System Impact Study
PID-247
180MW Plant

Prepared by:

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Rev	Issue Date	Description of Revision	Revised By	Project Manager
0	2/7/2011	Posting System Impact Study	EC	BR
1	2/24/11	Section 13.3 (pg.55) revised to include language regarding additional sensitivity analysis performance and Appendix F added describing assumptions used during the Stability Study	EC	BR
2	10/6/11	Revised to include Addendum A for Stability Restudy	EC	BR

Contents

Executive Summary

This System Impact Study is the second step of the interconnection process and is based on the PID-247 request for interconnection on Entergy's transmission system to the Stowell 138kV substation in Texas. This report is organized in four sections, namely, Energy Resource Interconnection Service (ERIS), Network Resource Interconnection Service (NRIS), Short Circuit/Breaker Rating Analysis, and Stability Study.

The ERIS section includes load flow (steady state) analysis. The NRIS section contains details of load flow (steady state) analysis. Transient stability analysis found in the Stability Study and Short Circuit Analysis as defined in FERC orders 2003, 2003A and 2003B for ERIS are also applicable to NRIS.

Requestor for PID-247 did request NRIS and ERIS; therefore, under ERIS, a load flow analysis was performed. PID-247 will be a new facility. PID-247 interconnection will consist of the addition of one 138kV transmission line from the customer's facility to the Stowell 138kV substation. The study evaluates connection of 180MW to the Entergy Transmission System. The load flow study was performed on the latest available 2014 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, 2011.

Results of the System Impact Study indicated that under ERIS the additional generation due to PID-247 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-247 plant with priors and without priors. Therefore, estimated upgrade costs under ERIS with and without prior is $0. See table below.

Estimated ERIS Project Planning Upgrade Cost

Interconnection Upgrades	**Planning Estimate for Upgrade***
Construct new 138kV transmission lines rated at 212MVA – 7 miles	$8,750,000

*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.

Estimated NRIS Project Planning Upgrades

Results of the System Impact Study indicated that under NRIS the upgrades listed below would be required for interconnection on Entergy's transmission system at the proposed POI.

Limiting Element	**Planning Estimate for Upgrade***
Bayshore - Brkscrk 138kV	$9,875,000
Hankamer - Crooked Bayou 138kV	$10,000,000
Stowell - Crooked Bayou 138kV	$13,675,000
Shiloh - Brkscrk 138kV	$4,137,500
Interconnection Upgrades	
Construct new 138kV transmission lines rated at 212MVA – 7 miles	$8,750,000

*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.

Energy Resource Interconnection Service

1. Introduction

This Energy Resource Interconnection Service (ERIS) is based on a request for 180MW interconnection on Entergy's transmission system at Stowell 138kV 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 the Customer 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.

2. Load Flow Analysis

2.1 Model Information

The load flow analysis was performed based on the projected 2014 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 2014 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 generator interconnection point does not have capacity to allow the 180MW generators without making improvements to the transmission system.

The proposed 180MW 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.

This study considered the following four scenarios:

Scenario No.	Approved Future Transmission Projects	Pending Transmission Service & Study Requests	Reference
1	Not Included	Not Included	Table 2.3 2
2	Not Included	Included	Table 2.3 3
3	Included	Not Included	Table 2.3 4
4	Included	Included	Table 2.3 5

The generator step-up transformers, generators, and interconnecting lines were modeled according to the information provided by the Customer.

2.2 Load Flow Analyses

2.2.1 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.

2.2.2 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.

2.2.3 Power Factor Consideration / Criteria

Entergy, consistent with the FERC Large Generator Interconnection Procedures (LGIP), requires the customer to be capable of supplying at least 0.33MVAR (*i.e.*, 0.95 lagging power factor) and absorbing at least 0.33MVAR (*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.

2.3 Analysis Results

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

Table 2.3 1: Summary of Results for PID-247 – ERIS Load Flow Study

Interface	Name	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.	2014	0	0	162	0
AMRN	Ameren Transmission	2014	150	0	162	0
CLEC	CLECO	2014	0	0	163	0
AEP-W	American Electric Power - West	2014	0	0	161	0
EES	Entergy	2014	151	0	0	0
EMDE	Empire District Electric Co	2014	0	0	162	0
LAFA	Lafayette Utilities System	2014	0	0	0	0
LAGN	Louisiana Generating, LLC	2014	107	0	0	0
LEPA	Louisiana Energy & Power Authority	2014	0	0	0	0
OKGE	Oklahoma Gas & Electric Company	2014	0	0	162	0
SMEPA	South Mississippi Electric Power Assoc.	2014	0	0	0	0
SOCO	Southern Company	2014	150	0	0	0
SPA	Southwest Power Administration	2014	0	0	162	0
TVA	Tennessee Valley Authority	2014	150	0	0	0

TABLE 2.3 2: DETAILS OF SCENARIO 1 RESULTS (WITHOUT FUTURE PROJECTS AND WITHOUT PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Est. cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Bayshore - Brkscrk 138kV	9,875,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Bayshore - Hankamer 138kV	4,350,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Brookhaven - Mallalieu (MEPA) 115kV	Included in 2011 ICT Base Plan											X			
Calico Rock - Melbourne 161kV	13,274,000													X	
Fancy Point - Port Hudson 230kV ckt 2	Included in 2011 ICT Base Plan									X					
Habetz - Richard 138kV	Included in 2011 ICT Base Plan							X							
Hankamer - Crooked Bayou 138kV	10,000,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Jackson Forrest Hill - Ray Braswell 115kV	6,550,000											X			
Jackson Forrest Hill - Southwest Jackson 115kV	3,625,000											X			
Lake Conway - Mayflower 115kV	4,937,500													X	
Lakeover 500/115kV transformer	18,000,000											X			
North Crowley - Scott1 138kV	Included in 2011 ICT Base Plan				X			X							
Pleasant Hill 500/161kV transformer	Included in 2011 ICT Base Plan						X							X	
Raceland - Coteau 115kV	15.325,000									X					
Ray Braswell - Baxter Wilson 500kV	Committed to by others									X		X	X		
Ray Braswell 500/115kV transformer 1	18,000,000											X			
Ray Braswell 500/230kV transformer ckt2	Committed to by others											X			
Richard - Scott1 138kV	Included in 2011 ICT Base Plan				X			X		X					

Limiting Element	Est. cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Russellville East - Russellville North 161kV	Included in 2011 ICT Base Plan	X	X				X				X			X	
Semere - Scott2 138kV	Included in 2011 ICT Base Plan							3MW							
Shiloh - 5L541T43 138kV	8,712,500	X	X	X	X	X	X	X	X		X	X	X	X	X
Shiloh - Brkscrk 138kV	4,137,500	X	X	X	X	X	X	X	X		X	X	X	X	X
Sterlington 500/115kV transformer 2	Committed to by Others								X						
Stowell - Crooked Bayou 138kV	13,675,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Vacherie - Waterford 230kV	32,182,500									X					

TABLE 2.3 3: DETAILS OF SCENARIO 2 RESULTS (WITHOUT FUTURE PROJECTS AND WITH PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Elements	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Alchem - Monochem1 138kV	Included in 2011 ICT Base Plan									X					
Bayshore - Brkscrk 138kV	9,875,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Bogalusa - Adams Creek 230kV ckt 1	6,355,000									X					
Bogalusa - Adams Creek 230kV ckt 2	6,355,000									X					
Bogalusa - Adams Creek 500/230kV transformer	19,110,000									X		X			
Brookhaven - Mallalieu (MEPA) 115kV	Included in 2011 ICT Base Plan											X			
Coly - Vignes 230kV - Supplemental Upgrade	Committed to by Others					X				X		X			
Coly 500/230kV transformer	21,000,000					X				X					
Fancy Point - Port Hudson 230kV ckt 2	Included in 2011 ICT Base Plan									X					
Fancy Point 500/230kV transformer 1	21,000,000					X				X					
Florence - South Jackson 115kV - Supplemental Upgrade	Committed to by Others											X			
Habetz - Richard 138kV	Included in 2011 ICT Base Plan							X							
Hankamer - Crooked Bayou 138kV	10,000,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Harrison East - Omaha 161kV	21,750,000						X								
Jackson Forrest Hill - Ray Braswell 115kV	6,550,000											X			
Jackson Forrest Hill - Southwest Jackson 115kV	3,625,000											X			
Jackson Miami - Jackson Monument Street 115kV	2,856,000											X			
Jackson Miami - Rex Brown 115kV	Included in 2011 ICT Base Plan											X			

Limiting Elements	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Jaguar - Tap Point Esso 230kV	Included in 2011 ICT Base Plan					X				X					
Louisiana Station - Thomas 138kV	1,562,500									X					
Mallalieu (MEPA) - Norfield 115kV	1,250,000											X			
McComb - Norfield 115kV	Included in 2011 ICT Base Plan											X			
Morton - Pelahatchie 115kV - Supplemental Upgrade	Committed to by Others											X			
North Crowley - Scott1 138kV	Included in 2011 ICT Base Plan				X			X		X					
Port Hudson 230/138 transformer 1	14,812,500									X					
Port Hudson 230/138 transformer 2	9,200,000									X					
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Committed to by Others					X		X	X	X		X	X		X
Rex Brown W - Rex Brown C 115kV ckt 1	TBD											X			
Richard - Scott1 138kV	Included in 2011 ICT Base Plan				X			X		X			X		
Semere - Scott2 138kV	Included in 2011 ICT Base Plan				X			X							
Shiloh - 5L541T43 138kV	8,712,500		X												
Shiloh - Brkscrk 138kV	4,137,500	X	X	X	X	X	X	X	X		X	X	X	X	X
Sterlington 500/115kV transformer 1	Committed to by Others								X						
Sterlington 500/115kV transformer 2	Committed to by Others								X						
Stowell - Crooked Bayou 138kV	13,675,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Willow Glen - Webre 500kV	Included in 2011 ICT Base Plan	X	X	X	X	X	X		X	X	X	X	X	X	X

Limiting Elements	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Willow Glen - Willow Glen 2 500/138kV transformer 1	Included in 2011 ICT Base Plan					X				X					
Willow Glen 500/230kV Transformer	Included in 2011 ICT Base Plan	X		X		X	X			X		X	X	X	X

TABLE 2.3 4: DETAILS OF SCENARIO 3 RESULTS (WITH FUTURE PROJECTS AND WITHOUT PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Bayshore - Brkscrk 138kV	9,875,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Calico Rock - Melbourne 161kV	20,787,500													X	
Hankamer - Crooked Bayou 138kV	10,000,000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Jackson Forrest Hill - Ray Braswell 115kV	6,550,000											X			
Raceland - Coteau 115kV	15,325,000									X					
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Committed to by Others					X		X	X	X		X	X		X
Ray Braswell 500/115kV transformer 1	18,000,000											X			
Ray Braswell 500/230kV transformer ckt2 - Supplemental Upgrade	Committed to by Others											X			
Shiloh - Brkscrk 138kV	4,137,500	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 2.3 5: DETAILS OF SCENARIO 4 RESULTS (WITH FUTURE PROJECTS AND WITH PENDING TRANSMISSION SERVICE & STUDY REQUEST)

Limiting Element	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Bayshore - Brkscrk 138kV	9,875,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Coly 500/230kV transformer	21,000,000					X				X		X			
Florence - South Jackson 115kV - Supplemental Upgrade	Committed to by Others											X			
Hankamer - Crooked Bayou 138kV	10,000,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Harrison East - Omaha 161kV	21,750,000						X								
Jackson Forrest Hill - Ray Braswell 115kV	6,550,000											X			
Jackson Forrest Hill - Southwest Jackson 115kV	3,625,000											X			
Jackson Miami - Rex Brown 115kV	Included in 2011 ICT Base Plan											X			
Morton - Pelahatchie 115kV - Supplemental Upgrade	Committed to by Others											X			
Port Hudson 230/138 transformer 1	14,812,500									X					
Port Hudson 230/138 transformer 2	9,200,000									X					
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Committed to by Others					X		X	X	X		X	X		X
Rex Brown W - Rex Brown C 115kV ckt 1	TBD											X			
Shiloh - Brkscrk 138kV	4,137,500	X	X	X	X	X	X	X	X		X	X	X	X	X
Sterlington 500/115kV transformer 2	Committed to by Others								X						
Stowell - Crooked Bayou 138kV	13,675,000	X	X	X	X	X	X	X	X		X	X	X	X	X
Willow Glen - Webre 500kV	Included in 2011 ICT Base Plan	X	X	X	X	X	X		X	X	X	X	X	X	X
Willow Glen 500/230kV Transformer	Included in 2011 ICT Base Plan					X				X		X			

2.3.1 DETAILS OF SCENARIO 1 - 2014

AECI

Limiting Element	Contingency Element	ATC
Russellville East - Russellville North 161kV	ANO - Fort Smith 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

AEP-W

Limiting Element	Contingency Element	ATC
Russellville East - Russellville North 161kV	ANO - Fort Smith 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	149
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	154
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	155
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	161
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	170
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	171
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

