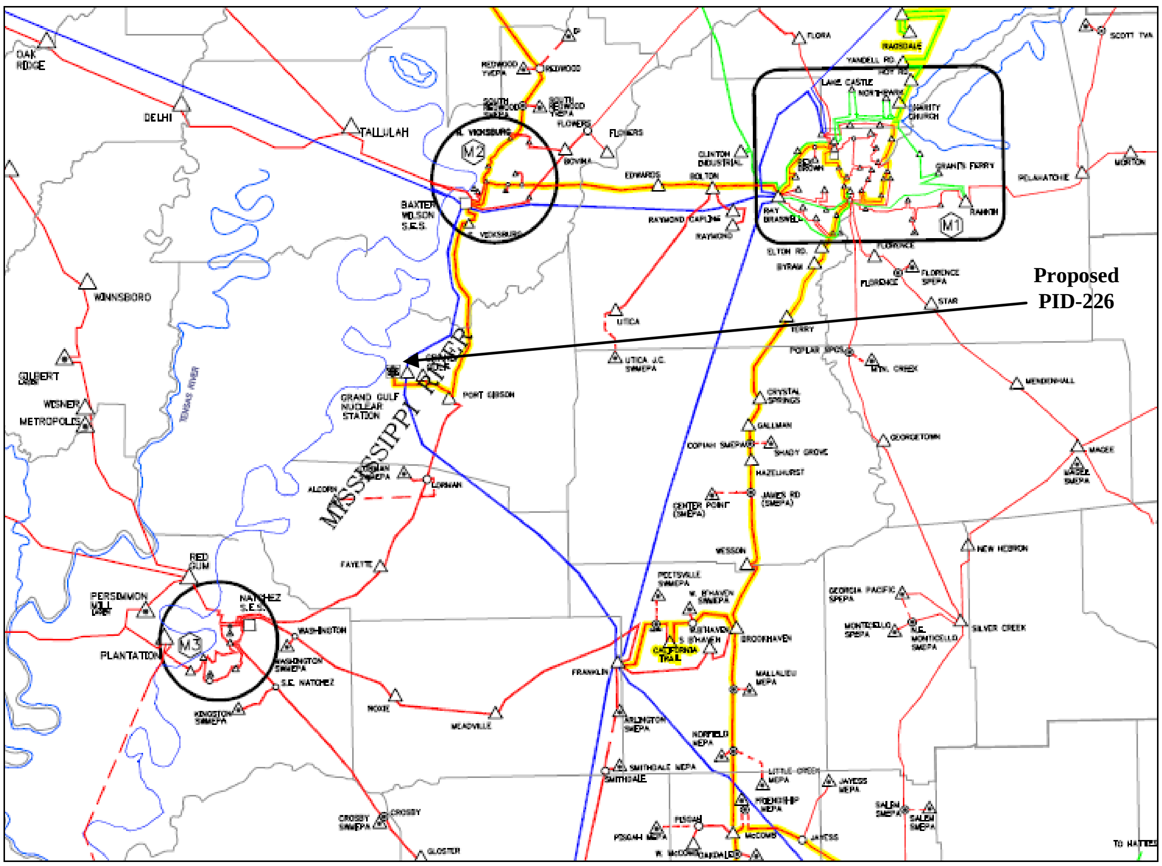

Figure 0-1 PID 226 Project location

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STABILITY ANALYSIS

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 Siemens-PTI's PSS/E™ dynamics program V30.3.2. Three-phase and single-phase line faults were simulated for the specified duration and synchronous machine rotor angles and wind turbine generator speeds were monitored to check whether synchronism is maintained following fault removal.

Based on the Entergy study criteria, three-phase faults with normal clearing and delayed clearing were simulated.

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.

For three-phase faults, a fault admittance of –j2E9 is used (essentially infinite admittance or zero impedance). For the single phase stuck breaker faults, the fault admittances considered are mentioned in Table 0-3.

<u>Transient Voltage Criteria</u>

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 local buses (115 kV and above) were monitored during each of the fault cases as appropriate.

As there is no specific voltage dip criteria for three-phase stuck breaker faults, the results of these faults were compared with the most stringent voltage dip criteria of - not to exceed 20 % for more than 20 cycles.

STUDY MODEL DEVELOPMENT

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

Power Flow Case

A Powerflow case "EN14S08 FINAL U0+Oupgd+P6+PID226-uncov.sav" representing the 2012 Summer Peak conditions was provided by SPP/ Entergy.

Two prior-queued projects, PID-223 and PID-224, were added to the basecase. Thus a pre-project powerflow case was established and named as 'PRE-PID-226.sav'.

The proposed PID-226 project is a 206 MW uprate at G. Gulf Unit. The additional 206 MW was dispatched against the White Bluff Unit #1. Table 2-1 summarizes the dispatch. Thus a post-project power flow case with PID-226 was established and named as 'POST-PID-226.sav'.

Table 0-1: PID-226 project details

System condition	MW	Point of Interconnection	Sink
2012 Summer Peak	206	G. Gulf (#336821)	White Bluff Unit 1 (#337652)

Figure 0-1 and Figure 0-2 show the PSS/E one-line diagrams for the local area WITHOUT and WITH the PID-226 project, respectively, for 2012 Summer Peak system conditions.

Stability Database

A basecase stability database was provided by SPP/Entergy in a PSSE *.dyr file format ('red11S_newnum.dyr').

To create a dynamic database (a snapshot file) for Pre-PID-226 powerflow case, stability data for PID-223 and PID-224 was appended to the basecase stability database.

After the proposed uprate of the G. Gulf unit the total MW output of the plant will be 1534 MW, higher than the existing maximum limit (0.90 p.u. on 1525 MVA) on the Governor. For the stability analysis purpose, to avoid the initial condition errors, the limit was changed from 0.90 p.u to 1.01 p.u. on 1525 MVA base. Given the large system under consideration impact of such assumption will not be significant. The pre-project stability database was updated to create dynamic database for Post-PID-226 powerflow case.

The data provided at the Interconnection Request for PID-226 is included in Appendix A. The PSS/E power flow and stability data for PID-226, used for this study, are included in Appendix B.

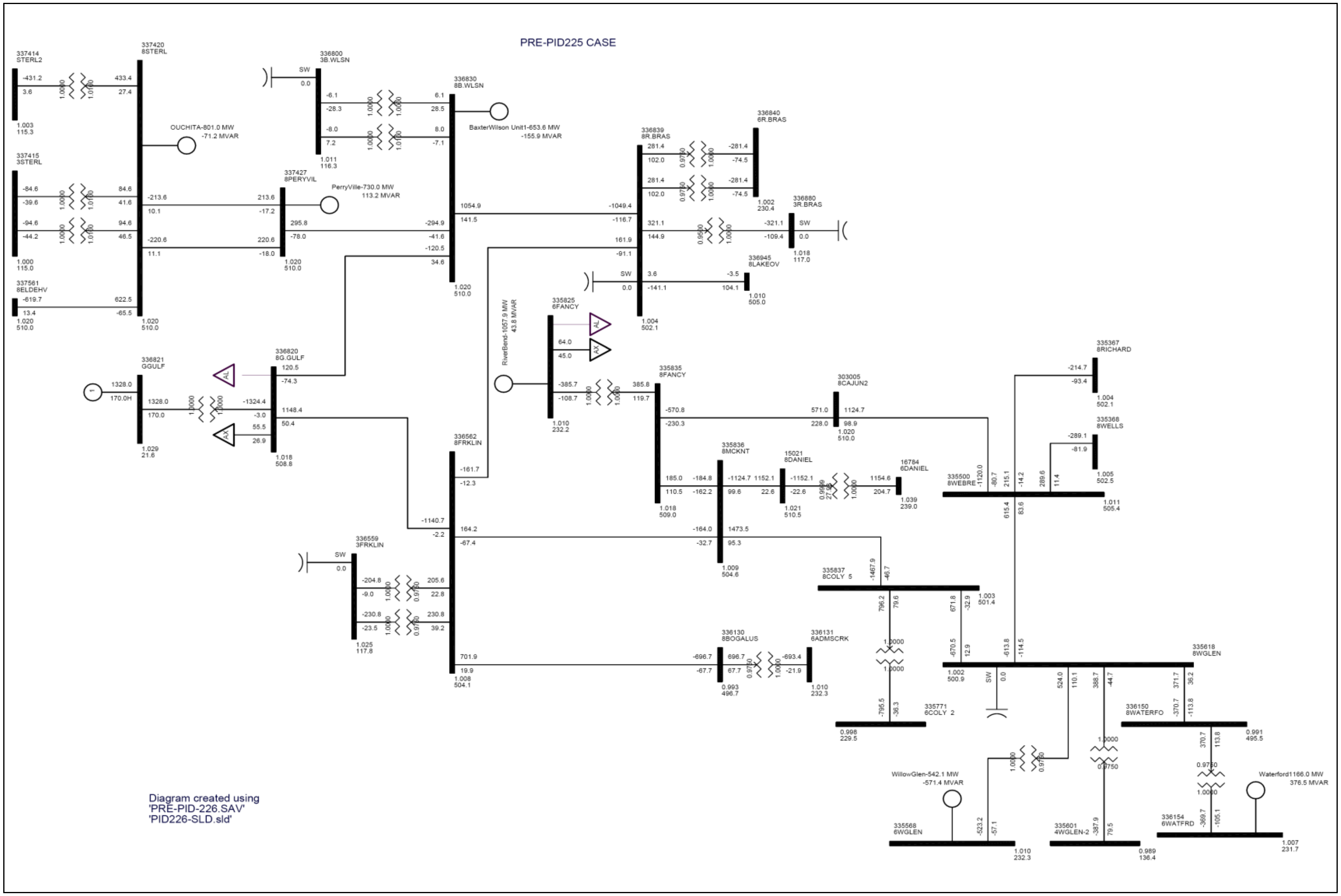


Figure 0-1 One-line Diagram of the local area <u>without</u> PID-226 (2012 Summer Peak)

