TRANSMISSION LINE & SUBSTATION PROJECTS

COMPANY:EMI

CUSTOMER: SPP

FACILITIES STUDY

EJO # F4PPMS0236

PID 226 INTERCONNECTION STUDY

Revision: 2

Rev	Issue Date	Description of Revision	Prepared By	Approved By
A	09/09/09	1st Draft	JWM	CN
B	09/09/09	2nd Draft to JET Members	JWM	CN
0	09/10/09	Approved Issue	JWM	CN
1	09/28/09	TPD Review	RB	BW
2	10/9/09	ICT Review and Classification	BEF	JDH

** Note: All required JET approvals and other stakeholder concurrences are shown in the voting polls in eRoom.*

TABLE OF CONTENTS

1. PROJECT SUMMARY

1.1. Background and Project Need

The purpose of this Facilities Study is to evaluate the impact of uprating the customer's existing generation by 206MW. The net output is presently 1287MW (1157MW EMO designated network resource and 130MW SMEPA designated network resource). After the 206MW uprate, the net output will be 1493MW.

PID 226 only requested ERIS. Upgrades were identified for ERIS.

According to the FERC Large Generator Interconnection Procedures (LGIP), a generator interconnection customer is required to be capable of supplying at least 0.33 MVAR for each MW of power injected into the grid, in order to meet the specified 0.95 leading power factor requirement. When the customer is serving maximum power at 1503.5MWe and 547.25MVAR, the power factor at the generator terminals is 0.940. After accounting for MW and MVAR losses in the customer's 500/20.9kV step-up transformer, the power reaching the POI is approximately 1443MWe and 298.25MVAR, corresponding to a 0.979 power factor. In order to meet the LGIP power factor design criteria, 200MVAR of additional capacitor bank installations and upgrades are required.

Due to the large amount of reactive power support required, it is not feasible to place the capacitor banks at the generator terminal. Consequently, for this particular generator interconnection, it is more advantageous in terms of system reliability for distributed capacitor bank placements at the load centers.

1.2. Scope Summary

- The overall scope of this project is summarized as follows:
    - Install 21.6MVAr capacitor bank at Schlater 115kV.

  This capacitor bank installation has been included in the 2009-2011 Entergy Construction Plan. If this project is approved, the customer will not have to fund this upgrade.

    - Install a 2nd 21.6MVAr capacitor bank at Winona 115kV.

  This capacitor bank installation has been included in the 2009-2011 Entergy Construction Plan. If this project is approved, the customer will not have to fund this upgrade.

    - Upgrade the 21.6MVAr capacitor bank at Greenwood 115kV to 32.4MVAr.

  This capacitor bank installation has been included in the 2009-2011 Entergy Construction Plan. If this project is approved, the customer will not have to fund this upgrade.

    - Install a 21.6MVAr capacitor bank at Rolling Fork 115kV.
    - Install a 21.6MVAr capacitor bank at Yazoo City Municipal 115kV.
    - Install a 21.6MVAr capacitor bank at Carthage 115kV.
    - Install a 21.6MVAr capacitor bank at Tylertown 115kV.

- Install a 2nd capacitor at Magee 115kV, sized at 32.4MVAr.
- Install a 32.4MVAr capacitor bank at Delhi 115kV.
  This capacitor bank installation has been included in the 2009-2011 Entergy Construction Plan
- Upgrade one of the 21.6MVAr capacitor banks at McComb 115kV to 32.4MVAr

1.3. Cost Summary

- The estimated total project cost is **$7,697,012.00.** This cost does not include Tax Gross Up which may apply. This is a good faith 20% estimate based on current conditions and the time frame allowed to complete the study.
- The ICT has assigned ***$3,948,860.00*** as Base Plan upgrades and ***$3,748,152.00*** as Supplemental Upgrade based on Attachment "T" of Entergy's ICT (Independent Coordinator of Transmission) filing to the FERC.

1.4. Schedule Summary

Item Number	Project/Station Description	Total Project	Construction start	Construction finish
1	***Schlater 115kV Substation	$1,121,598.00	July 1, 2009	December 1, 2009
2	***Winona 115kV Substation	$1,361,695.00	April 1, 2009	December 1, 2009
3	***Greenwood 115kV Substation	$527,888.00	July 1, 2009	December 1, 2009
4	Rolling Fork 115kV Substation	$652,418.00	September 22,2010	March 14, 2011
5	Yazoo City Municipal 115kV Sub.	$617,916.00	November 7, ,2010	March 18,2011
6	Carthage 115kV Substation	$844,708.00	January 5, 2011	June 06,2011
7	Tylertown 115kV Substation	$900,297.00	February 17,2011	July 19,2011
8	Magee 115kV Substation	$656,843.00	March 31,2011	July 27,2011
9	***Delhi 115kV Substation	$937,679.00	April 6, 2009	November 30, 2009
10	McComb 115kV Substation	$75,970.00	April 14,2011	September 08,2011

***Projects are existing WIP capital projects

NOTE: Projects 4,5,6,7,8 and 10 In Service Dates are based on a ***preliminary, non-constrained (unbaselined) project schedules***, and include significant schedule assumptions, such as timing of funding authorization(s), outage approvals, ROW/permitting, etc.

1.5. Automatic Generation Control

- Upgrades required by Entergy for AGC service are discussed in Entergy's OASIS posting "Entergy Transmission Guidelines for Automatic Generator Control Applications". See link below:

http://oasis.e-terrasolutions.com/documents/EES/AGC%20Guidelines%20for%20Entergy%20Transmission.pdf

2. SAFETY REQUIREMENTS

Safety is a priority with Entergy. Safety will be designed into substations and lines. The designs will be done with the utmost safety for personnel in mind for construction, operation, and maintenance of the equipment.

All employees working directly or indirectly for Entergy shall adhere to all rules and regulations outlined within the Entergy Safety manual. Entergy requires safety to be the highest priority for all projects. All Entergy and Contract employees must follow all applicable safe work procedures.

Should the work contained within this Facility Study be approved, a detailed Safety Plan will be formulated and incorporated within the project plan.

3. GENERAL ASSUMPTIONS

A common assumption across all projects is that adequate space is available in all substation sites. When necessary Work order specific assumptions will be included in the scope of work section below; otherwise

- Upon receipt of formal approval from customer authorizing design and construction, Entergy will prepare a detailed project execution plan with a definitive baselined schedule for each project.
- Where necessary wetland mitigation and SWPPP cost will be included in the work order scope of work.
- All permits will be attainable in a reasonable period.
- Due to timing and/or funding constraints, site visits, surveys, and soil borings were not performed in order to develop this facility study.
- All costs above represent good faith estimates in today’s dollars. Price escalation for work in future years has not been included.
- Assumptions to meet a March 1, 2012 In-service date on all projects is based on internal/external labor resources and funding availability allowing for executions of designs, material ordering and construction resources to be acquired in a timely manner.
- All Class 3 estimates are based on EMCC PERI Guidelines.

4. SCOPE OF WORK

4.1. Schlater 115kV Substation: Install 21.6MVAr Capacitor Bank

Site Work

The existing site has very soft soil. We are assuming the top 3 ft of soil will need to be removed and filled with adequate fill material. The site work will require the following materials:

750 cu yds of fill dirt
750 cu yds of cut
250 tons of limestone

210 ft of new fence
100 ft of removal of existing fence

Foundation Work

The following foundations will need to be installed totaling 31 cu yards of concrete:
One (1) 3 phase capacitor bank foundation
One (1) 115kV Cap switcher foundation
Nine (9) 115kV Low elevation bus support foundations
One (1) 115kV Low elevation switch support foundation
Three (3) 115kV Tubular CVT support foundations
Install approximately 1000 ft of grounding to expand the station
Install approximately 400 ft of conduit.

Steel and Electrical Work

Extend the bus on the west side of the 115kV yard to install the following for a capacitor bank:
One (1) 115kV 21.6MVAR Capacitor bank
One (1) 115kV Cap switcher and support structure
One (1) 115kV 2000A disconnect switch, manually operated
One (1) 115kV switch support structure, type CE
Three (3) CVT support structures for the bus CVT's
Nine (9) 115kV bus supports
Eighteen (18) insulators
One (1) yard light
Approximately 300ft of rigid bus work and 150ft of strung bus work.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451 and spare relay Control house may not have indoor space for a capacitor control panel.

Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.

Control House Equipment:
Upgrade RTU - Status cards & Control cards
Install one (1) SEL 2032.
One Lot of Control Cable

Communications and SCADA Work

This RTU will be upgraded to MEII/8979 this year (Mike Hendrix is doing this project). Sufficient capacity for a typical capacitor bank addition exists.

4.2. Winona 115kV Substation: Install a 21.6MVAr Capacitor Bank

Site Work

The existing site should require minimal work to prepare the site. A broken culvert will need to be replaced and a small amount of fill will be required. The site work will require the following materials:

200 cu yds of fill dirt
100 cu yds of cut
200 tons of limestone
200 ft of new fence
100 ft of removal of existing fence
125 ft of 12" culvert

Foundation Work

The following foundations will need to be installed totaling 31 cu yds of concrete:

One (1) 3 phase capacitor bank foundation
One (1) 115kV Cap switcher foundation
Nine (9) 115kV Low elevation bus support foundations
One (1) 115kV Low elevation switch support foundation
Three (3) 115kV Tubular CVT support foundations
Install approximately 1000 ft of grounding to expand the station
Install approximately 400 ft of conduit.

Steel and Electrical Work

Extend the bus on the west side of the 115kV yard to install the following for a capacitor bank:

One (1) 115kV 21.6MVAR Capacitor bank
One (1) 115kV Cap switcher and support structure
(Design will have Planning evaluate if Reactor's are necessary to control back to back switching at the appropriate time)
One (1) 115kV 2000A disconnect switch, manually operated
One (1) 115kV switch support structure, type CE
Three (3) CVT support structures for the bus CVT's
Nine (9) 115kV bus supports
Eighteen (18) insulators
Approximately 300ft of rigid buswork and 150ft of strung bus work
One (1) yard light

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable

Settings will need to be derived for capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU - Status cards & Control cards
Install one (1) Orion 5R
One Lot of Control Cable

Communications and SCADA Work

Indoor Rittal cabinet; Will need to add SDAC (S Westerm backplane is existing); Only 2 spare controls points are available; Need to upgrade microprocessor board to MEII; Protocol is already 8979- no conversion required.

4.3. Greenwood 115kV Substation: Upgrade existing 21.6MVAr capacitor bank to 32.4MVAr.

Site Work

No work identified.

Foundation Work

Install conduit for the neutral PT.

Steel and Electrical Work

Upgrade capacitor bank from 21.6MVAR to 32.4MVAR by replacing cans to the existing Westinghouse capacitor banks. The bottom racks are already full. Therefore, this bank can not be expanded any further by adding more 200 KVAR cans, even if the top rack is not full. The only way that this bank can be expanded to 32.4 MVAR is to replace all of the existing units with 300 KVAR cans. (108 x 300 = 32,400 KVAR).
Remove all existing cans:
Westinghouse, 200kVAr, 22,800 volt,Year mfg. 09-1986, Style # or S.O. # is IN0320044IG
Install the following:
108 only capacitor units, 300 kvar, 22.8 kV, 60 Hz, 1 bushing, 150 kV BIL
108 type CXP fuses, 26.2 kV class, 15K link, c/w fuse ejector springs.

Note: Approval was received from Planning's Kyle Watson to upgrade the existing Capacitor Bank to 32.4 MVAr because there was no room in the Greenwood Substation to expand.
A New fuseless bank design mounted on the same footing will be evaluated at the appropriate time. This alternative may be a cheaper option.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU - Status cards & Control cards
One Lot of Control Cable

Communications and SCADA Work

Indoor open rack; sufficient capacity for a typical capacitor bank addition (only 5 spare controls, though); Existing ME microprocessor board and 8979 protocol- no changes needed for this.

4.4. Rolling Fork 115kV Substation Install 21.6 MVAr Capacitor Bank

Site Work

No Site Work Required.

Foundations

The following foundations are required. Foundation design will be based on existing foundations.

Install one (1) 115kV 21 MVAR Capacitor Bank foundation
Install one (1) 115kV Cap Switcher Foundation
Install one (1) 115kV CE Tower foundation
Install three (3) 115kV Equipment Pedestal foundations

Electrical

Install one (1) fuseless 115 kV 21.6MVAR ungrounded wye capacitor bank. There are two parallel strings in each phase. 6 capacitor units in series and each capacitor has 6 internal sections, giving 36 series sections per string. Each capacitor can has a rating of 600kVAR.

Install one (1) CE switch structure of 16ft.

Install one (1) Southern States Cap Switcher with pre-insertion resistor that includes its support structure (115kV, 1200A continuous rating).
Install one (1) vertical break disconnect switch (mounted on new CE tower).
Install three (3) new CVTs and their support structures between switch and Cap Switcher.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU to MEII - Status cards & Control cards
Install one (1) Orion 5R.
One Lot of Control Cable

Communications and SCADA Work

Existing M microprocessor board and Harris protocol - upgrade needed for this.

4.5. Yazoo City Municipal115kV Substation Install 21.6MVAr Capacitor Bank

Site Work

No Site Work Required.

Foundations

The following foundations are required. Foundation design will be based on existing foundations.

Install six (6) 115kV Bus Support Foundation
Install one (1) 115kV 21 MVAR Capacitor Bank foundation
Install one (1) 115kV Cap Switcher Foundation
Install one (1) 115kV CE Tower foundation
Install three (3) 115kV Equipment Pedestal foundations

Electrical

Install one (1) fuseless 115 kV 21.6MVAR ungrounded wye capacitor bank. There are two parallel strings in each phase. 6 capacitor units in series and each capacitor has 6 internal sections, giving 36 series sections per string. Each capacitor can has a rating of 600kVAR.

Install one (1) CE switch structure of 16ft.
Install one (1) Southern States Cap Switcher with pre-insertion resistor that includes its support structure (115kV, 1200A continuous rating).
Install one (1) vertical break disconnect switch (mounted on new CE tower).
Install three (3) new CVTs and their support structures between switch and Cap Switcher.
Install six (6) new bus support structures with insulators.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU - Status cards & Control cards
Install one (1) Orion 5R.
One Lot of Control Cable

Communications and SCADA Work

Existing microprocessor board and 8979 protocol – no upgrade at this time needed.

4.6. Carthage 115kV Substation: Install 21.6 MVAr Capacitor Bank

Site Work

Significant site work will be required to expand the substation in order to accommodate the new capacitor bank. There is approximately 4’ change in elevation in the new portion of the substation. Expand the Northeast corner of the substation by approximately 12,000 sq ft (84’ to the east, 55’ to the north, and 65’ to the south.) The following materials are required to complete the site work.

2000 cu yds of fill
250 cu yds of soil stripping and disposal

1 acre seeded and mulched
110 ft of existing fence removal
358 ft of new fence

Foundations

The following foundations are required. Foundation design will be based on existing foundations.

Install twelve (12) 115kV Bus Support Foundations
Install one (1) 115kV 21 MVAR Capacitor Bank foundation
Install one (1) 115kV Cap Switcher Foundation
Install one (1) 115kV CE Tower foundation
Install three (3) 115kV Equipment Pedestal foundations

Electrical

Install one (1) fuseless 115 kV 21.6MVAR ungrounded wye capacitor bank. There are two parallel strings in each phase. 6 capacitor units in series and each capacitor has 6 internal sections, giving 36 series sections per string. Each capacitor has a rating of 600kVAR.

Install one (1) CE switch structure of 16ft.
Install one (1) Southern States Cap Switcher with pre-insertion resistor that includes its support structure (115kV, 1200A continuous rating).
Install one (1) vertical break disconnect switch (mounted on new CE tower).
Install three (3) new CVTs and their support structures between switch and Cap Switcher.
Install twelve (12) new bus support structures with insulators.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Install one (1) Trap - Capbank
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU to MEII - Status cards & Control cards
Install one (1) Orion 5R.
One Lot of Control Cable

Communications and SCADA Work

Existing M++ microprocessor board and Harris protocol - upgrade needed for this.

4.7. Tylertown 115kV Substation: Install 21.6 MVAr Capacitor Bank

Site Work

Significant site work will be required to expand the substation in order to accommodate the new capacitor bank. There is approximately 6' change in elevation in the new portion of the substation. Expand the northern most corner of the substation by 13,000 sq ft (41' to the West, 103' to the North, and 74' to the East.)

The following materials are required to complete the site work
3500 cu yds of fill
300 cu yds of soil stripping and disposal
1 acre seeded and mulched
106 ft of existing fence removal
394 ft of new fence

Foundations

The following foundations are required. Foundation design will be based on existing foundations.

Install twelve (12) 115kV Bus Support Foundations
Install one (1) 115kV 21 MVAR Capacitor Bank foundation
Install one (1) 115kV Cap Switcher Foundation
Install one (1) 115kV CE Tower foundation
Install three (3) 115kV Equipment Pedestal foundations

Electrical

Install one (1) fuseless 115 kV 21.6MVAR ungrounded wye capacitor bank. There are two parallel strings in each phase. 6 capacitor units in series and each capacitor has 6 internal sections, giving 36 series sections per string. Each capacitor can has a rating of 600kVAR.

Install one (1) CE switch structure of 16ft.
Install one (1) Southern States Cap Switcher with pre-insertion resistor that includes its support structure (115kV, 1200A continuous rating).
Install one (1) vertical break disconnect switch (mounted on new CE tower).
Install three (3) new CVTs and their support structures between switch and Cap Switcher.
Install twelve (12) new bus support structures with insulators.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU to MEII - Status cards & Control cards
Install one (1) Orion 5R.
One Lot of Control Cable

Communications and SCADA Work

Existing M microprocessor board and 8979 protocol - upgrade needed for this.

4.8. Magee 115kV Substation: Install a second 32.4 MVAr Capacitor Bank

Site Work

No Site Work Required.

Foundations

The following foundations are required. Foundation design will be based on existing foundations.

Install one (1) 115kV 32.4 MVAR Capacitor Bank foundation
Install one (1) 115kV Cap Switcher Foundation
Install one (1) 115kV CE Tower foundation
Install three (3) 115kV Equipment Pedestal foundations

Electrical

Install one (1) fuseless 115 kV 32.4MVAR ungrounded wye capacitor bank. There are two parallel strings in each phase. 6 capacitor units in series and each capacitor has 6 internal sections, giving 36 series sections per string. Each capacitor can has a rating of 600kVAR.

Install one (1) CE switch structure of 16ft.
Install one (1) Southern States Cap Switcher with pre-insertion resistor that includes its support structure (115kV, 1200A continuous rating).
Install one (1) vertical break disconnect switch (mounted on new CE tower).

Install three (3) new CVTs and their support structures between switch and Cap Switcher.
Install an additional pre-insertion resistor on existing Mark IV.

Relay and Settings Work

Capacitor Bank Control:
Install one (1) Capacitor Bank Control Panel The panel will use a SEL-451
Install three (3) CVT, 115kv
Install one (1) Junction Box, CVT, Termination, Cable
Install one (1) Neutral PT
Install one (1) Neutral PT Junction Box, Termination, Cable
Settings will need to be derived for one capacitor bank control panel consisting of one SEL 451 relay.
Control House Equipment:
Upgrade RTU to MEII - Status cards & Control cards
Install one (1) Orion 5R.
One Lot of Control Cable

Communications and SCADA Work

Existing M+ microprocessor board and 8979 protocol - upgrade needed for this.

4.9. Delhi 115kV Substation: Install 36 MVAr Capacitor Bank

Site Work

A capacitor bank is required to support the initial customer load when connected to the 115kV system, and this equipment will be installed at Delhi 115kV Substation. Per current information in Meridian, the site has sufficient property to expand the substation site and accommodate the new 115kV 36MVAR capacitor bank

Foundations

Install new foundations for the following equipment:

Six (6) bus supports
One (1) C switch support
One (1) capacitor switcher
One (1) capacitor bank
Three (3) “E” towers
Install conduit from new equipment to existing duct bank:
Capacitor switcher – 2 runs, and neutral potential device – 2 runs
Extend perimeter ground for new substation area and tie new fence section and new equipment to ground grid per Entergy standards

Electrical

Extend transfer bus one bay (6 bus supports – 44 feet west)
Install the following equipment:

One (1) vertical break group operated disconnect switch
One (1) capacitor switcher
One (1) capacitor bank with line trap
Three (3) E towers for bus potential devices

Relaying

Install one cap switcher and 36MVAR capacitor bank. The cap bank will be controlled by an Entergy standard ungrounded cap bank panel that will utilize the SEL 451 relay for control and protection. Install a 69kV potential transformer on the neutral of the cap bank. Install a PT junction box. One status card will need to be purchased and installed. There are very few drawings on the server for this substation, therefore the operational one line, RTU drawings, AC & DC panels, etcetera will need to be developed. There is one spare breaker on the AC panel, and numerous blank spots. There are two spare breakers on the DC panel and one blank spot.