AMRN

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

CLECO

Limiting Element	Contingency Element	ATC
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	89
North Crowley - Scott1 138kV	Wells 500/230kV transformer	130
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	151
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	156
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	157
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	179

EES

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	151
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	156
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	157
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	179

EMDE

Limiting Element	Contingency Element	ATC
Pleasant Hill 500/161kV transformer	ANO 500/161/22kV transformer	0
Russellville East - Russellville North 161kV	ANO - Fort Smith 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172

Limiting Element	Contingency Element	ATC
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

LAFA

Limiting Element	Contingency Element	ATC
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	Habetz - Richard 138kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
North Crowley - Scott1 138kV	Habetz - Richard 138kV	1
Semere - Scott2 138kV	Habetz - Richard 138kV	18
Richard - Scott1 138kV	North Crowley - Scott1 138kV	21
Semere - Scott2 138kV	North Crowley - Richard 138kV	24
North Crowley - Scott1 138kV	Wells 500/230kV transformer	39
Semere - Scott2 138kV	Wells 500/230kV transformer	79
Habetz - Richard 138kV	Wells 500/230kV transformer	139
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	152
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	157
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	157
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	180

LAGN

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	107
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	151
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	156
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	157
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	179

LEPA

Limiting Element	Contingency Element	ATC
Fancy Point - Port Hudson 230kV ckt 2	Fancy Point - Port Hudson 230kV ckt 1	0
Fancy Point - Port Hudson 230kV ckt 2	Coly 500/230kV transformer	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Raceland - Coteau 115kV	Terrebone 230/115kV transformer	62
Vacherie - Waterford 230kV	Raceland - Waterford 230kV	65
Richard - Scott1 138kV	North Crowley - Scott1 138kV	71
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	97

OKGE

Limiting Element	Contingency Element	ATC
Russellville East - Russellville North 161kV	ANO - Fort Smith 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	155
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

SMEPA

Limiting Element	Contingency Element	ATC
Ray Braswell 500/230kV transformer ckt2	McAdams 500/230kV transformer 1	0
Ray Braswell 500/230kV transformer ckt2	McAdams - Pickens 230kV	0
Ray Braswell 500/230kV transformer ckt2	Richard - Wells 500kV	0
Ray Braswell 500/230kV transformer ckt2	Franklin - Ray Braswell 500kV	0
Ray Braswell 500/230kV transformer ckt2	Canton - Pickens 230kV	0
Ray Braswell 500/230kV transformer ckt2	Lakeover 500/115kV transformer	0
Ray Braswell 500/230kV transformer ckt2	Rex Brown - Rex Brown C 230/115kV transformer 1	0
Ray Braswell 500/230kV transformer ckt2	Pelahatchie - Rankin 115kV	0
Ray Braswell 500/230kV transformer ckt2	Hartburg - Roy S. Nelson 500kV	0
Ray Braswell 500/230kV transformer ckt2	Base Case	0
Jackson Forrest Hill - Ray Braswell 115kV	South Jackson 230/115kV transformer 1	0
Ray Braswell 500/115kV transformer 1	Ray Braswell 500/230kV transformer ckt1 and ckt2 Test Contingency	0
Jackson Forrest Hill - Southwest Jackson	South Jackson 230/115kV transformer 1	0

Limiting Element	Contingency Element	ATC
115kV		
Lakeover 500/115kV transformer	Ray Braswell 500/230kV transformer ckt1 and ckt2 Test Contingency	0
Brookhaven - Mallalieu (MEPA) 115kV	Bogalusa - Adams Creek 500/230kV transformer	0
Brookhaven - Mallalieu (MEPA) 115kV	Bogalusa - Franklin 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	80
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	151
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	156
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	179

SOCO

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	156
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	158
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	179

SPA

Limiting Element	Contingency Element	ATC
Lake Conway - Mayflower 115kV	Pleasant Hill 500/161kV transformer	0
Pleasant Hill 500/161kV transformer	ANO 500/161/22kV transformer	0
Russellville East - Russellville North 161kV	ANO - Fort Smith 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Calico Rock - Melbourne 161kV	Dell - Independence SES 500kV	154
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171

Limiting Element	Contingency Element	ATC
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

TVA

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	150
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	155
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	156
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	162
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	173
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	173
Bayshore - Hankamer 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Cheek - South Beaumont 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	178

2.3.2 DETAILS OF SCENARIO 2

AECI

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

AEP-W

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	158
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	163
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Shiloh - 5L541T43 138kV	China Bulk - Sabine 230kV	180

AMRN

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

CLECO

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	62
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	160
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	165
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	166
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	172
Semere - Scott2 138kV	Wells 500/230kV transformer	174
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

EES

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Willow Glen 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Licar 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Licar 230kV	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0
Coly - Vignes 230kV - Supplemental Upgrade	Vulchlor - Woodstock 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Woodstock 230kV	0
Willow Glen 500/230kV Transformer	Jaguar - Tap Point Esso 230kV	0
Jaguar - Tap Point Esso 230kV	Addis - Big Cajun 1 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Waterford - Willow Glen 500kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Waterford 500/230 transformer kV	0
Willow Glen 500/230kV Transformer	Addis - Big Cajun 1 230kV	0
Willow Glen 500/230kV Transformer	Fancy Point 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Waterford - Willow Glen 500kV	0
Willow Glen 500/230kV Transformer	Waterford 500/230 transformer kV	0
Willow Glen - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Enjay - Fancy 230kV	0
Willow Glen 500/230kV Transformer	Fancy Point - Waterloo 230kV	0
Jaguar - Tap Point Esso 230kV	Willow Glen 500/230kV Transformer	0
Fancy Point 500/230kV transformer 1	Riverbend - Fancy Point 230kV	0
Jaguar - Tap Point Esso 230kV	Fancy Point - Waterloo 230kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0

Limiting Element	Contingency Element	ATC
Coly 500/230kV transformer	Fancy Point 500/230kV transformer 1	93
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	165
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	165
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	172
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	180

EMDE

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Harrison East - Omaha 161kV	Green Forest South - PID223TAP 161kV	125
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	158
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAFA

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	19
Semere - Scott2 138kV	Wells 500/230kV transformer	61
Habetz - Richard 138kV	Wells 500/230kV transformer	139
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	160
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	166
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	166
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	173
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAGN

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Sterlington 500/115kV transformer 1	Sterlington 500/115kV transformer 2	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	160
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	165
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	165
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LEPA

Limiting Element	Contingency Element	ATC
Fancy Point - Port Hudson 230kV ckt 2	Fancy Point - Port Hudson 230kV ckt 1	0
Fancy Point - Port Hudson 230kV ckt 2	Coly 500/230kV transformer	0
Fancy Point - Port Hudson 230kV ckt 2	Coly - McKnight 500kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0
Jaguar - Tap Point Esso 230kV	Addis - Big Cajun 1 230kV	0
Willow Glen 500/230kV Transformer	Jaguar - Tap Point Esso 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Coly - Vignes 230kV - Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Willow Glen 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Licar 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Licar 230kV	0
Willow Glen 500/230kV Transformer	Addis - Big Cajun 1 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Woodstock 230kV	0
Willow Glen 500/230kV Transformer	Fancy Point 500/230kV transformer 1	0
Willow Glen - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	0
Port Hudson 230/138 transformer 2	Port Hudson 230/138 transformer 1	0
Port Hudson 230/138 transformer 1	Port Hudson 230/138 transformer 2	0
Willow Glen 500/230kV Transformer	Waterford - Willow Glen 500kV	0
Willow Glen 500/230kV Transformer	Waterford 500/230 transformer kV	0
Willow Glen 500/230kV Transformer	Enjay - Fancy 230kV	0
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Jaguar - Tap Point Esso 230kV	Willow Glen 500/230kV Transformer	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Alchem - Monochem1 138kV	Wintz - Willow Glen 230kV	0

Limiting Element	Contingency Element	ATC
Alchem - Monochem1 138kV	Wintz - Polsky Carville 230kV	0
Alchem - Monochem1 138kV	A.A.C. - Polsky Carville 230kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Alchem - Monochem1 138kV	A.A.C. - Licar 230kV	0
Alchem - Monochem1 138kV	Belle Helene - Licar 230kV	0
Fancy Point 500/230kV transformer 1	Riverbend - Fancy Point 230kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
Jaguar - Tap Point Esso 230kV	Fancy Point - Waterloo 230kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Coly 500/230kV transformer	Coly - Willow Glen 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Alchem - Monochem1 138kV	Belle Helene - Woodstock 230kV	45
Alchem - Monochem1 138kV	Vulchlor - Woodstock 230kV	46
Coly 500/230kV transformer	Fancy Point 500/230kV transformer 1	46
Bogalusa - Adams Creek 500/230kV transformer	Franklin - Mcknight 500kV	98
Louisiana Station - Thomas 138kV	Big Cajun 2 - Webre 500kV	98
Fancy Point - Port Hudson 230kV ckt 2	Willow Glen - Webre 500kV	111
Willow Glen - Willow Glen 2 500/138kV transformer 1	Coly 500/230kV transformer	114
Bogalusa - Adams Creek 230kV ckt 1	Bogalusa - Adams Creek 230kV ckt 2	127
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	132

OKGE

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	158
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SMEPA

Limiting Element	Contingency Element	ATC
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Willow Glen 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Wintz - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Polsky Carville 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	A.A.C. - Licar 230kV	0
Jackson Forrest Hill - Ray Braswell 115kV	South Jackson 230/115kV transformer 1	0
Willow Glen 500/230kV Transformer	Waterford - Willow Glen 500kV	0
Willow Glen 500/230kV Transformer	Waterford 500/230 transformer kV	0

Limiting Element	Contingency Element	ATC
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Licar 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Belle Helene - Woodstock 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Vulchlor - Woodstock 230kV	0
Coly - Vignes 230kV - Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Jackson Forrest Hill - Southwest Jackson 115kV	South Jackson 230/115kV transformer 1	0
Brookhaven - Mallalieu (MEPA) 115kV	Bogalusa - Adams Creek 500/230kV transformer	0
Brookhaven - Mallalieu (MEPA) 115kV	Bogalusa - Franklin 500kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Ray Braswell 500/115kV transformer 1	0
Mallalieu (MEPA) - Norfield 115kV	Bogalusa - Adams Creek 500/230kV transformer	0
Mallalieu (MEPA) - Norfield 115kV	Bogalusa - Franklin 500kV	0
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	South Jackson 230/115kV transformer 1	0
Rex Brown W - Rex Brown C 115kV ckt 1	Jackson HICO - North Jackson 115kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Jackson HICO - Rex Brown E 115kV	0
Jackson Miami - Rex Brown 115kV	South Jackson 230/115kV transformer 1	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
McComb - Norfield 115kV	Bogalusa - Adams Creek 500/230kV transformer	0
McComb - Norfield 115kV	Bogalusa - Franklin 500kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Klean - Jackson Northeast 115kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	North Jackson - Jackson Canton Road 115kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Lake Castle - Lakeover 230kV	0
Florence - South Jackson 115kV - Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Florence - South Jackson 115kV - Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Klean - Flowood 115kV	0
Jackson Miami - Jackson Monument Street 115kV	South Jackson 230/115kV transformer 1	0
Florence - South Jackson 115kV - Supplemental Upgrade	South Jackson - Pop Spring 115kV	99
Rex Brown W - Rex Brown C 115kV ckt 1	Lake Castle - North Park 230kV	108
Florence - South Jackson 115kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	109
Florence - South Jackson 115kV - Supplemental Upgrade	Georgetown - Pop Spring 115kV	123
Florence - South Jackson 115kV - Supplemental Upgrade	Georgetown - Silver Creek 115kV	129
Florence - South Jackson 115kV - Supplemental Upgrade	Franklin - Ray Braswell 500kV	146
Florence - South Jackson 115kV - Supplemental Upgrade	Franklin - Mcknight 500kV	155
Bogalusa - Adams Creek 500/230kV transformer	Franklin - Mcknight 500kV	157
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	165
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	165
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	172

Limiting Element	Contingency Element	ATC
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179
Morton - Pelahatchie 115kV - Supplemental Upgrade	Angie - Adams Creek 230kV	179

SOCO

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	165
Richard - Scott1 138kV	Richard - Wells 500kV	171
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Richard - Scott1 138kV	Richard - Wells 500kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SPA

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	158
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

TVA

Limiting Element	Contingency Element	ATC
Willow Glen 500/230kV Transformer	Big Cajun 2 - Fancy Point 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	159
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	164
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	165

Limiting Element	Contingency Element	ATC
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	171
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

2.3.3 DETAILS OF SCENARIO 3 - 2014

AECI

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

AEP-W

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	161
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	167
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	167
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	174
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

AMRN

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

CLECO

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174

Limiting Element	Contingency Element	ATC
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

EES

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

EMDE

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAFA

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAGN

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

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LEPA

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Vacherie - Waterford 230kV	Raceland - Waterford 230kV	59
Raceland - Coteau 115kV	Terrebone 230/115kV transformer	92

OKGE

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	167
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SMEPA