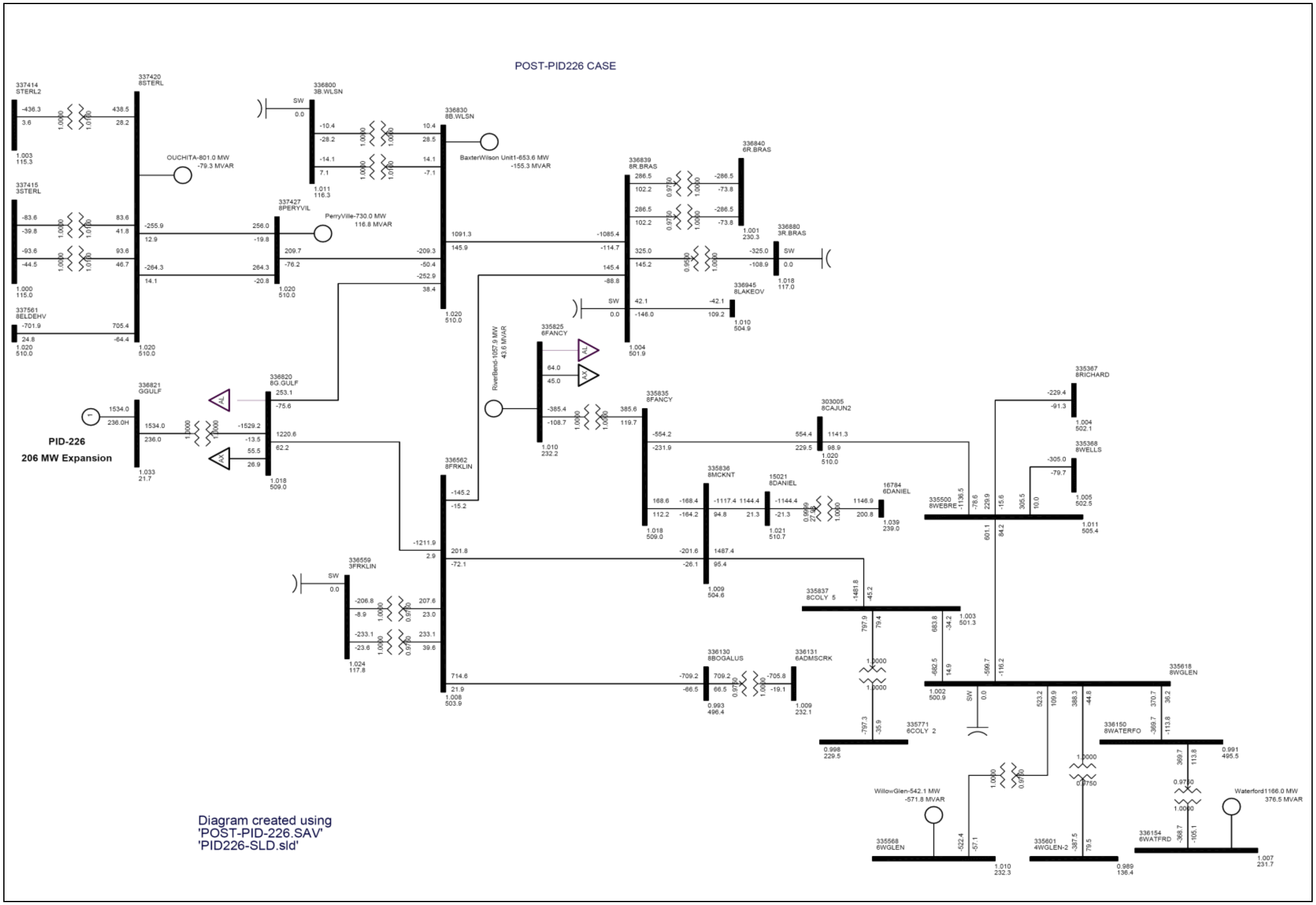


Figure 0-2 One-line Diagram of the local area with PID-226 (2012 Summer Peak)

2.2 *TRANSIENT STABILITY ANALYSIS*

Stability simulations were run to examine the transient behavior of the G. Gulf Unit and impact of the proposed uprate on the Entergy system. Stability analysis was performed using the following procedure. First, three-phase faults with normal clearing were simulated. Next, the three-phase stuck breaker (IPO: 3PH-1PH) faults were simulated. The fault clearing times used for the simulations are given inTable 0-2.

Table 0-2: Fault Clearing Times

Contingency at kV level	Normal Clearing	Delayed Clearing
500	5 cycles	5+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 fault remains in place for Three-phase stuck-breaker (IPO: 3PH-1PH) faults. The fault admittances is changed to Thevenin equivalent admittance of single phase faults.

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-226 project.

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

Table 0-3 and Table 0-4 list all the fault cases that were simulated in this study.

Fifteen (15) three phase normally cleared and twenty seven (27) three-phase stuck breaker converted into single-line-to-ground fault (following Independent Pole Operation of breakers) were simulated.

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.

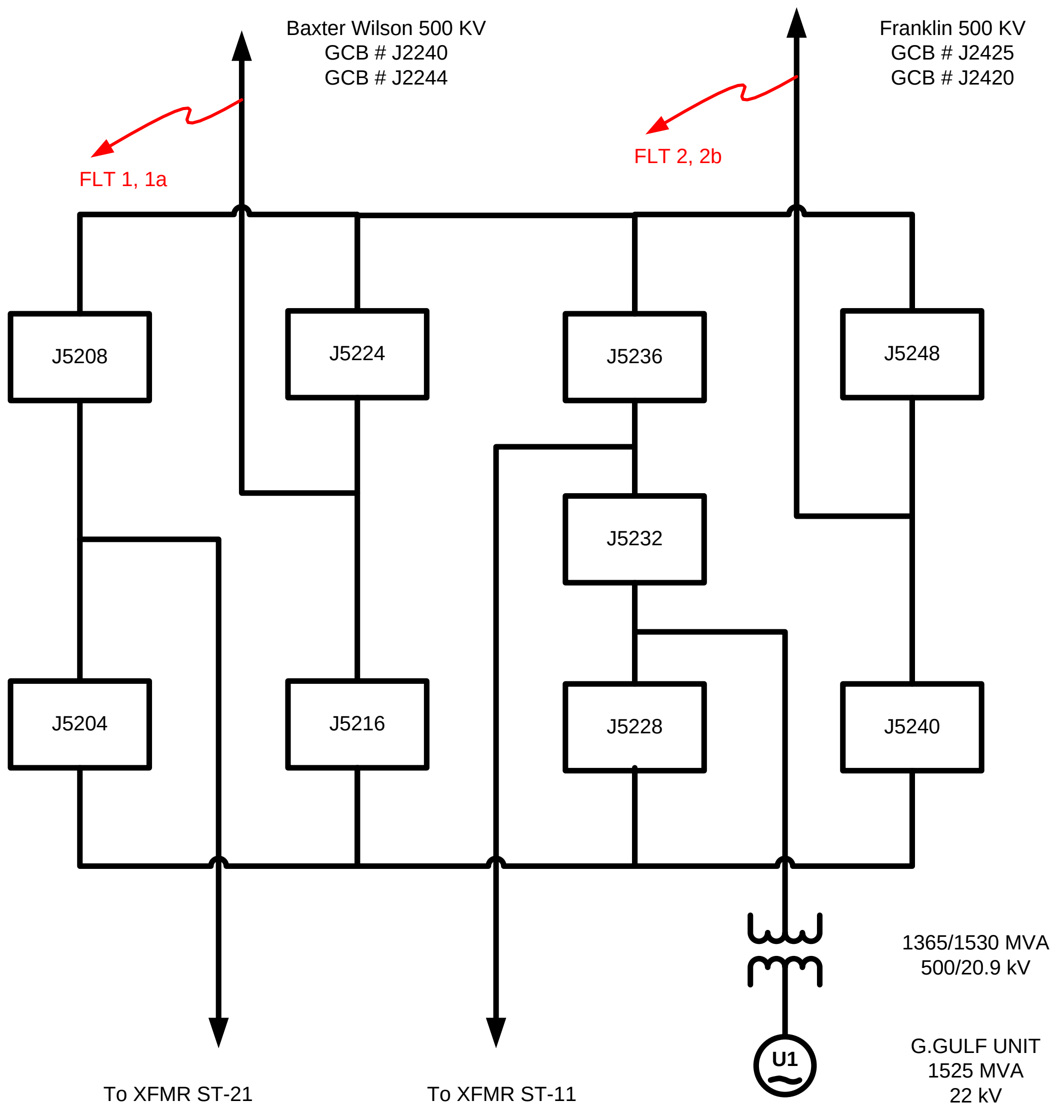
Table 0-3 List of 3 Phase faults simulated for stability analysis

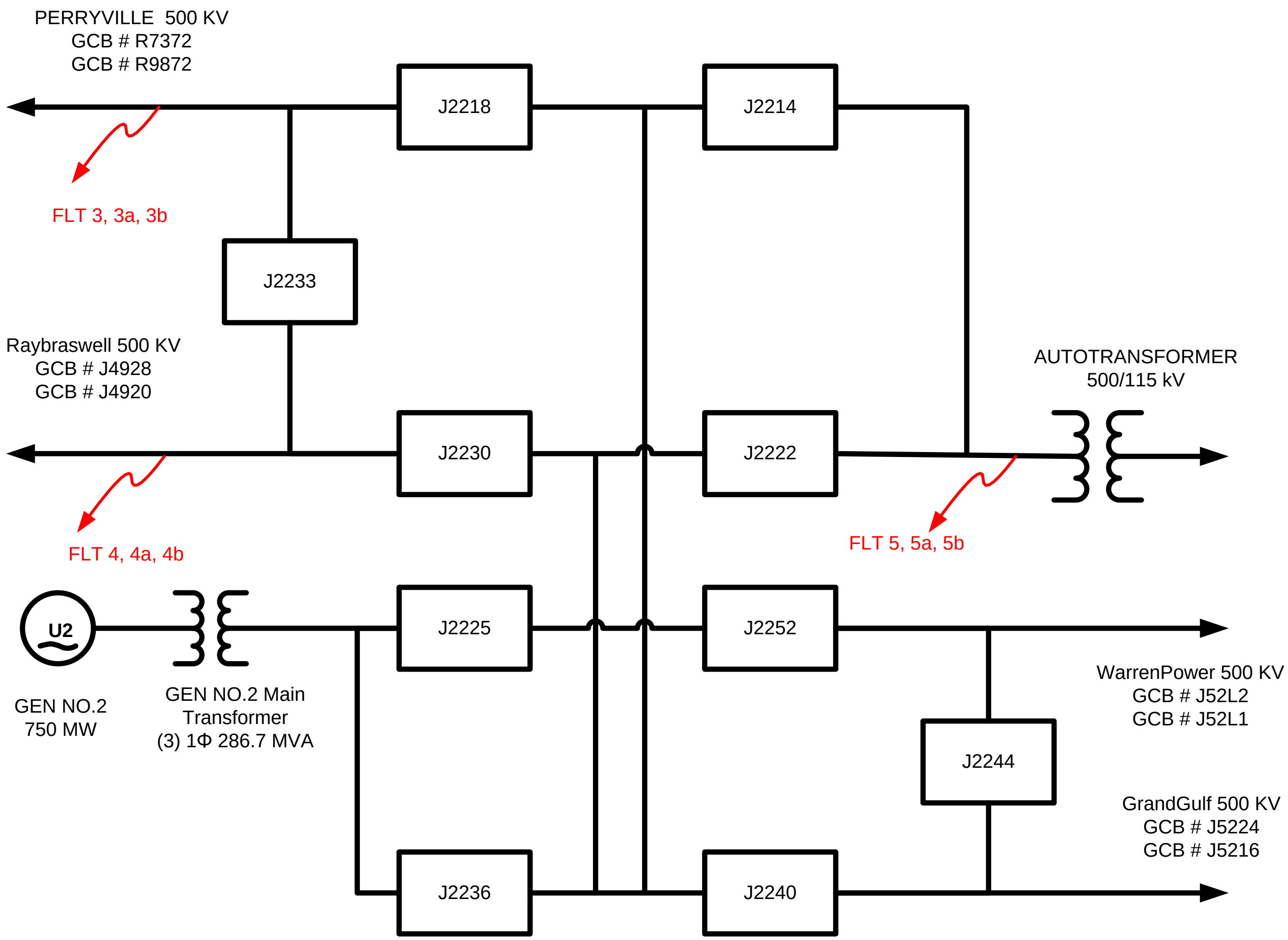
CASE	LOCATION	TYPE	CLEARING TIME (cycles)	BREAKER TRIP #	TRIPPED FACILITIES
FAULT-1	G. Gulf - B. Wilson 500 kV	3 PH	5	J5224, J5216, J2240, J2244	G. Gulf - B. Wilson 500 kV
FAULT-2	G. Gulf - Franklin 500 kV	3 PH	5	J2425, J2420, J5248, J5240	G. Gulf - Franklin 500 kV
FAULT-3	B. Wilson - Perryville 500 kV	3 PH	5	R7372,R9872, J2233, J2218	B. Wilson - Perryville 500 kV
FAULT-4	B. Wilson - Ray Braswell 500 kV	3 PH	5	J4928, J4920, J2230, J2233	B. Wilson - Ray Braswell 500 kV
FAULT-5	B. Wilson 500/115 kV transformer #1	3 PH	5	J2214, J2222,	B. Wilson 500/115 kV transformer #1
FAULT-6	Ray Braswell - Franklin 500 kV	3 PH	5	J2404, J2408, J4908, J4904	Ray Braswell - Franklin 500 kV
FAULT-7	Ray Braswell - Lakeover 500 kV	3 PH	5	J4928,J4908, J9218, J9234	Ray Braswell - Lakeover 500 kV
FAULT-8	Ray Braswell - B. Wilson 500 kV	3 PH	5	J4928, J4920, J2230, J2233	Ray Braswell - B. Wilson 500 kV
FAULT-9	Ray Braswell 500/ 115 kV Transformer #1	3 PH	5	J4904, J4917	Ray Braswell 500/ 115 kV Transformer #1
FAULT-10	Ray Braswell 500/ 230 kV Transformer #1	3 PH	5	J4917, J4920	Ray Braswell 500/ 230 kV Transformer #1
FAULT-11	Franklin - McKinight 500 kV	3 PH	5	BRK#21105, BRK#21110, J2416,2412	Franklin - McKinight 500 kV
FAULT-12	Franklin - Bogal USA - Adams Creek 500 kV	3 PH	5	S4402, S4405, J2416, J2420	Franklin - Bogal USA - Adams Creek 500 kV
FAULT-13	Franklin - Ray Braswell 500 kV	3 PH	5	J2404, J2408, J4908, J4904	Franklin - Ray Braswell 500 kV
FAULT-14	Franklin - G. Gulf 500 kv	3 PH	5	J2425, J2420, J5248, J5240	Franklin - G. Gulf 500 kv
FAULT-15	Franklin 500/115 kV transformer #1	3 PH	5	J2425, J2404	Franklin 500/115 kV transformer #1

