System Impact Study Report
PID 224
100 MW Plant

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Rev	Issue Date	Description of Revision	Revised By	Project Manager
0	1/12/09	Posted	HDE	JDH
1	1/15/09	Minor Revision & Repost	HDE	JDH
2	1/23/09	Cost Revision & Repost	HDE	JDH

Executive Summary:

This System Impact Study is the second step of the interconnection process and is based on the PID-224 request for interconnection on Entergy's transmission system 9.82 miles from the Harrison West 161 kV substation. This report is organized in 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-224 did request NRIS and ERIS. PID 224 is a new facility. PID 224 intends to install forty (40) 2.5 MW wind turbines between the 161 kV Green Forest – Harrison West line. The study evaluates connection of 100 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 short circuit study was performed on the Entergy system short circuit model using ASPEN software. The proposed in-service date for NRIS is December 1, 2009.

Results of the System Impact Study contend that under ERIS, the estimated upgrade cost with priors is $0 and without priors is $0. Under NRIS, the estimated upgrade cost with priors is $16,400,000 +TBD and without priors is $7,160,000 +TBD.

Estimated Project Planning Upgrades for PID 224

Study	Estimated cost With Priors ($)	Estimated cost Without Priors ($)
ERIS	0	0
NRIS	$16,400,000+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 ERIS

I. Introduction

This Energy Resource Interconnection Service (ERIS) is based on PID-224 request for interconnection on Entergy's transmission system between Green Forest South 161kV and Harrison West 161kV substations located at 9.82 mi from Harrison West substation. The objective of this study is to assess the reliability impact of the new facility on the Entergy transmission system with respect to the steady state and transient stability performance of the system as well as its effects on the system's existing short circuit current capability. It is also intended to determine whether the transmission system meets standards established by NERC Reliability Standards and Entergy's planning guidelines when 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 is 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.

This ERIS System Impact Study was based on information provided by PID-224 and assumptions made by Entergy's Transmission Technical System Planning group. All supplied information and assumptions are documented in this report. If the actual equipment installed is different from the supplied information or the assumptions made, the results outlined in this report are subject to change.

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

II. Short Circuit Analysis / Breaker Rating Analysis

A. Model Information

The short circuit analysis was performed on the Entergy system short circuit model using ASPEN software. This model includes all generators interconnected to the Entergy system or interconnected to an adjacent system and having an impact on this interconnection request, IPP's with signed IOAs, and approved future transmission projects on the Entergy transmission system including the proposed PID 224 unit.

B. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID 224 generation is as follows:

1. Three phase and single phase to ground faults were simulated on the Entergy base case short circuit model and the worst case short circuit level was determined at each station. The PID 224 generator as well as the necessary NRIS upgrades shown in Section B, IV were then modeled in the base case to generate a revised short circuit model. The base case short circuit results were then compared with the results from the revised model to identify any breakers that were under-rated as a result of additional short circuit contribution from PID 224 generation. The breakers identified to be upgraded through this comparison are *mandatory* upgrades.

C. Analysis Results

The results of the short circuit analysis indicates that the additional generation due to PID-224 generator **does not** cause an increase in short circuit current such that they exceed the fault interrupting capability of the high voltage circuit breakers within the vicinity of the PID-224 plant with priors and without priors. The priors included 213, 211, 215, 216, 217, 220, 222, & 223.

III. Load Flow Analysis

Model Information

The load flow analysis was performed based on the projected 2012 summer peak load flow model. The loads were scaled based on the forecasted loads for the year. All firm power transactions between Entergy and its neighboring control areas were modeled for the year 2012 excluding short-term firm transactions on the same transmission interface. An economic dispatch was carried out on Entergy generating units after the scaling of load and modeling of transactions. The proposed PID-224 generation and the associated facilities were then modeled in the case to build a revised case for the load flow analysis. Transfers were simulated between thirteen (13) control areas and Entergy using requesting generator as the source and adjacent control area as sink. (Note: Refer to NRIS [Section – B] for details of dispatch within Entergy system)

This study considered the following four scenarios:

Scenario No.	Approved Future Transmission Projects	Pending Transmission Service & Study Requests
1	Not Included	Not Included
2	Not Included	Included
3	Included	Not Included
4	Included	Included

Load Flow Analysis

A. Load Flow Analysis:

With the above assumptions implemented, the First Contingency Incremental Transfer Capability (FCITC) values are calculated. The FCITC depends on various factors – the system load, generation dispatch, scheduled maintenance of equipment, and the configuration of the interconnected system and the power flows in effect among the interconnected systems. The FCITC is also dependent on previously confirmed firm reservations on the interface.

B. Performance Criteria

The criteria for overload violations are as follows:

A) With All Lines in Service

- The MVA flow in any branch should not exceed Rate A (normal rating).

B) Under Contingencies

- The MVA flow through any facility should not exceed Rate A.

C. Power Factor Consideration / Criteria

Entergy, consistent with the FERC Large Generator Interconnection Procedures (LGIP) requires the customer to be capable of supplying at least 0.33 MVAR (*i.e.*, 0.95 lagging power factor) and absorbing at least 0.33 MVAR (*i.e.*, 0.95 leading power factor) for every MW of power injected into the grid. In the event that, under normal operating conditions, the customer facility does not meet the prescribed power factor requirements at the point of interconnection, the customer shall take necessary steps, such as the installation of reactive power compensating devices, to achieve the desired power factor.

Analysis Results

Summary of the analysis results are documented in following table for each scenario.

Table II-C Summary of Results for PID 224 – ERIS Load Flow Study

Interface		Summer Peak Case Used	FCITC Available for Scenario 1	FCITC Available for Scenario 2	FCITC Available for Scenario 3	FCITC Available for Scenario 4
AECI	Associated Electric Cooperative, Inc.	2012	100	100	88	88
AMRN	Ameren Transmission	2012	0	0	0	0
CLEC	CLECO	2012	0	0	0	0
AEP-W	American Electric Power - West	2012	0	25	0	88
EDE	Empire District Electric Co	2012	100	100	88	88
EES	Entergy	2012	0	0	0	0
LAF	Lafayette Utilities System	2012	0	0	0	0
LAGN	Louisiana Generating, LLC	2012	0	0	0	0
LEPA	Louisiana Energy & Power Authority	2012	0	0	0	0
OGE	Oklahoma Gas & Electric Company	2012	0	0	88	88
SMEPA	South Mississippi Electric Power Assoc.	2012	0	0	0	0
SOCO	Southern Company	2012	0	0	0	0
SPA	Southwest Power Administration	2012	100	100	88	88
TVA	Tennessee Valley Authority	2012	0	0	0	0

Scenario No.	Approved Future Transmission Projects	Pending Transmission Service & Study Requests
1	Not Included	Not Included
2	Not Included	Included
3	Included	Not Included
4	Included	Included

TABLE II-C-1 DETAILS OF SCENARIO 1 RESULTS: (WITHOUT FUTURE PROJECTS AND WITHOUT PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Alchem - Monochem1 138kV	$7,601,200									X					
Baxter Wilson - Ray Braswell 500kV	$144,900,000			X	X	X		X	X	X		X	X		X
Bonin - Cecelia 138kV	$4,792,500									X					
Colonial Academy - Richard 138kV	$7,957,500							X		X					
Danville - North Magazine REA 161kV	$10,530,000										X				
Gibson - Humphrey 115kV	$47,327,390				X			X		X					
Greenwood - Humphrey 115kV	$3,838,000				X			X		X					
Greenwood - Terrebone 115kV	$22,850,381				X			X		X					
Judice - Scott1 138kV	$10,000,000				X					X					
Livonia - Wilbert 138kV	$41,123,000				X			X							
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	TBD		X												
North Crowley - Scott1 138kV	$39,707,607							X		X					
Scott1 - Bonin 138kV	$7,410,000							X		X					
Semere - Scott2 138kV	$24,345,000							X		X					
Sterlington 500/115kV transformer 1	$19,401,000					X									
Sterlington 500/115kV transformer 2	$19,401,000					X									

TABLE II-C-2 DETAILS OF SCENARIO 2 RESULTS: (WITHOUT FUTURE PROJECTS AND WITH PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Alchem - Monochem1 138kV	$7,601,200									X					
Baxter Wilson - Ray Braswell 500kV	$144,900,000			X	X	X		X	X	X		X	X		X
Bonin - Cecelia 138kV	$4,792,500									X					
Colonial Academy - Richard 138kV	$7,957,500							X		X					
Danville - North Magazine REA 161kV	$10,530,000										X				
Gibson - Humphrey 115kV	$47,327,390				X			X		X					
Greenwood - Humphrey 115kV	$3,838,000				X			X		X					
Greenwood - Terrebone 115kV	$22,850,381				X			X		X					
Judice - Scott1 138kV	$10,000,000				X					X					
Livonia - Wilbert 138kV	$41,123,000				X			X							
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	TBD		X												
North Crowley - Scott1 138kV	$39,707,607							X		X					
Scott1 - Bonin 138kV	$7,410,000							X		X					
Semere - Scott2 138kV	$24,345,000							X		X					
Sterlington 500/115kV transformer 1	$19,401,000					X									
Sterlington 500/115kV transformer 2	$19,401,000					X									