Limiting Element	Contingency Element	ATC
Ray Braswell 500/230kV transformer ckt2	Eldorado EHV - Sterlington 500kV	0
Ray Braswell 500/230kV transformer ckt2	McAdams - Pickens 230kV	0
Ray Braswell 500/230kV transformer ckt2	Canton - Pickens 230kV	0
Ray Braswell 500/230kV transformer ckt2	Roy S. Nelson - Richard 500kV	0
Ray Braswell 500/230kV transformer ckt2	Franklin - Ray Braswell 500kV	0
Ray Braswell 500/230kV transformer ckt2	Canton South - Canton 230kV	0
Ray Braswell 500/230kV transformer ckt2	Base Case	0
Jackson Forrest Hill - Ray Braswell 115kV	South Jackson 230/115kV transformer 1	0
Ray Braswell 500/115kV transformer 1	Ray Braswell 500/230kV transformer ckt1 and ckt2 Test Contingency	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174

Limiting Element	Contingency Element	ATC
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SOCO

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SPA

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Calico Rock - Melbourne 161kV	ANO - Fort Smith 500kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	174
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

TVA

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

2.3.4 DETAILS OF SCENARIO 4 – 2014

AECI

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

AEP-W

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	162
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

AMRN

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

CLECO

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	170

Limiting Element	Contingency Element	ATC
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	177
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

EES

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Bayou Laboutte 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Iberville - Bayou Laboutte 230kV	0
Coly 500/230kV transformer	Bogalusa - Adams Creek 500/230kV transformer	0
Coly 500/230kV transformer	Bogalusa - Franklin 500kV	0
Coly 500/230kV transformer	Fancy Point 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	107
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	175
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	180

EMDE

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Harrison East - Omaha 161kV	Green Forest South - PID223TAP 161kV	24
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Harrison East - Omaha 161kV	Green Forrest - Green Forrest South 161kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAFA

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	165
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	170
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	175
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	177
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LAGN

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1 and 3	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	170
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

LEPA

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Willow Glen 500/230kV Transformer	Bayou Laboutte 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Iberville - Bayou Laboutte 230kV	0
Coly 500/230kV transformer	Coly - Willow Glen 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Port Hudson 230/138 transformer 2	Port Hudson 230/138 transformer 1	0
Coly 500/230kV transformer	Bogalusa - Adams Creek 500/230kV transformer	0
Coly 500/230kV transformer	Bogalusa - Franklin 500kV	0
Port Hudson 230/138 transformer 1	Port Hudson 230/138 transformer 2	0
Coly 500/230kV transformer	Fancy Point 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	74

OKGE

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	168
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SMEPA

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Willow Glen 500/230kV Transformer	Bayou Laboutte 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Iberville - Bayou Laboutte 230kV	0
Jackson Forrest Hill - Ray Braswell 115kV	South Jackson 230/115kV transformer 1	0
Rex Brown W - Rex Brown C 115kV ckt 1	Ray Braswell 500/115kV transformer 1	0
Rex Brown W - Rex Brown C 115kV ckt 1	South Jackson 230/115kV transformer 1	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Coly 500/230kV transformer	Bogalusa - Adams Creek 500/230kV transformer	0
Coly 500/230kV transformer	Bogalusa - Franklin 500kV	0
Florence - South Jackson 115kV - Supplemental Upgrade	Bogalusa - Adams Creek 500/230kV transformer	0
Florence - South Jackson 115kV - Supplemental Upgrade	Bogalusa - Franklin 500kV	0
Jackson Miami - Rex Brown 115kV	South Jackson 230/115kV transformer 1	0
Rex Brown W - Rex Brown C 115kV ckt 1	Jackson HICO - North Jackson 115kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Jackson HICO - Rex Brown E 115kV	0
Rex Brown W - Rex Brown C 115kV ckt 1	Klean - Jackson Northeast 115kV	0
Florence - South Jackson 115kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	34
Florence - South Jackson 115kV - Supplemental Upgrade	South Jackson - Pop Spring 115kV	40
Florence - South Jackson 115kV - Supplemental Upgrade	Franklin - Mcknight 500kV	56
Florence - South Jackson 115kV - Supplemental Upgrade	Georgetown - Pop Spring 115kV	64
Jackson Forrest Hill - Southwest Jackson 115kV	South Jackson 230/115kV transformer 1	74
Rex Brown W - Rex Brown C 115kV ckt 1	Lake Castle - Lakeover 230kV	106
Rex Brown W - Rex Brown C 115kV ckt 1	Klean - Flowood 115kV	106
Morton - Pelahatchie 115kV - Supplemental Upgrade	Angie - Adams Creek 230kV	123
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169

Limiting Element	Contingency Element	ATC
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	177
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SOCO

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

SPA

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

TVA

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174

Limiting Element	Contingency Element	ATC
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

Network Resource Interconnection Service

3. Introduction

A Network Resource Interconnection Services (NRIS) study was requested to serve 180MW of Entergy network load. The expected in service date for this NRIS generator is December 1, 2011. 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 E.

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

4. Analysis

4.1 Models

The models used for this analysis is the 2014 summer peak cases developed in 2009.

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 2014.
- Approved transmission reliability upgrades for 2012 - 2014 were included in the base case. These upgrades can be found at Entergy's OASIS web page http://www.oatioasis.com/EES/EESDocs/Disclaimer.html under approved future projects. Reference Appendix D.
- Added one 138kV transmission lines, rated at 212MVA, from the customer's desired interconnection point to Stowell 138kV substation.

4.2 Contingencies and Monitored Elements

Single contingency analyses on Entergy's transmission facilities (including tie lines) 69kV and above were considered. All transmission facilities on Entergy transmission system above 100kV were monitored.

5. Generation used for the transfer

The Customer's generators were used as the source for the deliverability to generation test.

6. Results

6.1 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 E.

6.2 Constraints

Study Case	Study Case with Priors
	Willow Glen - Webre 500kV
	Willow Glen 500/230kV Transformer
Ray Braswell - Baxter Wilson 500kV	Ray Braswell - Baxter Wilson 500kV
	Coly 500/230kV transformer
Bayshore - Brkscrk 138kV	Bayshore - Brkscrk 138kV
Hankamer - Crooked Bayou 138kV	Hankamer - Crooked Bayou 138kV
Stowell - Crooked Bayou 138kV	Stowell - Crooked Bayou 138kV
Shiloh - Brkscrk 138kV	Shiloh - Brkscrk 138kV

6.3 DFAX Study Case Results

Limiting Element	Contingency Element	ATC
Ray Braswell - Baxter Wilson 500kV	Franklin - Grand Gulf 500kV	0
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	163
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	168
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	169
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	171
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	174
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	175
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	177
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	179

6.4 DFAX Study Case with Priors Results

Limiting Element	Contingency Element	ATC
Willow Glen - Webre 500kV	Coly - McKnight 500kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Bayou Laboutte 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Iberville - Bayou Laboutte 230kV	0
Coly 500/230kV transformer	Bogalusa - Adams Creek 500/230kV transformer	0
Coly 500/230kV transformer	Bogalusa - Franklin 500kV	0
Coly 500/230kV transformer	Fancy Point 500/230kV transformer 1	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	107
Bayshore - Brkscrk 138kV	China Bulk - Sabine 230kV	164
Stowell - Crooked Bayou 138kV	China Bulk - Sabine 230kV	169
Shiloh - Brkscrk 138kV	China Bulk - Sabine 230kV	170
Bayshore - Brkscrk 138kV	Stowell - Big Hill 138kV	172
Stowell - Crooked Bayou 138kV	Stowell - Big Hill 138kV	174
Shiloh - Brkscrk 138kV	Stowell - Big Hill 138kV	175
Hankamer - Crooked Bayou 138kV	China Bulk - Sabine 230kV	176
Hankamer - Crooked Bayou 138kV	Stowell - Big Hill 138kV	178
Bayshore - Brkscrk 138kV	Bayou Farm - Big Hill 138kV	180

6.5 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 E.

A. Amite South: Passed

B. WOTAB: Passed

C. Western Region: Passed

7. Required Upgrades for NRIS

7.1 Preliminary Estimates of Direct Assignment of Facilities and Network Upgrades

Limiting Element	**Planning Estimate for Upgrade***
Bayshore - Brkscrk 138kV	$9,875,000
Hankamer - Crooked Bayou 138kV	$10,000,000
Stowell - Crooked Bayou 138kV	$13,675,000
Shiloh - Brkscrk 138kV	$4,137,500

*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.

Short Circuit Analysis / Breaker Rating Analysis

8. 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-247 unit.

9. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID-247 generation is as follows:

> 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-247 generator as well as the necessary NRIS upgrades shown in Section 7 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-247 generation.

10. Analysis Results

The results of the short circuit analysis indicates that the additional generation due to PID-247 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-247 plant with priors and without priors. The priors included 221, 223, 224, 226, 228, 231, 233, 238, 240, and 246.

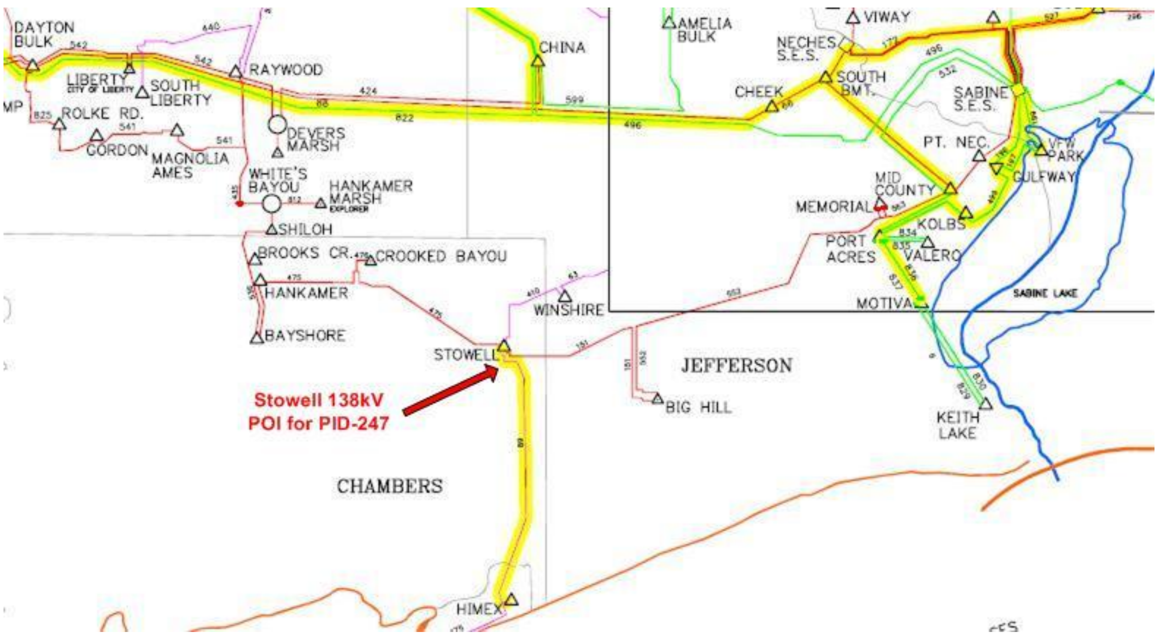
Stability Study

11. Executive Summary

Southwest Power Pool (SPP) commissioned ABB Inc. to perform a stability study for the interconnection of project PID-247. The proposed project is a 180 MW wind farm that is requesting interconnection at the Stowell 138 kV substation in the Entergy transmission system.

The objective of this study is to evaluate the impact of proposed PID-247 project on the stability of the transmission system and nearby generating stations. The study was performed on a 2014 Summer Peak case, provided by SPP-ICT/Entergy.

Figure11-1: PID-247 interconnecting substation



12. Final conclusions

Based on the results of stability analysis, it can be concluded that interconnection of the proposed PID-247 (180 MW) project at Stowell 138 kV substation does not adversely impact the stability of the Entergy System in the local area. Results indicate that the system is stable following all simulated three-phase normally cleared and stuck breaker faults. There were also no voltage criteria violations following these faults.

13. Stability Analysis

13.1 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.”

Based on the Entergy study criteria, three-phase faults with normal clearing and delayed clearing were simulated. If system is unstable following a three-phase stuck breaker fault, it will be repeated assuming a single-phase stuck breaker fault. Three-phase and single-phase line faults were simulated for the specified duration and synchronous machine rotor angles were monitored to make sure they maintained synchronism following fault removal.

Stability analysis was performed using the PSS/E™ dynamics program V30.3.3 CVF build. PSS/E™ is a positive sequence program. Balanced faults such as three-phase faults can be simulated by applying a fault admittance of –j2E9 (essentially infinite admittance or zero impedance).

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.

13.2 Study Model Development

13.2.1 Siemens 2.3MW Type 4 Wind Turbine Generator

PID-247 comprises of Siemens 2.3MW type 4 wind turbine generators (WTGs). These generators have a ±0.9 p.f. capability and are connected to the grid using full-power voltage source converters in these machines.

The study model consists of power flow case and dynamics database, that was developed as described below.