The RTU already has a D20 ME board installed.

Install an Orion 5R communications processor.

Relay Settings

Settings will need to be derived for one Entergy standard ungrounded capacitor bank panel using a SEL 451 relay

4.10. McComb 115kV Substation: Upgrade one of the 21.6MVAr capacitor banks to 32.4 MVAr

Site Work

No Site Work Required.

Foundations

No Site Work Required.

Relay and Settings Work

Settings will need to be derived for capacitor bank control panel consisting of one ZIV relay

5. COST AND COST CLASSIFICATION

The ICT has reviewed and determined whether each required upgrade will be considered a Base Plan Upgrade or a Supplemental Upgrade. For more information on cost responsibility for Base Plan and Supplemental Upgrades, see Attachment T to Entergy's OATT.

The costs shown in the table include overheads and AFUDC, but do not include tax gross up. Entergy incurs a tax liability proportional to the amount of customer contributions. In addition to proposed project costs, the customer may be charged a "Tax gross-up" (TGU) at applicable rates. Rates are subject to change. TGU is not included in any of the estimates.

Projected Costs

Project/Station Description	Base Plan	Supplemental	Total Project
***Schlater 115kV Substation	$1,121,598.00		$1,121,598.00
***Winona 115kV Substation	$1,361,695.00		$1,361,695.00
***Greenwood 115kV Substation	$527,888.00		$527,888.00
Rolling Fork 115kV Substation		$652,418.00	$652,418.00
Yazoo City Municipal 115kV Substation		$617,916.00	$617,916.00
Carthage 115kV Substation		$844,708.00	$844,708.00
Tylertown 115kV Substation		$900,297.00	$900,297.00
Magee 115kV Substation		$656,843.00	$656,843.00
***Delhi 115kV Substation	$937,679.00		$937,679.00
McComb 115kV Substation		$75,970.00	$75,970.00
Grand Totals	**$3,948,860.00**	**$3,748,152.00**	**$7,697,012.00**

***Projects are existing WIP capital projects

6. SCHEDULE

A detailed schedule will be prepared subsequent to customer approval to proceed with the project. Based on the Task duration schedules listed below, the overall project in-service date is projected to be **March 1, 2012.** ***Note: see General Assumption in Section 3.*** The projects listed in "RED" below are presently being constructed; the projects in "Black" have estimated dates with schedules subject to change.

Task Name	Proposed Construction Start Date	Proposed ISD (Preliminary, unbaseline)
***Schlater 115kV Substation	July 1, 2009	December 1, 2009
***Winona 115kV Substation	April 1, 2009	December 1, 2009
***Greenwood 115kV Substation	July 1, 2009	December 1, 2009
Rolling Fork 115kV Substation	September 22,2010	March 14, 2011

Yazoo City Municipal 115kV Sub.	November 7, ,2010	March 18,2011
Carthage 115kV Substation	January 5, 2011	June 06,2011
Tylertown 115kV Substation	February 17,2011	July 19,2011
Magee 115kV Substation	March 31,2011	July 27,2011
***Delhi 115kV Substation	April 6, 2009	November 30, 2009
McComb 115kV Substation	April 14,2011	September 08,2011

***Projects are existing WIP capital projects

Notes to Duration Schedules:

- All construction work requiring outages will be performed during acceptable periods of system load flow, which most often is the off-peak load season. Line outages will be discussed with the SOC and TOC and the assumption is made that line outages will be executed as planned. However, last minute denial of outages by the SOC/TOC along with resulting schedule delay is possible.
- Substation construction will be coordinated with the transmission line outages when possible.
- Construction resources are available when required.
- Transmission Line and Substation projects will begin subsequent to Definition phase Project Execution Plan.
- In Service Dates are based on a ***preliminary, non-constrained (unbaselined) project schedules***, and state significant schedule assumptions, such as timing of funding authorization(s), outage approvals, ROW/permitting, etc.
- This schedule does not account for adverse weather conditions.
- Schedule durations are high level estimates at this time. A detailed schedule will be prepared upon project approval.

7. RISK ASSESSMENT

Identify risk events that may impact cost and/or schedule during execution of the project.

Risk	Comment	Impact
Underground site issues (Pipelines, wells, containments)	Unknown underground factors will add mitigation costs and may impact schedule	***
Substation Site will require minimal site work	Site may be in flood plain, wetlands, Soil Contamination	**
Material transportation could affect cost/schedule	Large transformers(other equipment) may require special transport to substation site	**
Material costs steel & Equipment	Rising steel, copper, fuel and other market conditions could greatly affect estimated cost.	****
Storm-water plan implementation	Best guess on SWPPP creation, implementation and monitoring can vary greatly dependant on outcome of environmental study.	**

Weather & Equipment Lead Times (Transformer, Poles)	Unexpected delays on material lead times, unusually inclement weather will impact schedule but might impact AFUDC costs as well.	**
Wetland mitigation	Undetermined until environmental analysis is complete.	***
Outages may not be available	Preliminary schedule only considers general outage constraints. Specific project schedule may be delayed by days, weeks or months dependant on system conditions. Delays of months = increased project costs.	**
Scope based on design assumptions which may change	Varied impact on cost and schedule.	***

*-low impact to cost, ** - moderate impact to cost, ***- high impact to cost, **** - very high impact to cost.

8. CONFIRMED RESERVATIONS

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

- Confirmed firm transmission reservations were modeled.
- Approved transmission reliability upgrades for 2009 – 2011 were included in the base case. These upgrades can be found at Entergy's OASIS web page, http://oasis.e-terrasolutions.com/OASIS/EES, under ICT Planning Studies and Related Documents.

Prior generator interconnection 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	Wolf Creek	875	In-Service
PID 222	Ninemile	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 Cajun 2 Unit 3	13	7/31/2009

Prior transmission service requests that were included in this study:

OASIS #		PSE	MW	Begin	End
1604055		Westar Energy Gen & Mktg	15	6/1/2010	6/1/2015
1615068		NRG Power Marketing	52	1/1/2010	1/1/2011

Pre-888 Transactions

See the following hyperlink for a complete listing of all Pre-888 transactions.

http://oasis.e-terrasolutions.com/documents/EES/Pre-Order888Transactions.xls

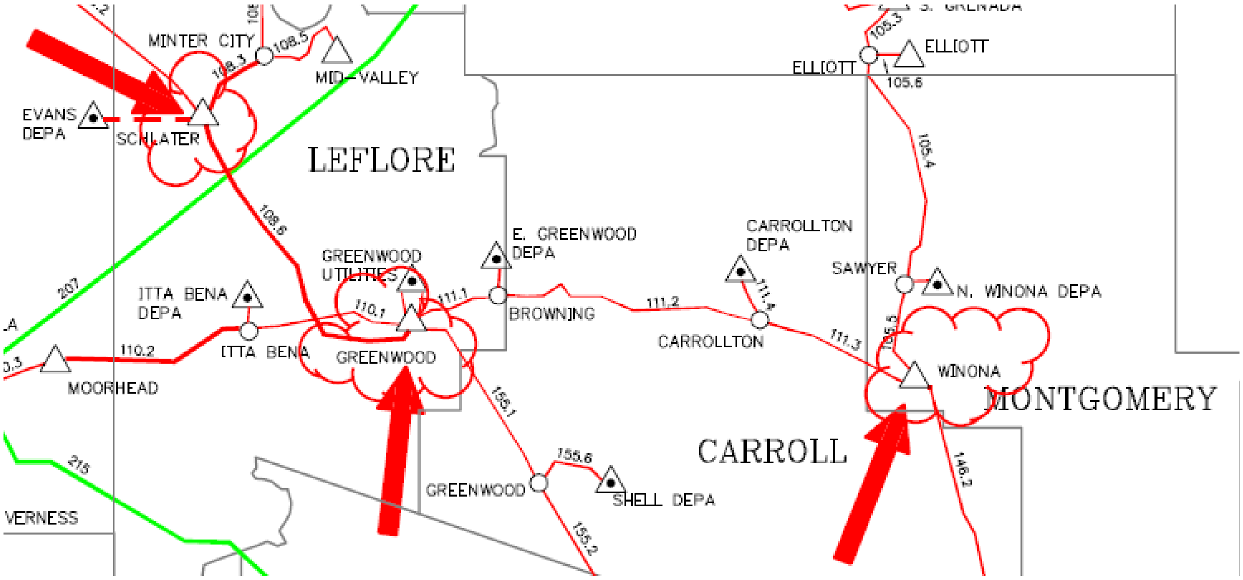
9. ATTACHMENTS

A. Table of Acronyms

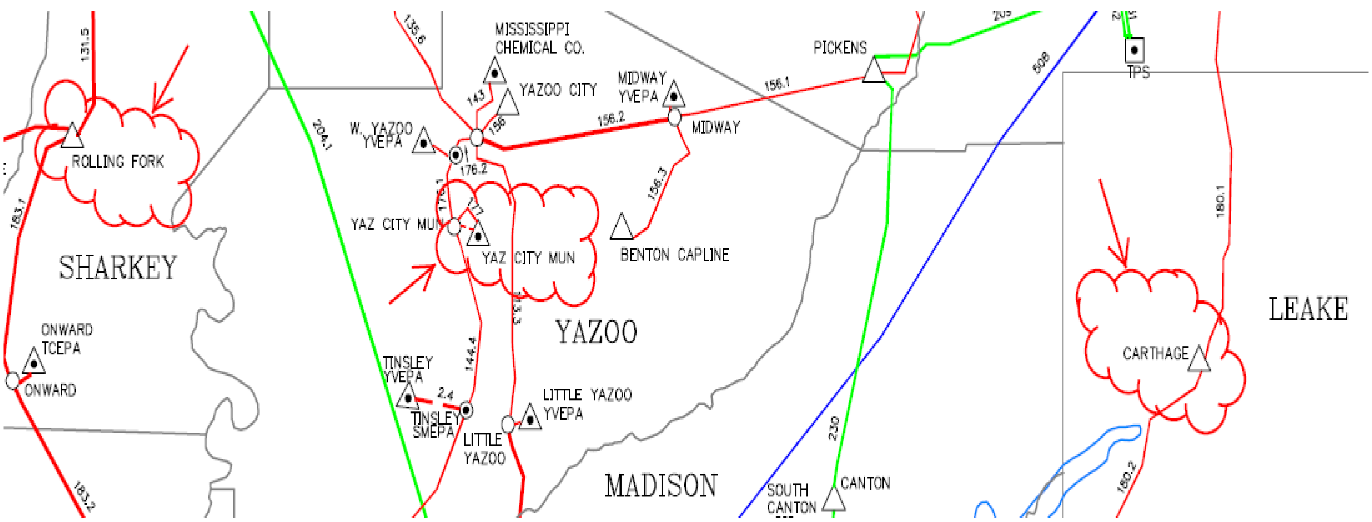
ACSR	**Aluminum Conductor Steel Reinforced**
ACSS	**Aluminum Conductor Steel Supported**
ADEQ	**Arkansas Department of Environmental Quality**
AFUDC	**Allowance for Funds Used During Construction**
ATC	**Available Transfer Capability**
EES	**Entergy Control Area**
EHV	**Extra-High Voltage**
ICT	**Independent Coordinator of Transmission**
kV	**Kilo-Volt**
MCM	**(M) Thousand Circular Mils**
MVA	**Mega-Volt Amp**
MW	**Mega-Watt**
NPDES	**National Pollution Discharge Elimination System**
NOI	**Notice of Intent**
OASIS	**Online Access and Same-time Information System**
OATT	**Open Access Transmission Tariff**
OG&E	**Oklahoma Gas & Electric**
POD	**Point of Delivery**
POR	**Point of Receipt**
SES	**Steam Electric Station**
SOC	**System Operations Center**
SHPO	**Arkansas State Historic Preservation Office**
SHV	**Super High Voltage**
SW	**Switch Station**
SWEPCO	**Southwest Electric Power Company**
TOC	**Transmission Operations Center**
WMUC	**City of West Memphis Control Area**

B. Scope Summary Diagram / Area Map

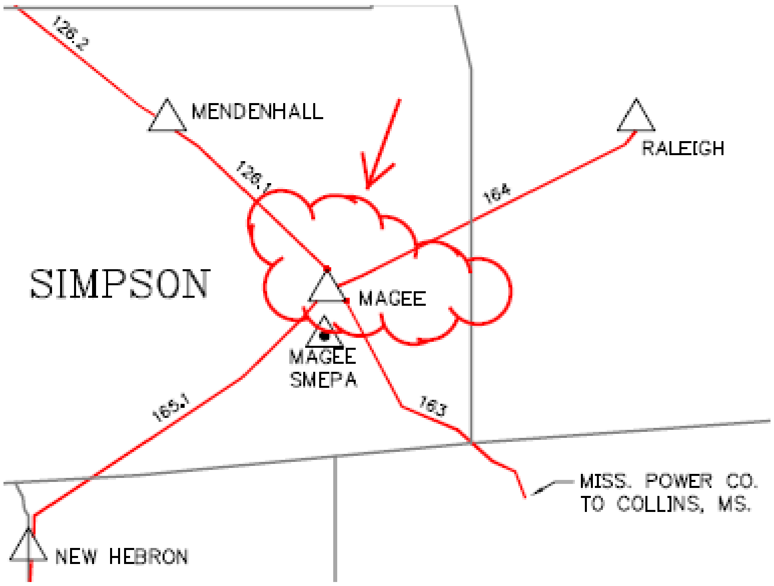
Schlater, Greenwood and Winona Substation



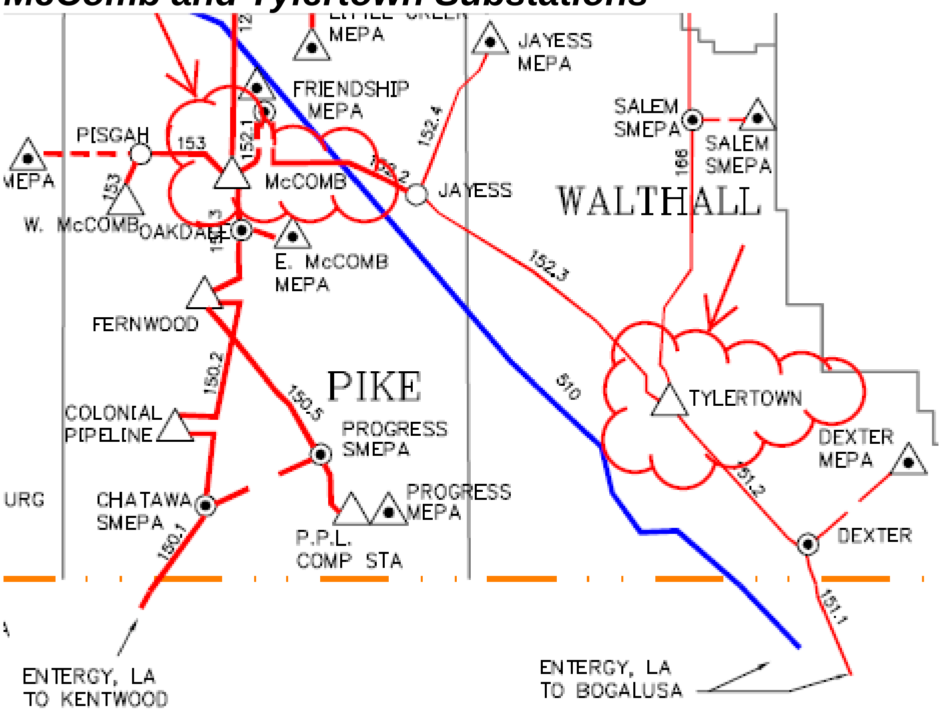
Rolling Fork, Yazzo City Municipal and Carthage Substations