TABLE II-C-3 DETAILS OF SCENARIO 3 RESULTS: (WITH FUTURE PROJECTS AND WITHOUT PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Acadia - Colonial Academy 138kV	$6,277,500							X		X					
Acadia GSU - Scanlan 138kV	$1,455,000							X							
Addis - Big Cajun 1 230kV	$31,175,000									X					
Alchem - Monochem1 138kV	$7,601,200									X					
Baxter Wilson - Ray Braswell 500kV	$144,900,000			X	X	X		X	X	X		X	X		X
Bonin - Cecelia 138kV	$4,792,500									X					
Colonial Academy - Richard 138kV	$7,957,500							X		X					
Coly - Hammond 230kV ckt2 Supplemental Upgrade	$85,741,791											X			
Gibson - Humphrey 115kV	$47,327,390									X					
Green Forest South - PID223 161kV	$4,125,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greenwood - Humphrey 115kV	$3,838,000									X					
Greenwood - Terrebone 115kV	$22,850,381									X					
Habetz - Richard 138kV	$3,272,500							X		X					
Harrison West - PID224 Line Tap 161kV	$12,275,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Judice - Meaux 138kV	$12,600,000									X					
Judice - Scott1 138kV	$10,000,000				X					X					
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	TBD		X												
Morton - Pelahatchie 115kV	$2,048,625											X			
North Crowley - Richard 138kV	$3,776,625							X							
North Crowley - Scott1 138kV	$39,707,607				X			X		X					
Port Hudson 230/138 transformer 1	TBD									X					
Port Hudson 230/138 transformer 2	TBD									X					
Raceland - Coteau 115kV	$3,065,000									X					
Richard - Scott1 138kV	$68,006,984				X			X		X					
Scott1 - Bonin 138kV	$7,410,000							X		X					
Semere - Scott2 138kV	$24,345,000				X			X		X					
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	$51,607,500											X			
Sterlington 500/115kV transformer 1	$19,401,000					X									
Sterlington 500/115kV transformer 2	$19,401,000					X									

TABLE II-C-4 DETAILS OF SCENARIO 4 RESULTS: (WITH FUTURE PROJECTS AND WITH PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Acadia - Colonial Academy 138kV	$6,277,500							X		X					
Acadia GSU - Scanlan 138kV	$1,455,000							X							
Addis - Big Cajun 1 230kV	$31,175,000									X					
Alchem - Monochem1 138kV	$7,601,200									X					
Baxter Wilson - Ray Braswell 500kV	$144,900,000			X	X	X		X	X	X		X	X		X
Bonin - Cecelia 138kV	$4,792,500									X					
Colonial Academy - Richard 138kV	$7,957,500							X		X					
Coly - Hammond 230kV ckt2 Supplemental Upgrade	$85,741,791											X			
Gibson - Humphrey 115kV	$47,327,390									X					
Green Forest South - PID223 161kV	$4,125,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greenwood - Humphrey 115kV	$3,838,000									X					
Greenwood - Terrebone 115kV	$22,850,381									X					
Habetz - Richard 138kV	$3,272,500							X		X					
Harrison West - PID224 Line Tap 161kV	$12,275,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Judice - Meaux 138kV	$12,600,000									X					
Judice - Scott1 138kV	$10,000,000				X					X					
Louisiana Station - Thomas 138kV	$9,462,500									X					
Morton - Pelahatchie 115kV	$2,048,625											X			
North Crowley - Richard 138kV	$3,776,625							X		X					
North Crowley - Scott1 138kV	$39,707,607				X			X		X					
Port Hudson 230/138 transformer 1	TBD									X					
Port Hudson 230/138 transformer 2	TBD									X					
Richard - Scott1 138kV	$68,006,984				X			X		X					
Scott1 - Bonin 138kV	$7,410,000							X		X					
Semere - Scott2 138kV	$24,345,000				X			X		X					
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	$51,607,500											X			
Sterlington 500/115kV transformer 1	$19,401,000					X			X						
Sterlington 500/115kV transformer 2	$19,401,000					X			X						

DETAILS OF SCENARIO 1

AECI

Limiting Element	Contingency Element	ATC
NONE	NONE	125

AEP-W

Limiting Element	Contingency Element	ATC
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Contingency of FlowGate 5029 DOLHILL7 345 TO SW SHV 7 345	0

AMRN

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

CLECO

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Livonia - Wilbert 138kV	Webre - Wells 500kV	26
Gibson - Humphrey 115kV	Webre - Wells 500kV	55

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0

EMDE

Limiting Element	Contingency Element	ATC
NONE	NONE	100

LAFA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Livonia - Wilbert 138kV	Webre - Wells 500kV	19
Gibson - Humphrey 115kV	Webre - Wells 500kV	46
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	53
Scott1 - Bonin 138kV	Point Des Mouton - Wells 230kV	63
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	91
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	94

LAGN

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

LEPA

Limiting Element	Contingency Element	ATC
Alchem - Monochem1 138kV	A.A.C. - Polsky Carville 230kV	0
Alchem - Monochem1 138kV	A.A.C. - Licar 230kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Alchem - Monochem1 138kV	Belle Helene - Licar 230kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Alchem - Monochem1 138kV	Belle Helene - Woodstock 230kV	0
Alchem - Monochem1 138kV	Vulchlor - Woodstock 230kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Gibson - Humphrey 115kV	Webre - Wells 500kV	19
Greenwood - Terrebone 115kV	Bayou Sales - Teche 138kV (CLECO)	42
Bonin - Cecelia 138kV	Acadia - Colonial Academy 138kV	52
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	61
Judice - Scott1 138kV	Greenwood - Terrebone 115kV	64

Limiting Element	Contingency Element	ATC
Greenwood - Terrebone 115kV	Bayou Sales - WaxLake 138kV (CLECO)	70

OKGE

Limiting Element	Contingency Element	ATC
Danville - North Magazine REA 161kV	ANO - Fort Smith 500kV	0

SMEPA

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

SOCO

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

SPA

Limiting Element	Contingency Element	ATC
NONE	NONE	100

TVA

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

DETAILS OF SCENARIO 2

AECI

Limiting Element	Contingency Element	ATC
NONE	NONE	100

AEP-W

Limiting Element	Contingency Element	ATC
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Contingency of FlowGate 5029 DOLHILL7 345 TO SW SHV 7 345	25

AMRN

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

CLECO

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Livonia - Wilbert 138kV	Webre - Wells 500kV	12
Gibson - Humphrey 115kV	Webre - Wells 500kV	62

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0

EMDE

Limiting Element	Contingency Element	ATC
NONE	NONE	100

LAFA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Livonia - Wilbert 138kV	Webre - Wells 500kV	9
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	50
Gibson - Humphrey 115kV	Webre - Wells 500kV	52
Scott1 - Bonin 138kV	Point Des Mouton - Wells 230kV	63
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	90
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	93

LAGN

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

LEPA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Greenwood - Terrebone 115kV	Webre - Wells 500kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Alchem - Monochem1 138kV	A.A.C. - Polsky Carville 230kV	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Alchem - Monochem1 138kV	A.A.C. - Licar 230kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Greenwood - Humphrey 115kV	Webre - Wells 500kV	0
Gibson - Humphrey 115kV	Webre - Wells 500kV	22
Greenwood - Terrebone 115kV	Bayou Sales - Teche 138kV (CLECO)	42
Bonin - Cecelia 138kV	Acadia - Colonial Academy 138kV	48
Alchem - Monochem1 138kV	Belle Helene - Licar 230kV	49
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	59
Judice - Scott1 138kV	Greenwood - Terrebone 115kV	63
Greenwood - Terrebone 115kV	Bayou Sales - WaxLake 138kV (CLECO)	71
Judice - Scott1 138kV	Hopkins - Moril 138kV	98

OKGE

Limiting Element	Contingency Element	ATC
Danville - North Magazine REA 161kV	ANO - Fort Smith 500kV	0

SMEPA

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

SOCO

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

SPA

Limiting Element	Contingency Element	ATC
NONE	NONE	100

TVA

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

DETAILS OF SCENARIO 3

AECI

Limiting Element	Contingency Element	ATC
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

AEP-W

Limiting Element	Contingency Element	ATC
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Contingency of FlowGate 5029 DOLHILL7 345 TO SW SHV 7 345	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

AMRN

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

CLECO

Limiting Element	Contingency Element	ATC
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Semere - Scott2 138kV	Wells 500/230kV transformer	35
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	60
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

EMDE

Limiting Element	Contingency Element	ATC
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

LAFA

Limiting Element	Contingency Element	ATC
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Acadia - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	9
Semere - Scott2 138kV	Richard - Scott1 138kV	10
Semere - Scott2 138kV	Wells 500/230kV transformer	14
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	35
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	37
Scott1 - Bonin 138kV	Point Des Mouton - Wells 230kV	51
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	52
Acadia - Colonial Academy 138kV	Point Des Mouton - Wells 230kV	61
North Crowley - Scott1 138kV	Wells 500/230kV transformer	78
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	79
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Habetz - Richard 138kV	Point Des Mouton - Wells 230kV	88
Acadia - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	90
North Crowley - Richard 138kV	Point Des Mouton - Wells 230kV	92
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	95

LAGN

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

LEPA

Limiting Element	Contingency Element	ATC
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Bonin - Cecelia 138kV	Acadia - Colonial Academy 138kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	0
Judice - Scott1 138kV	Hopkins - Moril 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Alchem - Monochem1 138kV	A.A.C. - Polsky Carville 230kV	0
Acadia - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Greenwood - Terrebone 115kV	Bayou Sales - Teche 138kV (CLECO)	4
Alchem - Monochem1 138kV	A.A.C. - Licar 230kV	12
Semere - Scott2 138kV	Richard - Scott1 138kV	17
Semere - Scott2 138kV	Wells 500/230kV transformer	28
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	28
Judice - Scott1 138kV	Greenwood - Terrebone 115kV	31
Greenwood - Terrebone 115kV	Bayou Sales - WaxLake 138kV (CLECO)	33
Judice - Scott1 138kV	Acadian - Bonin 230kV (LAFA)	50
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	56
Port Hudson 230/138 transformer 2	Port Hudson 230/138 transformer 1	65
Greenwood - Terrebone 115kV	ELPTAP - Wax Lake 138kV (CLECO)	66
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	71
Port Hudson 230/138 transformer 1	Port Hudson 230/138 transformer 2	74
Greenwood - Humphrey 115kV	Bayou Sales - Teche 138kV (CLECO)	75
Gibson - Humphrey 115kV	Bayou Sales - Teche 138kV (CLECO)	85
Raceland - Coteau 115kV	Terrebone 230/115kV transformer	86
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