13.2.2 Power Flow Case

A post-project power flow case representing 2014 Summer Peak conditions, ‘EN14S09_U3+ApprCP_Scenario4_r2+PID247_unconv.sav,’ was provided by SPP/ Entergy. In the case, 180MW PID-247 wind farm was already modeled at an 18kV bus which was connected to Stowell 138kV through a 138/18kV transformer.

The representation of PID-247 was updated to reflect data for 2.3MW Siemens wind turbine generator. The wind farm was modeled as a lumped equivalent as shown in Figure 13.1. The generator was modeled at a 0.69kV bus with a 0.69/34.5kV transformer, collector system impedance and 34.5/138kV transformer connecting the wind farm to Stowell 138kV. The generator was modeled to control voltage at the high side of 34.5/138kV transformer to 1.03 pu. Data for modeling the generator, 0.69/34.5 kV and 34.5/138kV transformers was provided by SPP while typical data was assumed for the wind farm collector system impedance.

A post-project power flow case with PID-247 was updated in this manner and named as 'EN14S09_U3+ApprCP_Scenario4_r2+PID247_unconv_modified.sav'.

Figure 13.1 shows the PSS/E one-line diagram for the local area with PID-247 project, for the 2014 Summer Peak system condition.

13.2.3 Stability Database

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

SPP also provided library file[1] for generic model of Siemens 2.3MW type 4 WTGs. The dynamic modeling was done per Siemens User Guide[2] for generic type 4 WTGs. Type 4 WTGs are variable speed generators with full power converters. It is our understanding that full power converters allow complete separation between the WTG and the grid, thus, the mechanical dynamics can be buffered from entering the grid. In other words, the generator and power converter have a more dominant role on system stability than the mechanical dynamics. Thus, the Generic Type 4 model represents the electrical dynamics of the generator and power converter but excludes the mechanical dynamics of the wind turbine (turbine aerodynamic characteristics, blade pitch control etc.). Additional details on the Generic Type 4 model can be found in Siemens User Guide[2].

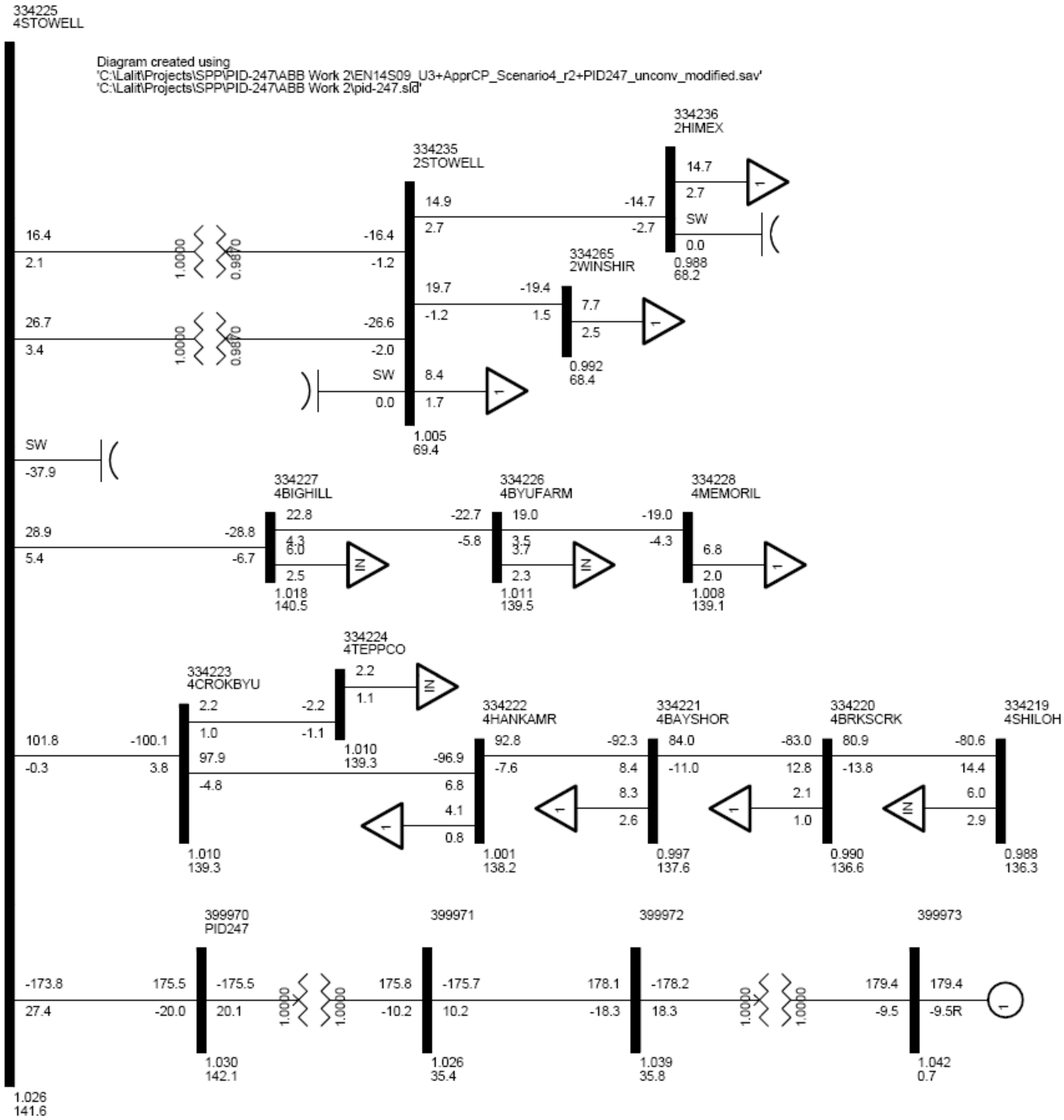
Dynamic data for PID-247 was appended to the stability database to create a dynamic database for the Post_PID247 power flow case.

The PSS/E power flow and dynamic data for PID-247 are included in Appendix B.

[1]'WT4_USER_rev303-CVF_ver01.LIB', dated June 21, 2010, 11:12 am

[2]'UserInformation_PSSE_SWT_2M3_3M6_And_3M0Alpha_PSSE_29_30_31_32_Generic_WT4_User_Dynamic_Wind_Turbine_Model_Ver_01.pdf,' Jorgen Nygaard Nielsen, Siemens Wind Power A/S, Jan 28, 2010

Figure13-1: 2014 Summer Peak flows and voltages with PID-247



13.3 Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID-247 project and its impact on the Entergy system. Stability analysis was performed using the following procedure.

Three-phase faults were chosen in the vicinity of PID-247 and simulated as either normal clearing or stuck-breaker faults. As data for breaker configuration of PID-247 wind farm was unavailable, an assumption was made. PID-247 was connected to the existing system with a breaker at the low side of 34.5/138kV transformer as shown in Figure 13-2.

Since PID-247 is a wind farm, it should exhibit Low Voltage Ride Through (LVRT) in the event of a fault. It implies that the wind farm should be able to ride through a fault for 9 cycles. PID-247 was first tested for this criterion.

Three-phase faults with normal clearing were then simulated. Next, three-phase stuck breaker faults were simulated. If a three-phase stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. The fault clearing times used for the simulations are given in Table 13-1.

Table13-1: Fault Clearing Times

Contingency at kV level	Normal Clearing	Delayed Clearing
138/69	6 cycles	6+9 cycles

Breaker failure scenarios were 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 and single-phase stuck-breakers.

3) The fault is then cleared by back-up clearing.

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

Table 13-1 shows the faults simulated to test LVRT capability of PID-247. Table 13-2 lists all the fault cases that were simulated in this study, including normally cleared three-phase faults and three-phase stuck breaker faults. Figure 13-2 to Figure 13-4 show the layout diagrams of the nearby 138 kV and 69 kV substations where faults were simulated, as well as fault locations.

For all cases analyzed, the initial disturbance was applied at t = 0.1 seconds.

Table13-1: Faults to test LVRT Capability of PID-247

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_1b	Stowell - Shiloh 138kV	Stowell 138kV	3PH	9	None	None	5295, 5330 (Shiloh)	None	Stowell - Crooked Bayou, Crooked Bayou - Hankamer, Hankamer - Bay Shore, Bay Shore - Brooks Creek, Brooks Creek - Shiloh; All are 138kV facilities
FAULT_2b	Stowell - Big Hill 138kV	Stowell 138kV	3PH	9	None	None	5440, 22325 (Big Hill)	None	Stowell-Big Hill138 kV

3PH = Three-phase

Table13-2: List of Simulated Faults

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_1	Stowell - Shiloh 138kV	Stowell 138kV	3PH	6	None	None	5295, 5330 (Shiloh)	None	Stowell - Crooked Bayou, Crooked Bayou - Hankamer, Hankamer - Bay Shore, Bay Shore - Brooks Creek, Brooks Creek - Shiloh; All are 138kV facilities
FAULT_2	Stowell - Big Hill 138kV	Stowell 138kV	3PH	6	None	None	5440, 22325 (Big Hill)	None	Stowell-Big Hill138 kV
FAULT_3	Stowell 138/69 kV Transformers	Stowell 138kV	3PH	6	None	None	5245,5295, 5440,5290	None	Stowell - Big Hill, Stowell - Crooked Bayou, Stowell transformers 138/69 #3, #4. PID - 247 is isolated, hence it is disconnected also.
FAULT_4		Stowell 69kV	3PH	6	None	None	5245, 5240, 22165, 23010	None	Stowell-Winshire 69 kV, Stowell 138/69 kV Xmer #3
FAULT_5		Stowell 69kV	3PH	6	None	None	2485, 23010, 5290	None	Stowell-Himex 69 kV, Stowell 138/69 kV Xmer #4
FAULT_6	Big Hill - Bayou Farms - Memorial - 138kV	Big Hill 138kV	3PH	6	None	None	22335, 15660 (Memorial)	None	Big Hill- Bayou Farms 138 kV, Bayou Farms - Memorial 138kV
FAULT_7	Shiloh - White's Bayou Tap 138kV	Shiloh 138kV	3PH	6	None	None	5325, 5200 (White's Bayou)	None	Shiloh - White's Bayou, White's Bayou - Raywood
FAULT_8	Stowell - Winshire 69kV	Stowell 69kV	3PH	6	None	None	5240, 5210 (Winshire)	None	Stowell - Winshire 69kV
FAULT_9	Stowell - Himex 69kV	Stowell 69kV	3PH	6	None	None	2485	None	Stowell - Himex 69kV
FAULT_10	Stowell - Shiloh 138kV	Stowell 138kV	3PHSB	6	9	5295 (Stowell)	5330 (Shiloh)	5440, 5245, 5290	Brooks Creek - Shiloh 138kV Stowell 138/69 kV transformers #3 and #4, Stowell - Big Hill, disconnect PID-247
FAULT_11	Stowell - Big Hill 138kV	Stowell 138kV	3PHSB	6	9	5440 (Stowell)	22325 (Big Hill)	5295, 5290, 5245	Stowell - Big Hill Stowell 138/69 kV transformers #3 and #4, Stowell - Crooked Bayou, disconnect PID-247
FAULT_12	Stowell 138/69 kV Transformers	Stowell 138kV	3PHSB	6	9	5295 (Stowell 138)	5440, 5245, 5290	5330 (Shiloh)	Stowell 138/69 kV transformers #3 and #4, Stowell - Big Hill 138kV, disconnect PID-247 Brooks Creek - Shiloh 138kv
FAULT_13	Stowell 138/69 kV Transformers	Stowell 138kV	3PHSB	6	9	5440 (Stowell 138)	5295, 5245, 5290	22325 (Big Hill)	Stowell 138/69 kV transformers #3 and #4, Stowell - Crooked Bayou, disconnect PID-247 Stowell - Big Hill 138kv
FAULT_14	Stowell - Winshire 69kV	Stowell 69kV	3PHSB	6	9	5240 (Stowell 69)	5210 (Winshire)	5245, 22165, 223010	Stowell - Winshire 69kV Stowell 138/69kV transformer #3, Clear Fault