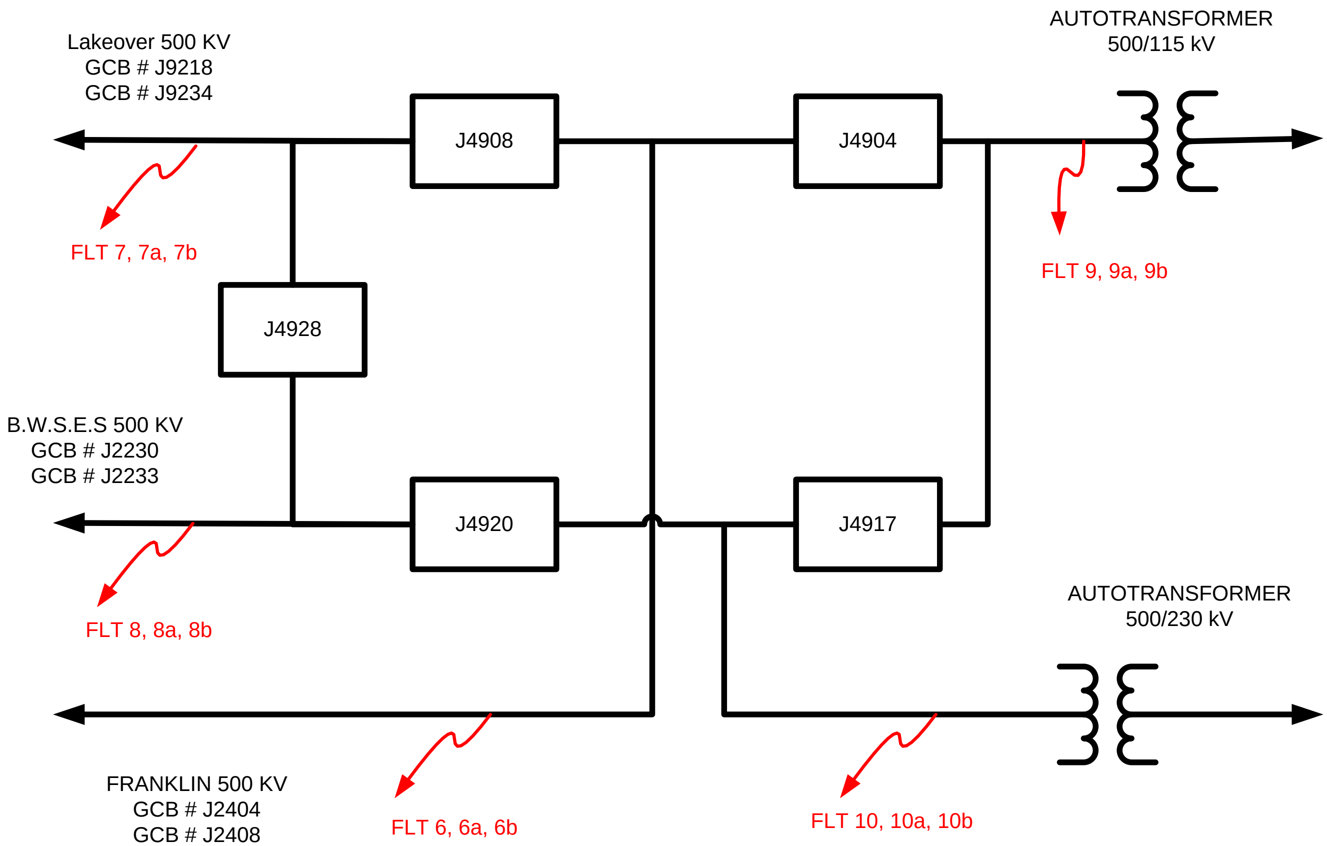
Table 0-4 List of 3 PhaseStuck Brekaer (IPO: 3PH-1PH) faults simulated for stability analysis

CASE	LOCATION	TYPE	CLEARING TIME (cycles)		SLG FAULT IMPEDANCE (MVA)	STUCK BREAKER #	PRIMARY BREAKER TRIP #	SECONDARY BREAKER TRIP	TRIPPED FACILITIES
			PRIMARY	Back-up					
FAULT-1a	G. Gulf - B. Wilson 500 kV	3 PH/SLG	5	9	640.02-j8505.34	J5224	J5216, J2240, J2244	J5208, J5236, J5248	G. Gulf - B. Wilson 500 kV
FAULT-2b	G. Gulf - Franklin 500 kV	3 PH/SLG	5	9	640.02-j8505.34	J5248	J2425, J2420, J5240	J5208, J5236, J5224	G. Gulf - Franklin 500 kV
FAULT-3a	B. Wilson - Perryville 500 kV	3 PH/SLG	5	9	779.96-j8641.41	J2233	R7372,R9872, J2218	J2230, J4928, J4920	B. Wilson - Perryville 500 kV; B. wilson Ray Braswell 500 kV
FAULT-3b	B. Wilson - Perryville 500 kV	3 PH/SLG	5	9	779.96-j8641.41	J2218	R7372,R9872, J2233	J2214, J2252, J2225	B. Wilson - Perryville 500 kV; B. Wilson 500/115 kV transformer#1
FAULT-4a	B. Wilson - Ray Braswell 500 kV	3 PH/SLG	5	9	779.96-j8641.41	J2233	J4928, J4920, J2230	R7372,R9872, J2218	B. Wilson - Ray Braswell 500 kV; B. Wilson - Perryville 500 kV
FAULT-4b	B. Wilson - Ray Braswell 500 kV	3 PH/SLG	5	9	779.96-j8641.41	J2230	J4928, J4920, J2233	J2240, J2236, J2222	B. Wilson - Ray Braswell 500 kV
FAULT-5a	B. Wilson 500/115 kV transformer #1	3 PH/SLG	5	9	779.96-j8641.41	J2214	J2222	J2218, J2252, J2225	B. Wilson 500/115 kV transformer #1
FAULT-6a	Ray Braswell - Franklin 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4908	J2404, J2408, J4904	J4928, J9218, J9234	Ray Braswell - Franklin 500 kV; Ray Braswell - Lakeover 500 kV
FAULT-6b	Ray Braswell - Franklin 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4904	J2404, J2408, J4908	J4917	Ray Braswell - Franklin 500 Kv; Ray Braswell 500/115 kV transformer #1
FAULT-7a	Ray Braswell - Lakeover 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4928	J4908, J9218, J9234	J2230, J2233, J4920	Ray Braswell - Lakeover 500 kV; Ray Braswell - B. Wilson 500 kV
FAULT-7b	Ray Braswell - Lakeover 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4908	J4928, J9218, J9234	J4904, J2404, J2408	Ray Braswell - Lakeover 500 kV, Ray Braswell - Franklin 500 kV
FAULT-8a	Ray Braswell - B. Wilson 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4928	J4920, J2230, J2233	J4908, J9218, J9234	Ray Braswell - B. Wilson 500 kV; Ray Braaswell - Lakeover 500 kV
FAULT-8b	Ray Braswell - B. Wilson 500 kV	3 PH/SLG	5	9	765.3-j6686.74	J4920	J4928, J2230, J2233	J4917	Ray Braswell - B. Wilson 500 kV; Ray Braswell 500/230 kV transformer #1
FAULT-9a	Ray Braswell 500/ 115 kV Transformer #1	3 PH/SLG	5	9	765.3-j6686.74	J4904	J4917	J2404, J2408, J4908	Ray Braswell 500/ 115 kV Transformer #1; Ray Braswell - Franklin 500 kV

CASE	LOCATION	TYPE	CLEARING TIME (cycles)		SLG FAULT IMPEDANCE (MVA)	STUCK BREAKER #	PRIMARY BREAKER TRIP #	SECONDARY BREAKER TRIP	TRIPPED FACILITIES
			PRIMARY	Back-up					
FAULT-9b	Ray Braswell 500/ 115 kV Transformer #1	3 PH/SLG	5	9	765.3-j6686.74	J4917	J4904	J4920	Ray Braswell 500/ 115 kV Transformer #1; Ray Braswell 500/230 kV transformer #1
FAULT-10a	Ray Braswell 500/ 230 kV Transformer #1	3 PH/SLG	5	9	765.3-j6686.74	J4920	J4917	J4928, J2230, J2233	Ray Braswell 500/ 230 kV Transformer #1; Ray Braswell - B. Wilson 500 kV
FAULT-10b	Ray Braswell 500/ 230 kV Transformer #1	3 PH/SLG	5	9	765.3-j6686.74	J4917	J4920	J4904	Ray Braswell 500/ 115 kV Transformer #1; Ray Braswell 500/230 kV transformer #1
FAULT-11a	Franklin - McKinight 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2416	BRK#21105, BRK#21110, J2412	J2420, S4402, S4405	Franklin - McKinight 500 kV; Franklin - Bogal USA - Adams Creek 500 kV
FAULT-11b	Franklin - McKinight 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2412	BRK#21105, BRK#21110, J2416	J2408	Franklin - McKinight 500 kV; Franklin 500/115 kV transformer #1
FAULT-12a	Franklin - Bogal USA - Adams Creek 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2416	S4402, S4405, J2420	BRK #21105, BRK#21110, J2412	Franklin - Bogal USA - Adams Creek 500 kV; Franklin - McKnight 500 kV
FAULT-12b	Franklin - Bogal USA - Adams Creek 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2420	S4402, S4405, J2416	J2420	Franklin - Bogal USA - Adams Creek 500 Kv; Franklin - G. Gulf 500 kV
FAULT-13a	Franklin - Ray Braswell 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2404	J2408, J4904, J4908	J2425	Franklin - Ray Braswell 500 Kv, Franklin 500/115 kV transformer #1
FAULT-13b	Franklin - Ray Braswell 500 kV	3 PH/SLG	5	9	823.73-j5887.89	J2408	J2404, J4908, J4904	J2412	Franklin - Ray Braswell 500 kV; Franklin 500/115 kV transformer #2
FAULT-14a	Franklin - G. Gulf 500 kv	3 PH/SLG	5	9	823.73-j5887.89	J2425	J2420, J5248, J5240	J2404	Franklin - G. Gulf 500 kV; Franklin 500/115 kV transformer #1
FAULT-14b	Franklin - G. Gulf 500 kv	3 PH/SLG	5	9	823.73-j5887.89	J2420	J5248, J5240, J2425	J2416, S4402, S4405	Franklin - G. Gulf 500 kV; Franklin - Bogal USA - Adams Creek 500 kV
FAULT-15a	Franklin 500/115 kV transformer #1	3 PH/SLG	5	9	823.73-j5887.89	J2404	J2425	J2408, J4904, J4908	Franklin 500/115 kV transformer #1; Franklin - Ray Braswell 500 kV
FAULT-15b	Franklin 500/115 kV transformer #1	3 PH/SLG	5	9	823.73-j5887.89	J2425	J2404	J2420, J5248, J5240	Franklin 500/115 kV transformer #1; Franklin - G. Gulf 500 kV