OKGE

Limiting Element	Contingency Element	ATC
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

SMEPA

Limiting Element	Contingency Element	ATC
Coly - Hammond 230kV ckt 2 Supplemental Upgrade	French Settlement - Sorrento 230kV	0
Coly - Hammond 230kV ckt 2 Supplemental Upgrade	French Settlement - Springfield 230kV	0
Coly - Hammond 230kV ckt 2 Supplemental Upgrade	Hammond - Springfield 230kV	0
Coly - Hammond 230kV ckt 2 Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Coly - Hammond 230kV ckt 2 Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Front Street - Michoud 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Front Street - Slidell 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Fairview - Gypsy 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Madisonville - Mandeville 230kV (CLECO)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Morton - Pelahatchie 115kV	Angie - Adams Creek 230kV	8
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

SOCO

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

SPA

Limiting Element	Contingency Element	ATC
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

TVA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

DETAILS OF SCENARIO 4

AECI

Limiting Element	Contingency Element	ATC
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

AEP-W

Limiting Element	Contingency Element	ATC
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

AMRN

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

CLECO

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	40
Semere - Scott2 138kV	Wells 500/230kV transformer	47
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

EMDE

Limiting Element	Contingency Element	ATC
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

LAGN

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88

LAFA

Limiting Element	Contingency Element	ATC
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Acadia - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	6
Semere - Scott2 138kV	Richard - Scott1 138kV	10
Semere - Scott2 138kV	Wells 500/230kV transformer	19
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	30
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	34
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	46
Scott1 - Bonin 138kV	Point Des Mouton - Wells 230kV	51
Acadia - Colonial Academy 138kV	Point Des Mouton - Wells 230kV	58
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	78
North Crowley - Scott1 138kV	Wells 500/230kV transformer	84
Habetz - Richard 138kV	Point Des Mouton - Wells 230kV	85
Acadia - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	86
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	88
North Crowley - Richard 138kV	Point Des Mouton - Wells 230kV	89

LEPA

Limiting Element	Contingency Element	ATC
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Point Des Mouton - Wells 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton - Wells 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Bonin - Cecelia 138kV	Acadia - Colonial Academy 138kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton - Wells 230kV	0
Judice - Scott1 138kV	Hopkins - Moril 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Port Hudson 230/138 transformer 2	Port Hudson 230/138 transformer 1	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Acadia - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Port Hudson 230/138 transformer 1	Port Hudson 230/138 transformer 2	0
Alchem - Monochem1 138kV	A.A.C. - Polsky Carville 230kV	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Greenwood - Terrebone 115kV	Bayou Sales - Teche 138kV (CLECO)	4
Alchem - Monochem1 138kV	A.A.C. - Licar 230kV	4
Semere - Scott2 138kV	Richard - Scott1 138kV	16
Richard - Scott1 138kV	Point Des Mouton - Wells 230kV	19
Judice - Scott1 138kV	Greenwood - Terrebone 115kV	33
Greenwood - Terrebone 115kV	Bayou Sales - WaxLake 138kV (CLECO)	33
Semere - Scott2 138kV	Wells 500/230kV transformer	38
Judice - Scott1 138kV	Acadian - Bonin 230kV (LAFA)	44
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	47
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	65
Greenwood - Terrebone 115kV	ELPTAP - Wax Lake 138kV (CLECO)	66
Alchem - Monochem1 138kV	Belle Helene - Licar 230kV	74
Greenwood - Humphrey 115kV	Bayou Sales - Teche 138kV (CLECO)	75
Louisiana Station - Thomas 138kV	Big Cajun 2 - Webre 500kV	76
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	77
Gibson - Humphrey 115kV	Bayou Sales - Teche 138kV (CLECO)	85
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

OKGE

Limiting Element	Contingency Element	ATC
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

SMEPA

Limiting Element	Contingency Element	ATC
Coly - Hammond 230kV ckt2 Supplemental Upgrade	French Settlement - Sorrento 230kV	0
Coly - Hammond 230kV ckt2 Supplemental Upgrade	French Settlement - Springfield 230kV	0
Coly - Hammond 230kV ckt2 Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Coly - Hammond 230kV ckt2 Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Coly - Hammond 230kV ckt2 Supplemental Upgrade	Hammond - Springfield 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Front Street - Michoud 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Front Street - Slidell 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Fairview - Gypsy 230kV	0
Slidell - Michoud 230kV ckt2 Supplemental Upgrade	Madisonville - Mandeville 230kV (CLECO)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Morton - Pelahatchie 115kV	Angie - Adams Creek 230kV	10
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

SOCO

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

SPA

Limiting Element	Contingency Element	ATC
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

TVA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Green Forest South - PID223 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South - PID223 161kV	88

IV. Stability Analysis

ABB Inc – Grid Systems Consulting

Technical Report

Southwest Power Pool	**No.** 2008-E0001433-R1	
Stability Study for PID-224	12/12/2008	# Pages 64

Author(s):	**Reviewed by:**	**Approved by:**
Amit Kekare	Sri Pillutla	Willie Wong

Executive Summary

SPP has commissioned ABB Inc. to perform a stability study for PID-224. PID-224 is a 100 MW windfarm to be located in Boone County, Arkansas with a point of interconnection on Entergy Green Forest South – Harrison West 161 kV transmission line approximately 9.82 miles from Harrison West 161 kV substation. The proposed in-service date for the Project is December 2009. As per the developer's request, the proposed PID-224 generation was studied using Clipper 2.5 MW wind turbines.

The stability analysis was conducted to identify the impact of the proposed project on the MAPP bulk power system. The feasibility (powerflow) study was not performed as a part of this study. Three phase normally cleared and stuck breaker faults were simulated in the vicinity of the proposed project.

This interconnection of wind farm was studied by using study model representing 2015 summer peak system conditions. No stability criteria violations were observed following series of simulated faults at or near the POI after interconnection of the proposed project.

Based on the results of the stability analysis, it is concluded that the proposed wind farm does not adversely impact the stability of the Entergy system.

FERC Order 661A Compliance – The Low Voltage Ride through (LVRT) capability was verified for compliance with Federal Energy Regulatory Commission's (FERC) standard for Interconnection of Wind generating plants: 'Low Voltage Ride-Through' (LVRT) requirement. The proposed project is planned to have LVRT capability which was modeled for all of the simulated faults.

The proposed project (PID-224) complies with the latest FERC order on low voltage ride through for wind farms. With this arrangement, these wind farms would not trip off line by voltage relay actuation for local faults near the POI.

Final conclusions:

1) The proposed PID-224 windfarm does not degrade the stability of the bulk power system in Entergy region.

2) The proposed PID-224 (100 MW) windfarm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

Rev No.	Revision Description	Date	Authored by	Reviewed by	Approved by
0	Draft Report	12/12/2008	A. Kekare	S. Pillutla	W. Wong
1	FINAL REPORT	1/7/2009	A. Kekare	S. Pillutla	W. Wong

DISTRIBUTION:
Daniel Epperson – Southwest Power Pool
Brad Finkbeiner – Southwest Power Pool

INTRODUCTION

SPP has commissioned ABB Inc. to perform a stability study for PID-224. PID-224 is a 100 MW of windfarm to be located in Boone County, Arkansas with a Point of Interconnection (POI) on Entergy Green Forest South – Harrison West 161 kV transmission line approximately 9.82 miles from Harrison West 161 kV substation. The new 161 kV windfarm substation would be connected to the POI through a 6 miles 161 kV line. The proposed in-service date for the Project is December 2009.

The objective of the impact study is to evaluate the impact on system stability after connecting the additional 100 MW generation and its impact on the nearby transmission system and generating stations. The study is performed on 2015 Summer Peak case, provided by Entergy. Figure IV-1 shows the location of the proposed 100 MW generation interconnecting station. Section 0 includes a detail description of the PID-224 project.

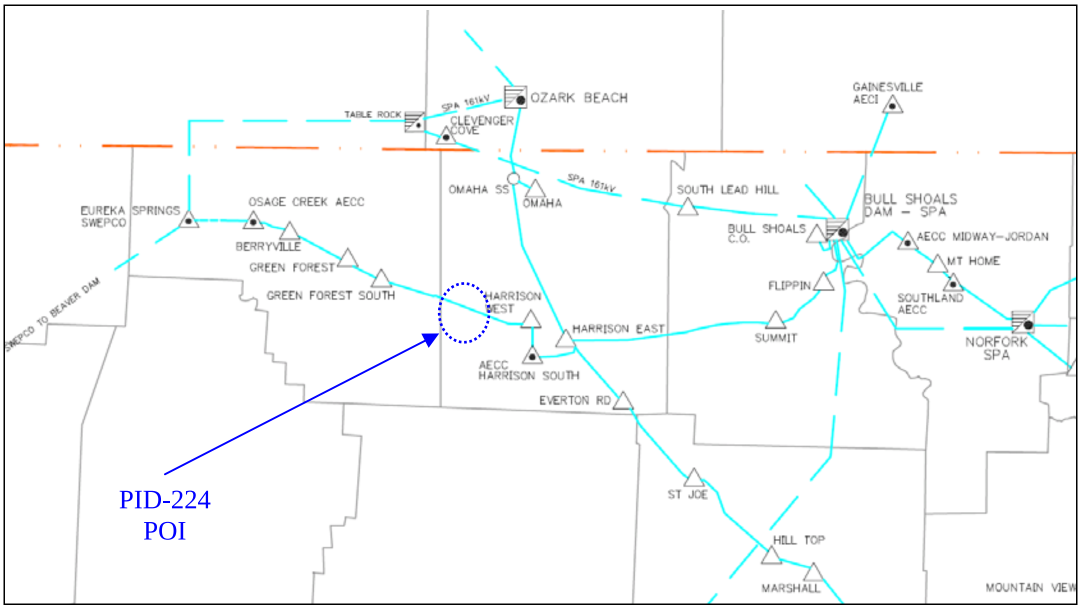


Figure IV-1: PID-224 interconnecting substation

PROJECT DESCRIPTION

The proposed PID-224 project will be located in Boone County, Arkansas. The power will be generated using forty (40) Clipper Liberty 2.5 MW wind-turbine generators. Figure IV-2 shows the interconnection scheme for the proposed project.