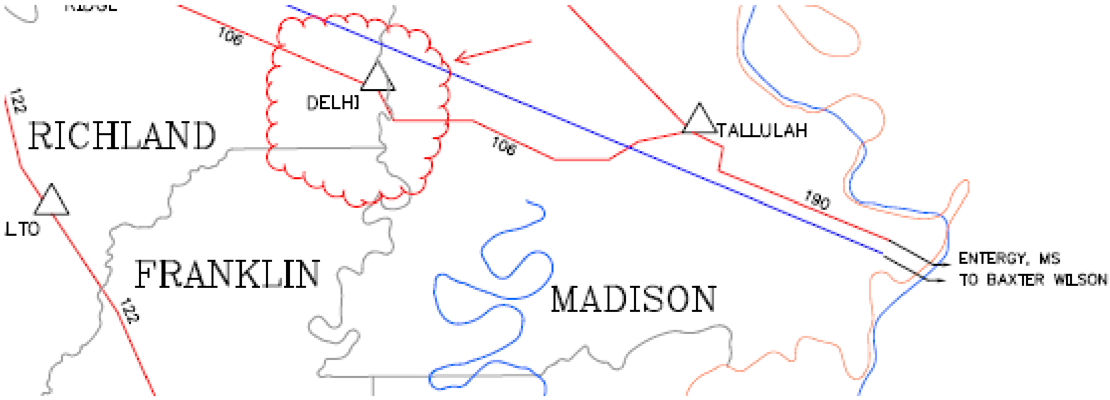
Magee Substation



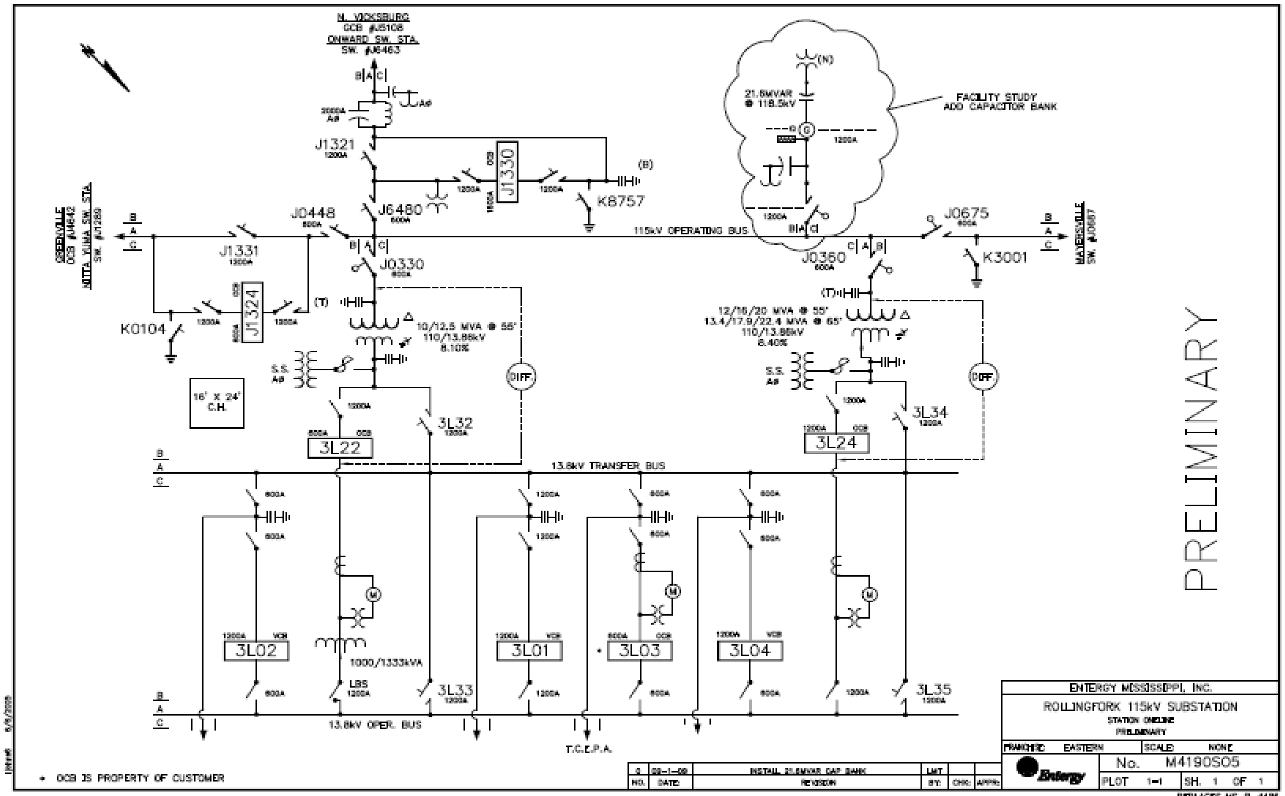
McComb and Tylertown Substations

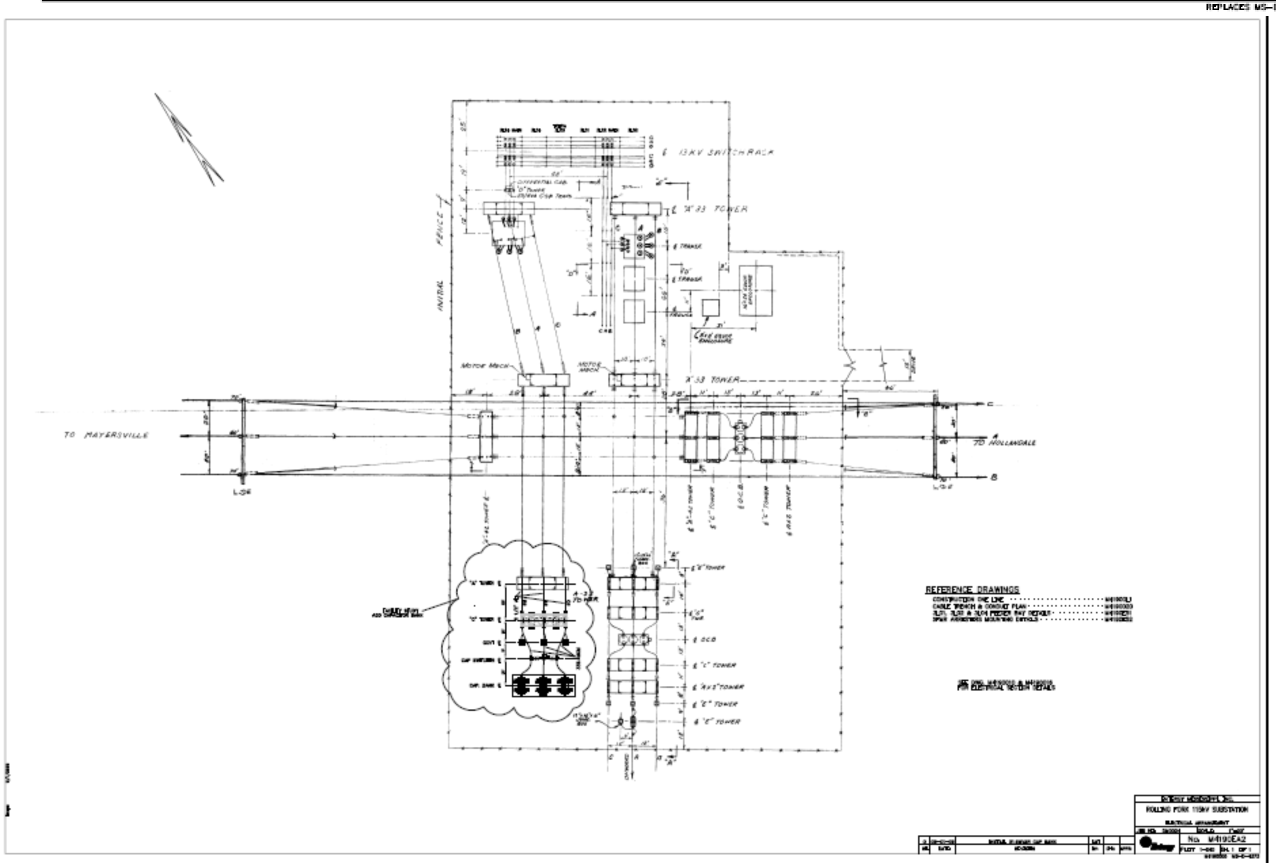


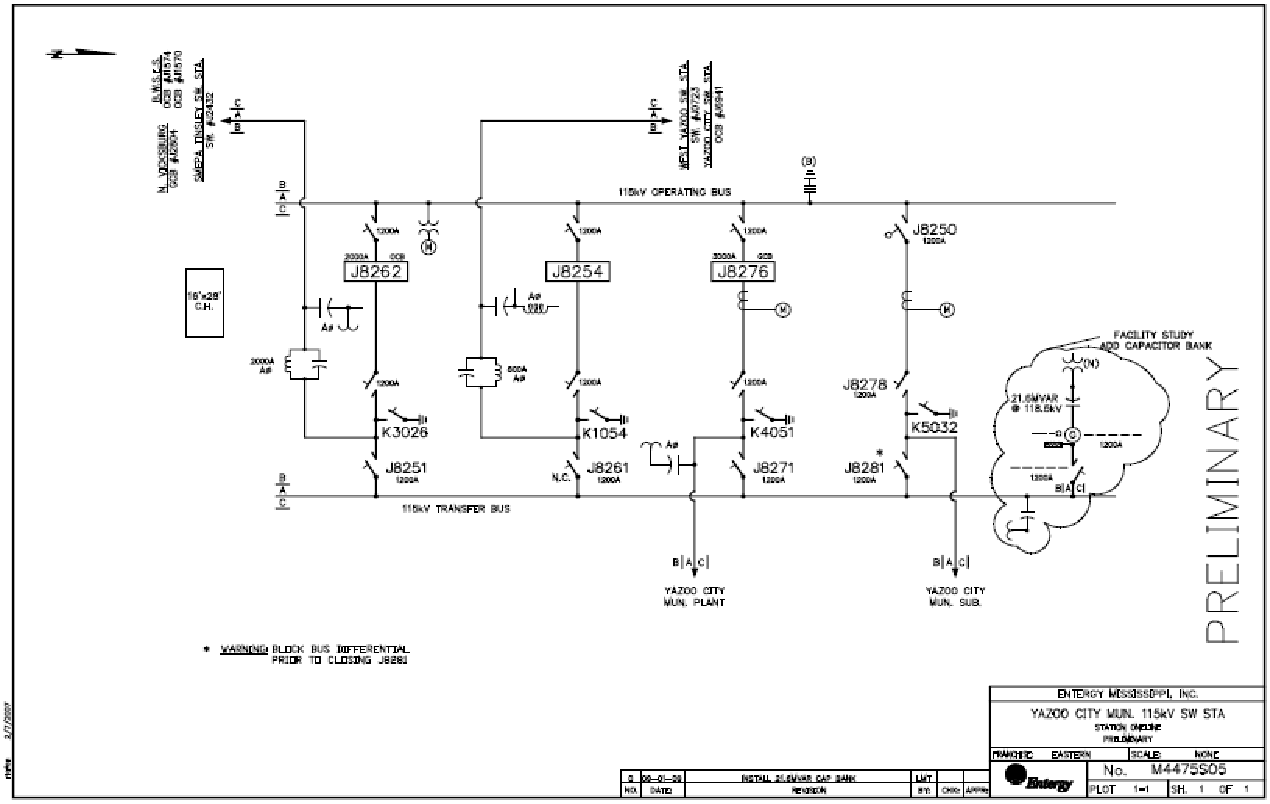
Entergy Louisiana North
Delhi Substation