Baxter Wilson 500 KV
GCB # J2240
GCB # J2244
Franklin 500 KV
GCB # J2425
GCB # J2420
FLT 1, 1a
FLT 2, 2b
J5208
J5224
J5236
J5248
J5232
J5204
J5216
J5228
J5240
1365/1530 MVA
500/20.9 kV
U1
G.GULF UNIT
1525 MVA
22 kV
To XFMR ST-21
To XFMR ST-11


PERRYVILLE 500 KV
GCB # R7372
GCB # R9872
J2218
J2214
FLT 3, 3a, 3b
J2233
Raybraswell 500 KV
GCB # J4928
GCB # J4920
AUTOTRANSFORMER
500/115 kV
J2230
J2222
FLT 4, 4a, 4b
FLT 5, 5a, 5b
U2
J2225
J2252
GEN NO.2
750 MW
GEN NO.2 Main
Transformer
(3) 1Φ 286.7 MVA
WarrenPower 500 KV
GCB # J52L2
GCB # J52L1
J2244
GrandGulf 500 KV
GCB # J5224
GCB # J5216
J2236
J2240


Lakeover 500 KV
GCB # J9218
GCB # J9234
AUTOTRANSFORMER
500/115 kV
J4908
J4904
FLT 7, 7a, 7b
FLT 9, 9a, 9b
J4928
B.W.S.E.S 500 KV
GCB # J2230
GCB # J2233
J4920
J4917
FLT 8, 8a, 8b
AUTOTRANSFORMER
500/230 kV
FRANKLIN 500 KV
GCB # J2404
GCB # J2408
FLT 6, 6a, 6b
FLT 10, 10a, 10b

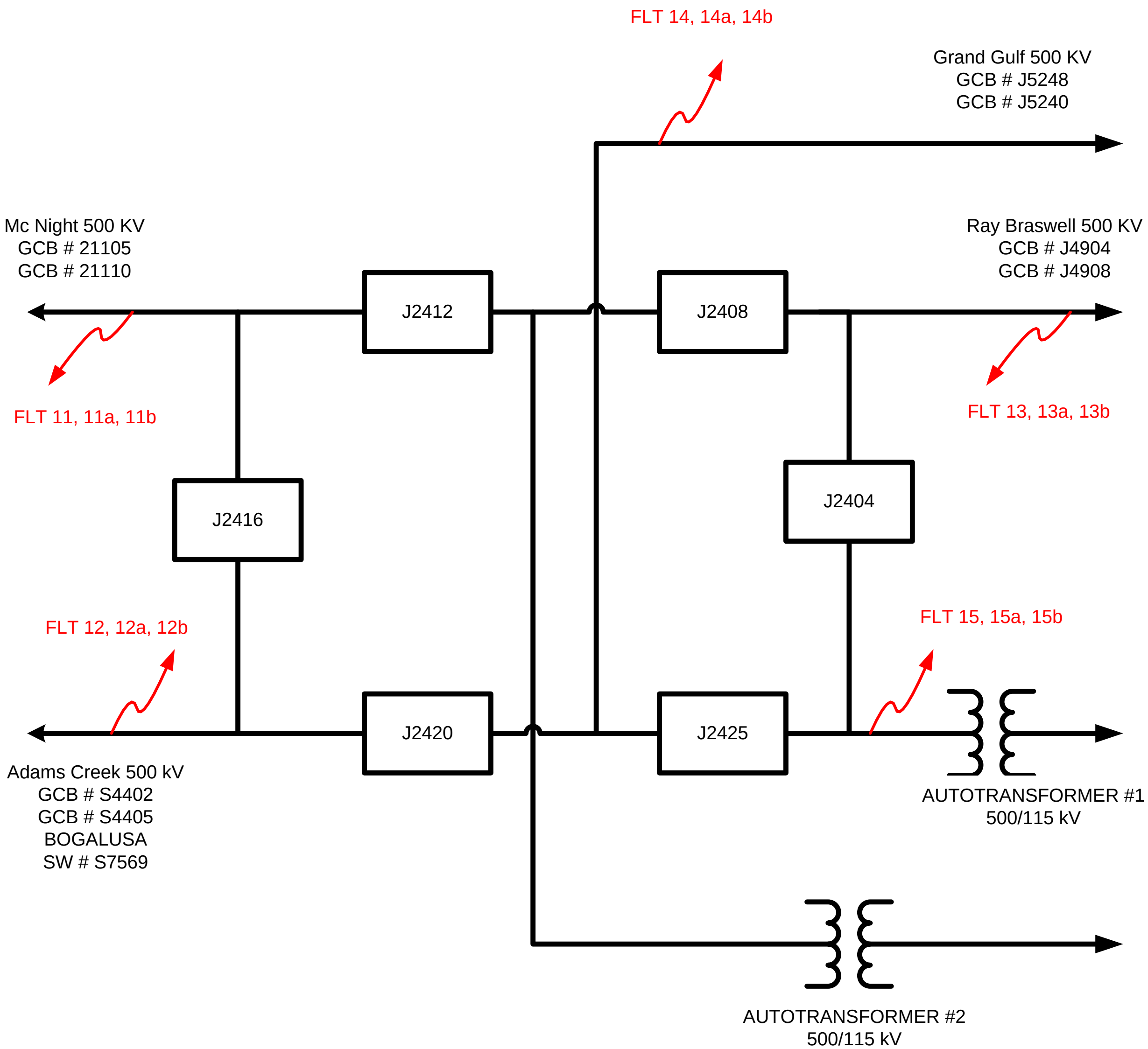

FLT 14, 14a, 14b
Grand Gulf 500 KV
GCB # J5248
GCB # J5240
Mc Night 500 KV
GCB # 21105
GCB # 21110
Ray Braswell 500 KV
GCB # J4904
GCB # J4908
J2412
J2408
FLT 11, 11a, 11b
FLT 13, 13a, 13b
J2416
J2404
FLT 12, 12a, 12b
FLT 15, 15a, 15b
J2420
J2425
Adams Creek 500 kV
GCB # S4402
GCB # S4405
BOGALUSA
SW # S7569
AUTOTRANSFORMER #1
500/115 kV
AUTOTRANSFORMER #2
500/115 kV

Table 0-5 Results of faults simulated for stability analysis

CASE	PRE-PID226		POST-PID226	
	Stable ?	Acceptable Voltages ?	Stable ?	Acceptable Voltages ?
FAULT-1	Not tested		YES	YES
FAULT-2	Not tested		YES	YES
FAULT-3	Not tested		YES	YES
FAULT-4	Not tested		YES	YES
FAULT-5	Not tested		YES	YES
FAULT-6	Not tested		YES	YES
FAULT-7	Not tested		YES	YES
FAULT-8	Not tested		YES	YES
FAULT-9	Not tested		YES	YES
FAULT-10	Not tested		YES	YES
FAULT-11	Not tested		YES	YES
FAULT-12	Not tested		YES	YES
FAULT-13	Not tested		YES	YES
FAULT-14	Not tested		YES	YES
FAULT-15	Not tested		YES	YES
FAULT-1a	Not tested		YES	YES
FAULT-2b	Not tested		YES	YES
FAULT-3a	Not tested		YES	YES
FAULT-3b	Not tested		YES	YES
FAULT-4a	Not tested		YES	YES
FAULT-4b	Not tested		YES	YES
FAULT-5a	Not tested		YES	YES
FAULT-6a	Not tested		YES	YES
FAULT-6b	Not tested		YES	YES
FAULT-7a	Not tested		YES	YES
FAULT-7b	Not tested		YES	YES
FAULT-8a	Not tested		YES	YES
FAULT-8b	Not tested		YES	YES
FAULT-9a	Not tested		YES	YES
FAULT-9b	Not tested		YES	YES
FAULT-10a	Not tested		YES	YES
FAULT-10b	Not tested		YES	YES
FAULT-11a	Not tested		YES	YES
FAULT-11b	Not tested		YES	YES
FAULT-12a	Not tested		YES	YES
FAULT-12b	Not tested		YES	YES
FAULT-13a	Not tested		YES	YES
FAULT-13b	Not tested		YES	YES
FAULT-14a	Not tested		YES	YES
FAULT-14b	Not tested		YES	YES
FAULT-15a	Not tested		YES	YES
FAULT-15b	Not tested		YES	YES

The system was found to be STABLE following all the simulated faults.

Transient Voltage Recovery

The voltages at all buses in the Entergy system (69 kV and above) were monitored during each of the fault cases as appropriate. No Voltage criteria violation was observed following a normally cleared three-phase fault.

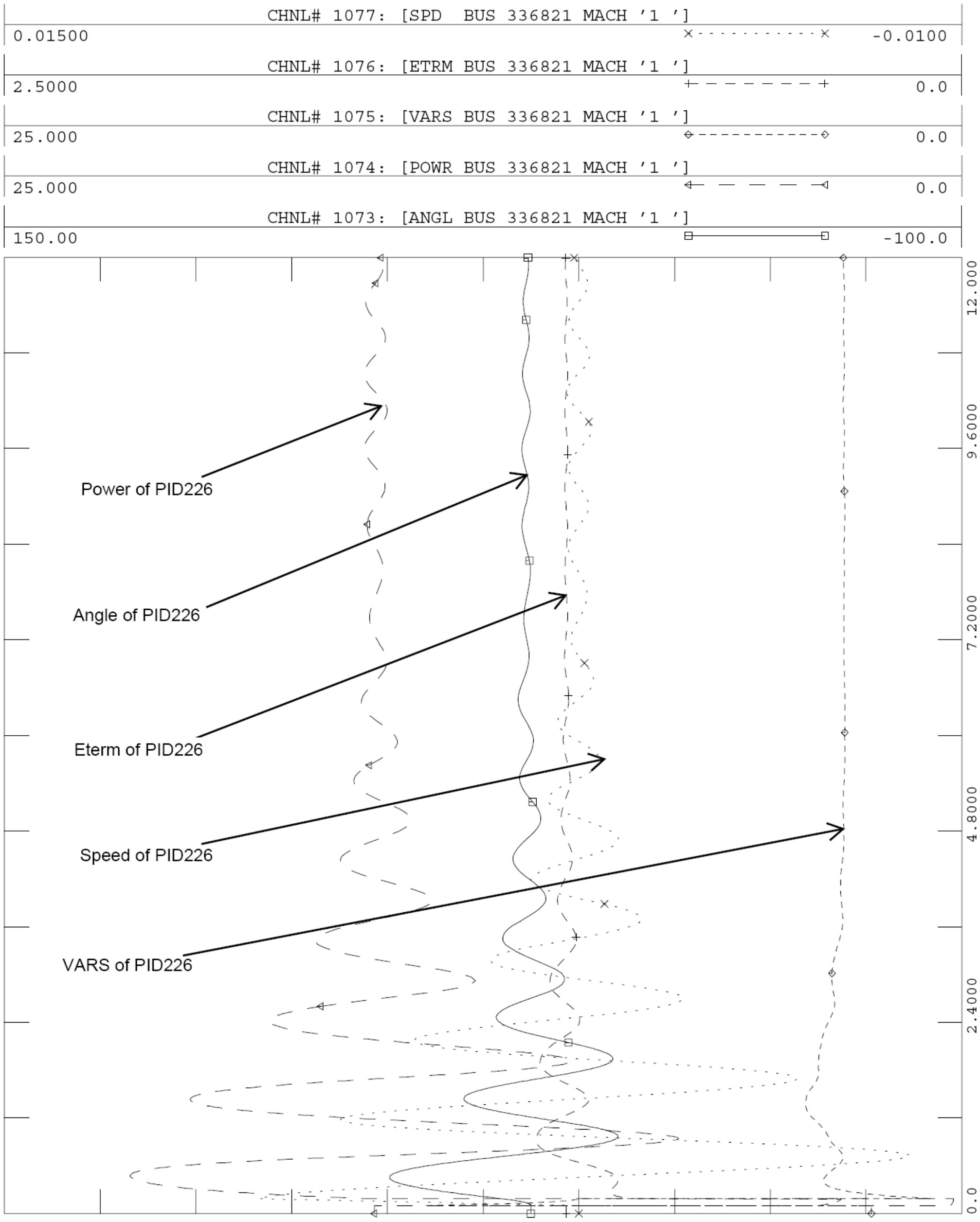
As there are no specific voltage dip criteria for three-phase fault converted into single-phase stuck breaker faults, the results of these faults were compared with the most stringent voltage dip criteria - not to exceed 20 % for more than 20 cycles. After comparison against the voltage-criteria, no voltage criteria violation was observed with the proposed uprate of G. Gulf unit (PID-226) case.