The following list summarizes the major project parameters:

- Wind field rating: 100.0 MW
- Interconnection:

  Voltage: 161 kV
  Location: Entergy Green Forest South – Harrison West 161 kV line. 9.82 miles from Harrison West substation
  A 6 mile 161 kV line will connect the new 161 kV substation to the POI on Green Forest South – Harrison West 161 kV line.
  Transformer: (typical data used)
  MVA: 69/92/115 MVA (ONAN/ONAF/ONAF)
  High voltage: 161 kV (Wye grounded)
  Low voltage: 34.5 kV (Wye grounded)
  Tertiary winding: 13.8 kV (delta) Not used
  Z: 10% on 69 MVA

- Wind turbines:

  Number: Forty (40)
  Manufacturer: Clipper
  Win turbine Generator: Clipper Liberty 2.5 MW
  Type: Synchronous generator
  Rated power: 2.5 MW
  Rated Terminal Voltage: 690 V
  Frequency: 60 Hz
  Generator Step-up Transformer (GSU):
  MVA: 2.75 MVA
  High voltage: 34.5 kV (Wye grounded)
  Low voltage: 0.690 kV (Wye grounded)
  Z: 5.75% on 2.75 MVA; X/R = 6.0

- Reactive power capability: The generator has fixed power factor (nominal unity).

  A 20 Mvar shunt capacitor was added at 34.5 kV collector bus to maintain approx. unity p.f. at the POI

- Low Voltage Ride through Capability: The manufacturer recommended Low Voltage Ride Through (LVRT) settings[1] were included (see Table IV-1).

[1] 'DC-045183-01_Rev_A_Liberty_PSSE_Model_Background' – Modeling the Windpower Liberty Series Wind Turbine for Load flow, Short Circuit, and stability studies using PSS/E ver 30, January 8, 2008.

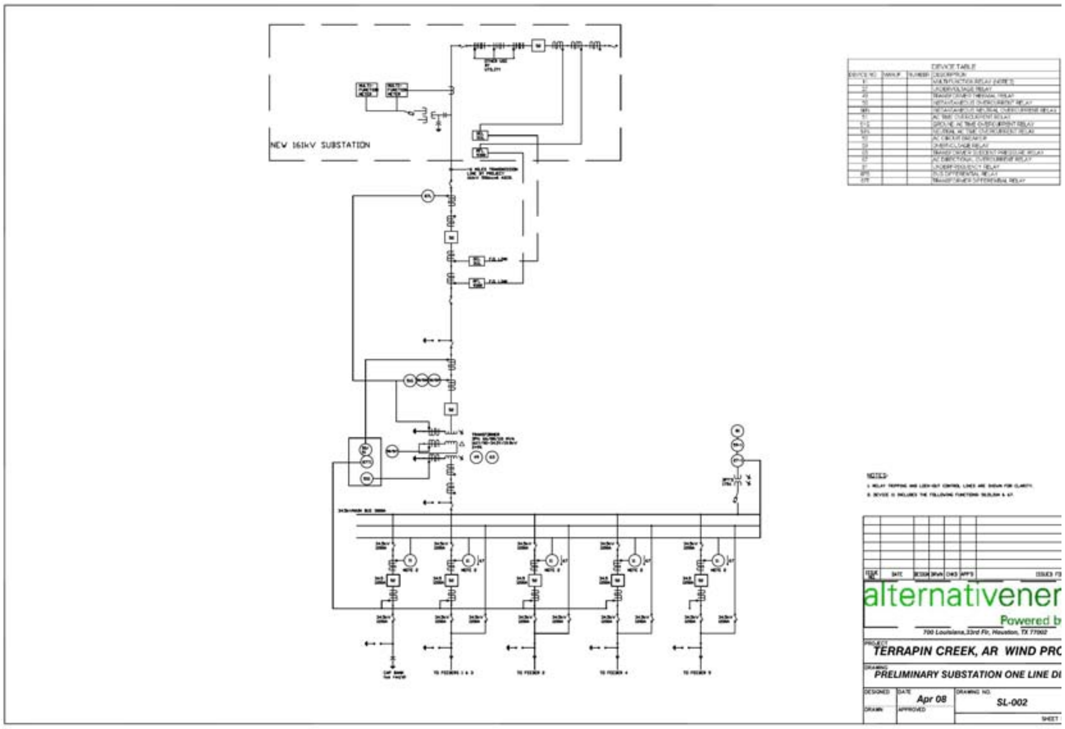


Figure IV-2: interconnection scheme for proposed project

Table IV-1: Transient Voltage/ Frequency Ride Through Characteristics of Clipper 2.5 MW wind turbine generators

Function	Pickup Setting	Trip Delay
1st Overvoltage	1.1 pu	5.0 s
2nd Overvoltage	1.2 pu	500 ms
3rd Overvoltage	1.3 pu	100 ms
1st Undervoltage	0.9 pu	3.0 s
2nd Undervoltage	0.1 pu	100 ms
Overfrequency	63.0 Hz	100 ms
Underfrequency	57.0 Hz	100 ms

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 durations and synchronous machine rotor angles and wind turbine generator speeds were monitored to check whether the system stays in synchronism following fault removal.

All the breakers at 161 kV system are assumed to be common trip breakers. Based on the Entergy study criteria, three-phase faults with normal clearing and delayed clearing were simulated.

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

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

FERC LVRT Criteria

Another important aspect of the stability analysis was to determine the ability of the wind generators to stay connected to the grid during disturbances. This is primarily determined by their low-voltage ride-through capabilities – or lack thereof – as represented in the models by low-voltage trip settings. The Federal Energy Regulatory Commission (FERC) Post-transition period LVRT standard for Interconnection of Wind generating plants includes a Low Voltage Ride Through (LVRT) requirement[2]. The key features of LVRT requirements are:

- A wind generating plant must remain in-service during three-phase faults with normal clearing (maximum 9 cycles) and single-line-to-ground faults with delayed clearing, and have subsequent post-fault recovery to pre-fault voltage unless the clearing of the fault effectively disconnects the generator from the system.
- The maximum clearing time the wind generating plant shall be required to withstand a three-phase fault shall be 9 cycles after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the wind generating plant may disconnect from the transmission system. A wind generating plant shall remain interconnected during such a fault on transmission system for a voltage level as low as zero volts, as measured at the high voltage side of the GSU.

[2] FERC Order 661A issued December 12, 2005, Appendix G Interconnection requirements for wind generating plant

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 (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 post-Project powerflow case from PID-223 impact study was used as a base case representing the 2015 Summer Peak conditions.

It was assumed that the proposed PID-224 project will be connected to the Green Forest South – Harrison West 161 kV line through a three breaker ring bus arrangement. The proposed project was added to the pre-project (Post-PID-223) case and the generation (100 MW) was dispatched against the White Bluff Unit 1. Table 2-1 summarizes the dispatch. Thus a post-project power flow case with PID-224 was established and named as 'POST-PID-224.sav'.

Table IV-2: PID-224 project details

System condition	MW	Point of Interconnection	Sink
2015 Summer Peak	100	Green Forest South – Harrison West 161 kV line	White Bluff Unit 1 (#337652)

PID-224 Windfarm modeling

The proposed windfarm was modeled as a single equivalent generator representing fifty (50) wind turbine generators. The single equivalent wind turbine generator was connected to the 34.5 kV collector bus via an equivalent generator step-up transformer (GSU). The details of the collector bus system were not available at the time of study hence were not modeled. The 34.5 kV collector bus was connected to the 161 kV substation through one 34.5/161 kV step-up transformer. the new 161 kV substation was connected to the Point of Interconnection (POI) through a 6 mile 161 kV line. Figure IV-3 shows the one-line diagram for the PID-224 windfarm. A 20 Mvar shunt capacitor was added to the 34.5 kV collector bus system to maintain a power factor of approximately unity at the point of interconnection.