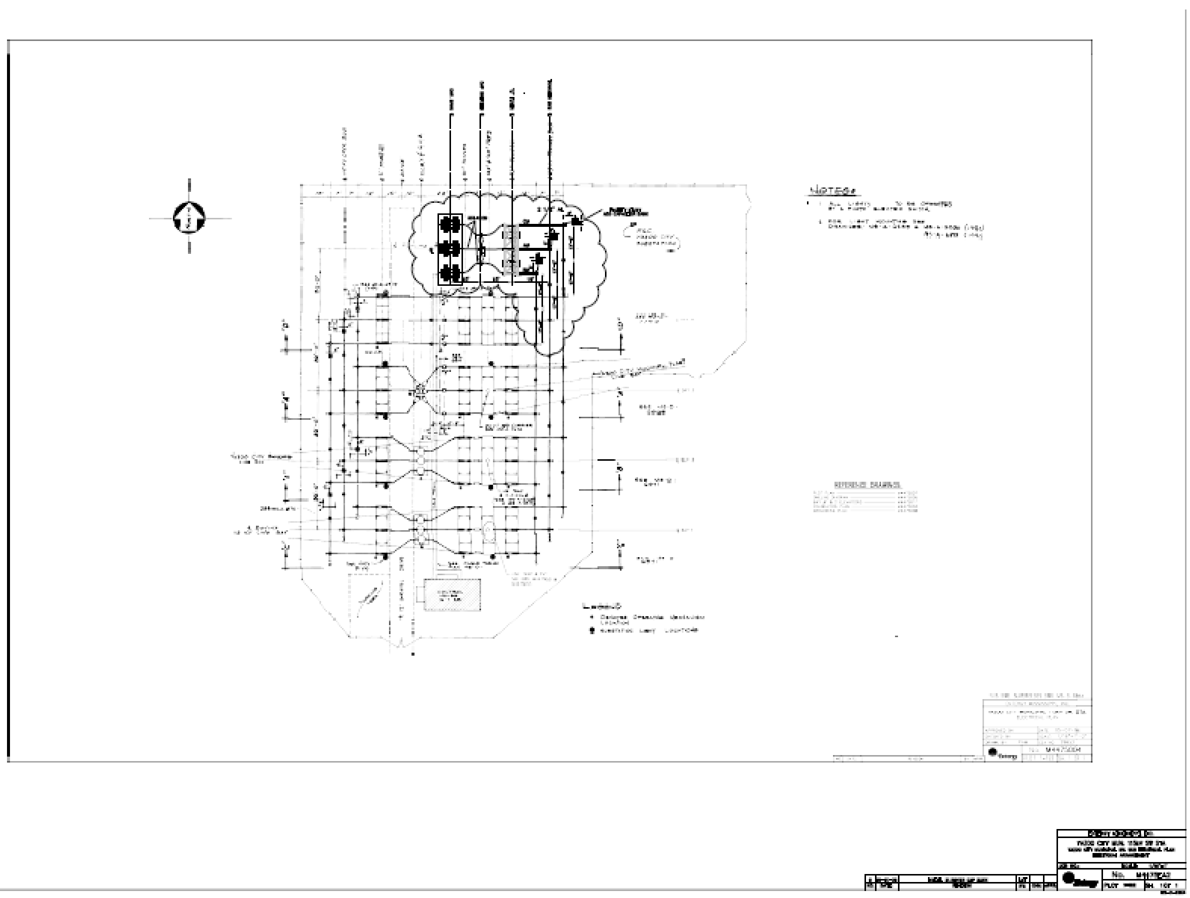


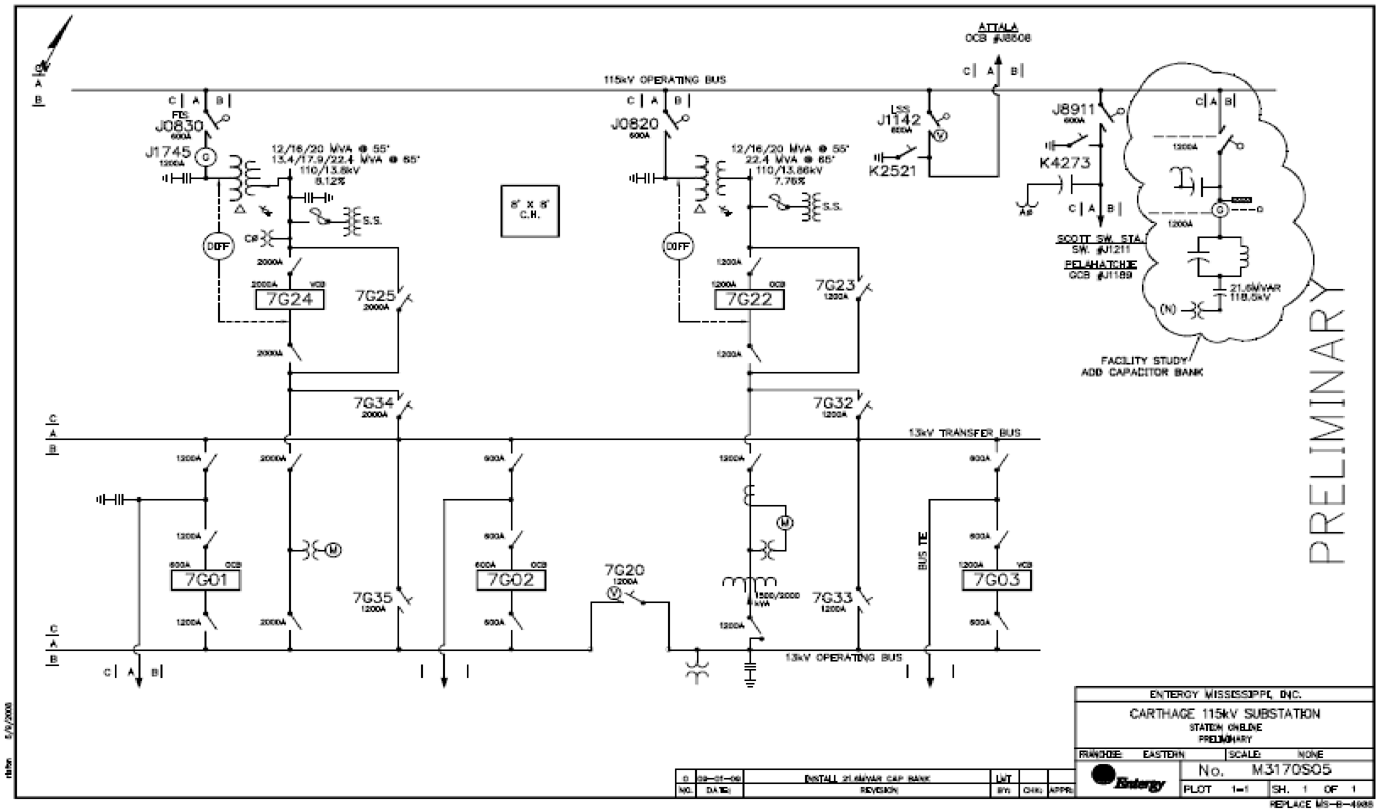
C. One Line Drawings

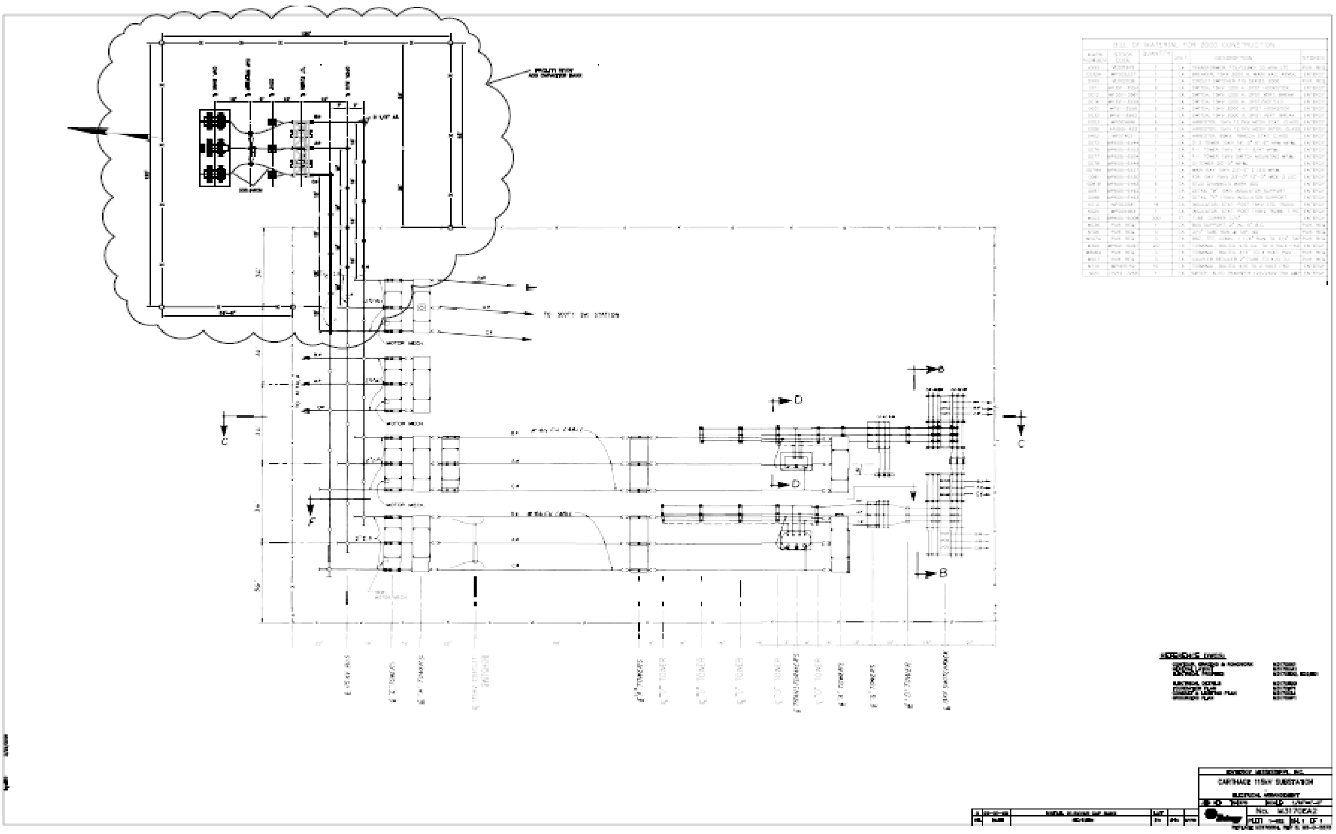


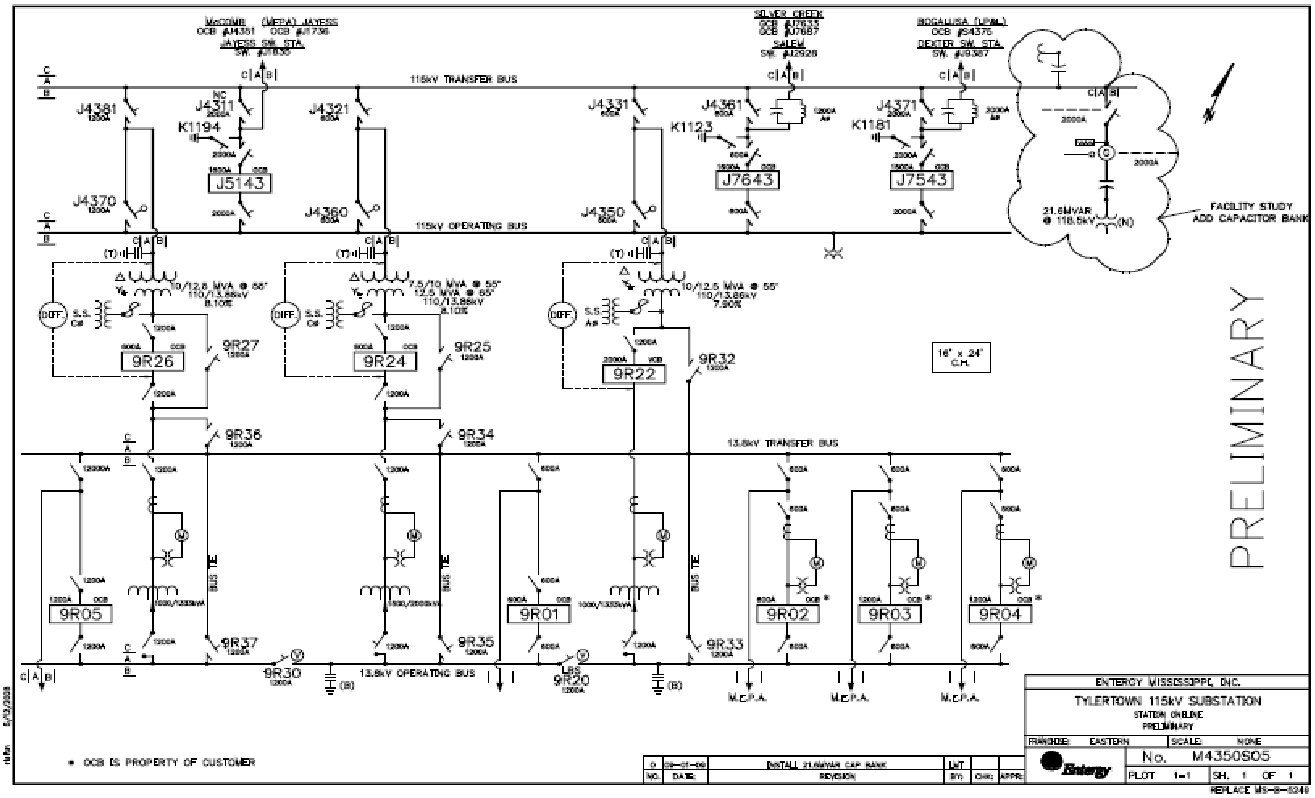


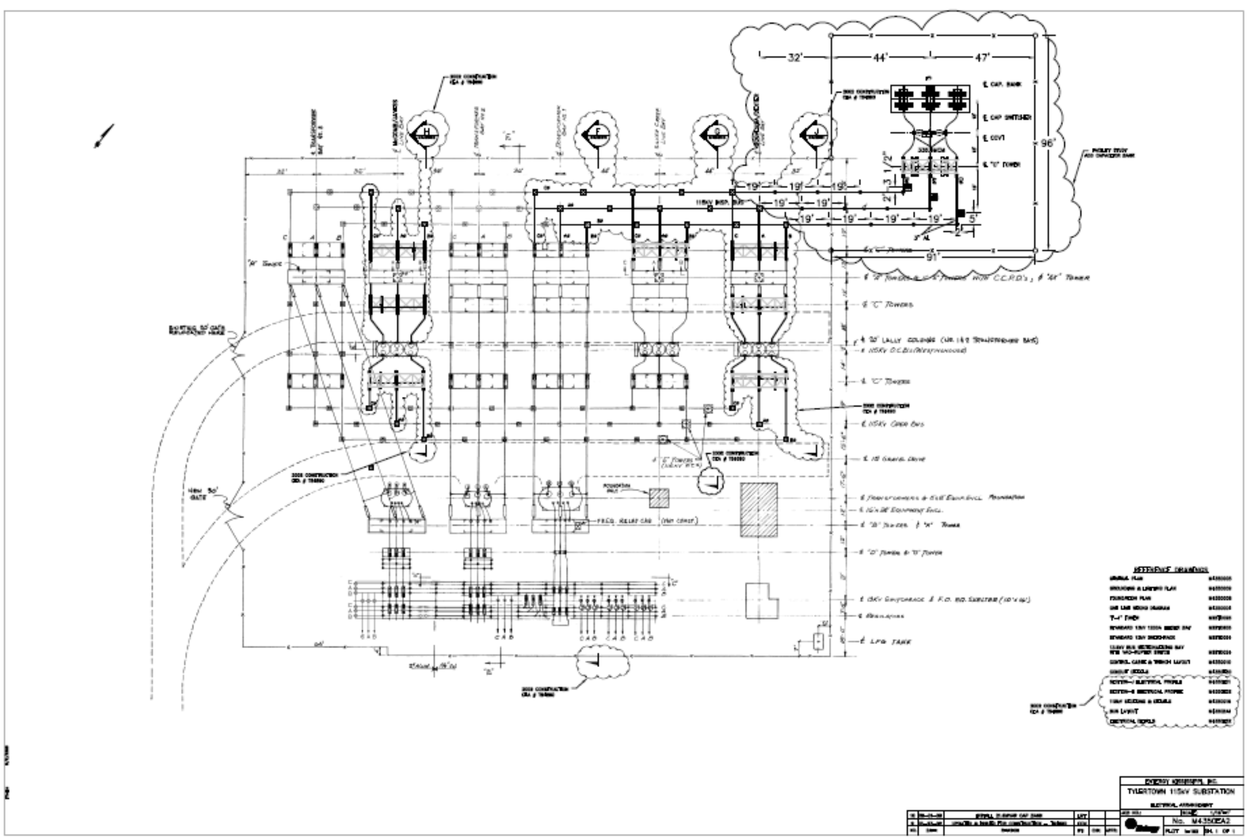

115kV OPERATING BUS
115kV TRANSFER BUS
J8262
J8254
J8276
J8250
J8278
K3026
K1054
K4051
K5032
J8251
J8261
J8271
J8281
16'x28' C.H.
FACILITY STUDY ADD CAPACITOR BANK
21.6MVAR @ 118.5kV
YAZOO CITY MUN. PLANT
YAZOO CITY MUN. SUB.
* WARNING: BLOCK BUS DIFFERENTIAL PRIOR TO CLOSING J8281
PRELIMINARY
ENTERGY MISSISSIPPI, INC.
YAZOO CITY MUN. 115kV SW STA
STATION ONELINE
PRELIMINARY
INSTALL 21.6MVAR CAP BANK
No. M4475S05

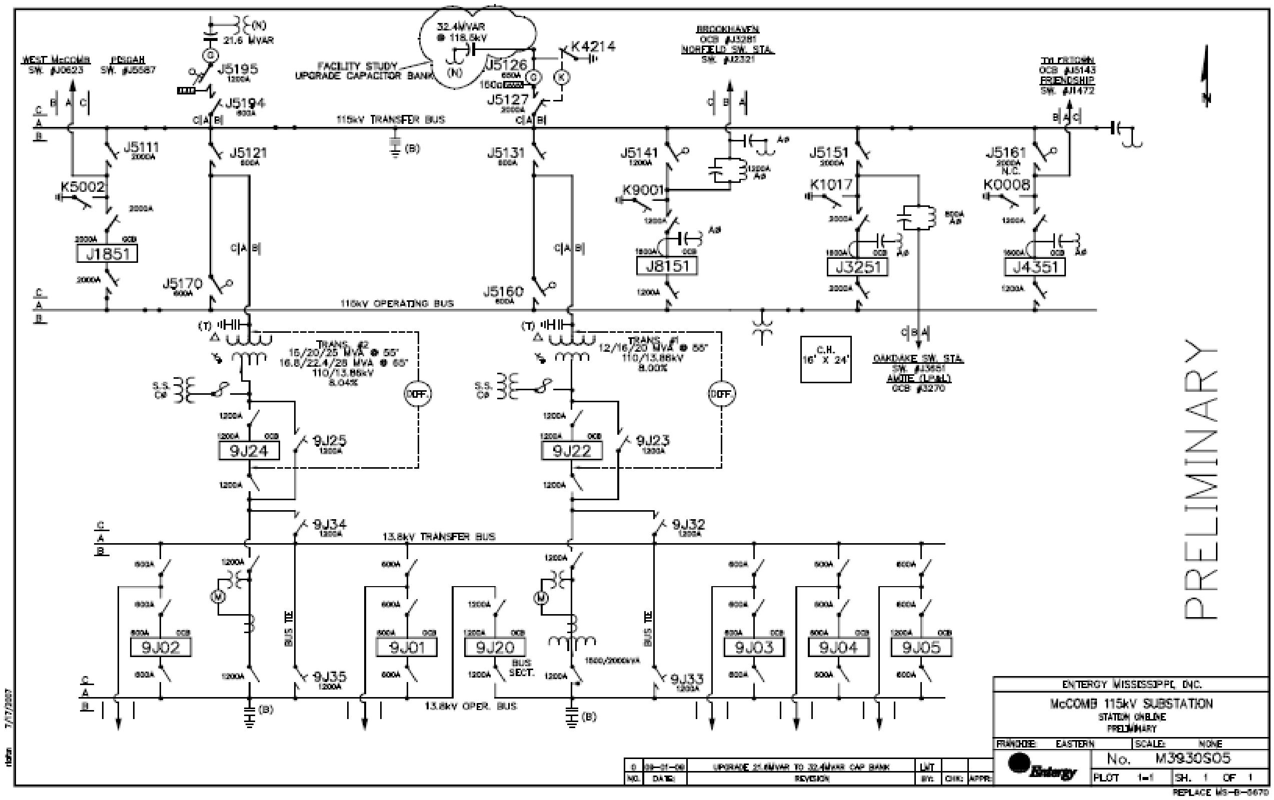


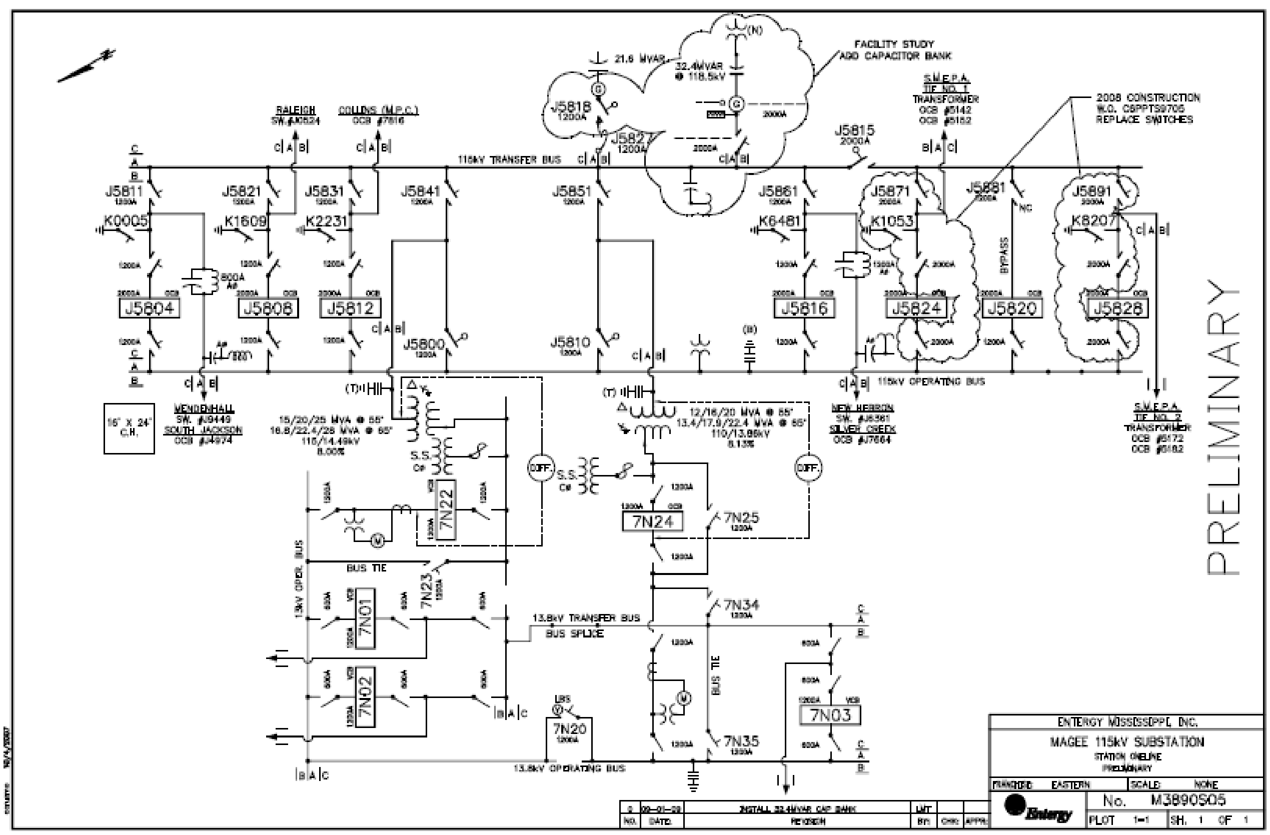

115kV OPERATING BUS
ATTALA OCB #J8508
J0830
J1745
J0820
J1142
K2521
J8911
K4273
12/16/20 MVA @ 55°
13.4/17.9/22.4 MVA @ 65°
110/13.8kV
8.12%
12/16/20 MVA @ 55°
22.4 MVA @ 65°
110/13.86kV
7.76%
8' x 8' C.H.
7G24
7G25
7G22
7G23
7G34
7G32
SCOTT SW. STA. SW. #J1211
PELAHATCHIE OCB #J1189
21.6MVAR 118.5kV
FACILITY STUDY ADD CAPACITOR BANK
13kV TRANSFER BUS
7G01
7G02
7G03
7G20
7G35
7G33
BUS TIE
13kV OPERATING BUS
PRELIMINARY
ENTERGY MISSISSIPPI, INC.
CARTHAGE 115kV SUBSTATION
STATION ONELINE
PRELIMINARY
FRANCHISE: EASTERN
SCALE: NONE
No. M3170S05
PLOT 1=1
SH. 1 OF 1
REPLACE MS-8-4988
INSTALL 21.6MVAR CAP BANK

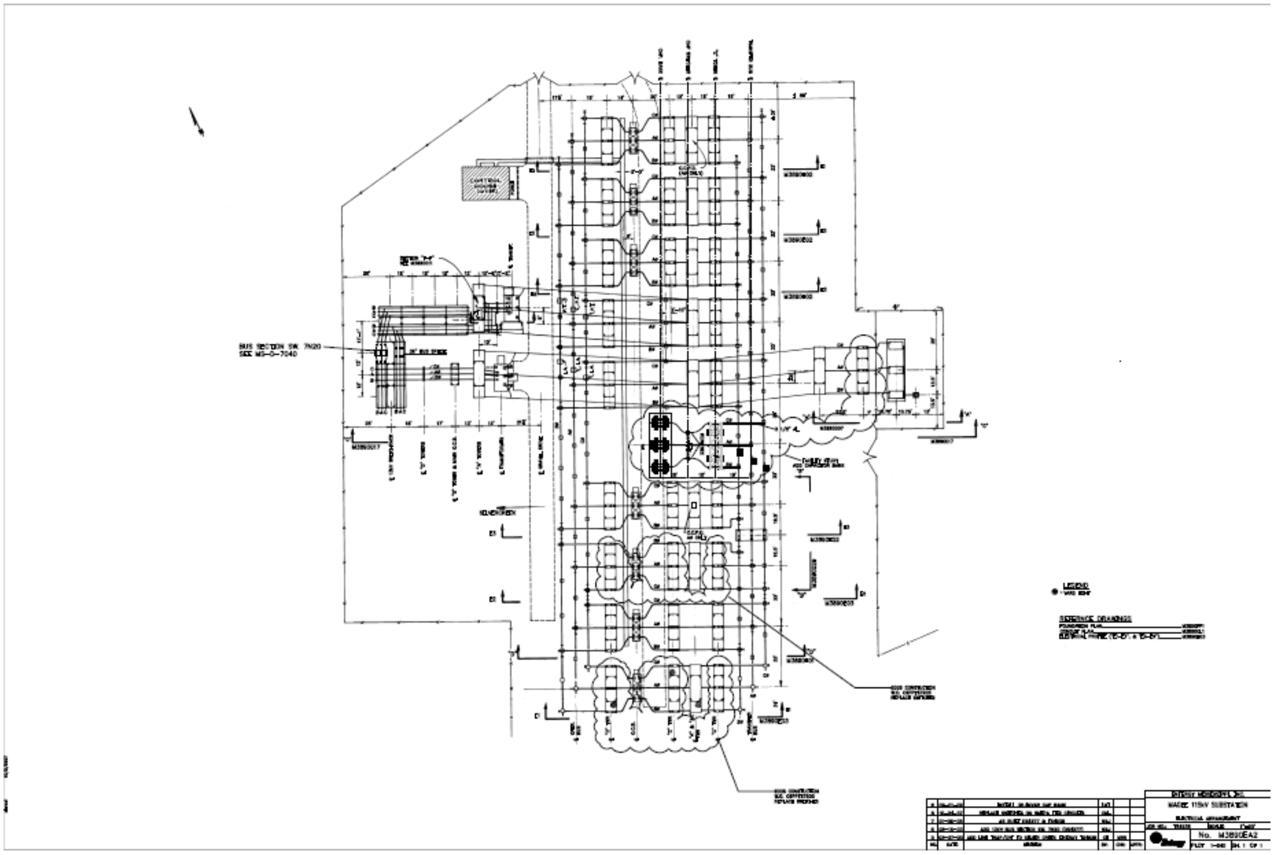



115kV TRANSFER BUS
115kV OPERATING BUS
13.8kV TRANSFER BUS
13.8kV OPERATING BUS
J4381
J4311
K1194
J5143
J4370
J4321
J4360
J4331
J4350
J4361
K1123
J7643
J4371
K1181
J7543
9R26
9R27
9R24
9R25
9R22
9R32
9R36
9R34
9R05
9R01
9R02
9R03
9R04
9R37
9R30
9R35
9R20
9R33
21.6MVAR @ 118.5kV
FACILITY STUDY ADD CAPACITOR BANK
16' x 24' C.H.
PRELIMINARY
M.E.P.A.
* OCB IS PROPERTY OF CUSTOMER
ENTERGY MISSISSIPPI, INC.
TYLERTOWN 115kV SUBSTATION
STATION ONELINE
PRELIMINARY
No. M4350S05
INSTALL 21.6MVAR CAP BANK
REPLACE MS-8-5249

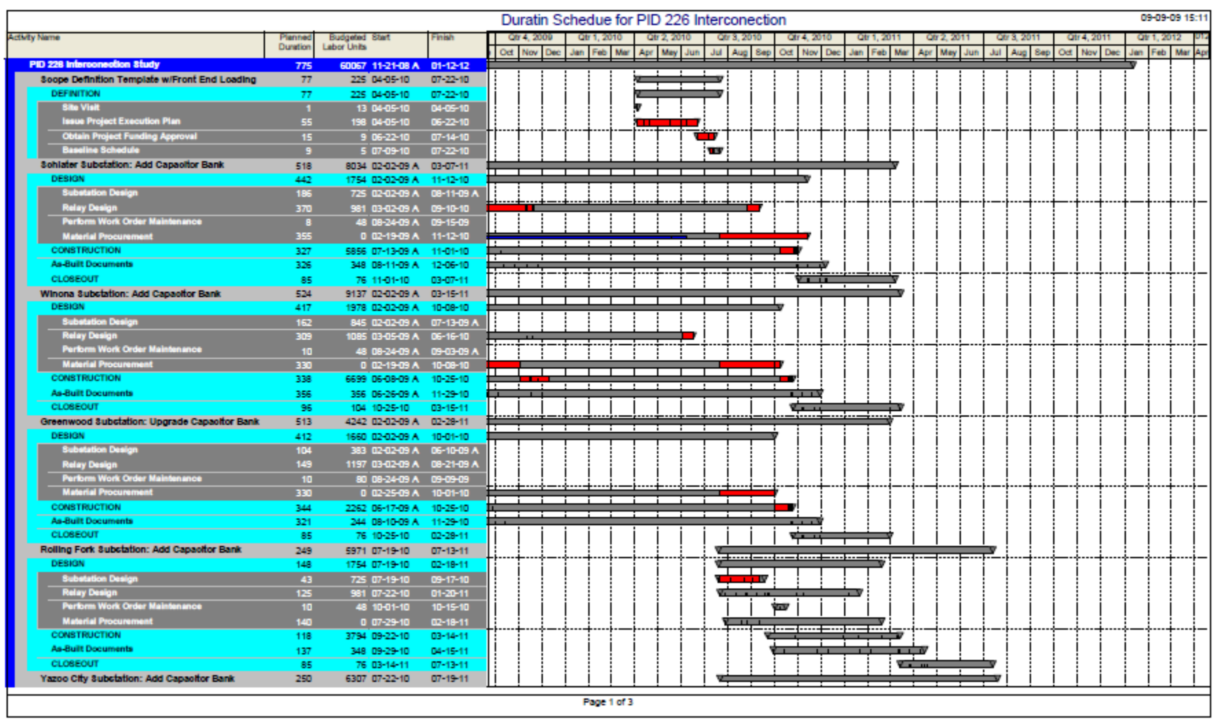

32'
44'
47'
96'
91'
19'
REFERENCE DRAWINGS
ENTERGY MISSISSIPPI, INC.
TYLERTOWN 115kV SUBSTATION


FACILITY STUDY UPGRADE CAPACITOR BANK
32.4MVAR @ 118.5kV
21.6 MVAR
115kV TRANSFER BUS
115kV OPERATING BUS
13.8kV TRANSFER BUS
13.8kV OPER. BUS
PRELIMINARY
ENTERGY MISSISSIPPI, INC.
McCOMB 115kV SUBSTATION
STATION ONELINE
PRELIMINARY
No. M3930S05
UPGRADE 21.6MVAR TO 32.4MVAR CAP BANK