POST-PID226 CASE

FILE: FLT_1_3PH.OUT

PID-226 PARAMETERS

TUE, MAR 24 2009 14:13

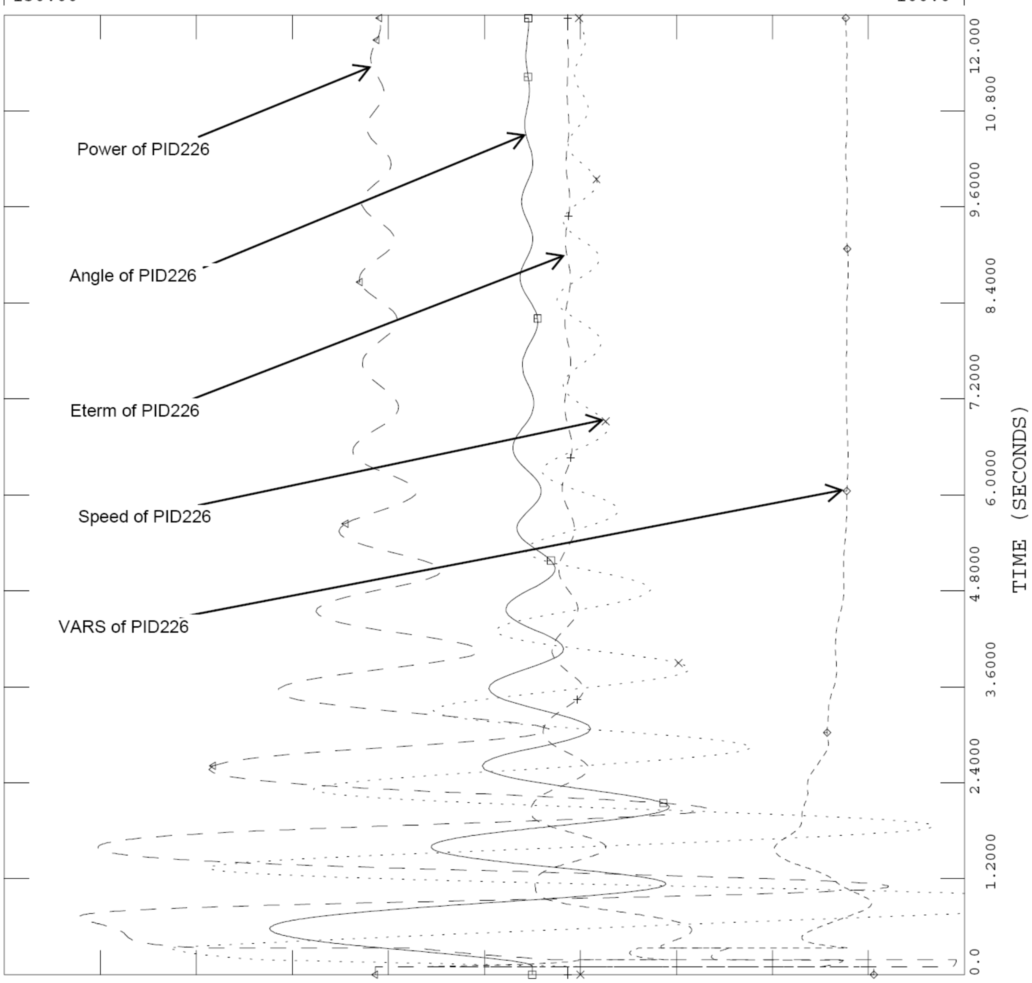


SIEMENS POWER TECHNOLOGIES INTERNATIONAL

POST-PID226 CASE

FILE: FLT_1a.OUT

	CHNL# 1077: [SPD BUS 336821 MACH '1 ']	
0.01500	×·········×	-0.0100
	CHNL# 1076: [ETRM BUS 336821 MACH '1 ']	
2.5000	+ – – – – – – +	0.0
	CHNL# 1075: [VARS BUS 336821 MACH '1 ']	
25.000	◇-----------◇	0.0
	CHNL# 1074: [POWR BUS 336821 MACH '1 ']	
25.000	◁— — — — —◁	0.0
	CHNL# 1073: [ANGL BUS 336821 MACH '1 ']	
150.00	□———————□	-100.0



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PID-226 PARAMETERS

ERIS Section A - CONCLUSIONS

The objective of this study was to evaluate the impact of proposed PID-226 (206 MW) uprate of existing Grand Gulf Unit #1 on system stability and the nearby transmission system and generating stations. The study was performed on 2012 Summer Peak case, provided by SPP/Entergy.

At the time of this study the accurate data for the changes in exciter and governor, if any, after the uprate of existing Grand Gulf Unit #1 was not available. Hence, the existing data for the Grand Gulf Unit #1 was used for this stability analysis. But when the more accurate data for changes, if any, after the uprate becomes available the stability analysis must be repeated to evaluate the impact of the proposed uprate on the Entergy system.

The system was stable following all simulated normally cleared and stuck-breaker faults. No voltage criteria violation was observed following simulated faults.

Based on the results of stability analysis it can be concluded that proposed 206 MW uprate of the Grand Gulf Unit #1 does not adversely impact the stability of the Entergy System in the local 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.

Section – B

Network Resource Interconnection Service

TABLE OF CONTENTS FOR NRIS – Section B

Introduction:

A Network Resource Interconnection Services (NRIS) study was requested by Generation Interconnection Customer PID 226 to serve 206 MW of Entergy network load. The expected in service date for this NRIS generator uprate is June 1, 2012. The tests were performed with only confirmed transmission reservations and existing network generators and with transmission service requests in study mode.

Two tests were performed, a deliverability to generation test and a deliverability to load test. The deliverability to generation (DFAX) test ensures that the addition of this generator will not impair the deliverability of existing network resources and units already designated as NRIS while serving network load. The deliverability to load test determines if the tested generator will reduce the import capability level to certain load pockets (Amite South, WOTAB and Western Region) on the Entergy system. A more detailed description for these two tests is described in Appendix B-A and Appendix B-B.

Also, it is understood that the NRIS status provides the Interconnection Customer with the capability to deliver the output of the Generating Facility into the Transmission System. NRIS in and of itself does not convey any right to deliver electricity to any specific customer or Point of Delivery

Analysis:

A. Models

The models used for this analysis is the 2012 and 2014 summer peak cases developed in 2008.

The following modifications were made to the base cases to reflect the latest information available:

- Non-Firm IPPs within the local region of the study generator were turned off and other non-firm IPPs outside the local area were increased to make up the difference.
- Confirmed firm transmission reservations were modeled for the years 2012 and 2014.
- Approved transmission reliability upgrades for 2012 were included in the base case.

Year	Approved Future Projects
2008 – 2010	2007CP_2009_Approved_ELL-S_Amite_South_Area_Improvements_PhaseII.idv
	2007CP_2009_Approved_ELL-S_EGSI-LA_Amite_South_Area_Improvements_PhaseIII.idv
	2008CP_EAI 2008 Maumelle Approved.idv
	2008CP_EAI 2010 SMEPA Approved.idv
	2011_Approved_ETI_Western_Region_Reliability_Improvement_Phase3_Interim

Year	Proposed Projects for prior generator interconnection requests
2012	Webre – Richard 500kV transmission line (56 miles triple bundled 954)
	Lewis Creek – Conroe 230kV transmission line
	BP08-038 - Loblolly-Hammond Build 230kv Line_R2Corrected.idv Upgraded to 954 DB
	Upgrade Fairview – Gypsy 230kV to 700MVA 34.33 miles Upgrade Madisonville – Mandeville 230kV (CLECO)10 miles Upgrade Front Street – Michoud to 800MVA Upgrade Front Street – Slidell to 800MVA Build Slidell – Michoud 230kV to 600MVA 30 miles Build Nine Mile – Michoud 230kV to 600MVA 22 miles Upgrade LaBarre – South Port 230kV to 700MVA 2.1 miles Add 3rd South Port – Nine Mile river crossing

Prior Generation Interconnection NRIS requests that were included in this study:

PID	Substation	MW	In Service Date
PID 211	Lewis Creek	570	6/1/2011
PID 216	Wilton 230kV	251	1/1/2010
PID 221	Wolfcreek	875	In Service
PID 222	Nine Mile	570	10/1/2012
PID 223	PID-223 Tap	125	10/1/2010
PID 224	PID-224 Tap	100	12/1/2009
PID 225	Big Cajun2 Unit 3	13	2/3/2009

Prior transmission service requests that were included in this study:

OASIS #	PSE	MW	Begin	End
1460900	Louisiana Energy & Power Authority	116	1/1/2009	1/1/2030
1481059	Constellation Energy Group	60	2/1/2011	2/1/2030
1481111	City of Conway	50	2/1/2011	2/1/2046
1481119	Constellation Energy Group	30	2/1/2011	2/1/2030
1481235	Louisiana Energy & Power Authority	50	2/1/2011	2/1/2016
1483241	NRG Power Marketing	103	1/1/2010	1/1/2020
1483243	NRG Power Marketing	206	1/1/2010	1/1/2020
1483244	NRG Power Marketing	309	1/1/2010	1/1/2020
1520043	Municipal Energy Agency of Miss	20	1/1/2011	1/1/2026
TVA 1	TVA	724	1/1/2009	1/1/2013
1585221	Constellation Energy Group	25	10/1/2009	10/1/2010
1604053	Westar Energy Gen & Mktg	27	6/1/2010	6/1/2040
1604055	Westar Energy Gen & Mktg	15	6/1/2010	6/1/2015
1604465	Union Power Partners, LP	535	6/1/2012	6/1/2027
1608099	NRG Power Marketing	45	9/1/2009	9/1/2016
1609078	City of Conway	10	9/1/2010	9/1/2020
1609079	City of Conway	15	9/1/2010	9/1/2020
1614443	NRG Power Marketing	100	1/1/2011	1/1/2017
1615068	NRG Power Marketing	52	1/1/2010	1/1/2011
1615069	NRG Power Marketing	52	1/1/2011	1/1/2016
1617595	Aquila	75	1/1/2009	1/1/2010
1617596	Aquila	75	1/1/2009	1/1/2010
1617597	Aquila	75	1/1/2009	1/1/2010
1617598	Aquila	75	1/1/2009	1/1/2010
1617600	Aquila	75	1/1/2010	1/1/2011
1617602	Aquila	75	1/1/2010	1/1/2011
1617604	Aquila	75	1/1/2010	1/1/2011
1617605	Aquila	75	1/1/2010	1/1/2011
1619635	NRG Power Marketing	100	1/1/2011	1/1/2017
1619638	NRG Power Marketing	100	1/1/2010	1/1/2017
1619639	NRG Power Marketing	100	1/1/2010	1/1/2017
1619640	NRG Power Marketing	100	1/1/2011	1/1/2017
1619734	CLECO Power LLC	40	5/1/2009	5/1/2018
1620327	NRG Power Marketing	15	1/1/2011	1/1/2021
1622570	NRG Power Marketing	103	1/1/2011	1/1/2016
1622576	NRG Power Marketing	103	1/1/2011	1/1/2016
1622577	NRG Power Marketing	103	1/1/2011	1/1/2016
1623762	AMEREN Union Electric	52	1/1/2012	1/1/2013
1623764	AMEREN Union Electric	52	1/1/2014	1/1/2015

Contingencies and Monitored Elements

Single contingency analyses on Entergy's transmission facilities (including tie lines) 115kV and above were considered. All transmission facilities on Entergy transmission system above 100 kV were monitored.