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_15	Stowell - Himex 69kV	Stowell 69kV	3PHSB	6	9	2485 (Stowell 69)		5290, 223010	No action Stowell 138/69kV transformer #4, Clear Fault
FAULT_16		Stowell 69kV	3PHSB	6	9	5245 (Stowell 69)	23010, 5240, 22165	5295, 5440, 5290	Stowell - Winshire 69kV, Split Stowell 69kV bus Stowell - Crooked Bayou 138kV, Stowell - Big Hill, Stowell 138/69kV transformer #4, disconnect PID-247
FAULT_17		Stowell 69kV	3PHSB	6	9	5240 (Stowell 69)	5245, 22165, 23010	5210 (Winshire)	Stowell 138/69kV transformer #3, Split Stowell 69kV bus Stowell - Winshire 69kv
FAULT_18		Stowell 69kV	3PHSB	6	9	23010 (Stowell 69)	5245, 5240, 22165	5290, 2485	Stowell 138/69kV transformer #3, Stowell - Winshire 69kV Stowell 138/69kV transformer #4, Stowell - Himex 69kV
FAULT_19		Stowell 69kV	3PHSB	6	9	5290 (Stowell 69)	23010, 2485	5295, 5440, 5245	Stowell - Himex 69kV, Split Stowell 69kV bus Stowell 138/69kV transformer #3, Stowell - Crooked Bayou 138kV, Stowell - Big Hill 138kV, disconnect PID-247
FAULT_20		Stowell 69kV	3PHSB	6	9	2485 (Stowell 69)	23010, 5290		Stowell 138/69kV transformer #4, Split Stowell 69kV bus No secondary action
FAULT_21		Stowell 69kV	3PHSB	6	9	23010 (Stowell 69)	5290, 2485	5245, 5240, 22165	Stowell 138/69kV transformer #4, Stowell - Himex 69kV Stowell 138/69kV transformer #3, Stowell - Winshire 69kV
FAULT_22	Shiloh - White's Bayou Tap 138kV	Shiloh 138kV	3PHSB	6	9	5325 (Shiloh 138)	5200 (Raywood)	5330	White's Bayou - Raywood 138 kV Shiloh - Brook's Creek 138 kV
FAULT_23	Big Hill - Bayou Farms - Memorial - 138kV	Big Hill 138kV	3PHSB	6	9	22335 (Big Hill)	15660 (Memorial)	4002, 22330	Bayou Farms - Memorial 138kV Clear Fault, Trip transformer #1 at Big Hill

3PH = Three-phase
3PHSB = Three-phase stuck breaker faults

Figure13-2: One-line diagram for Stowell 138 and 69 kV substation

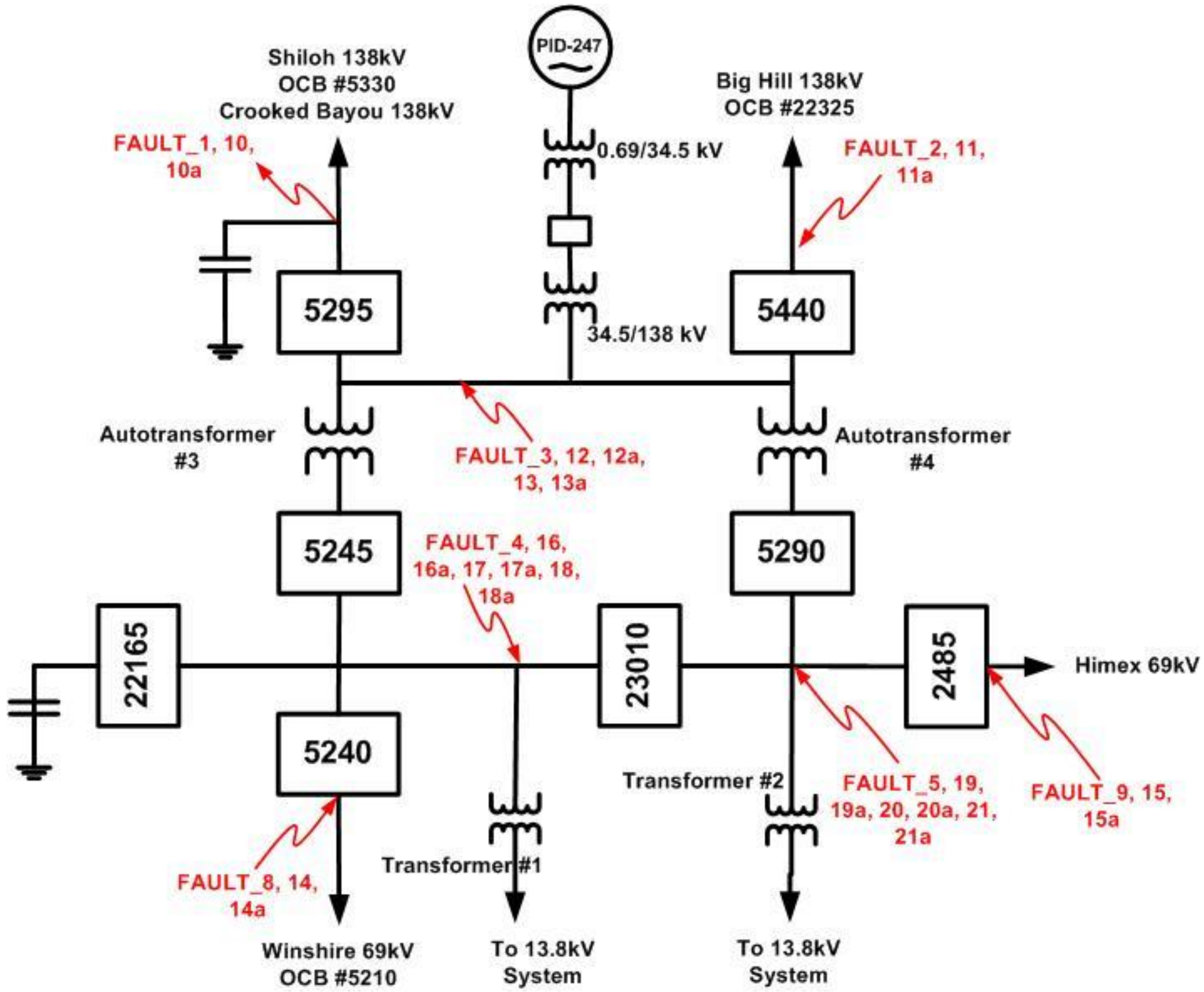


Figure13-3: One-line diagram for Big Hill 138kV substation

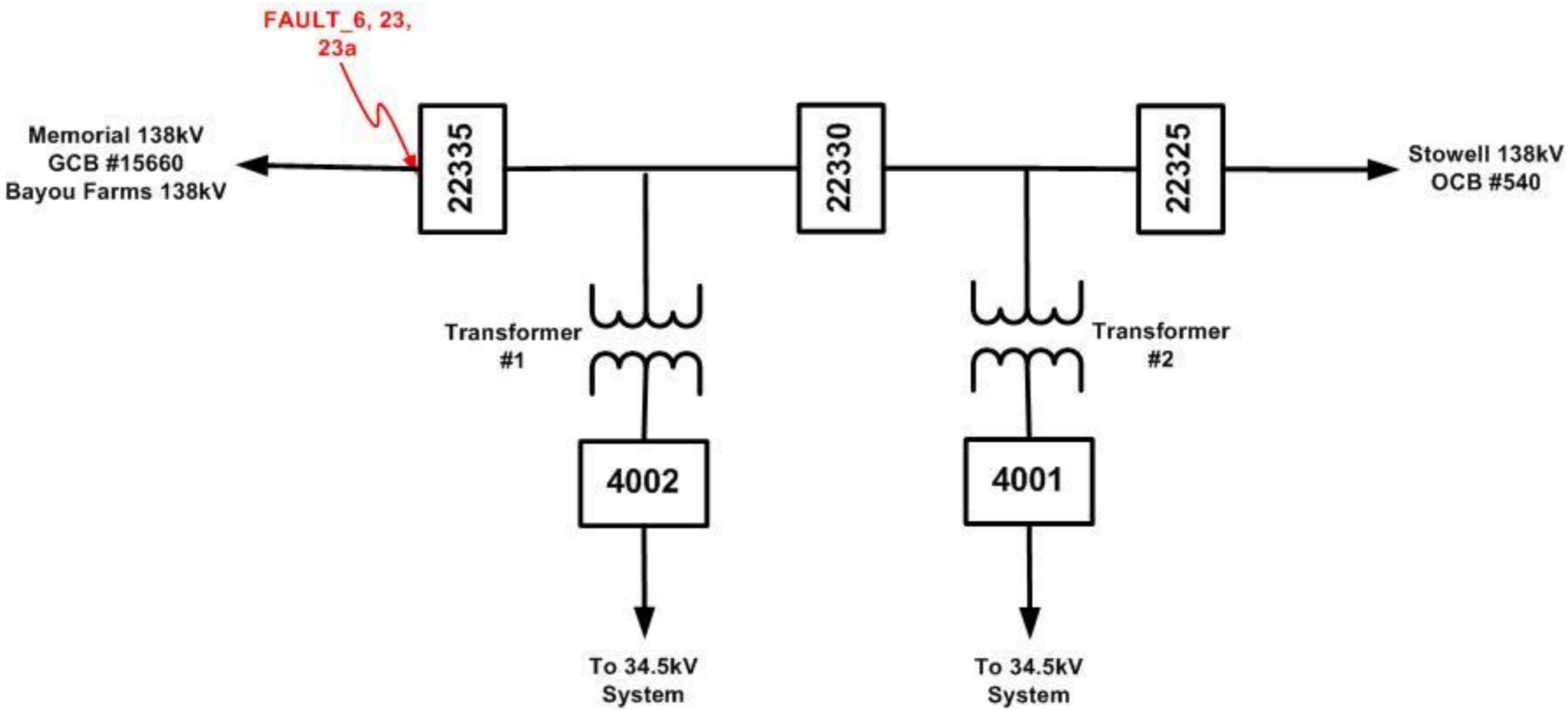
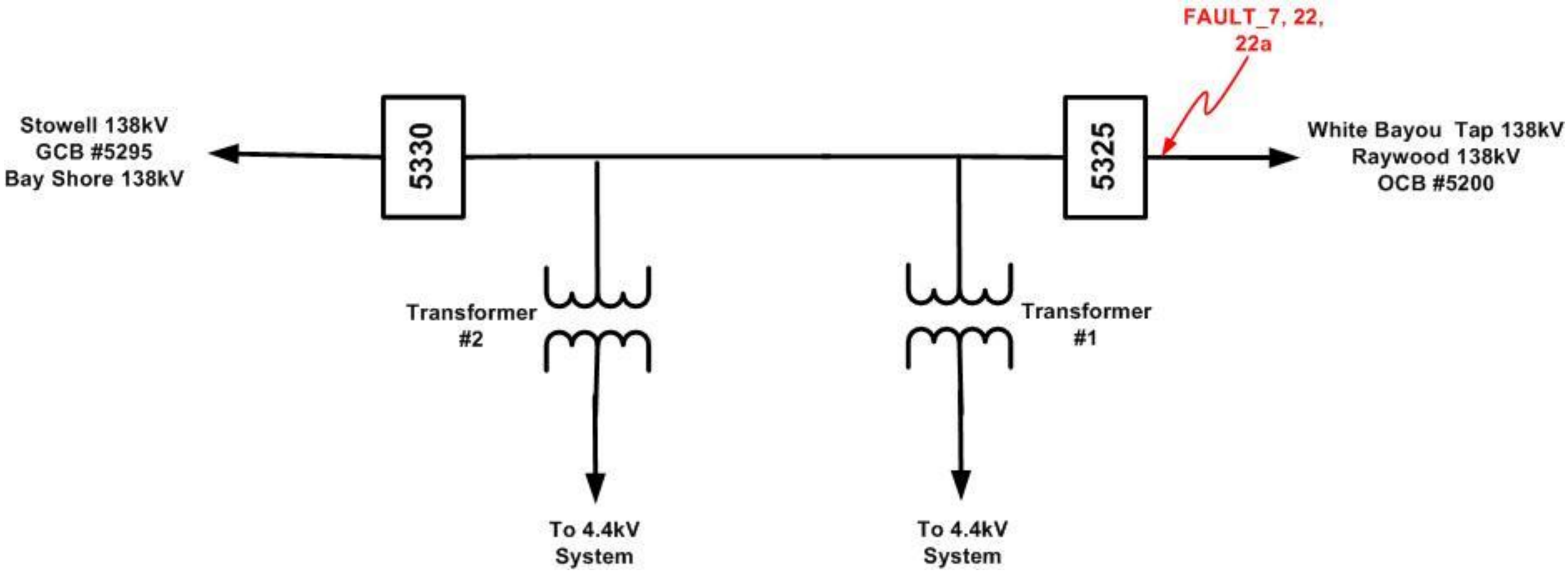


Figure13-4: One-line diagram for Shiloh 138kV substation



PID-247 was found to satisfy LVRT requirements. The plots from LVRT simulations are shown in Appendix C.

Analyses on the post-project case showed the system to be stable following all three-phase normally cleared and stuck breaker faults.

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 are not applicable for three-phase stuck-breaker faults unless the determined impact is extremely widespread.

The voltages at all buses were monitored during each of the fault cases as appropriate. No voltage criteria violations were observed following normally cleared three-phase faults.

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 i.e., not to exceed 20% for more than 20 cycles. No voltage criteria violations were observed.

Sensitivity analysis was run for a case in which voltage at the high side of 34.5/138kV transformer was controlled at 1.0 pu. The proposed wind farm still satisfied LVRT requirement. Faults 1, 2, 10 and 11 were run and no stability or voltage criteria violations were observed.