FACILITY STUDY ADD CAPACITOR BANK
32.4MVAR @ 118.5kV
21.6 MVAR
2008 CONSTRUCTION W.O. C5PPTS9705 REPLACE SWITCHES
115kV TRANSFER BUS
115kV OPERATING BUS
13.8kV TRANSFER BUS
13.8kV OPERATING BUS
PRELIMINARY
ENTERGY MISSISSIPPI, INC.
MAGEE 115kV SUBSTATION
STATION ONELINE
PRELIMINARY
No. M3890S05
INSTALL 32.4MVAR CAP BANK



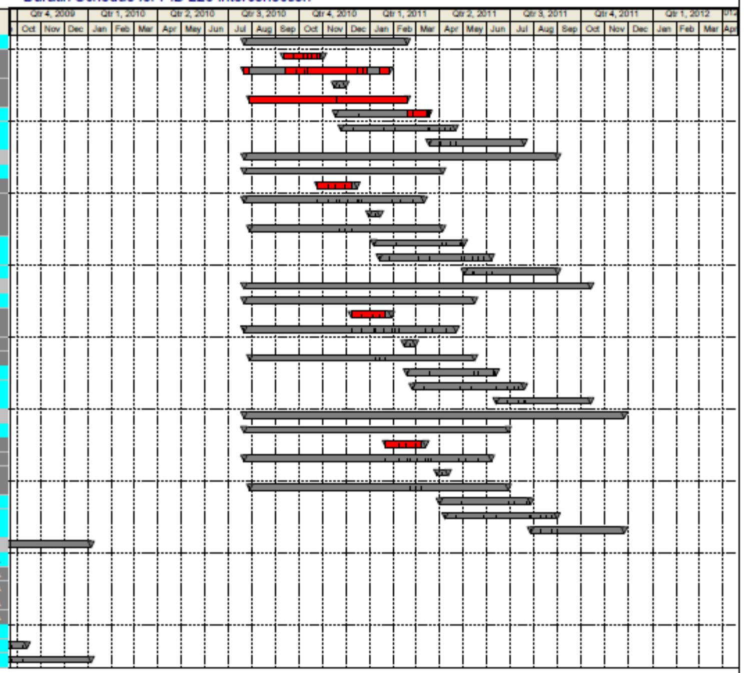
D. Duration Schedule



Activity Name	Planned Duration	Budgeted Labor Units	Start	Finish
PID 226 Interconection Study	775	60067	11-21-08 A	01-12-12
Scope Definition Template w/Front End Loading	77	225	04-05-10	07-22-10
DEFINITION	77	225	04-05-10	07-22-10
Site Visit	1	13	04-05-10	04-05-10
Issue Project Execution Plan	55	198	04-05-10	06-22-10
Obtain Project Funding Approval	15	9	06-22-10	07-14-10
Baseline Schedule	9	5	07-09-10	07-22-10
Schlater Substation: Add Capacitor Bank	518	8034	02-02-09 A	03-07-11
DESIGN	442	1754	02-02-09 A	11-12-10
Substation Design	186	725	02-02-09 A	08-11-09 A
Relay Design	370	981	03-02-09 A	09-10-10
Perform Work Order Maintenance	8	48	08-24-09 A	09-15-09
Material Procurement	355	0	02-19-09 A	11-12-10
CONSTRUCTION	327	5856	07-13-09 A	11-01-10
As-Built Documents	326	348	08-11-09 A	12-06-10
CLOSEOUT	85	76	11-01-10	03-07-11
Winona Substation: Add Capacitor Bank	524	9137	02-02-09 A	03-15-11
DESIGN	417	1978	02-02-09 A	10-08-10
Substation Design	162	845	02-02-09 A	07-13-09 A
Relay Design	309	1085	03-05-09 A	06-16-10
Perform Work Order Maintenance	10	48	08-24-09 A	09-03-09 A
Material Procurement	330	0	02-19-09 A	10-08-10
CONSTRUCTION	338	6699	06-08-09 A	10-25-10
As-Built Documents	356	356	06-26-09 A	11-29-10
CLOSEOUT	96	104	10-25-10	03-15-11
Greenwood Substation: Upgrade Capacitor Bank	513	4242	02-02-09 A	02-28-11
DESIGN	412	1660	02-02-09 A	10-01-10
Substation Design	104	383	02-02-09 A	06-10-09 A
Relay Design	149	1197	03-02-09 A	08-21-09 A
Perform Work Order Maintenance	10	80	08-24-09 A	09-09-09
Material Procurement	330	0	02-25-09 A	10-01-10
CONSTRUCTION	344	2262	06-17-09 A	10-25-10
As-Built Documents	321	244	08-10-09 A	11-29-10
CLOSEOUT	85	76	10-25-10	02-28-11
Rolling Fork Substation: Add Capacitor Bank	249	5971	07-19-10	07-13-11
DESIGN	148	1754	07-19-10	02-18-11
Substation Design	43	725	07-19-10	09-17-10
Relay Design	125	981	07-22-10	01-20-11
Perform Work Order Maintenance	10	48	10-01-10	10-15-10
Material Procurement	140	0	07-29-10	02-18-11
CONSTRUCTION	118	3794	09-22-10	03-14-11
As-Built Documents	137	348	09-29-10	04-15-11
CLOSEOUT	85	76	03-14-11	07-13-11
Yazoo City Substation: Add Capacitor Bank	250	6307	07-22-10	07-19-11

Duratin Schedue for PID 226 Interconection 09-09-09 15:11

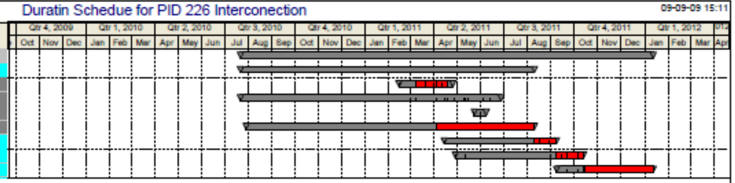
Activity Name	Planned Duration	Budgeted Labor Units	Start	Finish
DESIGN	145	1754	07-22-10	02-18-11
Substation Design	36	725	09-10-10	11-01-10
Relay Design	129	981	07-22-10	01-26-11
Perform Work Order Maintenance	10	48	11-15-10	11-30-10
Material Procurement	140	0	07-29-10	02-18-11
CONSTRUCTION	82	4130	11-17-10	03-18-11
As-Built Documents	101	348	11-24-10	04-21-11
CLOSEOUT	85	76	03-18-11	07-19-11
Carthage Substation: Add Capacitor Bank	281	6307	07-22-10	08-31-11
DESIGN	176	1754	07-22-10	04-04-11
Substation Design	35	725	10-25-10	12-14-10
Relay Design	160	981	07-22-10	03-11-11
Perform Work Order Maintenance	10	48	12-30-10	01-14-11
Material Procurement	171	0	07-29-10	04-04-11
CONSTRUCTION	82	4130	01-05-11	05-02-11
As-Built Documents	101	348	01-12-11	06-06-11
CLOSEOUT	85	76	05-02-11	08-31-11
Tylertown Substation: Add Capacitor Bank	311	6979	07-22-10	10-13-11
DESIGN	206	1754	07-22-10	05-16-11
Substation Design	35	725	12-07-10	01-28-11
Relay Design	190	981	07-22-10	04-22-11
Perform Work Order Maintenance	10	48	02-14-11	02-28-11
Material Procurement	201	0	07-29-10	05-16-11
CONSTRUCTION	81	4802	02-17-11	06-13-11
As-Built Documents	101	348	02-24-11	07-19-11
CLOSEOUT	86	76	06-13-11	10-13-11
Magee Substation: Add Capacitor Bank	341	6307	07-22-10	11-25-11
DESIGN	236	1754	07-22-10	06-28-11
Substation Design	35	725	01-21-11	03-14-11
Relay Design	220	981	07-22-10	06-06-11
Perform Work Order Maintenance	10	48	03-28-11	04-11-11
Material Procurement	231	0	07-29-10	06-28-11
CONSTRUCTION	82	4130	03-31-11	07-27-11
As-Built Documents	101	348	04-07-11	08-30-11
CLOSEOUT	85	76	07-27-11	11-25-11
Delhi: Install 38MVAR Cap Bank	264	1884	11-21-08 A	01-05-10
DESIGN	192	1688	11-21-08 A	08-13-09 A
Substation Design	101	845	11-24-08 A	04-20-09 A
Relay Design	186	795	11-28-08 A	08-13-09 A
Perform Work Order Maintenance	14	48	02-16-09 A	05-11-09 A
Material Procurement	120	0	11-21-08 A	06-01-09 A
CONSTRUCTION	118	0	03-30-09 A	09-14-09
As-Built Documents	76	128	06-29-09 A	10-14-09
CLOSEOUT	80	68	09-10-09	01-05-10



Page 2 of 3

Duratin Schedue for PID 226 Interconection 09-09-09 15:11

Activity Name	Planned Duration	Budgeted Labor Units	Start	Finish
McComb Substation: Upgrade Capacitor Bank	372	4674	07-22-10	01-12-12
DESIGN	266	1660	07-22-10	08-10-11
Substation Design	50	383	02-14-11	04-25-11
Relay Design	235	1197	07-22-10	06-27-11
Perform Work Order Maintenance	10	80	05-23-11	06-07-11
Material Procurement	261	0	07-29-10	08-10-11
CONSTRUCTION	102	2694	04-14-11	09-08-11
As-Built Documents	117	244	04-28-11	10-13-11
CLOSEOUT	86	76	09-08-11	01-12-12



Page 3 of 3

E. ABB Facility Analysis Study

The ICT commissioned a separate stability study for this Facilities Study report and the following results have been provided:

POWER SYSTEMS DIVISION
GRID SYSTEMS CONSULTING

STABILITY ANALYSIS FOR FACILITY STUDY OF PID-226

FINAL REPORT

REPORT NO.: 2009-E3350-R1
Issued On: August 19, 2009
Revised on: August 27, 2009

Prepared for:
Southwest Power Pool, Inc.

ABB Inc.
Power Systems Division
Grid Systems Consulting
940 Main Campus Drive, Suite 300
Raleigh, NC 27606

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ABB Inc – Grid Systems Consulting **Technical Report**

Southwest Power Pool, Inc.	**No.** 2009-E3350-R1	
Facility Study for PID-226	Date: 8/21/2009	# Pages 45

Author(s):	**Reviewed by:**	**Approved by:**
Trinadh Dwibhashyam	Amit Kekare	Willie Wong

Executive Summary

Southwest Power Pool, Inc (SPP) at the request of Entergy Services Inc. has commissioned ABB Inc. to perform a stability analysis for Facility study of PID-226, which is a request for 206 MW uprate of existing G. Gulf Unit #1 in the Entergy transmission system.

A system impact study for the PID-226 has previously been completed. The objective of this study was to supplement the stability analysis performed in the system impact study for PID-226 Project. To that end, selected faults at G. Gulf 500 kV substation were simulated and a Critical Clearing Time Analysis was performed at G. Gulf 500 kV substation. The study was performed on 2012 Summer Peak case, provided by SPP/Entergy.

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

The Critical Clearing times at G. Gulf 500 kV substations are within the capabilities of the existing protection systems. The smallest CCT at G. Gulf 500 kV substation was 5 + 15 cycles for a fault involving loss of G. Gulf – B. Wilson 500 kV.

Based on the results of stability analysis it can be concluded that proposed PID-226 project does not adversely impact the stability of the Entergy System in the local area. Also, PID-226 does not adversely impact the Critical Clearing time at G. Gulf 500 kV substations. Hence, no transmission reinforcements and/ or upgrades were identified for the interconnection of the PID-226 project.

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.

Rev No.	Revision Description	Date	Authored by	Reviewed by	Approved by
0	Draft Report	8/21/09	Trinadh	A. Kekare	W. Wong
1	Updated per Entergy comments	8/27/09	Trinadh	A. Kekare	W. Wong

DISTRIBUTION:
Daniel Epperson – Southwest Power Pool, Inc.
Brad Finkbeiner – Southwest Power Pool, Inc.
Mukund Chander – Entergy Services Inc.

TABLE OF CONTENTS

1 INTRODUCTION

Southwest Power Pool, Inc. (SPP) at the request of Entergy Services Inc. has commissioned ABB Inc. to perform a stability analysis for Facility Study of PID-226, which is a request for 206 MW uprate of the existing G. Gulf Unit in the Entergy transmission system.

A system impact study[1] for the PID-226 has previously been completed. The objective of this study was to supplement the stability analysis performed in the system impact study for PID-226 Project. The study was performed on 2012 Summer Peak case, provided by Entergy. Figure 1-1 shows the location of the G. Gulf Unit with proposed 206 MW increase of generation.

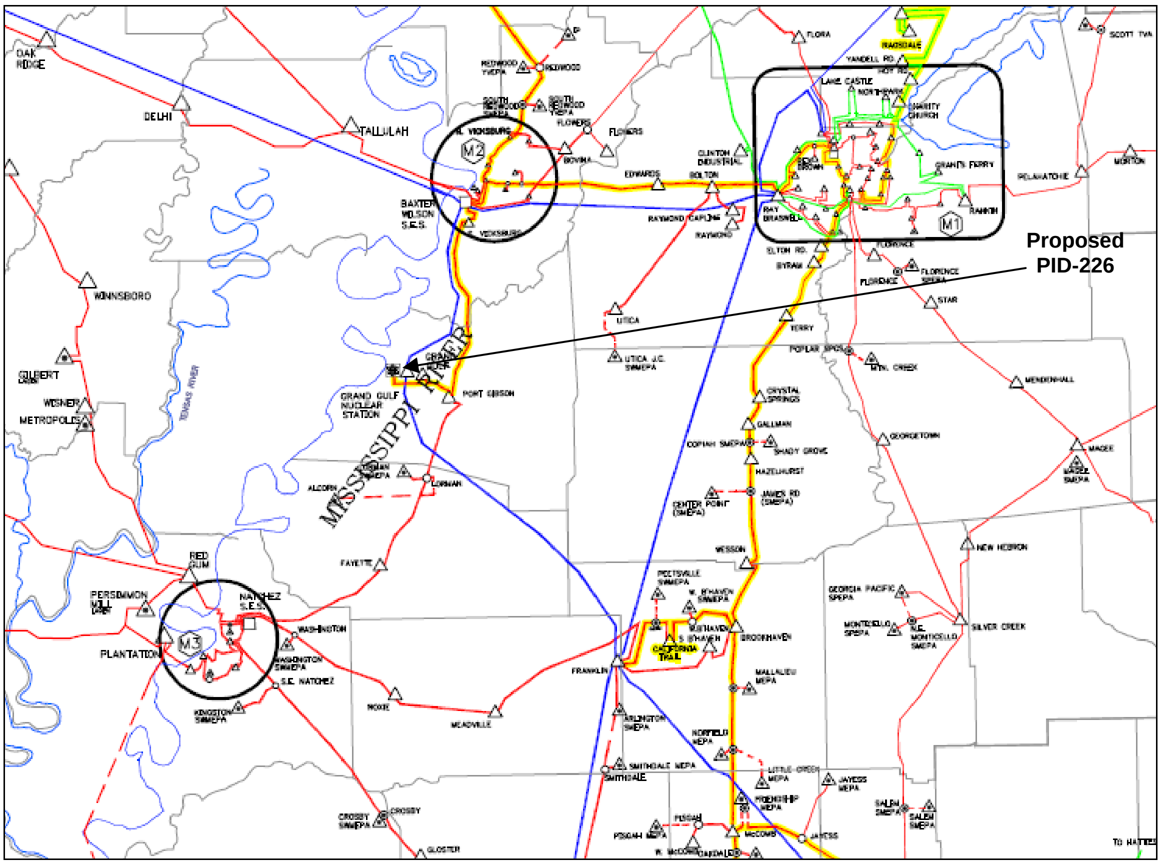


Figure 1-1 PID 226 Project location

[1] "Stability Analysis for PID-226 System Impact study", March 30, 2009

2 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^{TM} 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 2-4.

Transient Voltage Criteria

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 (above 115 kV) 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.

Critical Clearing Time (CCT) Analysis

An evaluation of the critical clearing times was carried out for faults on lines and transformers in the G. Gulf 500 kV substation

Critical Clearing Time assessment was performed on 2012 summer peak system conditions.

Critical Clearing Time (CCT) was calculated for a three-phase stuck-breaker fault on each branch connected to G. Gulf 500 kV substation. CCT is defined as the longest fault clearing time for which stability is maintained.

Independent pole operation (IPO) was assumed for breakers in both switchyards, with breaker failure occurring on only a single phase. This results in a three-phase fault becoming a single-phase fault at the normal clearing time. The single phase fault is then cleared by backup protection.

The Normal Clearing Time was kept equal to the normal value (5 cycles on 500 kV and 6 cycles on 230 kV) and the backup clearing time was varied to find the CCT. All machines in the Entergy system were monitored for stability.

2.2 STUDY MODEL DEVELOPMENT

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

Power Flow Case

A Powerflow case "EN12S08_Final_U2_With Upgrades_unconv.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 base case. 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 2-1 PID-226 project details

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

Figure 2-1 shows the PSS/E one-line diagram for the local area WITH the PID-226 project, for 2012 Summer Peak system conditions.

Stability Database

A base case 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 and the dynamic data in 'dystop.dyr' was appended to the base case stability database.

After the proposed uprate of the G. Gulf unit the total MW output of the plant will be 1544 MW, higher than the existing maximum limit (0.90 p.u. on 1600 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 0.97 p.u. on 1600 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.

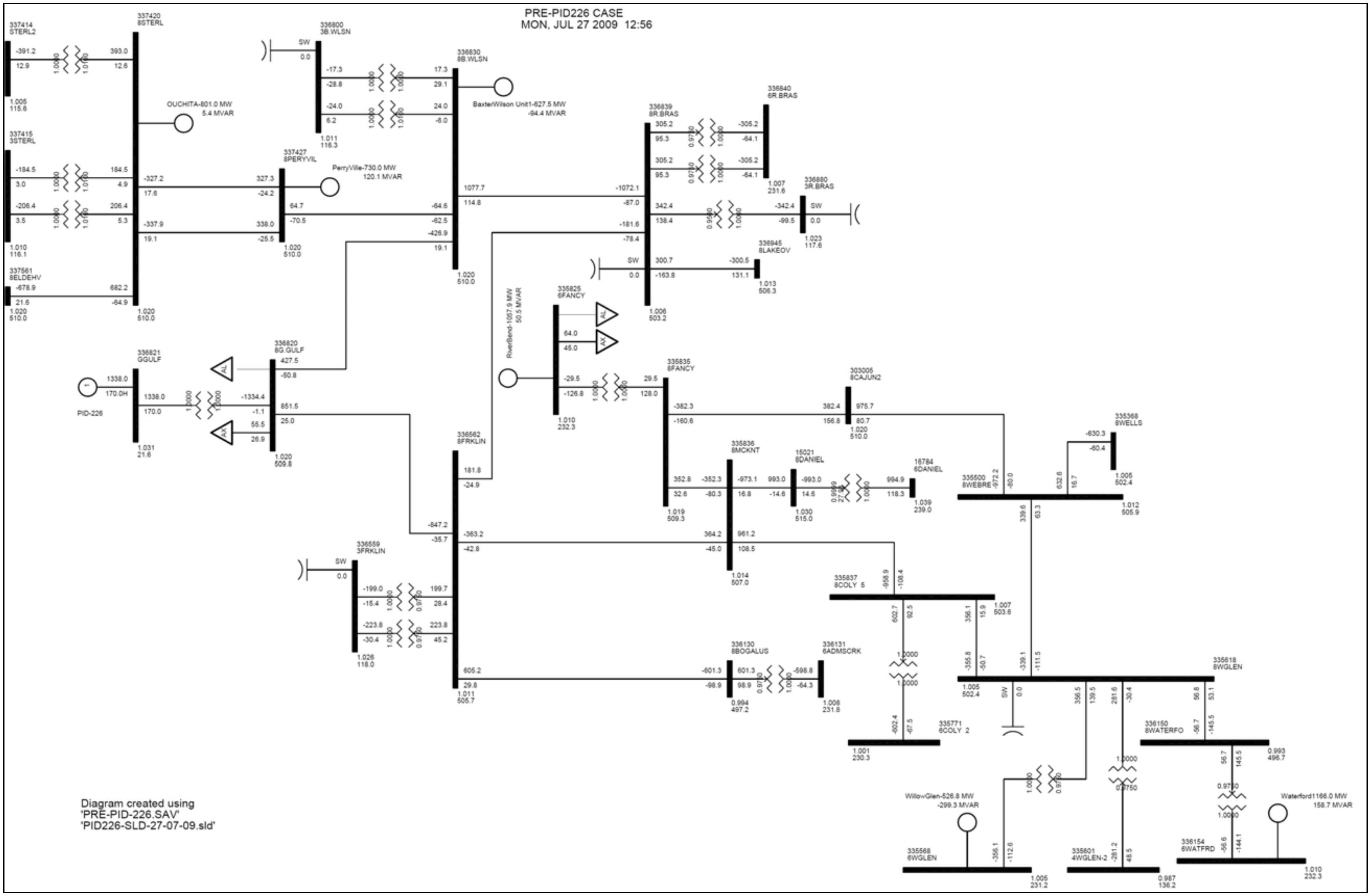


Figure 2-1 One-line Diagram of the local area <u>without</u> PID-226 (2012 Summer Peak)