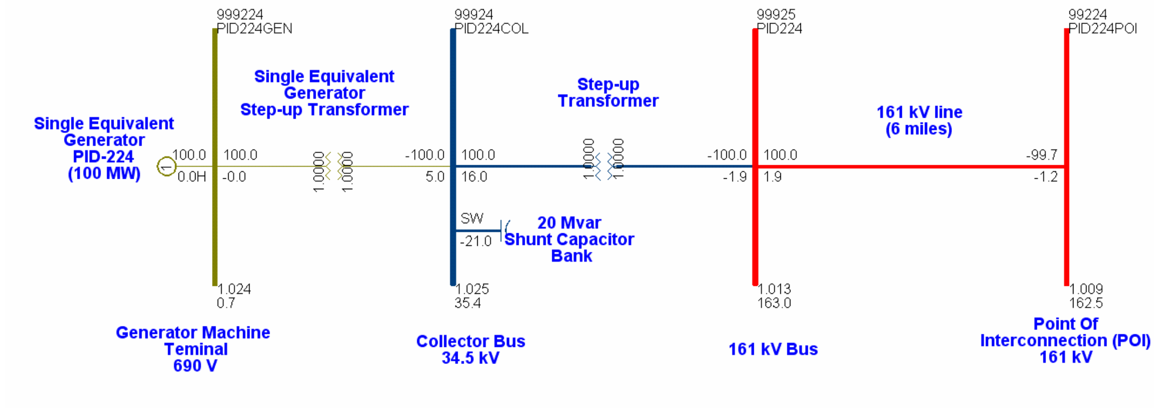


Figure IV-3: One Diagram for PID-224 windfarm

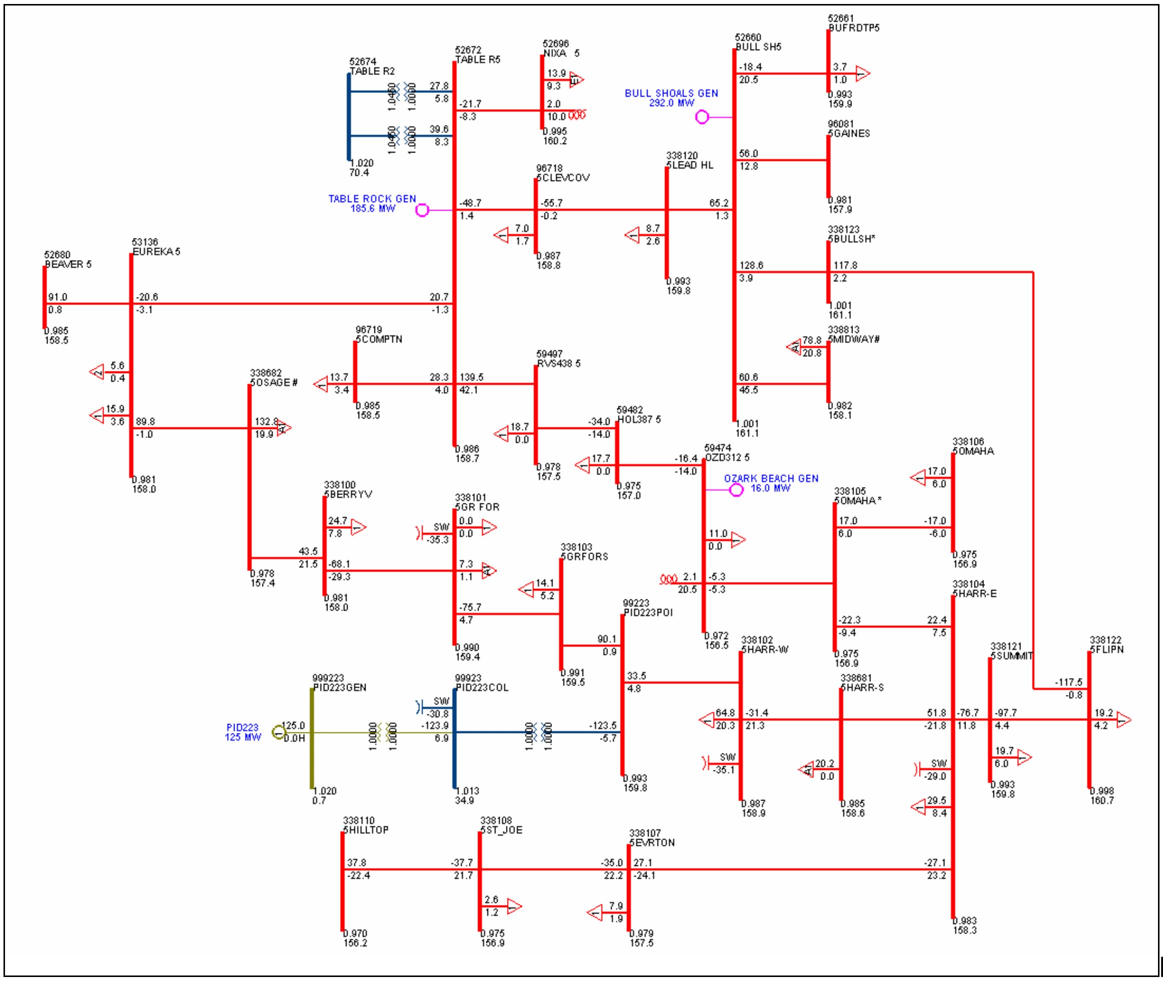
Stability Database

A basecase stability database was provided by SPP/Entergy in a PSSE *.dyr file format ('red11S_newnum.dyr'). A snapshot file corresponding to the Pre-PID-224 case was created.

Then, the stability data for PID-224 was appended to the pre-project stability database to create dynamic database for Post-PID-224 powerflow case.

SPP provided a dynamic model for Clipper Liberty Series 2.5 MW wind turbine generators. The '*C93TUR*' – turbine model – produces a blade pitch angle that maintains the rotor speed near its rated value during wind excess of that which results in rated turbine output power. The '*C93GEN*' – torque control model – represents nearly instantaneous torque response of the generator/inverter subsystem in response to the torque commands generated by the torque controller. The model assumes that the available wind power (i.e. wind speed) is constant over the period of the simulations. The over/under voltage and frequency protection settings have been included in the model with fixed setpoints and time delays as shown in Table IV-1.

Figure 2-1 and Figure 2-2 show the PSS/E one-line diagrams for the local area WITHOUT and WITH the PID-224 project, respectively, for 2015 Summer Peak system conditions. The power flow and stability model representation of PID-224 project is shown in Appendix B.



Fig

Figure IV-4: Powerflow diagram <u>without</u> PID-224 (2015 summer peak)

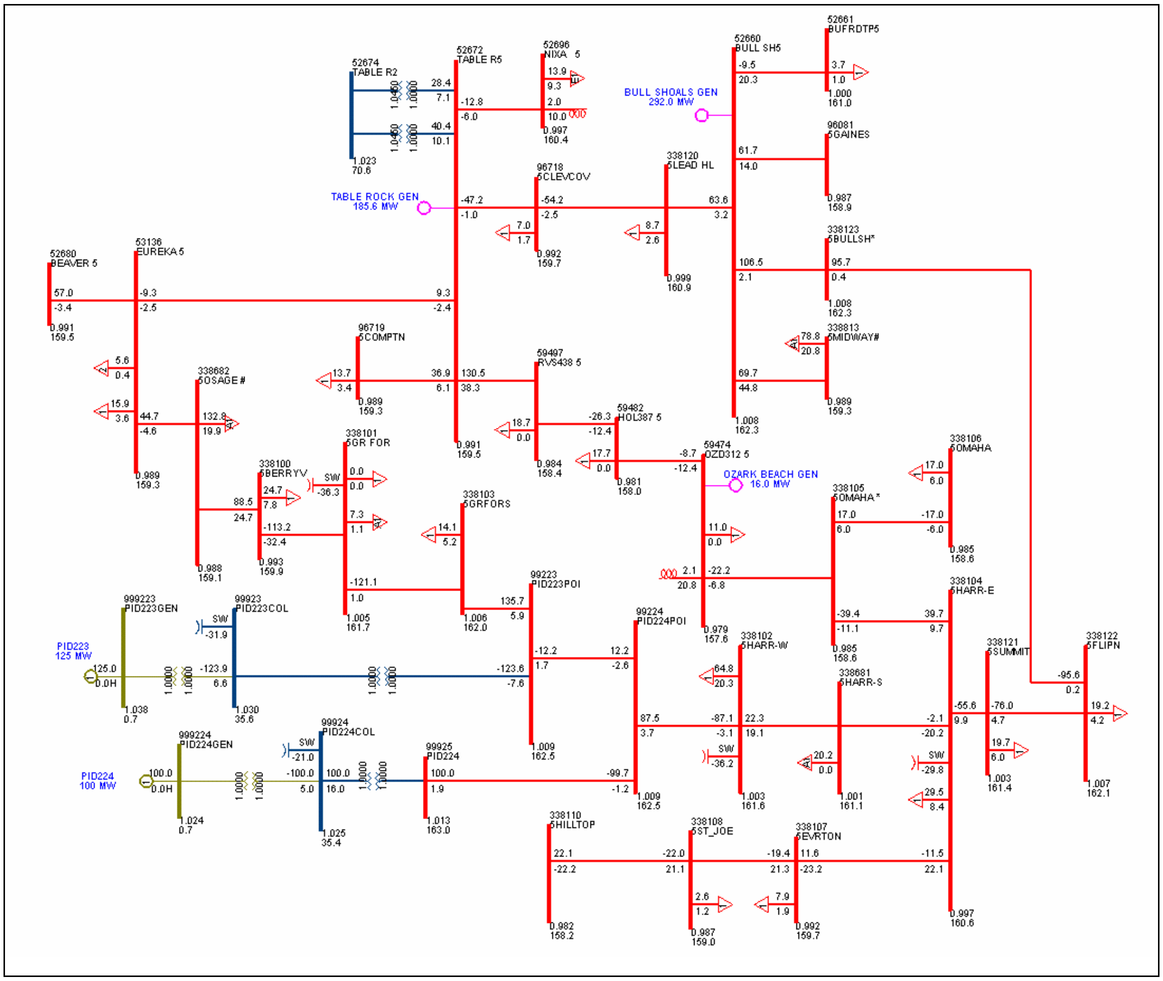


Figure IV-5: Powerflow diagram with PID-224 (2015 summer peak)

TRANSIENT STABILITY ANALYSIS

Stability simulations were run to examine the transient behavior of the PID-224 wind turbine generator and its impact on the Entergy system. Stability analysis was performed using the following procedure. First, three-phase faults with normal clearing were simulated. Next, the stuck breaker three phase fault conditions were simulated. If a stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. This procedure is being followed since if the units are stable for a more severe fault (such as three phase fault with breaker failure) then the need to study stability for a less severe fault (such as SLG fault with breaker failure) does not arise. The fault clearing times used for the simulations are given inTable IV-3.

Table IV-3: Fault Clearing Times

Contingency at kV level	Normal Clearing	Delayed Clearing
161	6 cycles	6+9 cycles

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

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

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

3) The fault is then cleared by back-up clearing. If the system was found to be unstable, then the fault was repeated without the proposed PID-224 plant.

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

Table IV-4 lists all the fault cases that were simulated in this study.

FLT_1_3PH to FLT_7_3PH represent the normally cleared 3-phase faults. FLT_8_3PH to FLT_10_3PH Faults represent the 3-phase stuck breaker faults.