Generation used for the transfer

The Grand Gulf generator was used as the source for the deliverability to generation test.

Results

Deliverability to Generation (DFAX) Test:

The deliverability to generation (DFAX) test ensures that the addition of this generator will not impair the deliverability of existing network resources and units already designated as NRIS while serving network load. A more detailed description for these two tests is described in Appendix B-A and Appendix B-B.

Constraints:

2012 Study Case	2012 Study Case with Priors
Baxter Wilson - Ray Braswell 500kV	Addis - Big Cajun 1 230kV
	Baxter Wilson - Ray Braswell 500kV
	McAdams 500/230kV transformer 1

2014 Study Case	2014 Study Case with Priors
Baxter Wilson - Ray Braswell 500kV	Addis - Big Cajun 1 230kV
McAdams 500/230kV transformer 1	Baxter Wilson - Ray Braswell 500kV
	McAdams 500/230kV transformer 1

DFAX Study Case Results:

2012:

Limiting Element	Contingency Element	ATC(MW)
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0

2014:

Limiting Element	Contingency Element	ATC(MW)
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
McAdams 500/230kV transformer 1	Choctaw - West Point 500kV (TVA)	50

DFAX Study Case with Priors Results:

2012:

Limiting Element	**Contingency Element**	**ATC(MW)**
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
McAdams 500/230kV transformer 1	Choctaw - West Point 500kV (TVA)	0
Jaguar - Tap Point Esso 230kV	Addis - Big Cajun 1 230kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0

2014:

Limiting Element	**Contingency Element**	**ATC(MW)**
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
McAdams 500/230kV transformer 1	Choctaw - West Point 500kV (TVA)	0
Jaguar - Tap Point Esso 230kV	Addis - Big Cajun 1 230kV	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0

Deliverability to Load Test:

The deliverability to load test determines if the tested generator will reduce the import capability level to certain load pockets (Amite South, WOTAB and Western Region) on the Entergy system. A more detailed description for these two tests is described in Appendix B-A and Appendix B-B.

Amite South: Passed

WOTAB: Passed

Western Region: Passed

Required Upgrades for NRIS

Preliminary Estimates of Direct Assignment of Facilities and Network Upgrades

Base Case

Limiting Element	Planning Estimate for Upgrade
Baxter Wilson - Ray Braswell 500kV	Upgrade terminal equipment at Baxter Wilson and Ray Braswell 500kV substations: *$7,160,000
McAdams 500/230kV transformer 1	TBD

Note 1: identified as long term reliability project

With Prior transmission service requests and GI:

Limiting Element	Planning Estimate for Upgrade
Addis - Big Cajun 1 230kV	Covered in Base Plan
Baxter Wilson - Ray Braswell 500kV	Upgrade terminal equipment at Baxter Wilson and Ray Braswell 500kV substations: *$7,160,000
McAdams 500/230kV transformer 1	TBD

The costs of the upgrades are planning estimates only. Detailed cost estimates, accelerated costs and solutions for the limiting elements will be provided in the facilities study. *Terminal equipment upgrade may be covered under confirmed Transmission Service Request.

APPENDIX A - DELIVERABILITY TEST FOR NETWORK RESOURCE INTERCONNECTION SERVICE RESOURCES

1. Overview

Entergy will develop a two-part deliverability test for customers (Interconnection Customers or Network Customers) seeking to qualify a Generator as an NRIS resource: (1) a test of deliverability "from generation", that is out of the Generator to the aggregate load connected to the Entergy Transmission system; and (2) a test of deliverability "to load" associated with sub-zones. This test will identify upgrades that are required to make the resource deliverable and to maintain that deliverability for a five year period.

1.1 The "From Generation" Test for Deliverability

In order for a Generator to be considered deliverable, it must be able to run at its maximum rated output without impairing the capability of the aggregate of previously qualified generating resources (whether qualified at the NRIS or NITS level) in the local area to support load on the system, taking into account potentially constrained transmission elements common to the Generator under test and other adjacent qualified resources. For purposes of this test, the resources displaced in order to determine if the Generator under test can run at maximum rated output should be resources located outside of the local area and having insignificant impact on the results. Existing Long-term Firm PTP Service commitments will also be maintained in this study procedure.

1.2 The "To Load" Test for Deliverability

The Generator under test running at its rated output cannot introduce flows on the system that would adversely affect the ability of the transmission system to serve load reliably in import-constrained sub-zones. Existing Long-term Firm PTP Service commitments will also be maintained in this study procedure.

1.3 Required Upgrades.

Entergy will determine what upgrades, if any, will be required for an NRIS applicant to meet deliverability requirements pursuant to Appendix B-B.

APPENDIX B - NRIS DELIVERABILITY TEST

Description of Deliverability Test

Each NRIS resource will be tested for deliverability at peak load conditions, and in such a manner that the resources it displaces in the test are ones that could continue to contribute to the resource adequacy of the control area in addition to the studied resources. The study will also determine if a unit applying for NRIS service impairs the reliability of load on the system by reducing the capability of the transmission system to deliver energy to load located in import-constrained sub-zones on the grid. Through the study, any transmission upgrades necessary for the unit to meet these tests will be identified.

Deliverability Test Procedure:

The deliverability test for qualifying a generating unit as a NRIS resource is intended to ensure that 1) the generating resource being studied contributes to the reliability of the system as a whole by being able to, in conjunction with all other Network Resources on the system, deliver energy to the aggregate load on the transmission system, and 2) collectively all load on the system can still be reliably served with the inclusion of the generating resource being studied.

The tests are conducted for "peak" conditions (both a summer peak and a winter peak) for each year of the 5-year planning horizon commencing in the first year the new unit is scheduled to commence operations.

1) Deliverability of Generation

The intent of this test is to determine the deliverability of a NRIS resource to the aggregate load on the system. It is assumed in this test that all units previously qualified as NRIS and NITS resources are deliverable. In evaluating the incremental deliverability of a new resource, a test case is established. In the test case, all existing NRIS and NITS resources are dispatched at an expected level of generation (as modified by the DFAX list units as discussed below). Peak load withdrawals are also modeled as well as net imports and exports. The output from generating resources is then adjusted so as to "balance" overall load and generation. This sets the baseline for the test case in terms of total system injections and withdrawals.

Incremental to this test case, injections from the proposed new generation facility are then included, with reductions in other generation located outside of the local area made to maintain system balance.

Generator deliverability is then tested for each transmission facility. There are two steps to identify the transmission facilities to be studied and the pattern of generation on the system:

1) Identify the transmission facilities for which the generator being studied has a 3% or greater distribution factor.

2) For each such transmission facility, list all existing qualified NRIS and NITS resources having a 3% or greater distribution factor on that facility. This list of units is called the Distribution Factor or DFAX list.

For each transmission facility, the units on the DFAX list with the greatest impact are modeled as operating at 100% of their rated output in the DC load flow until, working down the DFAX list, a 20% probability of all units being available at full output is reached (e.g. for 15 generators with a Forced Outage Rate of 10%, the probability of all 15 being available at 100% of their rated output is 20.6%). Other NRIS and NITS resources on the system are modeled at a level sufficient to serve load and net interchange.

From this new baseline, if the addition of the generator being considered (coupled with the matching generation reduction on the system) results in overloads on a particular transmission facility being examined, then it is not "deliverable" under the test.

2) Deliverability to Load

The Entergy transmission system is divided into a number of import constrained sub-zones for which the import capability and reliability criteria will be examined for the purposes of testing a new NRIS resource. These sub-zones can be characterized as being areas on the Entergy transmission system for which transmission limitations restrict the import of energy necessary to supply load located in the sub-zone.

The transmission limitations will be defined by contingencies and transmission constraints on the system that are known to limit operations in each area, and the sub-zones will be defined by the generation and load busses that are impacted by the contingent transmission lines. These sub-zones may change over time as the topology of the transmission system changes or load grows in particular areas.

An acceptable level of import capability for each sub-zone will have been determined by Entergy Transmission based on their experience and modeling of joint transmission and generating unit contingencies. Typically the acceptable level of transmission import capacity into the sub-zones will be that which is limited by first-contingency conditions on the transmission system when generating units within the sub-region are experiencing an abnormal level of outages and peak loads.

The "deliverability to load" test compares the available import capability to each sub-zone that is required for the maintaining of reliable service to load within the sub-zone both with and without the new NRIS resource operating at 100% of its rated output. If the new NRIS resource does not reduce the sub-zone import capability so as to reduce the reliability of load within the sub-zone to an unacceptable level, then the deliverability to load test for the unit is satisfied. This test is conducted for a 5-year planning cycle. When the new NRIS resource fails the test, then transmission upgrades will be identified that would allow the NRIS unit to operate without degrading the sub-zone reliability to below an acceptable level.

Other Modeling Assumptions:

1) Modeling of Other Resources

Generating units outside the control of Entergy (including the network resources of others, and generating units in adjacent control areas) shall be modeled assuming "worst case" operation of the units – that is, a pattern of dispatch that reduces the sub-zone import capability, or impact the common limiting flowgates on the system to the greatest extent for the "from generation" deliverability test.

2) Must-run Units

Must-run units in the control area will be modeled as committed and operating at a level consistent with the must-run operating guidelines for the unit.

3) Base-line Transmission Model

The base-line transmission system will include all transmission upgrades approved and committed to by Entergy Transmission over the 5-year planning horizon. Transmission line ratings will be net of TRM and current CBM assumptions will be maintained.

APPENDIX C - DATA PROVIDED BY CUSTOMER

Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

UNIT RATINGS

kVA __1525000______ °F __95____ Voltage __22000____
Power Factor _0.9 lag____
Speed (RPM) _1800______ Connection (e.g. Wye) __Wye______
Short Circuit Ratio __0.78__ Frequency, Hertz __60_______
Stator Amperes at Rated kVA __40020____ Field Volts ______________
Max Turbine MW __1310_______ °F _95___

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = _____0.92____________ kW sec/kVA
Moment-of-Inertia, WR^2 = _____1874828_______ lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	1.2315	X_{qv}	1.1989
Synchronous – unsaturated	X_{di}	1.4463	X_{qi}	1.4081
Transient – saturated	X'_{dv}	0.3392	X'_{qv}	0.5068
Transient – unsaturated	X'_{di}	0.3855	X'_{qi}	0.5759
Subtransient – saturated	X''_{dv}	0.2605	X''_{qv}	0.2600
Subtransient – unsaturated	X''_{di}	0.3023	X''_{qi}	0.3017
Negative Sequence – saturated	$X2_v$	0.2603		
Negative Sequence – unsaturated	$X2_i$	0.3020		
Zero Sequence – saturated	$X0_v$	0.1641		
Zero Sequence – unsaturated	$X0_i$	0.1727		
Leakage Reactance	Xl_m	0.2344		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	7.714	T'_{qo}	0.860
Three-Phase Short Circuit Transient	T'_{d3}	1.1816	T'_{q}	0.310
Line to Line Short Circuit Transient	T'_{d2}	2.719		
Line to Neutral Short Circuit Transient	T'_{d1}	3.160		
Short Circuit Subtransient	T''_{d}	0.035	T''_{q}	0.05
Open Circuit Subtransient	T''_{do}	0.046	T''_{qo}	0.068

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.375
Line to Line Short Circuit	T_{a2}	0.375
Line to Neutral Short Circuit	T_{a1}	0.329

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	0.00322
Negative	R_2	0.04551
Zero	R_0	0.00253

Rotor Short Time Thermal Capacity I_2^2t = 5.47

Field Current at Rated kVA, Armature Voltage and PF = 8300 amps

Field Current at Rated kVA and Armature Voltage, 0 PF = 11400 amps

Three Phase Armature Winding Capacitance = 1.464 microfarad

Field Winding Resistance = 0.04923 ohms 75 °C

Armature Winding Resistance (Per Phase) = 0.000584 ohms 75 °C

CURVES

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

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Capacity Self-cooled/Maximum Nameplate
__1365_________/___1530_____________kVA

Voltage Ratio(Generator Side/System side/Tertiary)
__20.9__________/____500 ________/___none________kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
__Delta_________/_____Wye___ ____/____none_______

Fixed Taps Available
__+7.5% / +5% / +2.5% / 0 / -2.5%___________________

Present Tap Setting
__Nominal____

IMPEDANCE

Positive Z_1 (on self-cooled kVA rating)___0.0029____________ %
X/R

Zero Z_0 (on self-cooled kVA rating)____13.4_________ % __46.41
X/R

DC-199 Site Specific Planning Model Inputs

Other Data

ANSI Rotor Short-Time Thermal Capacity (Unbalanced Faults)	$I_2^2 t \leq 5.47$ (p.u.)^2 * sec
Three Phase Armature Winding Capacitance (microfarads)	1.464 μF
Armature Winding DC Resistance per phase (specify temperature)	0.000584 Ohms at 75°C
Field Winding DC Resistance (specify temperature)	0.04923 Ohms at 75°C
Field Current at Rated MVA, Armature Voltage and PF	8300 Amps
Field Current at Rated MVA, Armature Voltage and 0 PF	11400 Amps

CURVES.