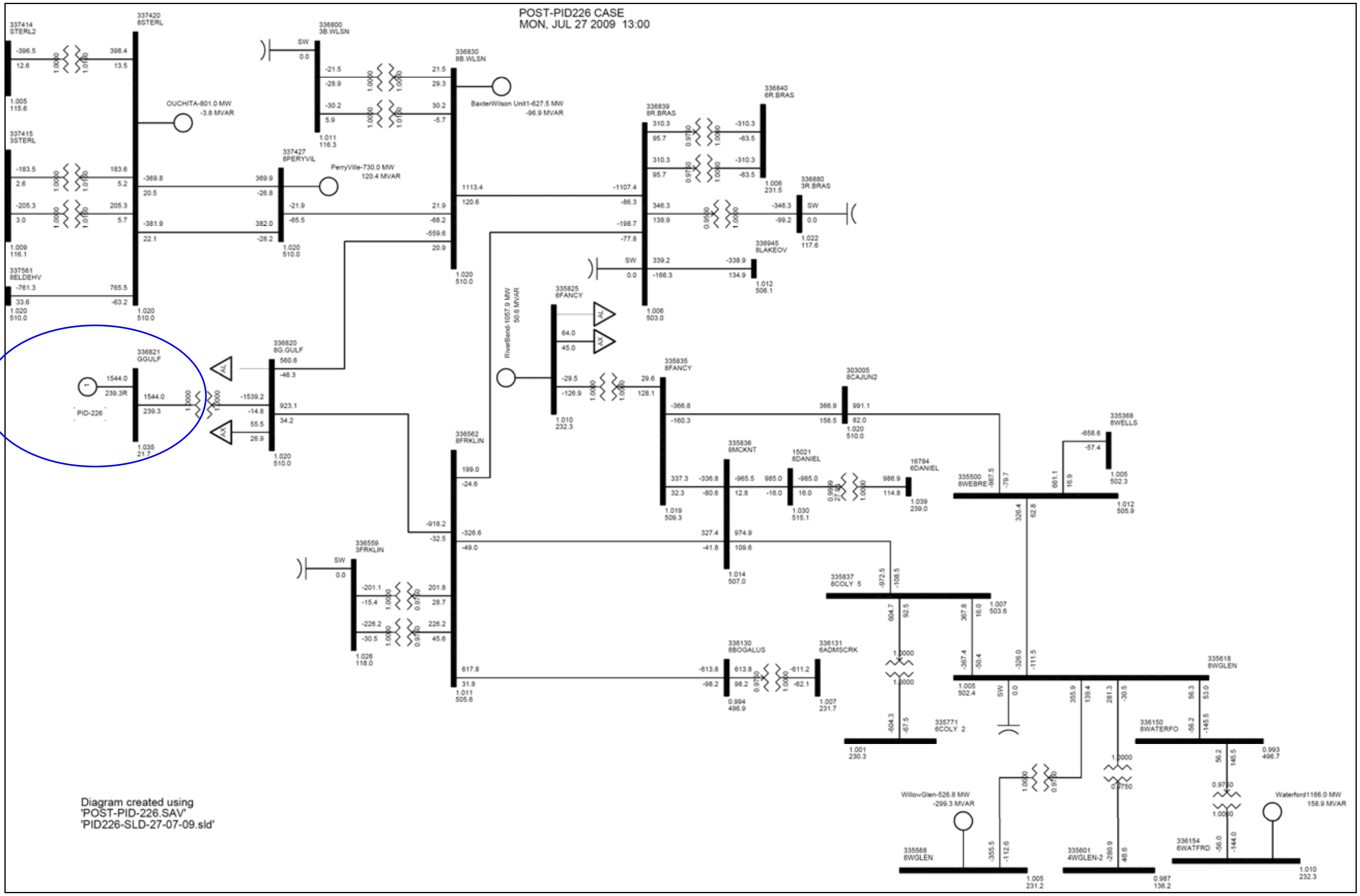


Figure 2-2 One-line Diagram of the local area with PID-226 (2012 Summer Peak)

2.3 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 2-2.

Table 2-2: 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 2-3 and Table 2-4 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.

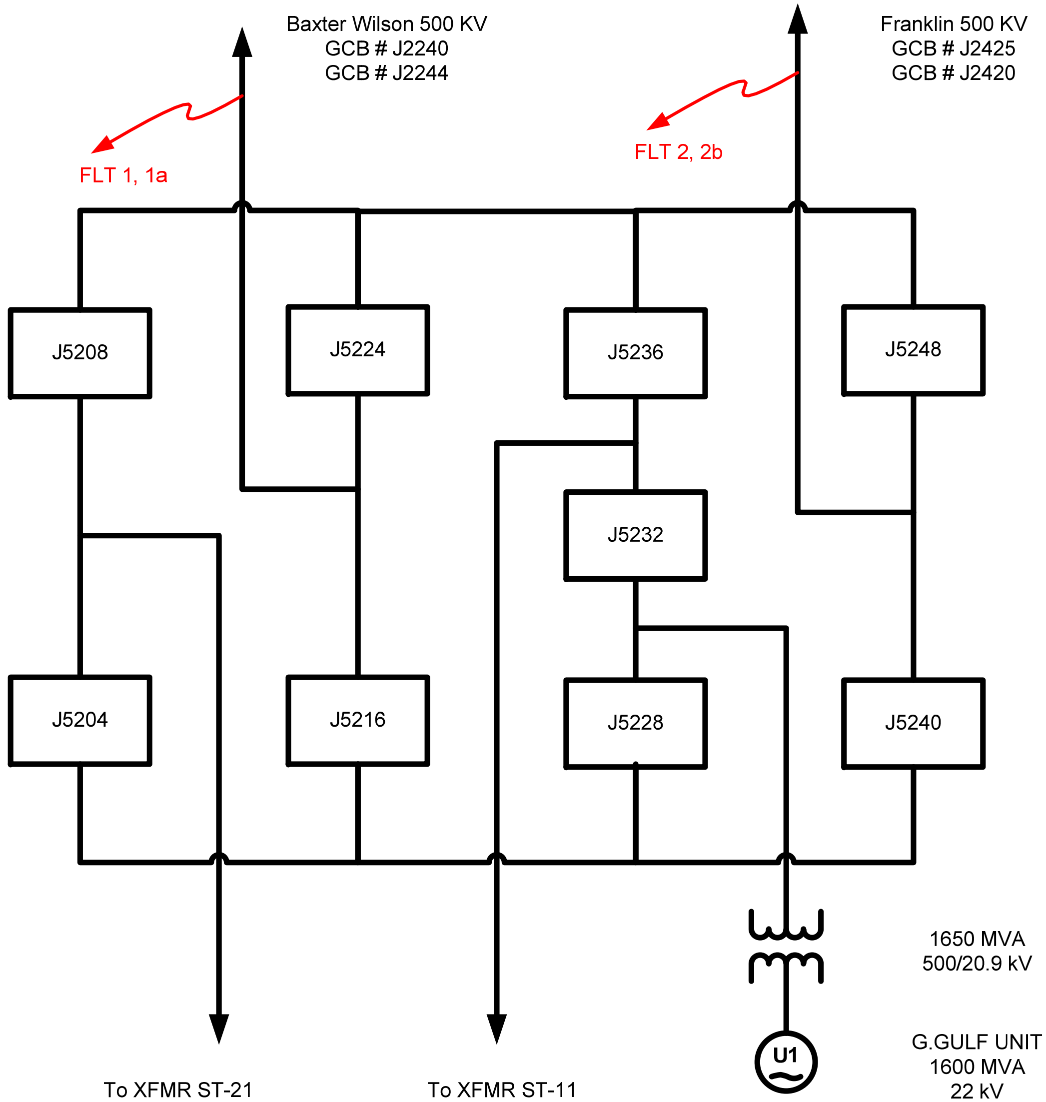
Table 2-3 List of 3 Phase faults simulated for stability analysis

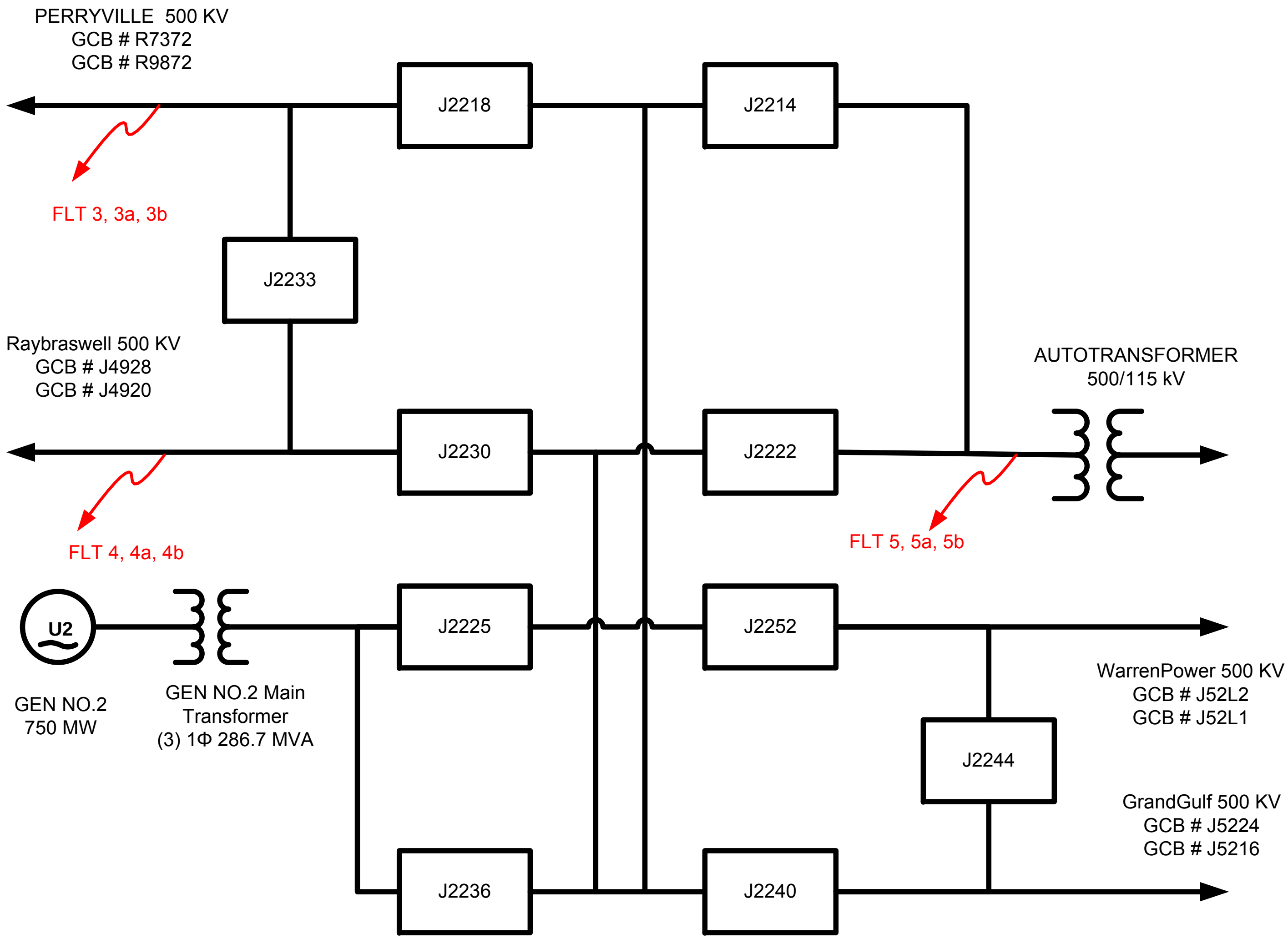
CASE	LOCATION	TYPE	CLEARING TIME (cycles)	BREAKER TRIP #	TRIPPED FACILITIES
FAULT-1	G. Gulf - B. Wilson 500 kV	3 PH	5	J5224, J5216, J2240, J2244	G. Gulf - B. Wilson 500 kV
FAULT-2	G. Gulf - Franklin 500 kV	3 PH	5	J2425, J2420, J5248, J5240	G. Gulf - Franklin 500 kV
FAULT-3	B. Wilson - Perryville 500 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

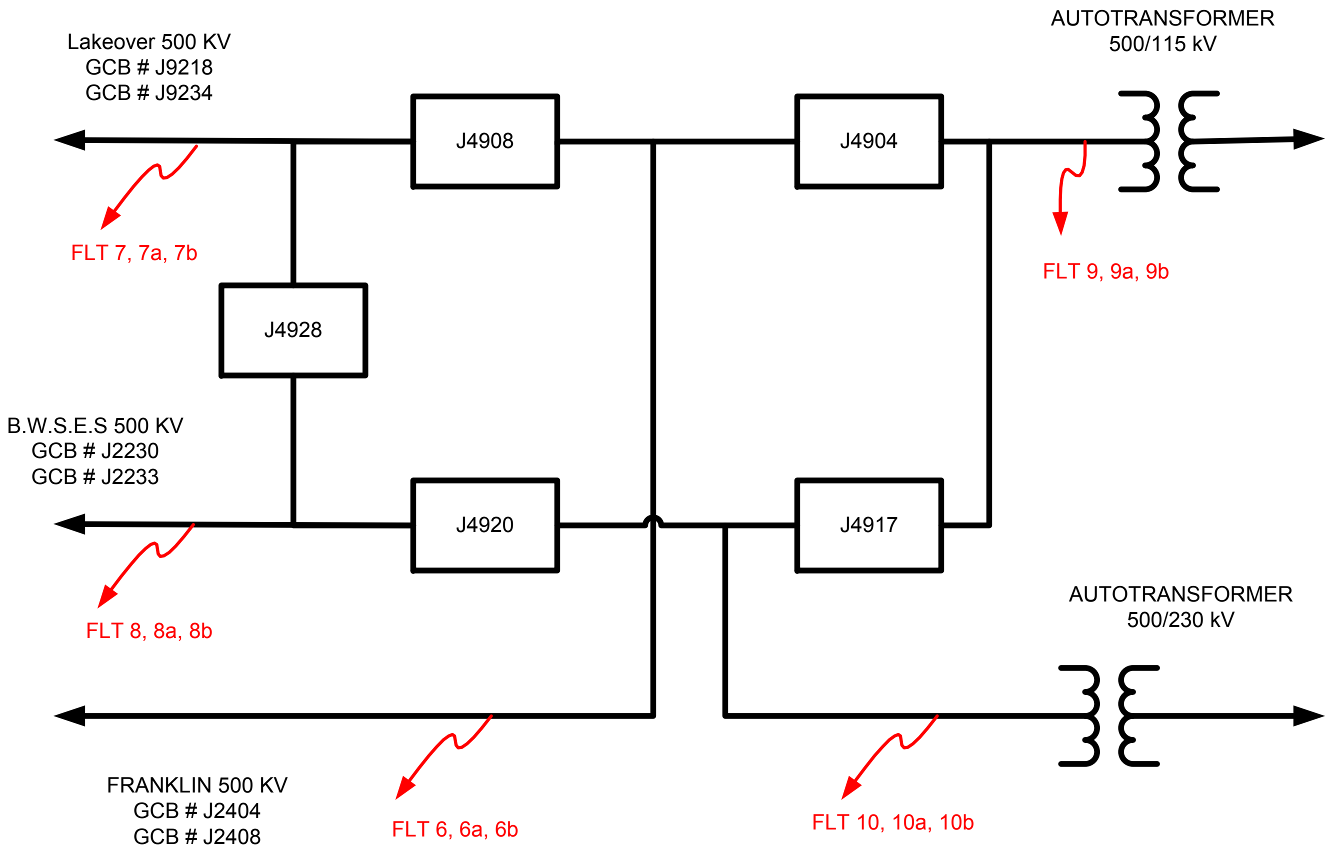
Table 2-4 List of 3 PhaseStuck Brekaer (IPO: 3PH-1PH) faults simulated for stability analysis

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
1650 MVA
500/20.9 kV
U1
G.GULF UNIT
1600 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


AUTOTRANSFORMER
500/115 kV
Lakeover 500 KV
GCB # J9218
GCB # J9234
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

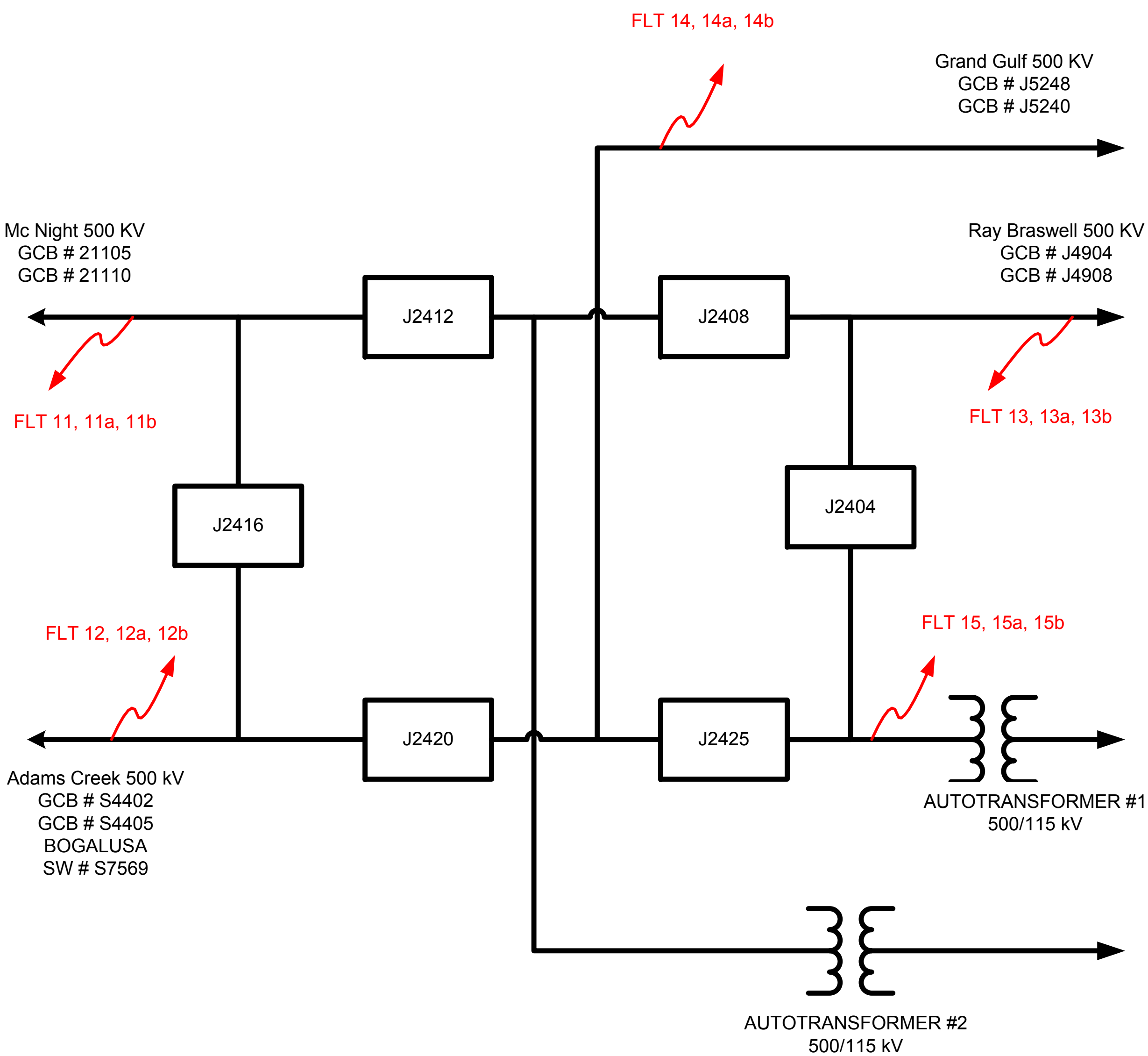

FLT 14, 14a, 14b
Grand Gulf 500 KV
GCB # J5248
GCB # J5240
Mc Night 500 KV
GCB # 21105
GCB # 21110
J2412
J2408
Ray Braswell 500 KV
GCB # J4904
GCB # J4908
FLT 11, 11a, 11b
FLT 13, 13a, 13b
J2416
J2404
FLT 12, 12a, 12b
FLT 15, 15a, 15b
J2420
J2425
Adams Creek 500 kV
GCB # S4402
GCB # S4405
BOGALUSA
SW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

Table 2-5 Results of faults simulated for stability analysis

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

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

Figure 2-3 and Figure 2-4 show plots for the G. Gulf unit response and the voltage recovery at POI following two selected faults.