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 IV-4: List of faults simulated for PID-224 stability analysis

Contingency Name	Contingency Description
FAULT_1_3PH	6 CY 3 PH fault at POI Cleared by tripping POI – PID-223 POI 161 kV line
FAULT_2_3PH	6 CY 3 PH fault at POI Cleared by tripping POI - Harrison West 161 kV line
FAULT_3_3PH	6 CY 3 PH fault at Eureka Springs Cleared by tripping Eureka - Beaver 161 kV line
FAULT_4_3PH	6 CY 3 PH fault at Eureka Springs Cleared by tripping Eureka - Table Rock 161 kV line
FAULT_5_3PH	6 CY 3 PH fault at Harrison East Cleared by Tripping Harrison East - Everton RD 161 kV
FAULT_6_3PH	6 CY 3 PH fault at Harrison East Cleared by Tripping Harrison East - Summit 161 kV
FAULT_7_3PH	6 CY 3 PH fault at Harrison East Cleared by Tripping Harrison East - Omaha 161 kV
FAULT_8_3PH_STK_BRK	6+9 CY 3 PH fault at Green Forest South Cleared by tripping Green Forest South – PID-223 POI 161 kV and Green Forest South - Green Forest 161 kV
FAULT_9_3PH_STK_BRK	6+9 CY 3 PH fault at Harrison West Cleared by tripping Harrison West – PID-224 POI 161 kV and Harrison West - Harrison South 161 kV

Contingency Name	Contingency Description
FAULT_10_3PH_STK_BRK	6+9 CY 3 PH at Eureka 161 kV Cleared by tripping Eureka - Beaver 161 kV

The system was found to be STABLE following all the normally cleared three-phase faults and all stuck breaker three-phase faults. Figure IV-6 and Figure IV-7 shows plot for PID-224 following FLT_8_3PH and FLT_9_3PH.

Transient Voltage Recovery

The voltage recovery for all the local buses was monitored. The results indicated no voltage criteria violations following simulated faults.

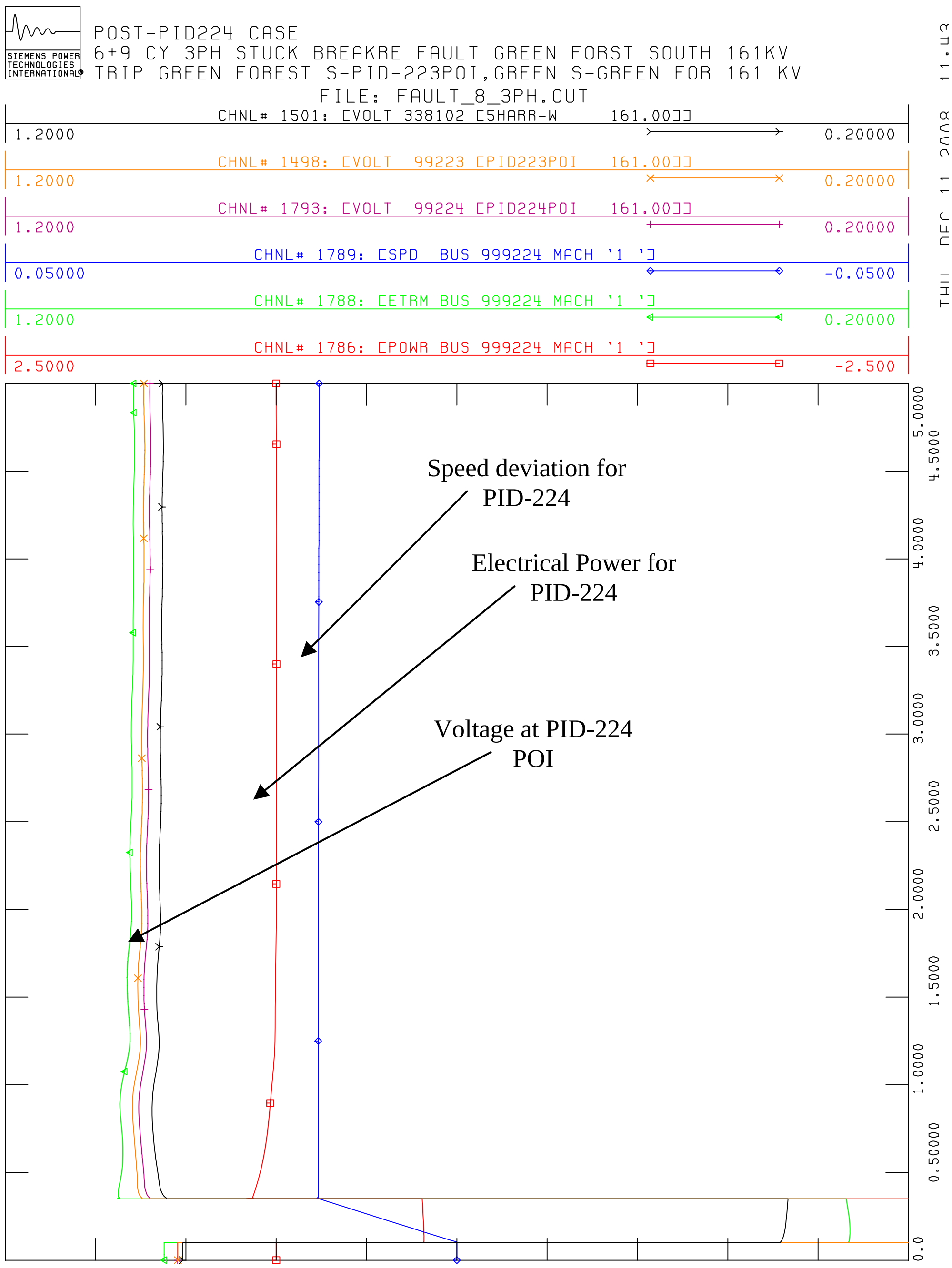


Figure IV-6: Fault_8_3PH with PID-224

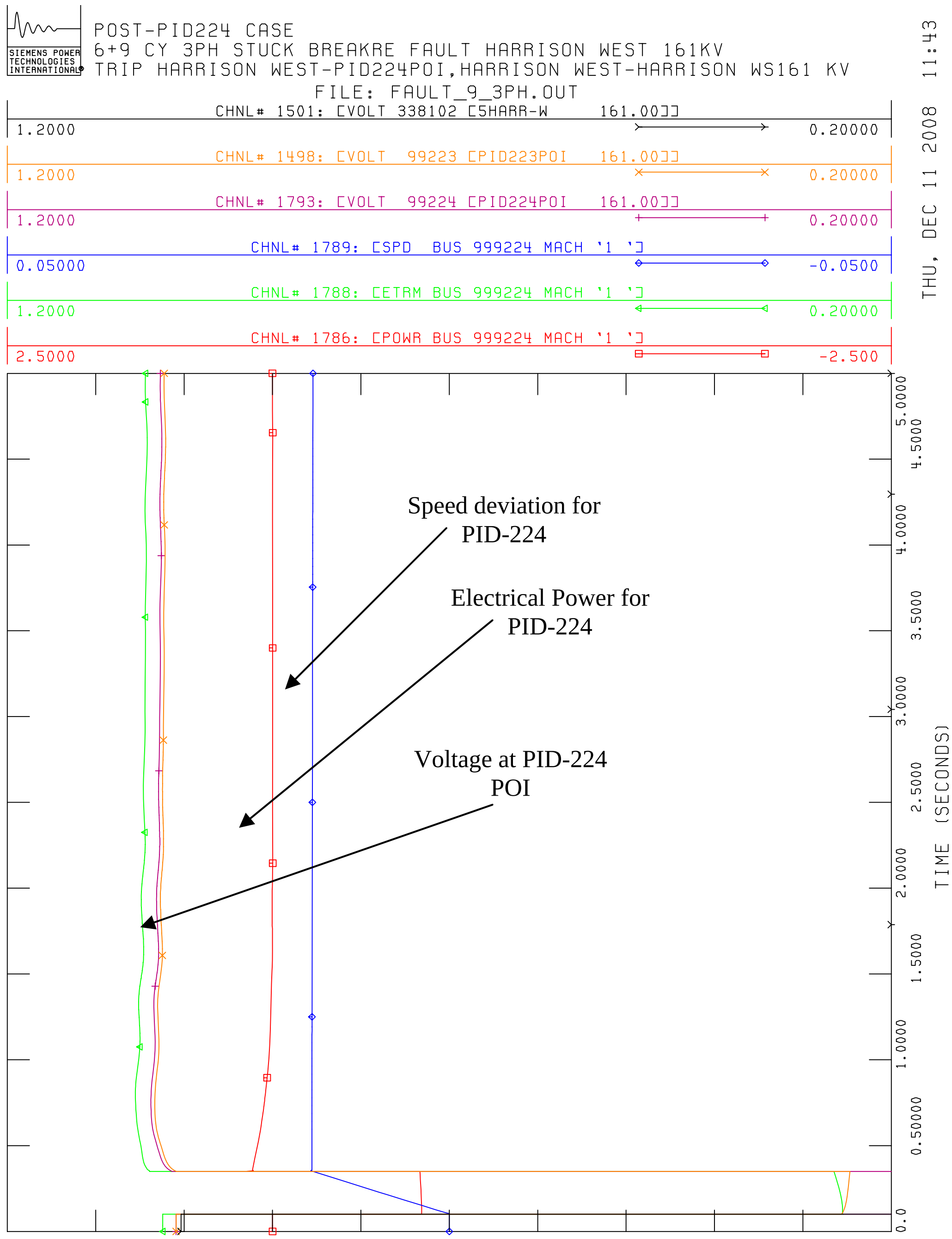


Figure IV-7: Fault_9_3PH with PID-224

Low Voltage Ride Through (LVRT)

As discussed in Section 0, the proposed project was modeled with low voltage ride through capability. The PID-224 Project Point-of-Interconnection (POI) is on Green Forest South – Harrison West 161 kV line. As discussed in section 0, the post-transition period LVRT capability of the Project was verified by simulating two (2) separate three-phase faults at POI 161 kV clearing one line at a time.