Generator curves, please, see below:

- Saturation curve – Fig.1.1.
- Vee curves – Fig. 1.2.
- Reactive Capability curve – Fig. 1.3.
- Description for coolant temperature correction versus generator load during operation, please, see in the Generator Instruction Book section 2.1-7710/1 "Coolant Temperature Control Requirements".

EXCITATION SYSTEM DATA

The model for computer representation of excitation system, please, see in Fig.2.1.

GOVERNOR SYSTEM DATA

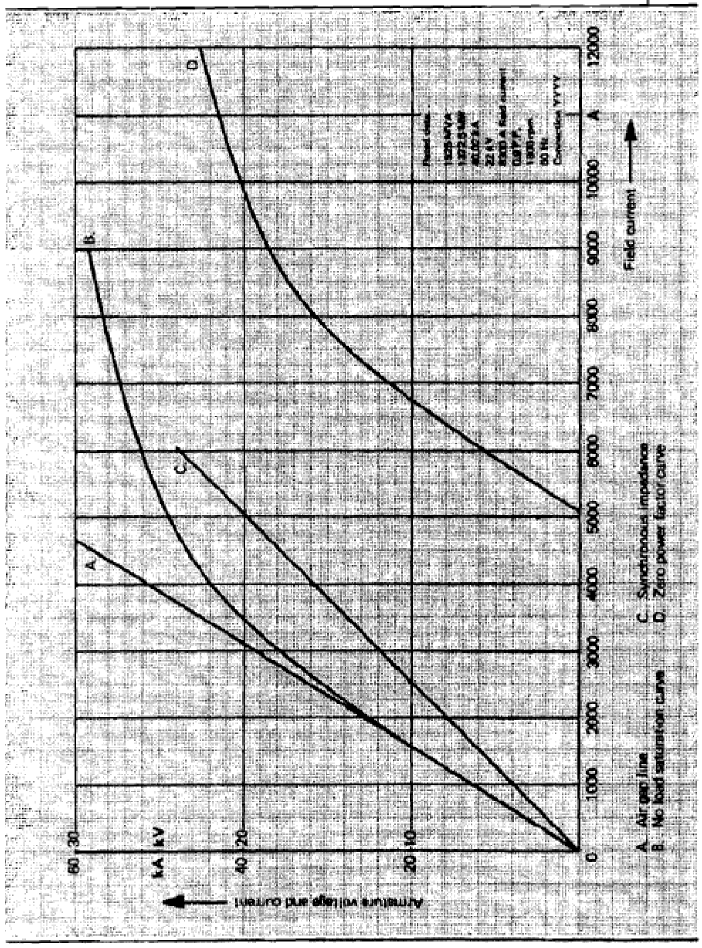
The model block diagram of governor system for computer representation in power system, please, see in Fig.3.1.

Two Winding Generator Step-Up Transformer Data

Transformer Base for Impedance	1365 MVA (455 MVA x 3)
Positive Sequence Impedance (resistance and Reactance) (R + jX)	0.0029 + j0.1346 p.u.
Zero Sequence Impedance (resistance and Reactance) ($R_0 + jX_0$)	0.0029 + j0.1346 p.u.
Full Load Rating (i.e. OA/FA/FOA)	1530 MVA (65°C FOA)
Available Tap Positions	+7.5% +5%/+2.5%/0/-2.5% (500kV)
Position of Tap in the field	288.675 kV (500 kV Y) (Nominal)
High Side Rated Voltage (kV)	288.675 kV (500 kV Y)
High Side Connection (Y / Delta)	Wye
High Side Grounding type and resistance value (if applicable)	Solid
Low Side Rated Voltage (kV)	20.9
Low Side Connection (Y / Delta)	Delta
Low Side Grounding type and resistance value (if applicable)	Not Applicable
BIL Rating	1425
Connection & winding (attach diagram) and reference diagram number	E-1045

Turbine Generators
Description

Generator Characteristic Curves



Kraftwerk Union

2.1–0400 / 1

Fig.1.1.

Turbine Generators
Description

Generator "V" Curves

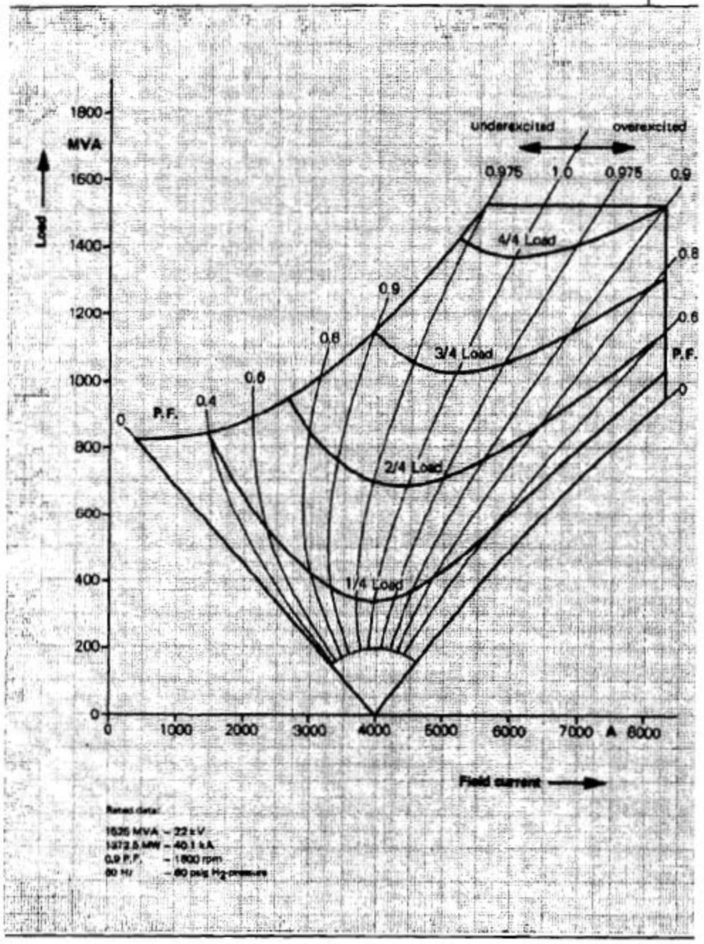


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Fig.1.2.

Turbine Generators Description

Reactive Capability Curve

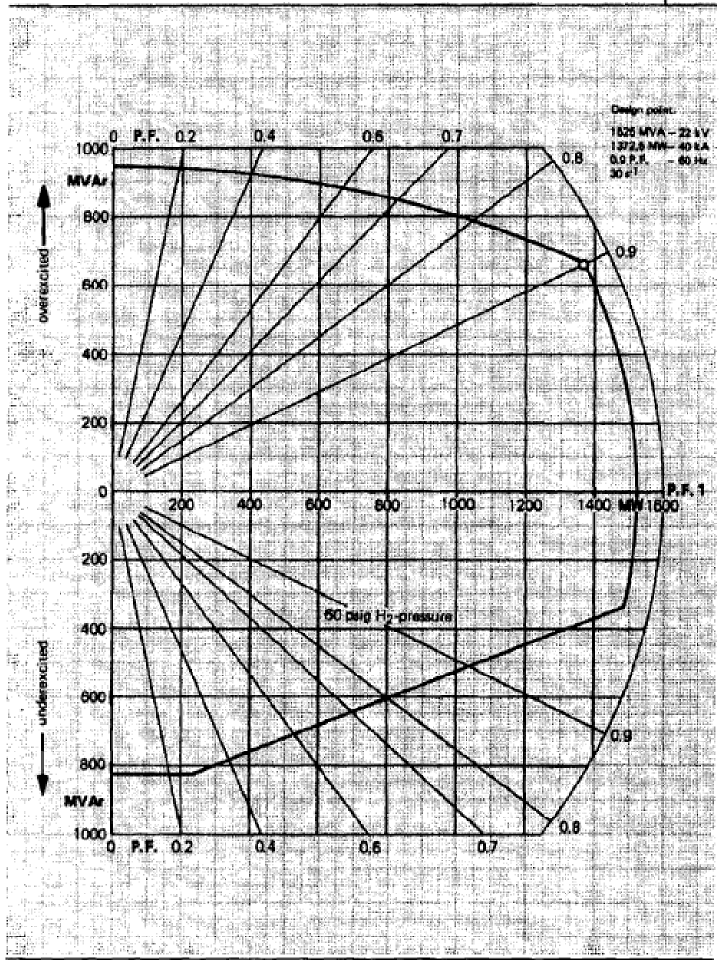

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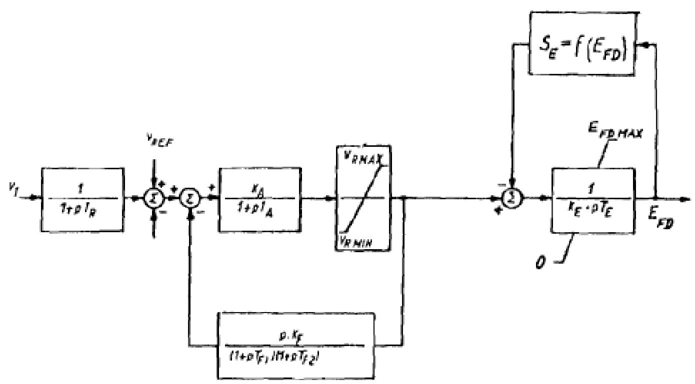
Fig.1.3.

GRAND C...
1525 MVA

SIEMENS

Excitation System
Thyrisiem
Computer Representation 1)



T_R = 0.20 s
T_A = 0.10 s
T_{F1} = 1.0 s
T_{F2} = 0.13 s
T_E = 0.22 s

K_A = 600
K_F = 0.02
K_E = 1.0

E_{FDMAX} = 3.7
S_{EMAX} = } 0.73
$S_{E0.75MAX}$ = } 0.73

V_{RMAX} = 6.4
V_{RMIN} = −6.4

1) According to IEEE

E111/Ro
17-03-82

Fig.2.1.