Transient Voltage Recovery

The voltages at all buses in the Entergy system (above 115 kV) 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.

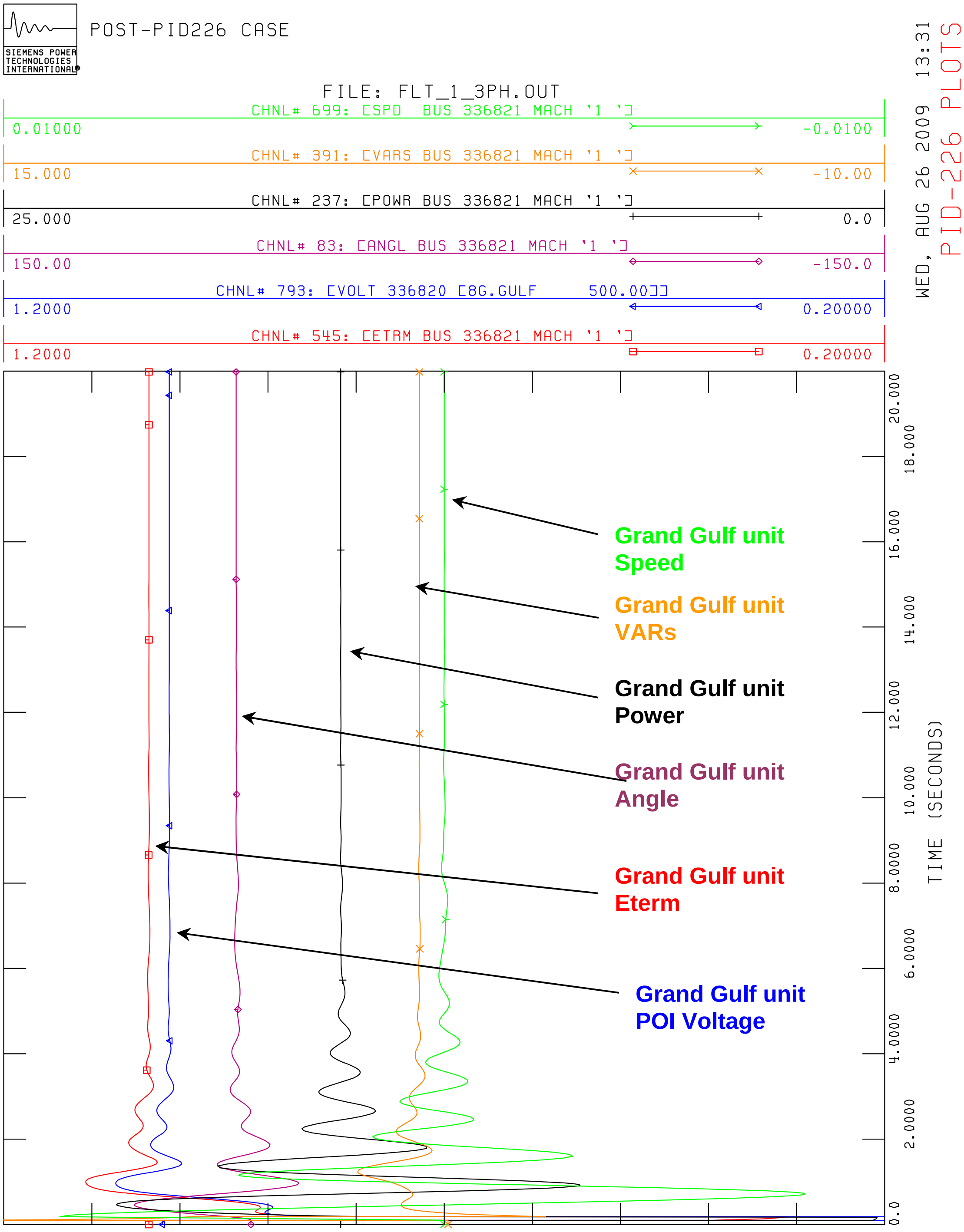


Figure 2-3 PID-226 Machine parameters for FLT_1_3PH

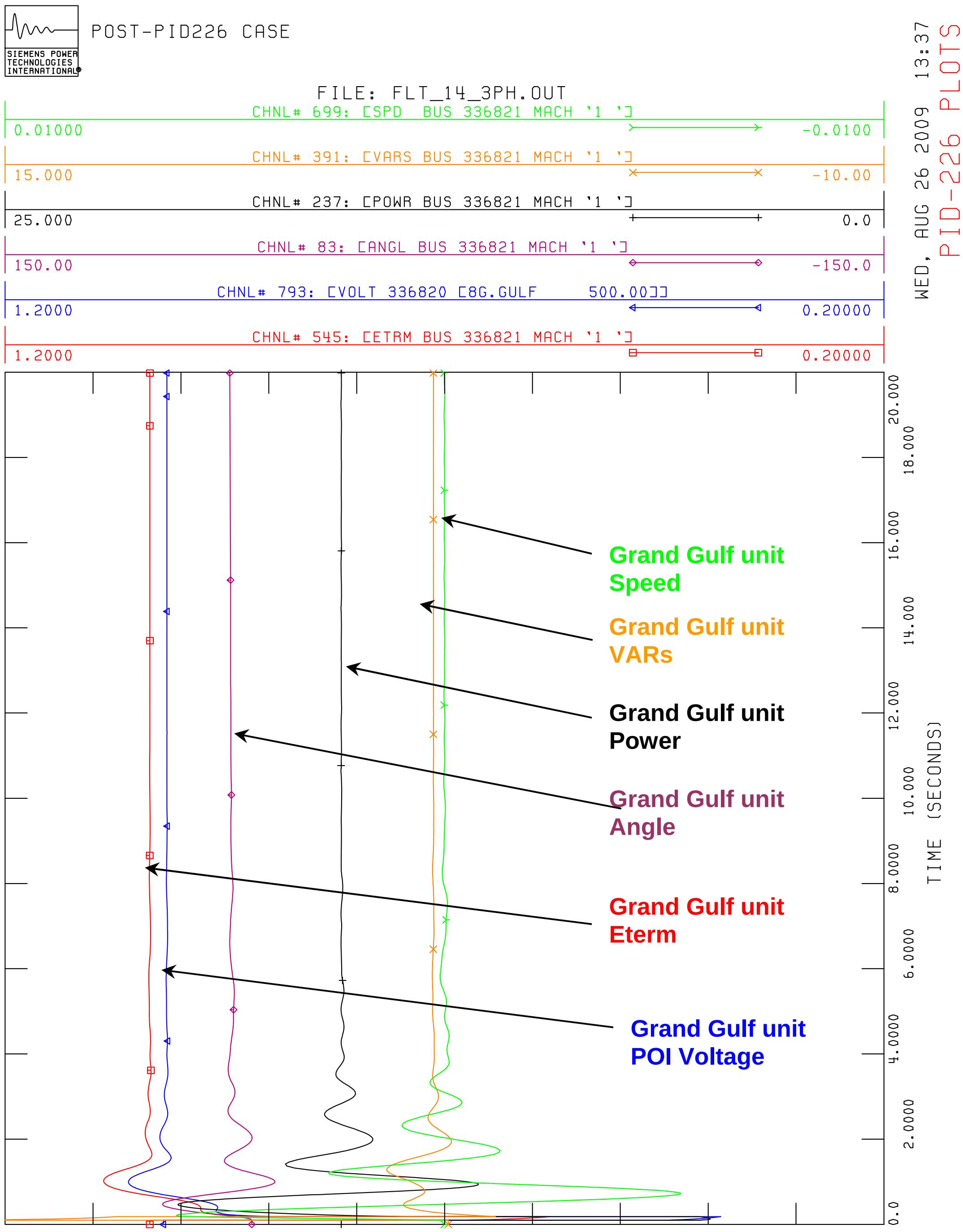


Figure 2-4 PID-226 Machine parameters for Fault _14_3PH

2.4 CRITICAL CLEARING TIME ANALYSIS

Evaluation of Critical Clearing Time (CCT) was carried out for faults at G. Gulf 500 kV substation. Two 3 phase stuck breaker (IPO operation) faults - Fault 1a and Fault 2b - at G. Gulf 500 kV substation were considered.

The primary Clearing Time was kept equal to the normal value (5 cycles on 500 kV and 6 cycles on 230 kV) and the backup clearing time was varied to find the CCT.

Table 2-6 shows the Critical Clearing Times calculated for the simulated faults with PID-222. Figure 2-5 and Figure 2-6 shows the excursions in the speed of G. Gulf unit following the two faults for both, WITH and WITHOUT PID-226 project.

Table 2-6: CCT Results

CASE	LOCATION	CCT (in cycles)		
		Primary clearing	Back-up Clearing	
			WITHOUT PID-226	WITH PID-226
FAULT_1a	G. Gulf - B. Wilson 500 kV	5	41	15
FAULT_2b	G. Gulf - Franklin 500 kV	5	46	18

It can be seen from the results that the smallest CCT at G. Gulf 500 kV substation was 5 + 15 cycles for a fault involving loss of G. Gulf – B. Wilson 500 kV line. The lowest critical clearing time 20 cycles (=5 + 15 cycles) is still larger than Entergy's standard clearing time of14 cycles (= 5 + 9 cycles) for 500 kV breakers.

Based on the results of critical clearing time analysis it can be concluded that proposed PID-226 project (206 MW uprate of G. Gulf Unit#1) does not adversely impact the critical clearing at G. gulf 500 kV substation.

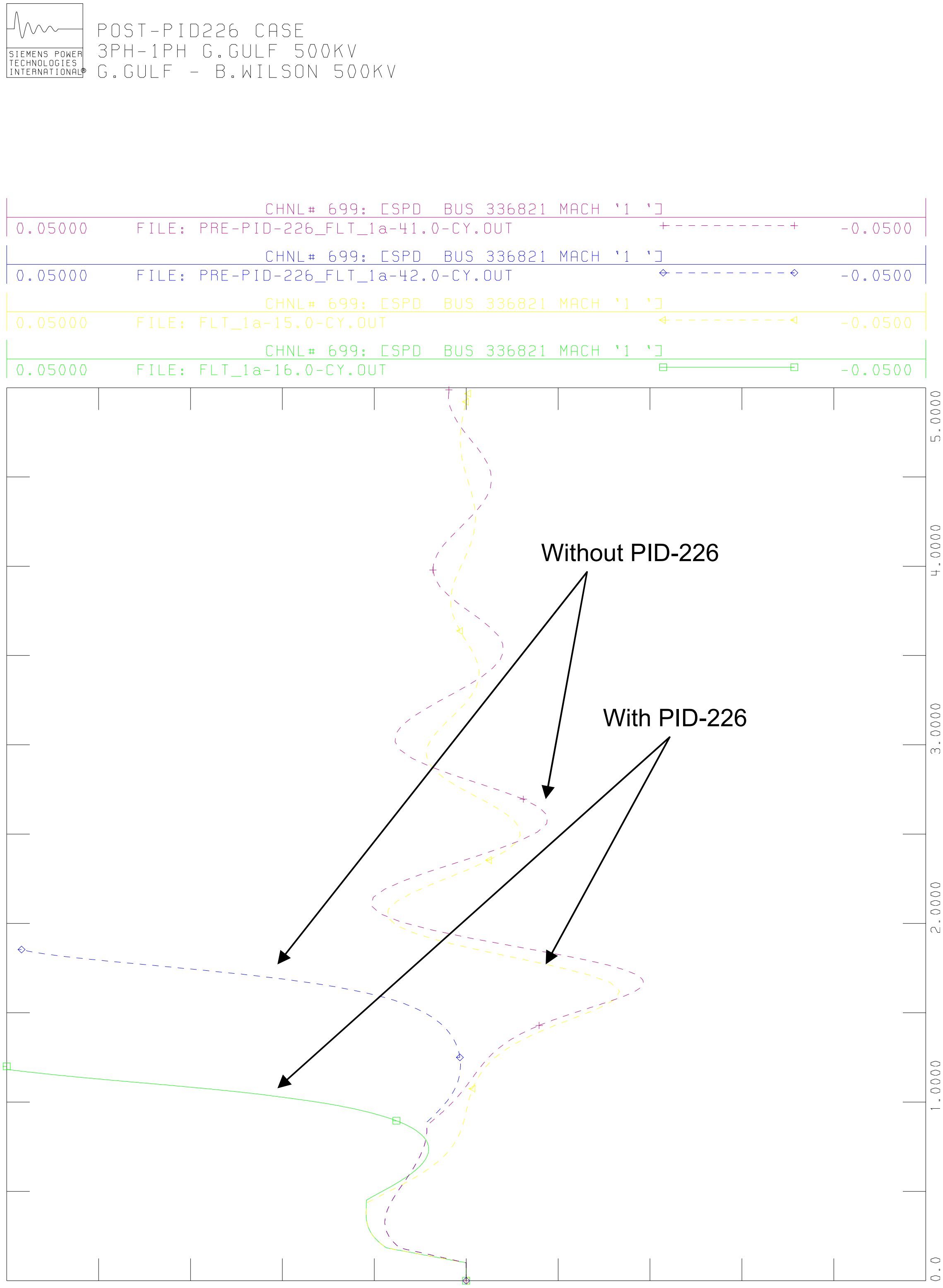


Figure 2-5 Critical Clearing Time comparison following Fault 1a

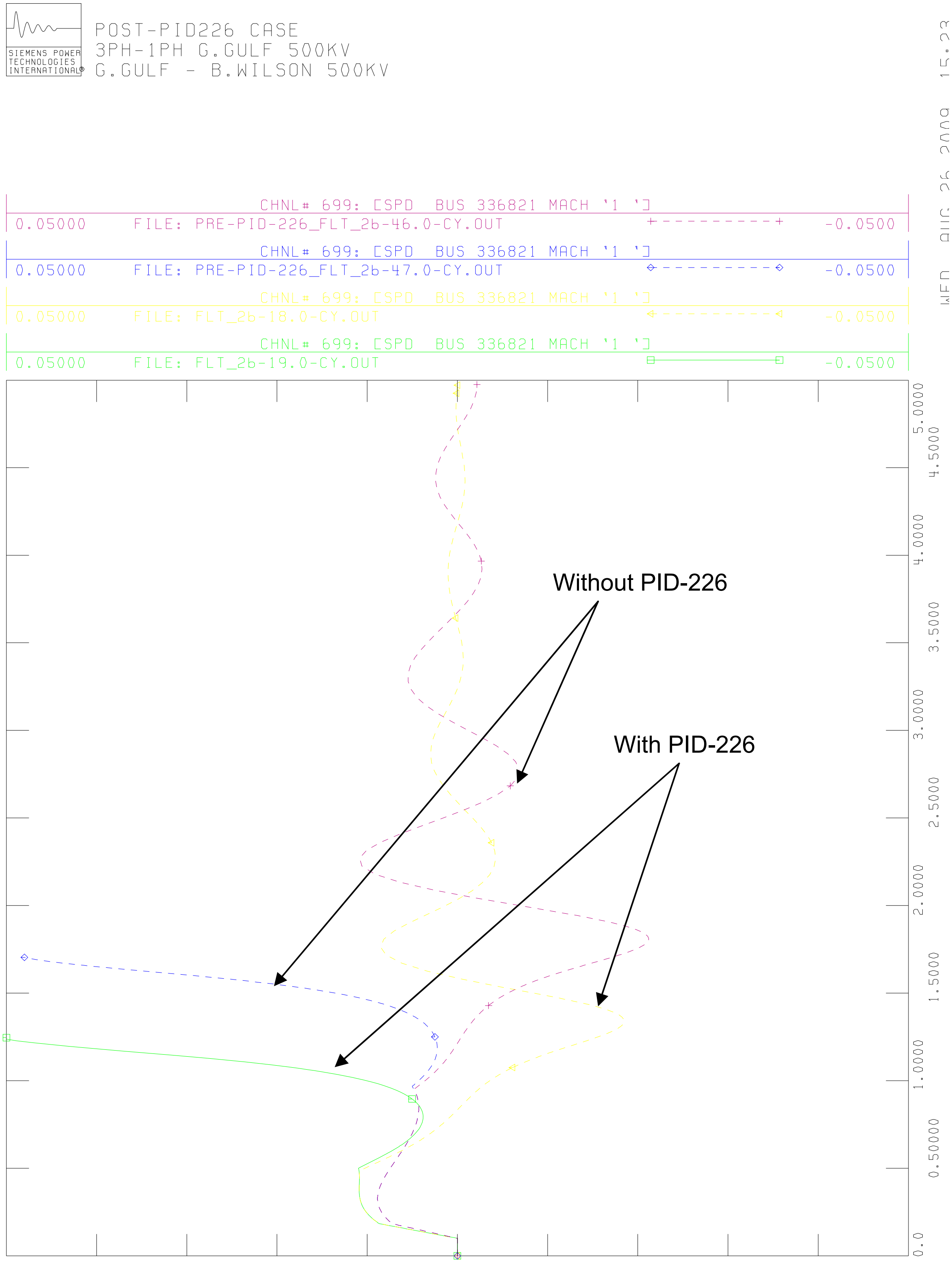


Figure 2-6 Critical Clearing Time comparison following Fault 2b

3 CONCLUSIONS

Southwest Power Pool, Inc (SPP) at the request of Entergy Services Inc. has commissioned ABB Inc. to perform a stability analysis for Facility study of PID-226, which is a request for 206 MW uprate of existing G. Gulf Unit #1 in the Entergy transmission system.

A system impact study for the PID-226 has previously been completed. The objective of this study was to supplement the stability analysis performed in the system impact study for PID-226 Project. To that end, selected faults at G. Gulf 500 kV substation were simulated and a Critical Clearing Time Analysis was performed at G. Gulf 500 kV substation. The study was performed on 2012 Summer Peak case, provided by SPP/Entergy.

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

The Critical Clearing times at G. Gulf 500 kV substations are within the capabilities of the existing protection systems. The smallest CCT at G. Gulf 500 kV substation was 5 + 15 cycles for a fault involving loss of G. Gulf – B. Wilson 500 kV.

Based on the results of stability analysis it can be concluded that proposed PID-226 project does not adversely impact the stability of the Entergy System in the local area. Also, PID-226 does not adversely impact the Critical Clearing time at G. Gulf 500 kV substations. Hence, no transmission reinforcements and/ or upgrades were identified for the interconnection of the PID-226 project.

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

APPENDIX A DATA PROVIDED BY CUSTOMER

Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

UNIT RATINGS

kVA 1600000 °F 95 Voltage 22000
Power Factor 0.9 lag
Speed (RPM) 1800 Connection (e.g. Wye) Wye
Short Circuit Ratio 0.75 Frequency, Hertz 60
Stator Amperes at Rated kVA 41989 Field Volts ______
Max Turbine MW 1525 °F 95

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 4.5112 kW sec/kVA
Moment-of-Inertia, WR^2 = 9644006 lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	1.292	X_{qv}	1.258
Synchronous – unsaturated	X_{di}	1.551	X_{qi}	1.473
Transient – saturated	X'_{dv}	0.380	X'_{qv}	0.751
Transient – unsaturated	X'_{di}	0.417	X'_{qi}	0.832
Subtransient – saturated	X''_{dv}	0.243	X''_{qv}	0.255
Subtransient – unsaturated	X''_{di}	0.288	X''_{qi}	0.302
Negative Sequence – saturated	$X2_v$	0.249		
Negative Sequence – unsaturated	$X2_i$	0.295		
Zero Sequence – saturated	$X0_v$	0.181		
Zero Sequence – unsaturated	$X0_i$	0.151		
Leakage Reactance	Xl_m	0.245		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	6.286	T'_{qo}	0.382
Three-Phase Short Circuit Transient	T'_{d3}	1.446	T'_{q}	0.501
Line to Line Short Circuit Transient	T'_{d2}	2.062		
Line to Neutral Short Circuit Transient	T'_{d1}	2.211		
Short Circuit Subtransient	T''_{d}	0.030	T''_{q}	0.043
Open Circuit Subtransient	T''_{do}	0.047	T''_{qo}	0.123

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.361
Line to Line Short Circuit	T_{a2}	0.361
Line to Neutral Short Circuit	T_{a1}	0.314

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	0.003656
Negative	R_2	0.04775
Zero	R_0	0.00253

Rotor Short Time Thermal Capacity I_2^2t = 5.47

Field Current at Rated kVA, Armature Voltage and PF = 8580 amps

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

Three Phase Armature Winding Capacitance = 1.464 microfarad

Field Winding Resistance = 0.0405 ohms 20 °C

Armature Winding Resistance (Per Phase) = 0.0004794 ohms 20 °C

CURVES

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

Please refer to Attachment 1.