Table13-3: Three-Phase Normally Cleared and Stuck Breaker Faults Simulation Results

Fault #	Comments
FAULT_1	STABLE
FAULT_2	STABLE
FAULT_3	STABLE
FAULT_4	STABLE
FAULT_5	STABLE
FAULT_6	STABLE
FAULT_7	STABLE
FAULT_8	STABLE
FAULT_9	STABLE
FAULT_10	STABLE
FAULT_11	STABLE
FAULT_12	STABLE
FAULT_13	STABLE
FAULT_14	STABLE
FAULT_15	STABLE
FAULT_16	STABLE
FAULT_17	STABLE
FAULT_18	STABLE
FAULT_19	STABLE
FAULT_20	STABLE
FAULT_21	STABLE
FAULT_22	STABLE
FAULT_23	STABLE

APPENDIX A: DATA PROVIDED BY CUSTOMER

LARGE GENERATING FACILITY DATA FOR THE
DEFINITIVE INTERCONNECTION SYSTEM IMPACT STUDY

Data below was written assuming a synchronous generator or asynchronous generator connected to the transmission system via a transformer. This is a variable-speed, full converter technology wind turbine. The interface with the power system is a full electronic ac-to-ac converter that fully decouples the prime mover from the grid.

Typical equivalent data applicable for the Siemens Variable-Speed Full-Converter WTG is provided below in red, using standard control settings.

UNIT RATINGS

Nameplate kVA ___2556_________ °F ___95______ Voltage ____690________
Prime Mover type ____Wind Turbine____________________
Power Factor: Lead ___0.9______ Lag __0.9____
Speed (RPM) __variable shaft speed_ Connection (e.g. Wye) __Wye____
Short Circuit Ratio _N/A_______ Frequency, Hertz _____60______
Stator Amperes at Rated kVA* __N/A________ Field Volts ____N/A__________
Max Turbine Power: Summer MW ___2.3_________°F __95____
Winter MW __2.3_________°F _95_____
* Full Load Amperes at rated kW, pf, and voltage = 2138.

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA
Section N/A; shaft decoupled from system

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

REACTANCE DATA (PER UNIT-RATED KVA)
Section N/A, but equivalent D-axis values provided below for short circuit assessment; transient = subtransient; no saturation; Q-axis N/A

	DIRECT AXIS	QUADRATURE AXIS
Synchronous – saturated	X_{dv} 0.85	X_{qv} ______
Synchronous – unsaturated	X_{di} 0.85	X_{qi} ______
Transient – saturated	X'_{dv} 0.64	X'_{qv} ______
Transient – unsaturated	X'_{di} 0.64	X'_{qi} ______
Subtransient – saturated	X''_{dv} 0.64	X''_{qv} ______
Subtransient – unsaturated	X''_{di} 0.64	X''_{qi} ______
Negative Sequence – saturated	$X2_v$ 4	
Negative Sequence – unsaturated	$X2_i$ 4	
Zero Sequence – saturated	$X0_v$ >50	
Zero Sequence – unsaturated	$X0_i$ >50	
Leakage Reactance	Xl_m N/A	

FIELD TIME CONSTANT DATA (SEC)

Section N/A, but equivalent values provided below for short circuit assessment

Open Circuit	T'_{do} 0.033	T'_{qo} _______
Three-Phase Short Circuit Transient	T'_{d3} 0.0167	T'_{q} _______
Line to Line Short Circuit Transient	T'_{d2} 0.0167	
Line to Neutral Short Circuit Transient	T'_{d1} N/A	
Short Circuit Subtransient	T''_{d} 0.0167	T''_{q} _______
Open Circuit Subtransient	T''_{do} 0.033	T''_{qo} _______

ARMATURE TIME CONSTANT DATA (SEC)

Section N/A

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)

Section N/A

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

Section N/A, except Reactive Capability Curves provided in PSS/E model.

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

268,000___________/ 445,000___________kVA

Voltage Ratio (Collector Side/System side/Tertiary)

34.5 (phase to phase) / 138 (phase to phase) / 12.5 (phase to phase)_________kV

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

WYE-GND____________/ WYE-GND_____________/ Delta___________

Fixed Taps Available Yes (up to 33 tap positions) +/-16 x 0.625% steps (+/-10%)

Present Tap Setting at rated voltage-138 KV_________________________

Impedance: Positive Z_1 (on self-cooled kVA rating) ________9_________%___40___X/R

Impedance: Zero Z_0 (on self-cooled kVA rating) __________8_________%___40___X/R

INDIVIDUAL TURBINE PAD-MOUNTED STEP-UP TRANSFORMER DATA RATINGS

Capacity Self-cooled/ Maximum Nameplate

2,600______________/ N/A_________kVA

Voltage Ratio (Generator Side/System side/Tertiary)

0.690 kV_______/ 34.5 kV___________/ N/A_________

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

WYE-GND____________/ Delta_____________/ N/A__________

Fixed Taps Available __Yes (5 tap positions, 2 -2 ½% and 2 + 2 ½% + rated voltage)

Present Tap Setting 34.5 kV____

Impedance: Positive Z_1 (on self-cooled kVA rating) ______7.25__________%___10.67 X/R

Impedance: Zero Z_0 (on self-cooled kVA rating) _______7.25__________%___10.67 X/R

EXCITATION SYSTEM DATA

Section N/A

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

Section 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:
174___________________

Elevation: __10 Feet_____ Single Phase ___X__ Three Phase

Inverter manufacturer, model name, number, and version:
___Siemens 2.3 VS_

List of adjustable set points for the protective equipment or software:
Under-voltage: 3, Over-voltage: 2, Under-frequency: 2, Over-frequency: 1, Overcurrent: 2, Ground Fault Current: 1

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
Section N/A; Generator not coupled to power system

(*) 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.

APPENDIX B: POWER FLOW AND STABILITY DATA

Following data is presented in PSS/E Version 30.3.3 format

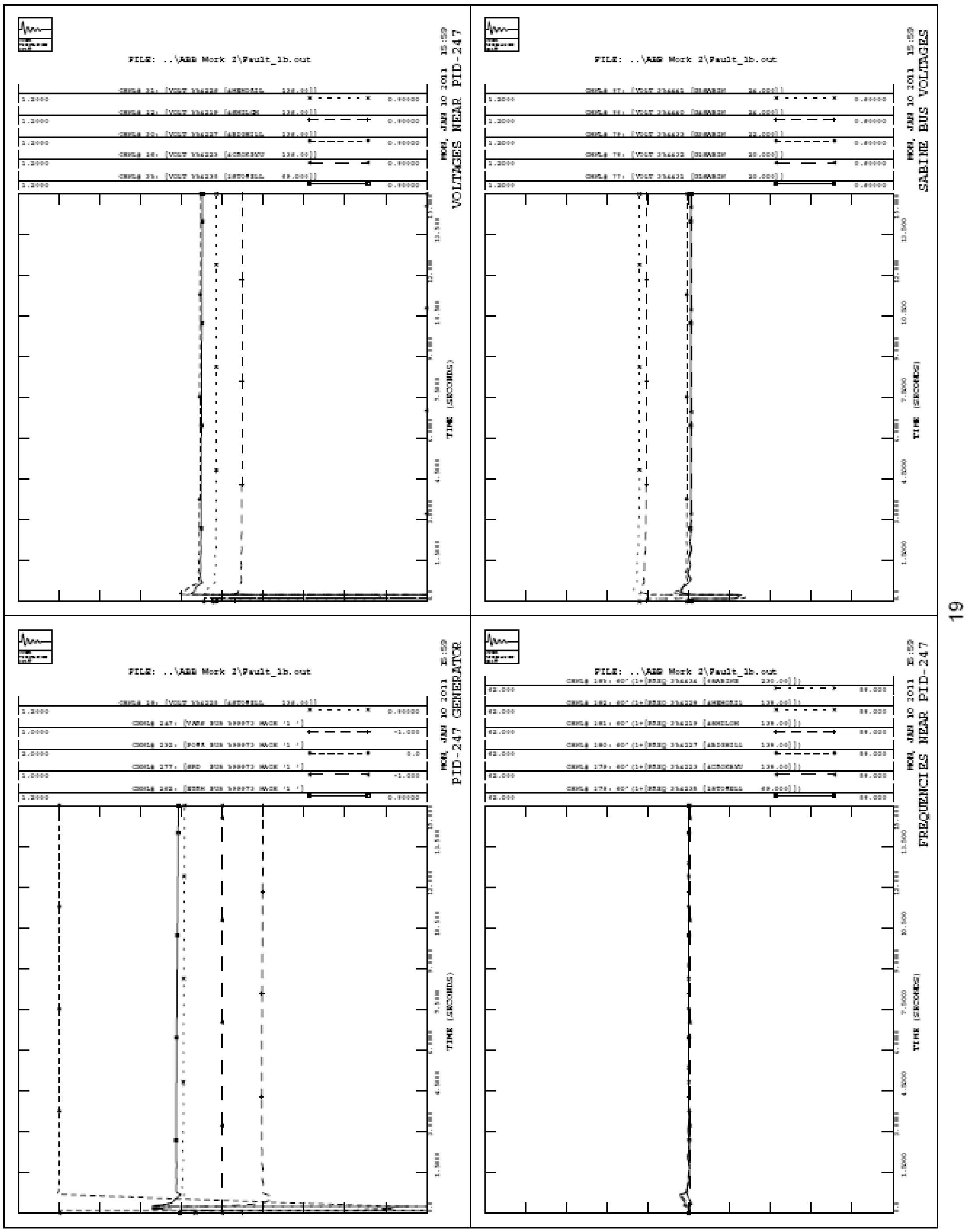
Powerflow Data

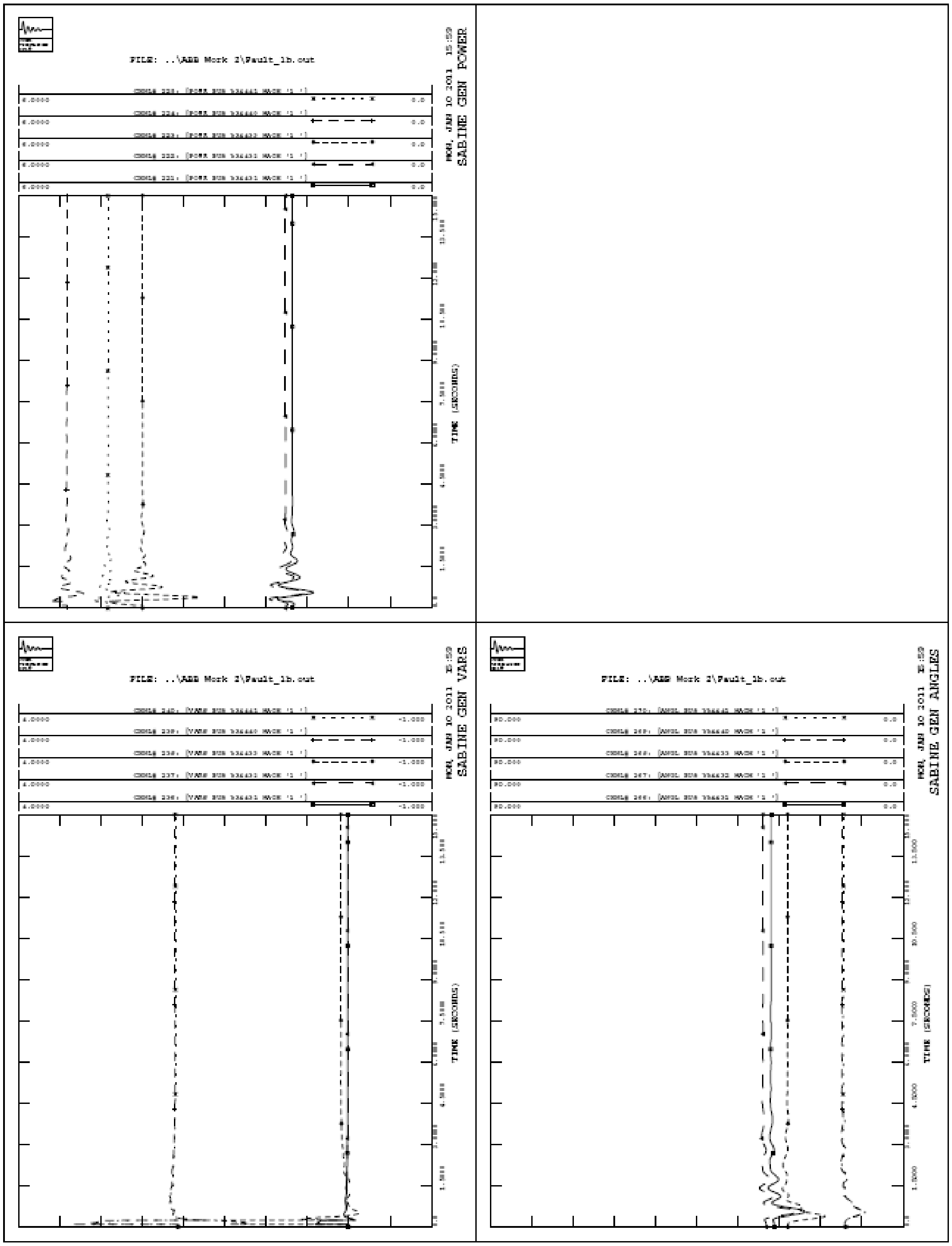
```
399971,'            ',  34.5000,1,     0.000,     0.000, 351, 105,1.00000,   0.0000,   1
399972,'            ',  34.5000,1,     0.000,     0.000, 351, 105,1.00000,   0.0000,   1
399973,'            ',   0.6900,2,     0.000,     0.000, 351, 105,1.00000,   0.0000,   1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
399973,'1 ',   179.400,     0.000,    86.900,   -86.900,1.02955,399970,   179.400,   0.00000,   0.64150,   0.00000,
0.00000,1.00000,1,  100.0,   179.400,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
399971, 399972,'1 ',   0.00810,   0.00750,   0.09730,  250.00,  250.00,  250.00,  0.00000,  0.00000,  0.00000,  0.00000,1,
0.00,   1,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
399970,399971,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.00225,   0.09000,   268.00
1.00000, 138.000,   0.000,   445.00,   445.00,   445.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000,
0.00000
1.00000,  34.500
399972,399973,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.00840,   0.06000,   202.80
1.00000,  34.500,   0.000,   250.00,   250.00,   250.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000,
0.00000
1.00000,   0.690
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
```