- LVRT_PID-224_1: 9 cycle, 3 Phase fault at POI 161 kV and cleared by tripping POI – PID-223 POI 161 kV line
- LVRT_ PID-224_2: 9 cycle, 3 Phase fault at POI 161 kV and cleared by tripping POI – Harrison West 161 kV line

As shown in Figure IV-8 and Figure IV-9, the wind turbine generator remains on-line for both fault cases. Therefore, the LVRT requirement is met.

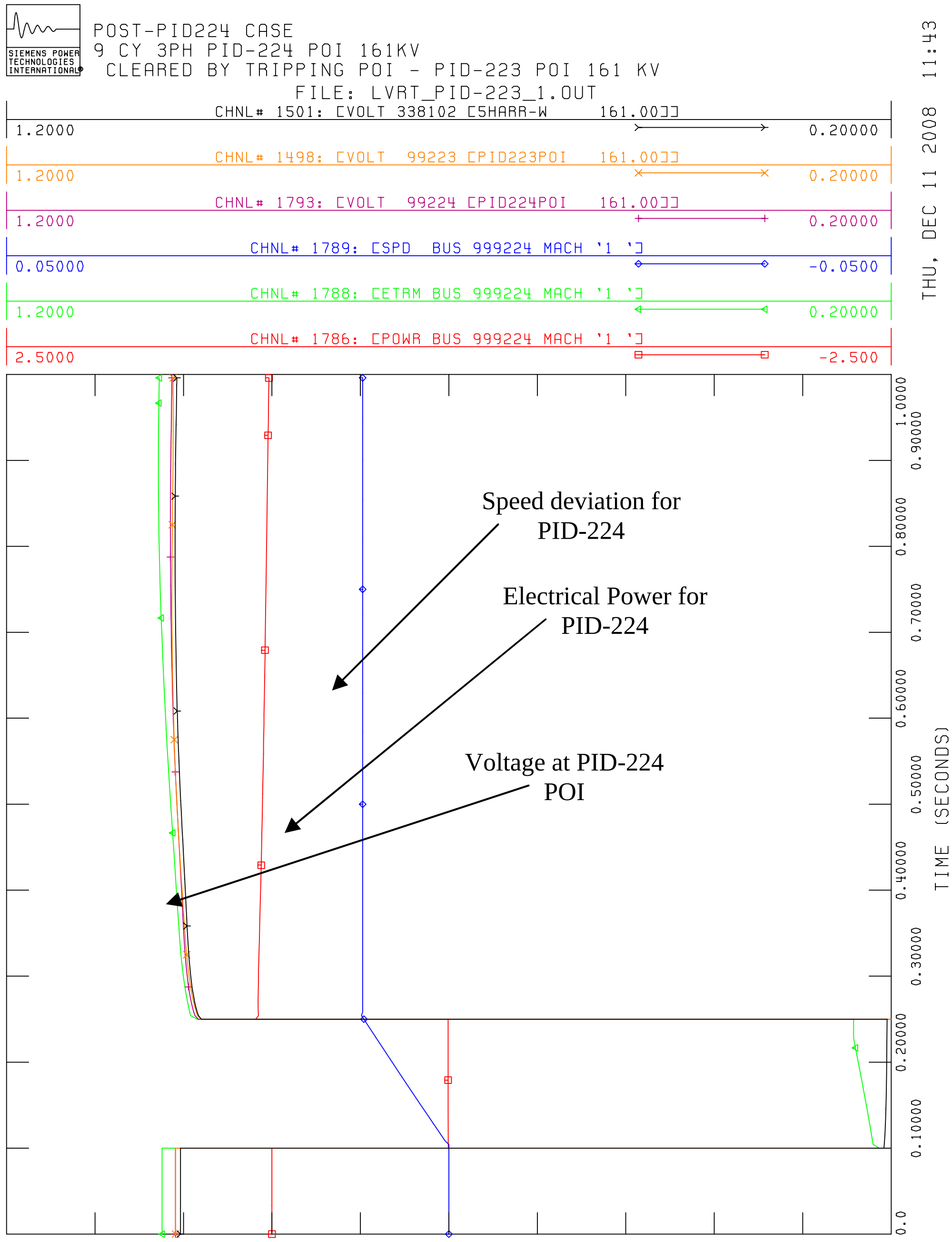


Figure IV-8: LVRT capability of PID-224 for (LVRT_PID-224_1)

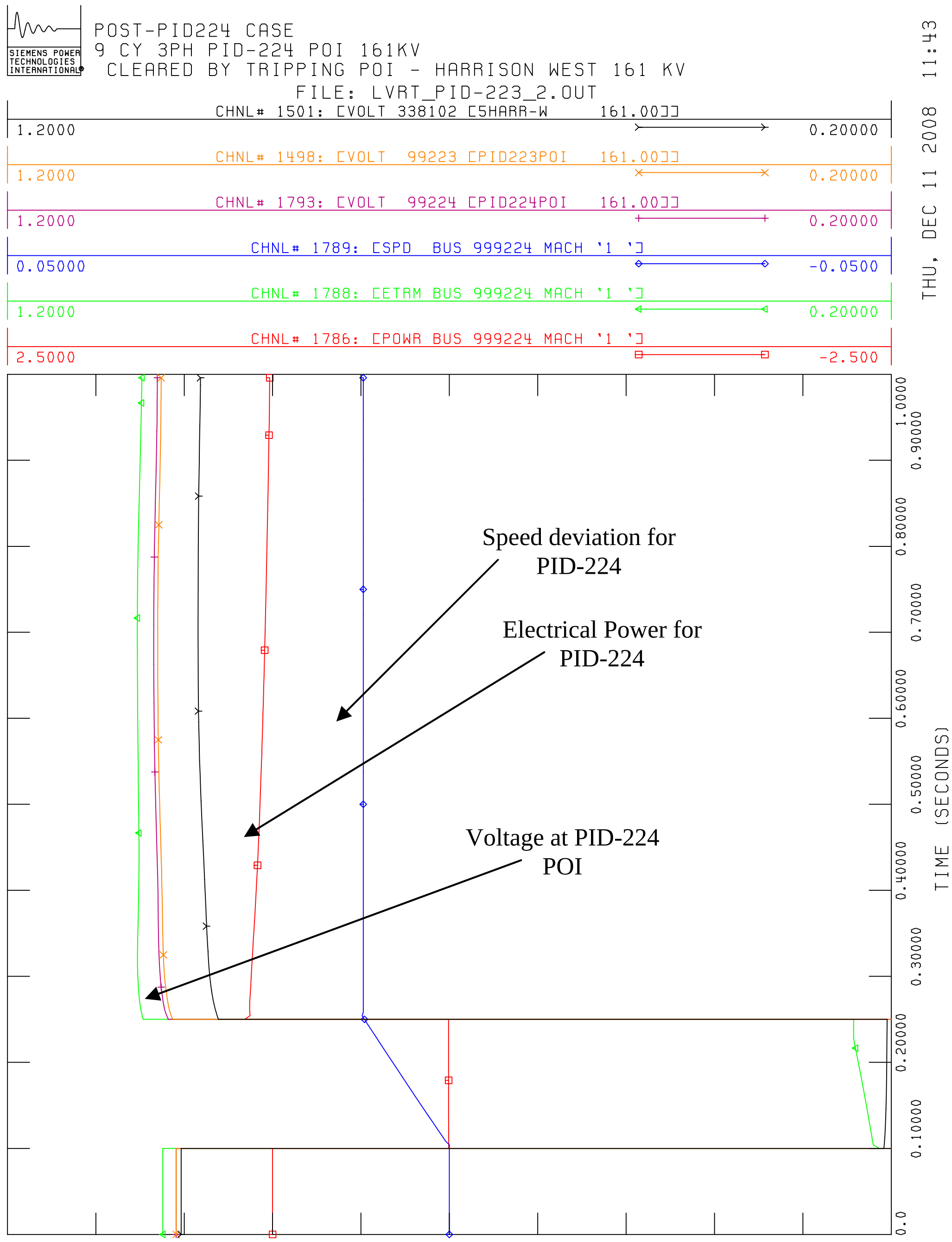


Figure IV-9: LVRT capability of PID-224 for (LVRT_PID-224_2)

Conclusions

SPP has commissioned ABB Inc. to perform a stability study for PID-224. PID-224 is a 100 MW windfarm to be located in Carroll County, Arkansas with a point of interconnection on Entergy Green Forest South – Harrison West 161 kV transmission line approximately 3.3 miles from Green Forest South substation. The proposed in-service date for the Project is December 2009. As per the developer's request, the proposed PID-224 generation was studied using Clipper 2.5 MW wind turbines.

The stability analysis was conducted to identify the impact of the proposed project on the MAPP bulk power system. The feasibility (powerflow) study was not performed as a part of this study. Three phase normally cleared and stuck breaker faults were simulated in the vicinity of the proposed project.

This interconnection of wind farm was studied by using study model representing 2015 summer peak system conditions. No stability criteria violations were observed following series of simulated faults at or near the POI after interconnection of the proposed project.

Based on the results of the stability analysis, it is concluded that the proposed wind farm does not adversely impact the stability of the Entergy system.

FERC Order 661A Compliance – The Low Voltage Ride through (LVRT) capability was verified for compliance with Federal Energy Regulatory Commission's (FERC) standard for Interconnection of Wind generating plants: 'Low Voltage Ride-Through (LVRT)' requirement. The proposed project is planned to have LVRT capability which was modeled for all of the simulated faults.

The proposed project (PID-224) complies with the latest FERC order on low voltage ride through for wind farms. With this arrangement, these wind farms would not trip off line by voltage relay actuation for local faults near the POI.