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Capacity Self-cooled/Maximum Nameplate
___1650000_________/_____1650000______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)__0.1627_______ % _46.41___ X/R

Zero Z_0 (on self-cooled kVA rating)__0.1627_______ % __46.41___ 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.

Please refer to attachment 2.

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.

Please refer to attachment 3.

WIND GENERATORS

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.

INDUCTION GENERATORS

(*) Field Volts: _________________
(*) Field Amperes: ______________
(*) Motoring Power (kW): ________
(*) Neutral Grounding Resistor (If Applicable): ____________
(*) I_2^2t or K (Heating Time Constant): ____________
(*) Rotor Resistance: ____________
(*) Stator Resistance: ____________
(*) Stator Reactance: _____________
(*) Rotor Reactance: _____________
(*) Magnetizing Reactance: ___________
(*) Short Circuit Reactance: ___________
(*) Exciting Current: ________________
(*) Temperature Rise: ________________
(*) Frame Size: _______________
(*) Design Letter: _____________
(*) Reactive Power Required In Vars (No Load): ________
(*) Reactive Power Required In Vars (Full Load): ________
(*) Total Rotating Inertia, H: ________Per Unit on KVA Base

Note: Please consult Transmission Provider prior to submitting the Interconnection Request to determine if the information designated by (*) is required.

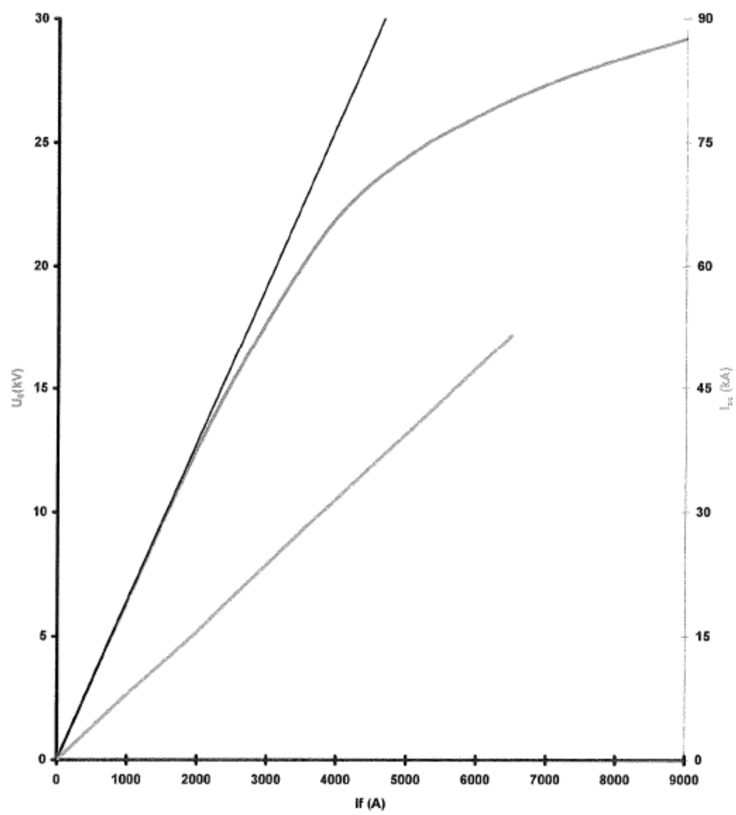
GENERATOR

Grand Gulf 1 - Uprate

Open Circuit Voltage and Short Circuit Current

Generator - Typ: THFF 180/76-18

S_N =	1600 MVA	PF =	0.90	I_{f0} =	4000 A
U_N =	22.00 kV	f_N =	60 Hz	I_{fN} =	8580 A
I_N =	41.989 kA	$T_{Cold\ Gas}$ =	40.0 °C		



SIEMENS
Energy Sector

Dr. Klocke
E F PR GN EN PL 42

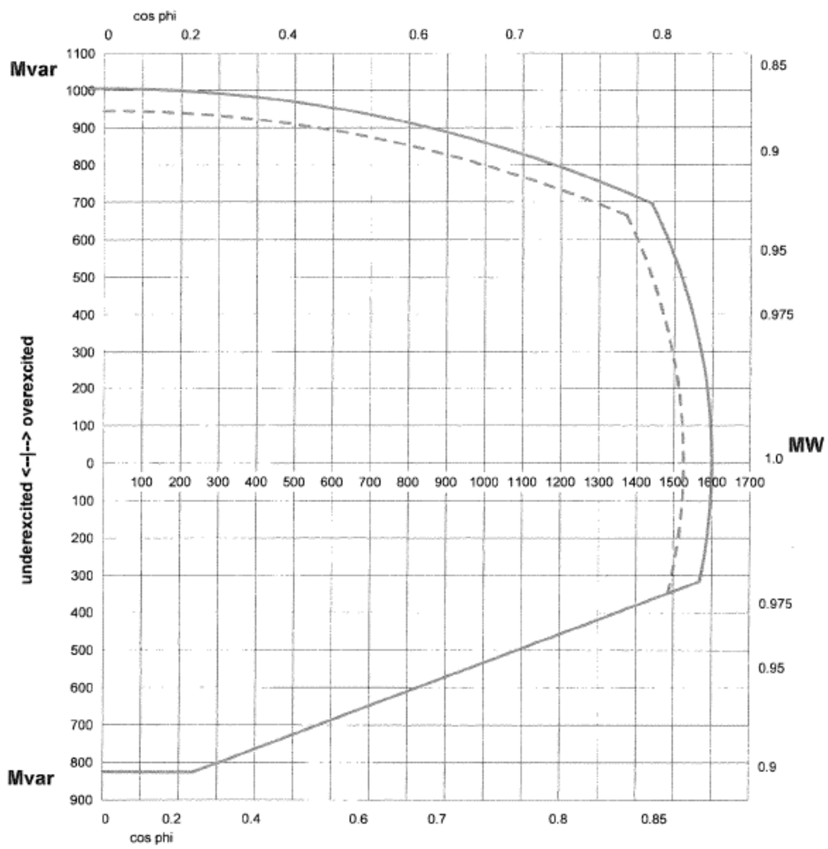
Rev. 000
2009-06-11

ATTACHMENT 1
Sheet 1 of 3

Turbogenerators

Grand Gulf 1 - Uprate to 1600 MVA
Reactive Capability Curve

Generator Type		**THFF 180/76-18**		
		uprate (———)		**prev. (— — —)**
Apparent Power	S	1600.00	MVA	1525.00 MVA
Armature Voltage	U	22.00	kV	
Armature Current	I	41.989	kA	40.021 kA
Frequency	f	60.0	Hz	
Power Factor	P.F.	0.900		0.900
H2-Pressure (gauge)	pe	5.170	bar	4.140 bar
Cold Gas Temperature	Tk	40.0	°C	40.0 °C



Siemens AG
Power Generation

GN EN PL42 / Jun 10, 2009
Generator Systems Engineering Mlh

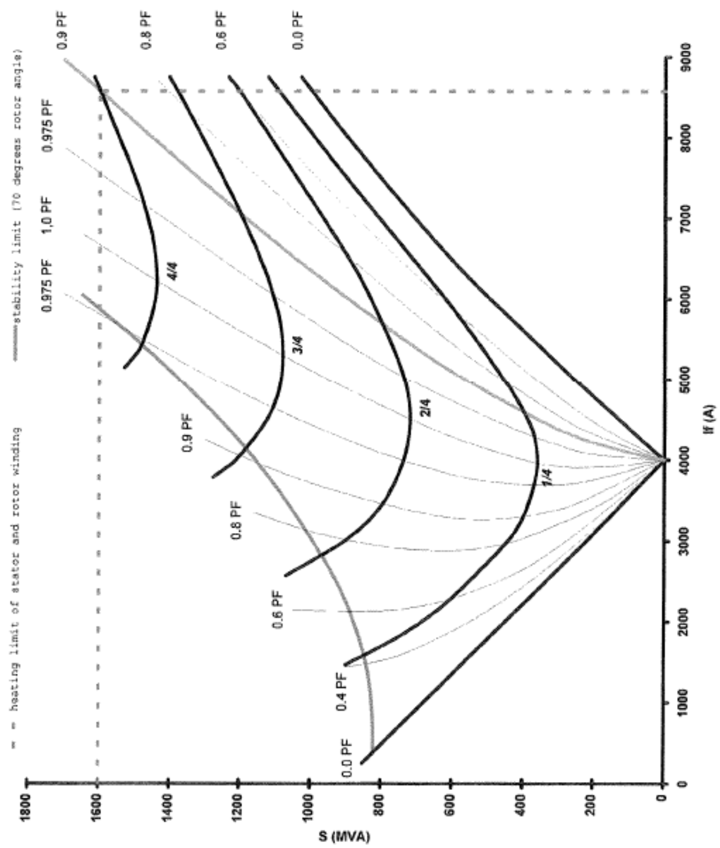
ATTACHMENT 1
Sheet 2 of 3

GENERATOR **Grand Gulf 1 - Uprate**

V-Curves at Rated Voltage

Generator - Typ: THFF 180/76-18

S_N =	1600 MVA	PF =	0.90	I_{f0} =	4000 A
U_N =	22.00 kV	f_N =	60 Hz	I_{fN} =	8580 A
I_N =	41.989 kA	$T_{Cold\ Gas}$ =	40.0 °C		



V-Curves Refer to Apparent Power

SIEMENS Dr. Klocke Rev. 000

Energy Sector E F PR GN EN PL 42 2009-06-10

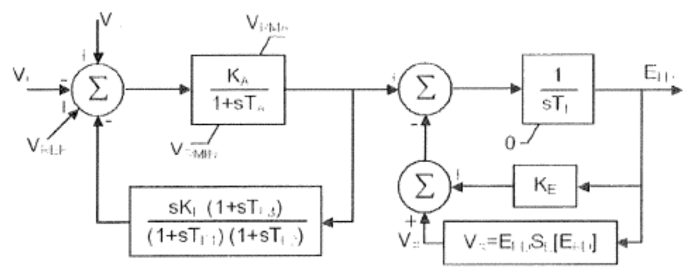
ATTACHMENT 1

Sheet 3 of 3

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"

Excitation system model data 061120. By J.D. Hurley. 12-7153. 12-7154.doc
Printed: 12/7/2006 2:02:21 PM

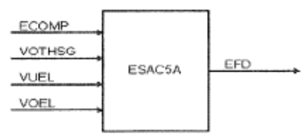
Siemens Westinghouse Confidential

ESAC5A

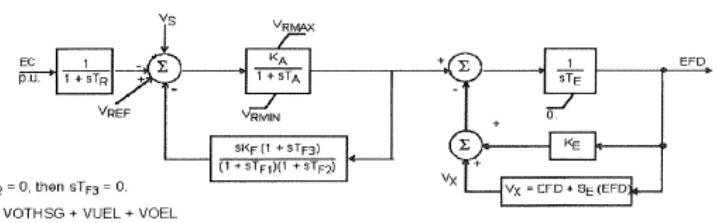
IEEE Type AC5A Excitation System

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	$S_E(E_2)$



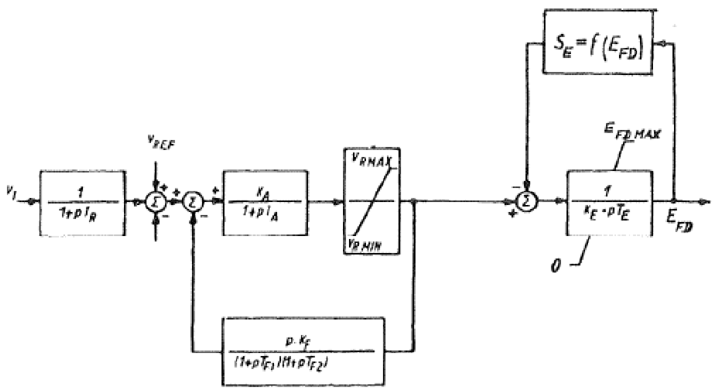
IBUS, 'ESAC5A', I, T_R, K_A, T_A, V_{RMAX}, V_{RMIN}, K_E, T_E, K_F, T_{F1}, T_{F2}, T_{F3}, E_1, $S_E(E_1)$, E_2, $S_E(E_2)$/



If $T_{F2} = 0$, then $sT_{F3} = 0$.
V_S = VOTHSG + VUEL + VOEL

SIEMENS

Excitation System
Thyrisiem
Computer Representation [1]



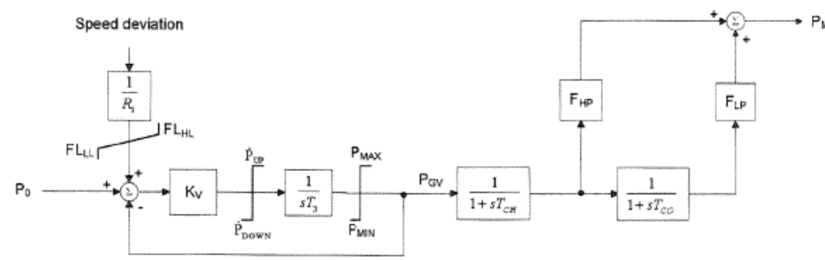
T_R = 0.20 s	K_A = 600	E_{FDMAX} = 3.7	V_{RMAX} = 6.4
T_A = 0.10 s	K_F = 0.02	S_{EMAX} = } 0.73	V_{RMIN} = −6.4
T_{F1} = 1.0 s	K_E = 1.0	$S_{E0.75MAX}$ = } 0.73	
T_{F2} = 0.13 s			
T_E = 0.22 s			

[1] According to IEEE

E111/Ro
17-03-82

Fig.2.1.

Steam Turbine Model for System Dynamic Studies for Grand Gulf



- 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)

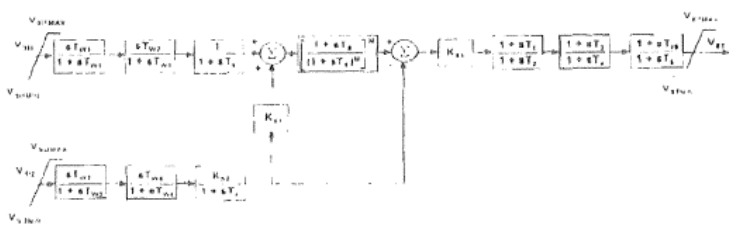
- P_0 = Initial Power when Simulation started (pU)
- P_{GV} = Power at Valve Outlet
- P_M = Mechanical Power Steam Turbine
- Power Limits imposed by Valve: $P_{MAX} = 1$ pU
  $P_{MIN} = 0$ pU
- Limits on Rate of Change of Power imposed by Control Valve Rate Limits: $\dot{P}_{UP} = 1$
  $\dot{P}_{DOWN} = -1$
- 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.

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

IEEEG1

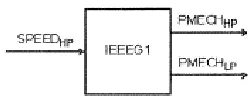
IEEE Type 1 Speed-Governing Model

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.

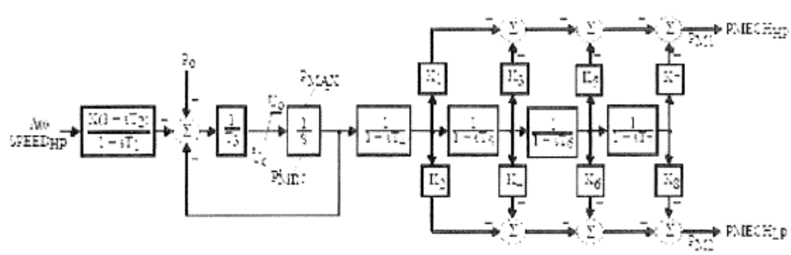
(Note: this is a non-cross compound unit)

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



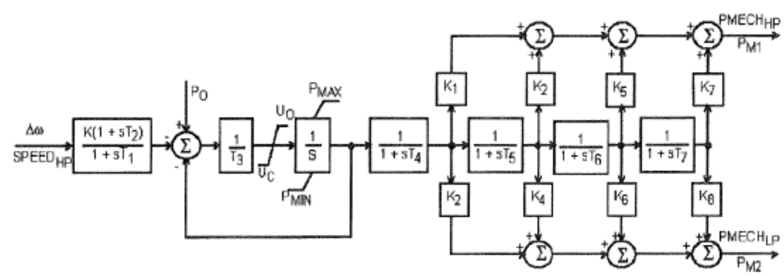
Correct Model: Note that K3 is properly represented.

GOVERNOR MODEL DATA SHEETS
IEEEG1 Power Technologies, Inc.



Incorrect Model: Note that there are two blocks with K2 and no block with K3.

IBUS, 'IEEEG1', I, JBUS, M, K, T_1, T_2, T_3, U_o, U_c, P_{MAX}, P_{MIN}, T_4, K_1, K_2, T_5, K_3, K_4, T_6, K_5, K_6, T_7, K_7, K_8/



APPENDIX B LOAD FLOW AND STABILITY DATA IN PSSE FORMAT

Loadflow Data

```
336821,'1 ', 1544.000,   0.000,   330.000,  -330.000,1.02000,336820,  1600.000,
0.003656,   0.2880,   0.00000,   0.00000,1.00000,1,  100.0,  1544.000,   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
   0.0035,   0.1627,   1650.00
1.00000,   0.000,   0.000,  1650.00,  1650.00,  1650.00, 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
```

Dynamics Data

```
REPORT FOR ALL MODELS                BUS 336821 [GGULF      21.000] MODELS


 ** GENROU **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
         336821 GGULF       21.000 1  130656-130669  51167-51172

          MBASE     Z S O R C E        X T R A N      GENTAP
         1600.0  0.00366+J 0.28800  0.00000+J 0.00000  1.00000

  T'D0 T''D0  T'Q0 T''Q0     H   DAMP   XD     XQ     X'D    X'Q   X''D    XL
  6.29 0.047  0.38 0.123   4.51  0.00 1.5510 1.4730 0.4170 0.8320 0.2880 0.2450

                          S(1.0)  S(1.2)
                          0.2000  0.5000


 ** PSS2A **   BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S     I C O N S
         336821 GGULF       21.000 1  130670-130686  51173-51188    8396-8399    4483-4488

               IC1 REMBUS1     IC2 REMBUS2       M       N
                 1       0      3       0      5      1

     TW1      TW2      T6       TW3      TW4      T7       KS2      KS3
    2.000    2.000    0.000    2.000    0.000    2.000    0.202    1.000

     T8       T9      KS1       T1       T2       T3       T4     VSTMAX   VSTMIN
    0.500    0.100    8.000    0.150    0.030    0.150    0.030    0.100   -0.100


 ** ESAC5A **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     VAR
         336821 GGULF       21.000 1  130687-130701  51189-51193    8400

   TR      KA      TA   VRMAX   VRMIN     KE     TE     KF     TF1    TF2    TF3
  0.200  600.00  0.100  6.400  -6.400   1.000  0.220  0.020  1.000  0.130  0.000

               E1     S(E1)    E2     S(E2)       KE VAR
             3.7000  0.7300  2.8000  0.7300       0.0000
```

```
** IEEEG1 **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S
        336821 GGULF       21.000 1  130702-130721  51194-51199    8401-8402

    K      T1      T2      T3     UO      UC    PMAX   PMIN     T4      K1
 12.00   0.000   0.000   0.075  0.600  -0.600 0.9700 0.0000   0.250   0.350

   K2      T5      K3      K4      T6      K5      K6      T7      K7      K8
 0.000   2.750   0.650   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

APPENDIX C PLOTS FOR STABILITY SIMULATIONS