Dynamics Data

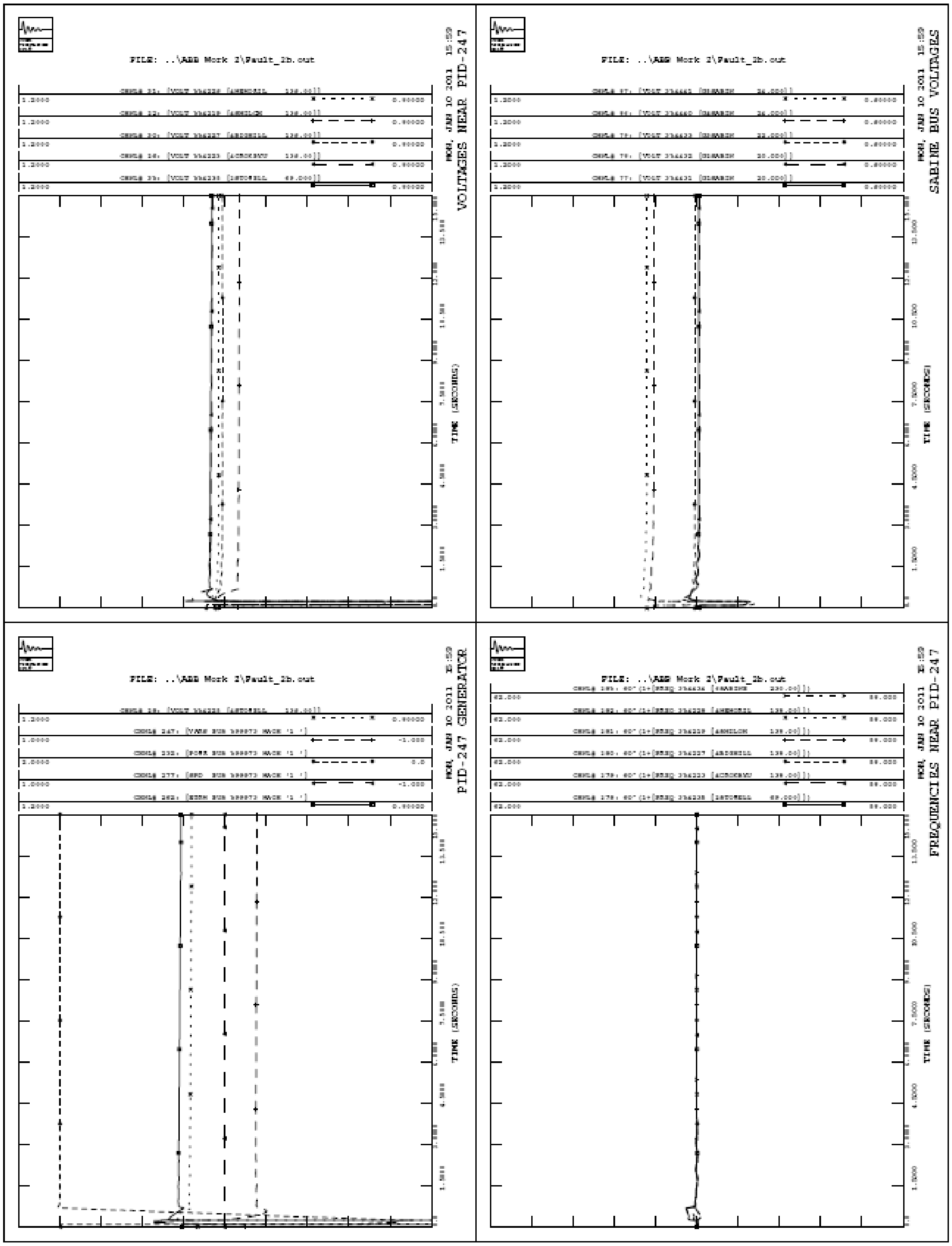
```
/ DYNAMIC DATA FOR PID-247 BASED ON SIEMENS 2.3 WTG
/ USING CUSTOMER PROVIDED SPREADSHEET
'SWT_2M3_3M6_And_3M0Alpha_PSSE_29_30_31_32_Generic_WT4_User_Dynamic_Model_data.xls'

/ W4GUR2 PSS/E Ver. 29, 30, 31 & 32, Generic Converter Data For SWT
 399973 'USRMDL' 1 'W4GUR2' 1  1  0  9  3  5
 0.010  0.020  0.400  -0.100  1.110  1.250  2.000  2.000  0.020  /

/ W4EUR2 PSS/E Ver. 29, 30, 31 & 32, Generic Control Data For SWT
 399973 'USRMDL' 1 'W4EUR2'  4  0  4  34  11  4
 399973  0  1  0
 0.000  15.000  2.000  0.080  0.010  0.000  0.080  1.000  -1.200  1.100
 0.000  0.500  -0.500  0.050  0.010  0.875  1.125  55.000  0.050  0.050
 1.115  1.25  1.085  0.020  0.875  0.050  0.000  2.000  1.000  1.000
 1.000  1.000   1.100  0.14154  /

/ WT4PLT PSS/E Ver. 29, 30, 31 & 32  Control Data
  0   'USRMDL'  0  'WT4PLT'  8  0  2  0  0  3  399973  '1'  /

/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, UV_1 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0.85  5  3  0.05  /
/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, UV_2 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0.7  5  2.6  0.05  /
/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, UV_3 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0.4  5  1.6  0.05  /
/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, UV_4 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0.15  5  0.85  0.05  /
/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, OV_1 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0  1.1  1  0.05  /
/ VTGTPA PSS/E Ver. 29, 30, 31 & 32, OV_2 Control Data
  0   'USRMDL'  0  'VTGTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0  1.2  0.15  0.05  /

/ FRQTPA PSS/E Ver. 29, 30, 31 & 32, UF_1 Control Data
  0   'USRMDL'  0  'FRQTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  57  100  10  0.05  /
/ FRQTPA PSS/E Ver. 29, 30, 31 & 32, UF_2 Control Data
  0   'USRMDL'  0  'FRQTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  56.4  100  0.1  0.05  /
/ FRQTPA PSS/E Ver. 29, 30, 31 & 32, OF_1 Control Data
  0   'USRMDL'  0  'FRQTPA'  0  2  6  4  0  1  399973  399973  '1'  0  0  0  0  62.4  0.1  0.05  /
```

APPENDIX C: PLOTS FOR STABILITY SIMULATIONS

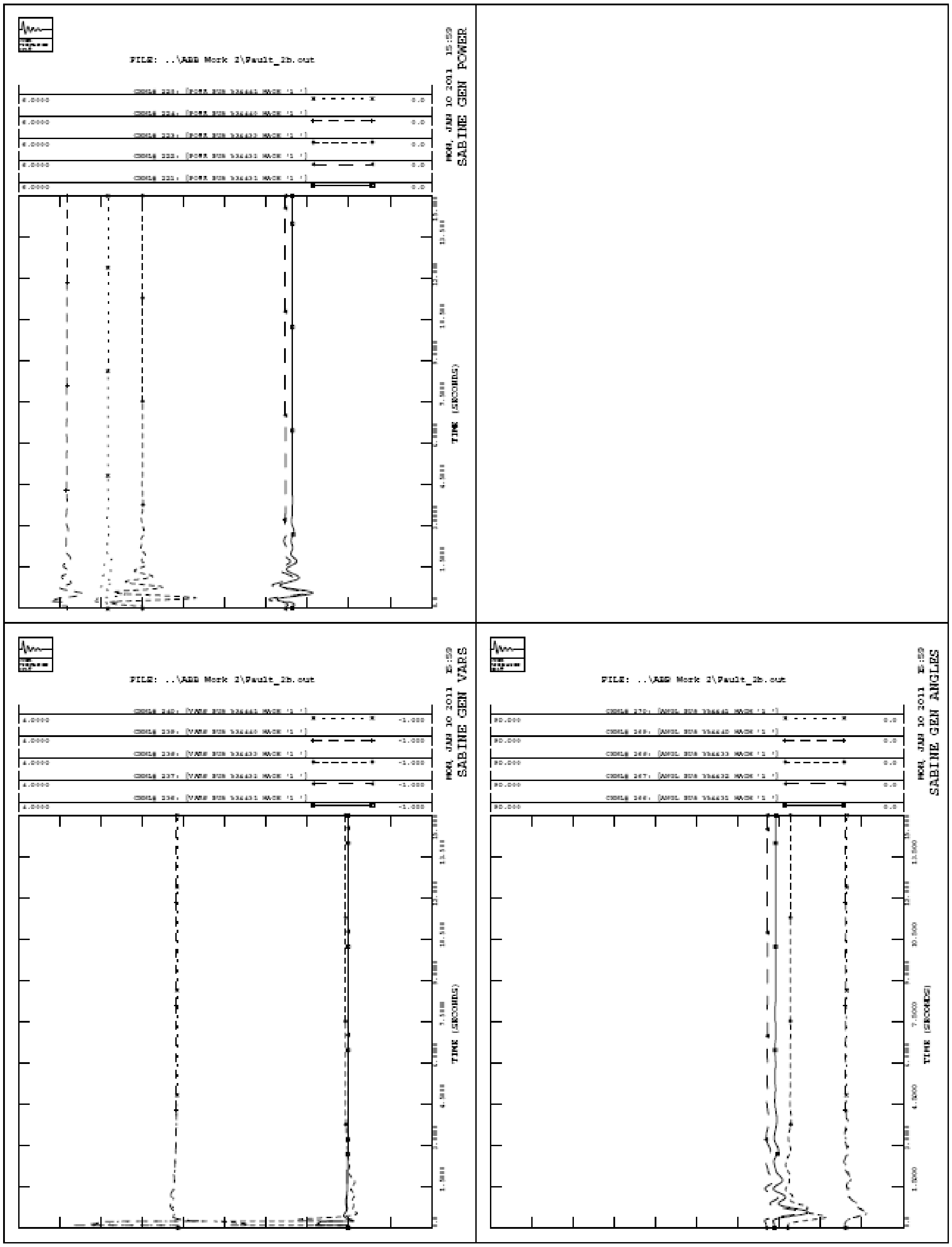



FILE: ..\ABB Work 2\Fault_1b.out
MON, JAN 10 2011 15:59
SABINE GEN POWER
TIME (SECONDS)
FILE: ..\ABB Work 2\Fault_1b.out
MON, JAN 10 2011 15:59
SABINE GEN VARS
TIME (SECONDS)
FILE: ..\ABB Work 2\Fault_1b.out
MON, JAN 10 2011 15:59
SABINE GEN ANGLES
TIME (SECONDS)

20


FILE: ..\ABB Work 2\Fault_2b.out
MON, JAN 10 2011 15:59
VOLTAGES NEAR PID-247
SABINE BUS VOLTAGES
PID-247 GENERATOR
FREQUENCIES NEAR PID-247
TIME (SECONDS)

21


FILE: ..\ABB Work 2\Fault_2b.out
MON, JAN 10 2011 15:59
SABINE GEN POWER
TIME (SECONDS)
FILE: ..\ABB Work 2\Fault_2b.out
MON, JAN 10 2011 15:59
SABINE GEN VARS
TIME (SECONDS)
FILE: ..\ABB Work 2\Fault_2b.out
MON, JAN 10 2011 15:59
SABINE GEN ANGLES
TIME (SECONDS)