Final conclusions:

1) The proposed PID-224 windfarm does not degrade the stability of the bulk power system in Entergy region.

2) The proposed PID-224 (100 MW) windfarm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

Data Provided by Customer

Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

UNIT RATINGS

kVA 2500 °F ________ Voltage 690V
Power Factor +/-0.95
Speed (RPM) Variable 1133rpm at rated Connection (e.g. Wye) Wye
Short Circuit Ratio 1.11 Frequency, Hertz 60
Stator Amperes at Rated kVA 2092 Field Volts N/A (PMG)
Max Turbine MW 2.5 °F -40 to +122

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 6.06 s or kW sec/kVA
Moment-of-Inertia, WR^2 = ________ lb. ft.^{2}

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	______	X_{qv}	______
Synchronous – unsaturated	X_{di}	______	X_{qi}	______
Transient – saturated	X'_{dv}	______	X'_{qv}	______
Transient – unsaturated	X'_{di}	______	X'_{qi}	______
Subtransient – saturated	X''_{dv}	______	X''_{qv}	______
Subtransient – unsaturated	X''_{di}	______	X''_{qi}	______
Negative Sequence – saturated	$X2_v$	______		
Negative Sequence – unsaturated	$X2_i$	______		
Zero Sequence – saturated	$X0_v$	______		
Zero Sequence – unsaturated	$X0_i$	______		
Leakage Reactance	Xl_m	______		

FIELD TIME CONSTANT DATA (SEC)

N/A as the wind turbine consists of 4 permanent magnet generators a DC converter and an AC inverter serially connected to the LV side of the padmount transformer

Open Circuit	T'_{do}	_______	T'_{qo}	_______
Three-Phase Short Circuit Transient	T'_{d3}	_______	T'_{q}	_______
Line to Line Short Circuit Transient	T'_{d2}	_______		
Line to Neutral Short Circuit Transient	T'_{d1}	_______		
Short Circuit Subtransient	T''_{d}	_______	T''_{q}	_______
Open Circuit Subtransient	T''_{do}	_______	T''_{qo}	_______

ARMATURE TIME CONSTANT DATA (SEC)

N/A as the wind turbine consists of 4 permanent magnet generators a DC converter and an AC inverter serially connected to the LV side of the padmount transformer

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

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)

N/A as the wind turbine consists of 4 permanent magnet generators a DC converter and an AC inverter serially connected to the LV side of the padmount transformer

Positive	R_1	_______
Negative	R_2	_______
Zero	R_0	_______

Rotor Short Time Thermal Capacity I_2^2t = _______

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

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

Three Phase Armature Winding Capacitance = ________ microfarad
Field Winding Resistance = ________ ohms ______ °C
Armature Winding Resistance (Per Phase) = _______ ohms ______ °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
69 / 92 / 115 MVA (ONAN / ONAF / ONAF)

Voltage Ratio(Generator Side/System side/Tertiary)
34.5 / 161 / 13.8 kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
W-g / W-g / DT — internal tertiary, not brought out per David Jones

Fixed Taps Available 2 x +/- 2.5%

Present Tap Setting 0
Nominal 161 kV

IMPEDANCE

Positive Z_1 (on self-cooled kVA rating) 10 % _____ X/R

Zero Z_0 (on self-cooled kVA rating) 9.4 % _____ X/R

Padmount transformer

- 2.750 MVA
- Z= 5.75% (Base rating)
- Zo= 5.75%
- Voltage Ratio: 0.69/34.5 (kV)
- Winding Connections: Y-g: Y-g
- Fixed Taps Available: +/- 2.5, set at 0.

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.

GOVERNOR SYSTEM DATA

N/A

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.

WIND GENERATORS

Number of generators to be interconnected pursuant to this Interconnection Request:
__40______

Elevation: _____________ _____ Single Phase _X__ Three Phase

Inverter manufacturer, model name, number, and version:
Manufacturer/model varies depending on supply chain________

List of adjustable setpoints for the protective equipment or software:
AC line over/under voltage and frequency and time delays_______________

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.
PSLF and PSS/E user models are available – see attached
In addition, an ASPEN file is included.

INDUCTION GENERATORS

N/A

(*) 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.

Load Flow and Stability Data

Loadflow Data

```
POST-PID224 CASE
 99224,'PID224POI   ', 161.0000,1,     0.000,     0.000, 351, 163,1.00909, -58.8869,   1
 99924,'PID224COL   ',  34.5000,1,     0.000,     0.000, 351, 163,1.02541, -49.9756,   1
 99925,'PID224      ', 161.0000,1,     0.000,     0.000, 351, 163,1.01264, -57.9986,   1
999224,'PID224GEN   ',   0.6900,2,     0.000,     0.000,   1,   1,1.02414, -47.1224,   1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
999224,'1 ',   100.000,     0.000,     0.000,     0.000,1.00000,     0,   100.000,
0.00000,9999.00000,   0.00000,   0.00000,1.00000,1,  100.0,   100.000,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
 99223,  99224,'1 ',   0.00398,   0.01893,   0.00932,  223.00,  223.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,   7.13,   1,1.0000
 99224,  99925,'1 ',   0.00335,   0.01592,   0.00784,  100.00,  100.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,   6.00,   1,1.0000
 99224, 338102,'1 ',   0.00550,   0.02614,   0.01287,  223.00,  223.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,   9.85,   1,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
 99925, 99924,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'PID224SUB   ',1,   1,1.0000
   0.00000,   0.10000,    69.00
1.00000,   0.000,   0.000,   135.00,   135.00,   135.00, 0,      0, 1.10000, 0.90000,
1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,   0.000
 99924,999224,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'PID224GSU   ',1,   1,1.0000
   0.00000,   0.05750,   110.00
1.00000,   0.000,   0.000,   110.00,   110.00,   110.00, 0,      0, 1.10000, 0.90000,
1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,   0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
 351,337653,   542.000,    10.000,'EES         '
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
 99924,0,1.00000,1.00000,     0,  100.0,'            ',   20.00, 1,  20.00
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
   1,'ZONE-001    '
 163,'EAINTH      '
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
   1,'CENT HUD    '
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA
```

Dynamics Data

```
POST-PID224 CASE
 PLANT MODELS
 REPORT FOR ALL MODELS                    BUS 999224 [PID224GEN   0.6900] MODELS

     ** C93GEN **  BUS  MACH        C O N S       S T A T E S
                 999224   1     130170-130174  51110- 51113

                     H     MBASE     KPLL    TAUPLL    ISPD
                    5.69  100.00     0.10     0.03     1.00


     ** C93TUR **  BUS  MACH        C O N S       S T A T E S
                 999224   1     130175-130180  51114- 51114

                   KPP      KPI    PAMIN    PAMAX    PAINIT   MBASE
                   63.50    6.95    0.00    90.00     0.00  100.00
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Section – B

Network Resource Interconnection Service

TABLE OF CONTENTS FOR NRIS

Introduction:

A Network Resource Interconnection Services (NRIS) study was requested by PID 224 to serve 100 MW of Entergy network load. The expected in service date for this NRIS generator is 12/1/2009. 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:

Models
The models used for this analysis is the 2012 summer peak case 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 year 2012.
- Approved transmission reliability upgrades for 2008 - 2012 were included in the base case. These upgrades can be found at Entergy's OASIS web page, http://www.entergy.com/etroasis/, under approved future projects.

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

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
1481438	NRG Power Marketing	20	2/1/2011	2/1/2021
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
ASA-2008-001	TVA	724	1/1/2009	1/1/2013
ASA-2008-003	Empire District Electric Co.	100	11/1/2008	11/1/2028
1551562	CLECO Power LLC	11	6/1/2009	6/1/2018
1557602	East Texas Electric Coop	1	1/1/2009	1/1/2017
1558911	NRG Power Marketing	100	1/1/2009	1/1/2014
1559579	NRG Power Marketing	500	5/1/2010	5/1/2015
1559580	NRG Power Marketing	500	5/1/2010	5/1/2015
1559581	NRG Power Marketing	150	5/1/2010	5/1/2015
1562340	Entergy Services (EMO)	1	7/1/2008	7/1/2009
1562529	Constellation Energy Grp	123	1/1/2009	1/1/2010

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 PID-224 100MW generators were 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:

Study Case	Study Case with Priors
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 2
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 1
Baxter Wilson - Ray Braswell 500kV	
Green Forest South – PID 223 Tap 161kV	
Harrison West - PID224 Line Tap 161kV	

DFAX Study Case Results:

Limiting Element	Contingency Element	ATC(MW)
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0

DFAX Study Case with Priors Results:

Limiting Element	Contingency Element	ATC(MW)
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Green Forest South – PID 223 Tap 161kV	Harrison West - PID224 Line Tap 161kV	88
Harrison West - PID224 Line Tap 161kV	Green Forest South – PID 223 Tap 161kV	88

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

With Priors

Limiting Element	Planning Estimate for Upgrade
Sterlington 500/115kV transformer 2	Supplemental Upgrade TBD
Sterlington 500/115kV transformer 1	Supplemental Upgrade TBD
Green Forest South – PID 223 Tap 161kV	Upgrade PID 223 Tap – Green Forest South 161kV line 3.3 miles to at least 250MVA: $4,125,000
Baxter Wilson - Ray Braswell 500kV	Potential Supplemental Upgrade $ TBD
Harrison West - PID224 Line Tap 161kV	Upgrade Harrison West – PID224 161kV line 9.82 miles to at least 250MVA: $12,275,000

Without Priors

Limiting Element	Planning Estimate for Upgrade
Sterlington 500/115kV transformer 2	Supplemental Upgrade TBD
Sterlington 500/115kV transformer 1	Supplemental Upgrade TBD
Baxter Wilson - Ray Braswell 500kV	Replace 2000 amp breakers & switches with 3000 amp breakers & switches at Baxter Wilson & Ray Braswell $ 7,160,000

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.

APPENDIX B-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-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.