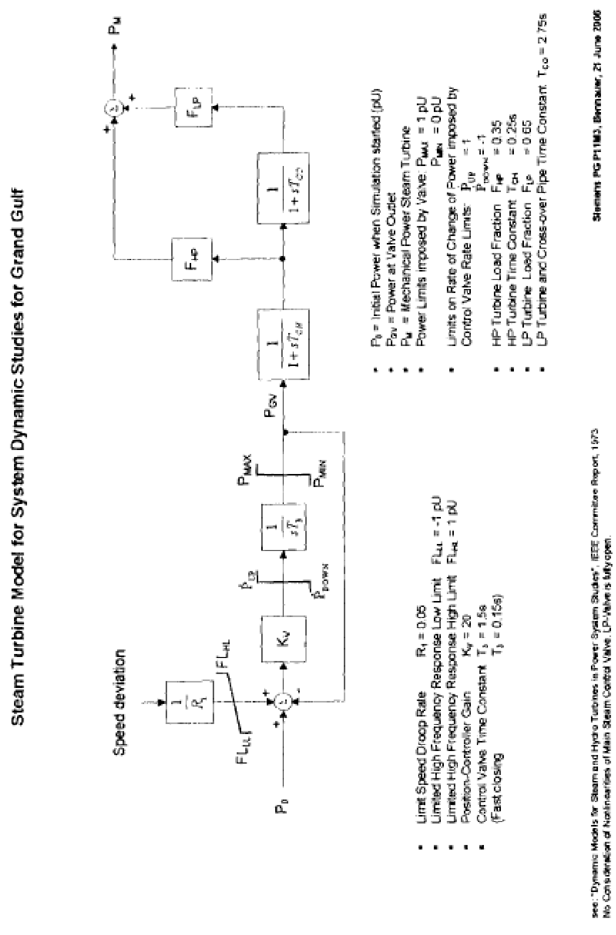
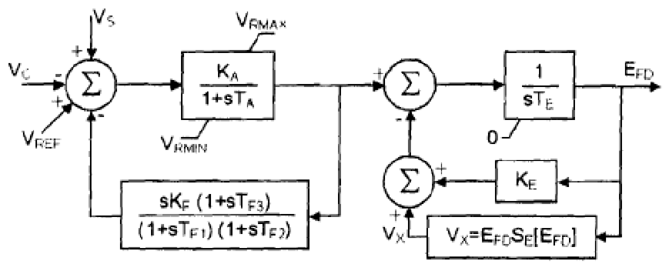

Steam Turbine Model for System Dynamic Studies for Grand Gulf
Speed deviation
$\frac{1}{R_1}$
FL_{HL}
FL_{LL}
P_0
K_V
$\dot{P}_{UP}$
$\dot{P}_{DOWN}$
$\frac{1}{sT_3}$
P_{MAX}
P_{MIN}
P_{GV}
$\frac{1}{1+sT_{CH}}$
$\frac{1}{1+sT_{CO}}$
F_{HP}
F_{LP}
P_M
Limit Speed Droop Rate $R_1 = 0.05$
Limited High Frequency Response Low Limit $FL_{LL} = -1$ pU
Limited High Frequency Response High Limit $FL_{HL} = 1$ pU
Position-Controller Gain $K_V = 20$
Control Valve Time Constant $T_3 = 1.5$s
(Fast closing $T_3 = 0.15$s)
P_0 = Initial Power when Simulation started (pU)
P_{GV} = Power at Valve Outlet
P_M = Mechanical Power Steam Turbine
Power Limits imposed by Valve: $P_{MAX} = 1$ pU
$P_{MIN} = 0$ pU
Limits on Rate of Change of Power imposed by
Control Valve Rate Limits: $\dot{P}_{UP} = 1$
$\dot{P}_{DOWN} = -1$
HP Turbine Load Fraction $F_{HP} = 0.35$
HP Turbine Time Constant $T_{CH} = 0.25$s
LP Turbine Load Fraction $F_{LP} = 0.65$
LP Turbine and Cross-over Pipe Time Constant: $T_{CO} = 2.75$s
see: "Dynamic Models for Steam and Hydro Turbines in Power System Studies", IEEE Committee Report, 1973
No Consideration of Nonlinearities of Main Steam Control Valve. LP-Valve is fully open.
Siemens PG P11M3, Bennauer, 21 June 2006

Fig.3.1.

GRAND GULF

IEEE TYPE AC5A EXCITATION SYSTEM MODEL DATA

K_A = 600 p.u.	T_A = 0.10 sec.
K_F = 0.02 p.u.	T_{F1} = 1.0 sec.
T_{F2} = 0.13 sec.	T_{F3} = 0
T_E = 0.22 sec.	T_R = 0.2 sec.
S_{E1} = 0.73	EFD_1 = 3.7 p.u.
S_{E2} = 0.73	EFD_2 = 2.8 p.u.
K_E = 1.0 p.u.	
V_{Rmax} = 6.4 p.u.	V_{Rmin} = -6.4 p.u.



IEEE Type AC5A Excitation System Model

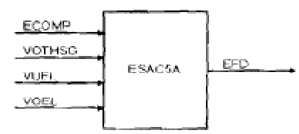
Reference: IEEE Standard 421.5-2005, "IEEE Recommended Practice for Excitation System Models for Power System Stability Studies"

ESAC5A

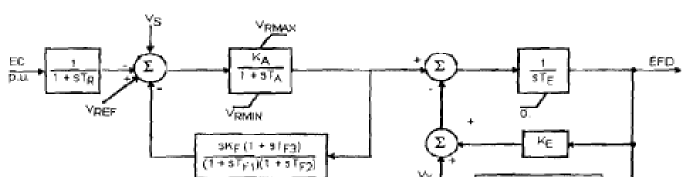
IEEE Type AC5A Excitation System

This model is located at system bus # _______ IBUS,
machine # _______ I.
This model uses CONs starting with # _______ J.

CONs	#	Value	Description
J		0.2	T_R (Seconds)
J+1		600	K_A
J+2		0.1	T_A (Seconds)
J+3		6.4	V_{RMAX} Or Zero
J+4		-6.4	V_{RMIN}
J+5		1	K_E Or Zero
J+6		0.22	$T_E > 0$ (Seconds)
J+7		0.02	K_F
J+8		1.0	$T_{F1} > 0$ (Seconds)
J+9		0.13	T_{F2} (Seconds)
J+10		0	T_{F3} (Seconds)
J+11		3.7	E_1
J+12		0.73	$S_E(E_1)$
J+13		2.8	E_2
J+14		0.73	$S_E(E_2)$



IBUS, 'ESAC5A', I, T_R, K_A, T_A, V_{RMAX}, V_{RMIN}, K_E, T_E, K_F, T_{F1}, T_{F2}, T_{F3}, E_1, $S_E(E_1)$, E_2, $S_E(E_2)$/



If $T_{F2} = 0$, then $sT_{F3} = 0$

V_S = VOTHSG + VUEL + VOEL

IEEEG1

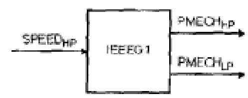
IEEE Type 1 Speed-Governing Model

This model is located at system bus	#	IBUS,
machine	#	I.
This Mmodel may be located at system bus	# 0	JBUS,
machine	# 0	M.
This model uses CONs starting with	#	J,

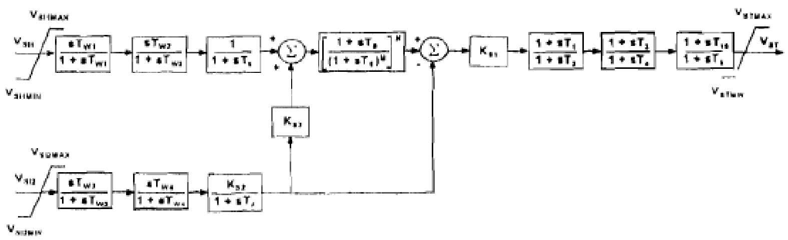
NOTE: JBUS and JM are set to zero for non-cross compound.

(Note: this is a non-cross compound unit)

CONs	#	Value	Description
J		12	K
J+1		0	T_1 (Seconds)
J+2		0	T_2 (Seconds)
J+3		0.075	T_3 (>0)(Seconds)
J+4		0.60	U_o (p.u./Seconds)
J+5		-0.60	U_c (<0.)(p.u./Seconds)
J+6		0.9	P_{MAX}(p.u. on Machine
			MVA Rating)
J+7		0	P_{MIN}(p.u. on Machine
			MVA Rating)
J+8		0.25	T_4(Seconds)
J+9		0.35	K_1
J+10		0	K_2
J+11		2.75	T_5 (Seconds)
J+12		0.65	K_3
J+13		0	K_4
J+14		0	T_6(Seconds)
J+15		0	K_5
J+16		0	K_6
J+17		0	T_7(Seconds)
J+18		0	K_7
J+19		0	K_8



TYPICAL EX2000 Power System Stabilizer (PSS)
IPS90995GD
TYPICAL DATA, NOT FOR DESIGN PURPOSES



Ref. IEEE 421.5-1992 Type PSS2A

Note: Parameters shown with ranges give the typical or useful ranges actual setting ranges are usually much wider.

VSI1 = speed input VSI2 = electrical power input
VSI1max, VSI1min - input #1 limits +/- 0.08 pu (fixed)
VSI2max, VSI2min - input #2 limits +/- 1.25 pu (fixed)
*T1 = lead #1 0.15 (range 0.1 - 2.0 sec) *T2 = lag #1 0.03 (range 0.01 - 1.0 sec)
*T3 = lead #2 0.15 (range 0.1 - 2.0 sec) *T4 = lag #2 0.03 (range 0.01 - 1.0 sec)
T5 = lag #3 0.0 (fixed not used in GE design) can be used if there are three lead lags or for equivalent torsional filter time constant which may be required for some units (determined by studies)
T6 = 0.0 (fixed) T7 = TW 2.0 sec (range 2 - 15 sec)
T8 = 0.5 sec (fixed) T9 = 0.1 sec (fixed)
T10 = Lag #3 = 0.0 (fixed not used in GE design)
N = 1 (fixed) M = 5 (fixed)
*KS1 = PSS gain = 8 - (range 3 - 20 typical)
KS2 = 0.202 = TW/(2H) - where H = combined turbine-gen. Inertia constant
KS3 = 1.0
VSTmax = (range 0.05 to 0.1) VSTmin = (range -0.05 to -0.1)
TW1 = TW see note on T7 above TW2 = TW see note on T7 above
TW3 = TW see note on T7 above TW4 = 0.0 (fixed)

* Note:Lead/Lags and Gain must be Determined by Studies

HCS 3-19-2002

APPENDIX D - LOAD FLOW AND STABILITY DATA

Loadflow Data

```
RDCH
1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
336821,'1 ',  1534.000,   170.000,   236.000,  -236.000,1.02000,336820,  1525.000,
0.00322,   0.30230,   0.00000,   0.00000,1.00000,1,  100.0,  1534.000,   150.000,
1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
336820,336821,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.0029,   0.134589,   1365.00
1.00000,   0.000,   0.000,  1530.00,  1530.00,     0.00, 0,      0, 1.07500, 0.97500,
1.07500, 0.97500, 5, 0, 0.00000, 0.00000
1.00000,   0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA

TEXT****DISPATCH PID226 AGAINST WHITE BLUFF UNIT#1******
SCAL
337652
1
,384   /* ORIGINAL OUTPUT = 590 MW
1
0
0
```

Dynamics Data

```
                                  PLANT MODELS

   BUS# X-- NAME --X BASKV ID  MODEL  X----CONS---X  X---STATES--X  X----VARS---X  X---
ICONS---X
 336821 GGULF       21.000 1   GENROU 130272-130285   51143- 51148
                               ESAC5A 130257-130271   51138- 51142    8173
                               IEEEG1 130286-130305   51149- 51154    8174-  8175

336821 'GENROU' 1     7.7410      0.46000E-01  0.86000      0.68000E-01
          4.9000       0.0000       1.4463       1.4081      0.38550
         0.57590      0.30230      0.23440      0.17400      0.52100    /
 336821 'ESAC5A' 1    0.20000       600.00      0.10000       6.4000
         -6.4000       1.0000      0.22000      0.20000E-01   1.0000
         0.13000       0.0000       3.7000      0.73000       2.8000
         0.73000    /
 336821 'IEEG1' 1          0            0        12.000       0.0000
          0.0000      0.75000E-01  0.60000     -0.60000       1.0100
          0.0000      0.25000      0.35000       0.0000       2.7500
         0.65000       0.0000       0.0000       0.0000       0.0000
          0.0000       0.0000       0.0000    /
```

APPENDIX E - PLOTS FOR STABILITY SIMULATIONS