22

APPENDIX D: Approved Projects and Transactions in Study Mode

Year	Approved Future Projects
2009 – 2013	2009F EAI Danville 161 kV Substation Rev 0.idv
	2009S EAI Blytheville POD - AECC Rev 1.idv
	2009S EAI Conway West - Donaghey 161 kV Line Reconductor.idv
	2009S EAI Gillette 115 kV Substation.idv
	2009S EAI Hamlet 161 kV Substation Rev 1.idv
	2009S EAI Sarepta Project Rev 0.idv
	2009W EAI Harrison East to Everton Road 161 kV Line Rev 1.idv
	2010S EAI AECC Avilla POD Rev 2.idv
	2010S EAI Coffeeville POD - AECC Rev 0.idv
	2010S EAI Melbourne - Sage 161 kV Line Upgrade Line Rev 0.idv
	2010S EAI Parkin to Twist 161 kV Line Trap Rev 0.idv
	2010S EAI Transmission Service (OG&E) Rev 0.idv
	2010S EAI Warren East 115 kV Substation Install Capacitor Bank Rev 1.idv
	2010Z EAI Beebe 115 kV Substation - Install Capacitor Bank Rev 0.idv
	2010Z EAI Donaghey - Conway South 161 kV Rev 1.idv
	2010Z EAI SMEPA (Plum Point) Rev 1.idv
	2011S EAI Osage Creek-Grandview New Line Rev 2.idv
	2012S EAI Albright (HS Hamilton) Substation 2014 Load.idv
	2012S EAI Cofer Road (Crawford) Substation 2014 Load Rev 0.idv
	2011W EAI Transmission Service (Aquila) Rev 0.idv
	2012S EAI Westar Transmission Service Rev 0.idv
	2009S EGSL Acadia 138 kV Substation capbank.idv
	2010Z EGSL Addis to Cajun 230kV line upgrade.idv
	2011S EGSL Acadiana Area Improvement Project Phase 1 Rev 2.idv
	2011S EGSL Alchem - Monochem 138 kV line upgrade.idv
	2011S EGSL Construct New Youngsville 138 kV Sub (run AAIP 1 first).idv
	2012S EGSL Acadiana Area Improvement Project Phase 2 (run AAIP 1 first).idv
	2012S EGSL Construct new Nelson - Moss Bluff 230 kV line.idv
	2012S EGSL Tejac - Marydale Upgrade 69 kV line.idv
	2012S EGSLELL Loblolly-Hammond Build 230kV Line.idv
	2014S Gulf Oxygen Load Correction.idv
	2009W ELLN Delhi 115 kV Substation - Add Cap Bank.idv
	2010W ELLN Delhi 115 kV Substation - Add series reactor.idv
	2010Z ELLS Bogalusa - Adams Creek 230 kV No 2.idv
	2010Z ELLS Snakefarm - Kenner 115 kV line upgrade.idv
	2011S ELLN Sarepta Project.idv
	2012S ELLS Bayou LaBoutte Construct new 500-230 kV Substation.idv
	2012 ELLN Ouachita Project Set 2 Run Second.idv
	2013S ELLN Ouachita Projects Set 1 Run First.idv
	2009W EMI Grenada-Winona-Greenwood Area Improvement Phase I.idv
	2010S EMI Grand Gulf Uprate Project.idv
	2010S EMI Indianola-Greenwood 115 kV Line Upgrade.idv
	2010S EMI Magee 115 kV substation - Replace switches.idv
	2010Z EMI TVA Affected System Upgrades.idv
	2011S EMI Church Road Substation (2014 load).idv
	2011S EMI Sunnybrook-only-2011.idv
	2011S EMI Waterways - Vicksburg East 115 kV Line Upgrade.idv
	2011Z EMI Florence - Florence SS - Star 115 kV Line Upgrade.idv

Year	Approved Future Projects
	2011Z EMI Grand Gulf Uprate add vars.idv
	2012S EMI Grenada-Winona-Greenwood Area Improvement Phase II.idv
	2012S EMI Ridgeland-Madison Reliability Improvement (Sunnybrook-2014).idv
	2009F ETI Gulfway 230kV Substation.idv
	2009S ETI Beaumont 69 kV Improvement Plan Option 2.idv
	2009S ETI Newton Bulk Replace Re-tap CT to Increase Rating on Holly Springs Line.idv
	2009S ETI Porter-Tamina Replace Breaker & Switches.idv
	2009W ETI Fawil Upgrade 138-69 kV Auto.idv
	2010S ETI Temco and Shepherd 138kV Substations.idv
	2010S ETI Western Region Reliability Improvement Plan Phase 3 Interim (Part 1).idv
	2010W ETI Western Region Reliability Improvement Plan Phase 3 Interim (Part 3).idv
	2011S ETI Grand Gulf Uprate Project.idv
	2011S ETI Western Region Reliability Improvement Plan Phase 3 Interim (Part 2).idv
	2011W ETI Tamina to Cedar Hill 138 kV line.idv

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

PID	Substation	MW	In Service Date
PID 221	Wolfcreek	875	In Service
PID 223	PID-223 Tap	125	10/1/2010
PID 224	PID-224 Tap	100	12/1/2009
PID 233	PID-233	150	4/30/2011
PID 238	Hinds	550	9/1/2010
PID 240	Hot Springs	650	9/1/2010

Prior transmission service requests that were included in this study:

OASIS #	PSE	MW	Begin	End
1668165	Entergy Services (SPO)	600	1/1/2013	1/1/2043

APPENDIX E: Deliverability Tests for Network Resource

Interconnection Service Resources

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.

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.

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.

Required Upgrades

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

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.

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.

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

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.

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.

Base-line Transmission Model

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

APPENDIX F: DATA ASSUMPTIONS

Dynamic modeling was done per Siemens User Guide for generic type 4 WTGs "UserInformation_PSSE_SWT_2M3_3M6_And_3M0Alpha_PSSE_29_30_31_32_Generic_WT4_User_Dynamic_Wind_Turbine_Model_Ver_01.pdf,' Jorgen Nygaard Nielsen, Siemens Wind Power A/S, Jan 28, 2010."

Generator and 138/34.5kV transformer powerflow data was taken from a file provided by SPP called 'SiemensWTG_LGIP2.pdf.' Typical collector data for the size of the proposed wind farm was assumed: R = 0.00810 pu, X = 0.00750 pu, B = 0.09730 pu.

Dynamic model parameters for the proposed wind farm were obtained from spreadsheet 'SWT_2M3_3M6_And_3M0Alpha_PSSE_29_30_31_32_Generic_WT4_User_Dynamic_Model_data.xls' that was provided with the above mentioned Siemens User Guide. Powerflow data for 34.5/0.69kV individual pad-mount transformer was also taken from this file. Default parameters as given in the spreadsheet were used. The wind farm is assumed to be in voltage control mode. Reactive power order is provided by the WindVar supervisory control. See data for model W4EUR2.

ADDENDUM A: Stability Study for Vestas Turbine

1. Executive Summary

Southwest Power Pool (SPP) commissioned ABB Inc. to perform a stability study for the interconnection of project PID-247. The project PID-247 is a 180 MW wind farm requesting interconnection at the Stowell 138 kV substation in the Entergy transmission system.

ABB Inc. completed the study in February 2011 [1]. The results of the study showed that interconnection of PID-247 did not adversely affect the stability performance of the Entergy system. Since the completion of the study, the wind developer changed the wind turbine generator type from Siemens 2.3 MW Type 4 to Vestas 1.8 MW Type 3. SPP has requested a stability sensitivity to be performed with the revised wind turbine generator data.

The objective of this study is to determine if revisions to the PID-247 wind turbine generator data adversely impact the findings of the previously performed study [1]. The sensitivity study was performed on a 2014 Summer Peak case, provided by SPP-ICT/Entergy.

Results indicate the system is stable following all simulated three-phase normally cleared and three-phase stuck-breaker faults. No voltage criteria violations were observed as a consequence of changing the wind turbine generator for PID-247. Based on the results of stability sensitivity analysis, it can be concluded that interconnection of the proposed PID-247 (180 MW) generation at the Stowell 138 kV bus **does not** adversely impact the stability of the Entergy System.

2. Final Conclusion

Based on results of sensitivity stability analysis, it can be concluded that change of wind turbine generator for PID-247 from Siemens 2.3 MW Type 4 to Vestas v100 1.8 MW VCS Type 3 does not adversely impact the stability results from the previous study [1]. The system was found to be stable following all simulated three-phase normally cleared and stuck breaker faults. There were also no voltage criteria violations due to PID-247 following the studied faults. As a result, interconnection of the proposed PID-247 (180 MW) project at Stowell 138 kV substation **does not** adversely impact the stability of the Entergy System in the local area.

3. Stability Analysis

3.1 Study Model Development

The previous study for PID-247 [1] comprised of Siemens 2.3 MW Type 4 wind turbine generators (WTGs). These generators have a ±0.9 p.f. capability and are connected to the grid using full-power voltage source converters.

For the current sensitivity study, PID-247 was modeled as Vestas v100 1.8 MW Vestas Converter System (VCS) WTGs. These are type 3 variable speed WTGs with three phase doubly fed induction generators and a power converter interfacing the WTG with the grid. The voltage at the wind turbine generator terminals is 690 V and is stepped up to feed a 34.5 kV collector system, which is in turn connected to the point of interconnection via a 34.5/138 kV main transformer and interconnection transmission line.

The wind turbine is capable of supplying/drawing reactive power to/from the grid thus contributing to grid voltage support. These generators have maximum capacitive power factor of 0.95 at full load and a maximum inductive power factor of 0.90 at full load. In addition, the wind turbine generators have the capability to regulate voltage at the point of interconnection through a closed-loop control system called Power Plant Controller (PPC). This system is typically structured to measure the voltage at a particular bus, often the point of interconnection, and regulate this voltage by sending a reactive power command to all the wind turbine generators within the wind farm. For purposes of this study, the wind farm was modeled in voltage control mode to regulate the voltage at Stowell 138 kV bus to 1.0 pu.

The study model consists of power flow case and dynamics database, that was developed as described below.

3.2 Power Flow Case

The post-project case developed in the previous study was used as the starting point for development of a post-project case for this study [1]. The starting case is called *'EN14S09_U3+ApprCP_Scenario4_r2+PID247_unconv_modified.sav'* and was developed from the 2014 Summer Peak case provided by SPP/Entergy. The PSS/E™ version used was 30.3.3 CVF build.

Using the case developed in the previous study, the representation of PID 247 was updated to reflect data for 1.8 MW Vestas V100 VCS wind turbine generator. The wind farm was modeled as a lumped equivalent as shown in Figure A-1. The generator was modeled at a 0.69kV bus with a 0.69/34.5kV transformer, collector system impedance and 34.5/138kV transformer connecting the wind farm to Stowell 138kV. The generator was modeled to control voltage at the point of interconnection, Stowell 138kV, to 1.0 pu. Data for modeling the generator, 0.69/34.5 kV and 34.5/138kV transformers, collector system and the interconnection transmission line was provided by SPP.

Other modeling changes were made and are listed below.

- Existing caps at Stowell 138 kV were turned off to let project PID-247 supply reactive power to the system. This was done to ensure the project does not 'lean' on the grid for reactive power.
- Qmax and Qmin for PID-247 were fixed at the output Qgen value after solving the case. This was done to satisfy a modeling requirement as given in Model User Manual for Vestas wind turbines [2].
- Output of PID-247 was reduced by 1 MW to achieve clean initialization during dynamic simulation.

A post-project power flow case with PID-247 was developed in this manner and named as *'EN14S09_U3+ApprCP_Scenario4_r2+PID247_unconv_modified2.sav'*.

Figure A-1 shows the PSS/E one-line diagram for the local area with PID-247 project, for the 2014 Summer Peak system condition.

3.3 Stability Database

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

SPP also provided the library file[3] for Vestas V100 1.8MW VCS wind turbine generators in PSS/E v30 CVF format. The dynamic modeling was done per Model User Manual for Vestas wind turbines [2]. The data sheet for the model was, however, not provided. Power Plant Controller (PPC) was enabled and set to control the point of interconnection bus voltage to 1.0 pu. Additional details for the model can be found in Model User Manual [2].

Dynamic data file provided with the model, *'V100VCS_1800_60_param.dyr,'* was used as the starting point for setting parameters for the dynamic model. Other parameters were set based on specific requirements of the project and are shown in Table A-1 through Table A-4. The following comments are in order for dynamic data.

- The parameter 'cmode' is not described in the Model User Manual [2] and was assumed to provide the same functionality as parameter 'WTGmode,' i.e., 0 for Q control and 1 for power factor control. The value set for this parameter was 0.

[3] 'VestasWT_7_4_1_PSSE30.lib, dated June 21, 2011, 02:21 pm

- SCR and X/R values provided by Entergy were used for all fault simulations.
- The Vestas turbine is equipped with Automatic Grid Option (AGO) which enables the WTG to stay connected to the grid in case of a number of severe faults. The model has two settings for under-voltage conditions. Under normal conditions, AGO option is set to 0 and settings from Table A-2 apply. The model is capable of detecting extremely low voltage conditions to implement ride-through functionality by changing AGO to 1. Under such conditions, voltage settings from Table A-3 apply. Upon voltage recovery, AGO status is automatically set to 0. Frequency protection settings with AGO enabled are shown in Table A-4.

Dynamic data for PID-247 was appended to the stability database to create a dynamic database for the post-project power flow case and was called *'abb_2.snp.'*

The PSS/E power flow and dynamic data for PID-247 are included in 0.

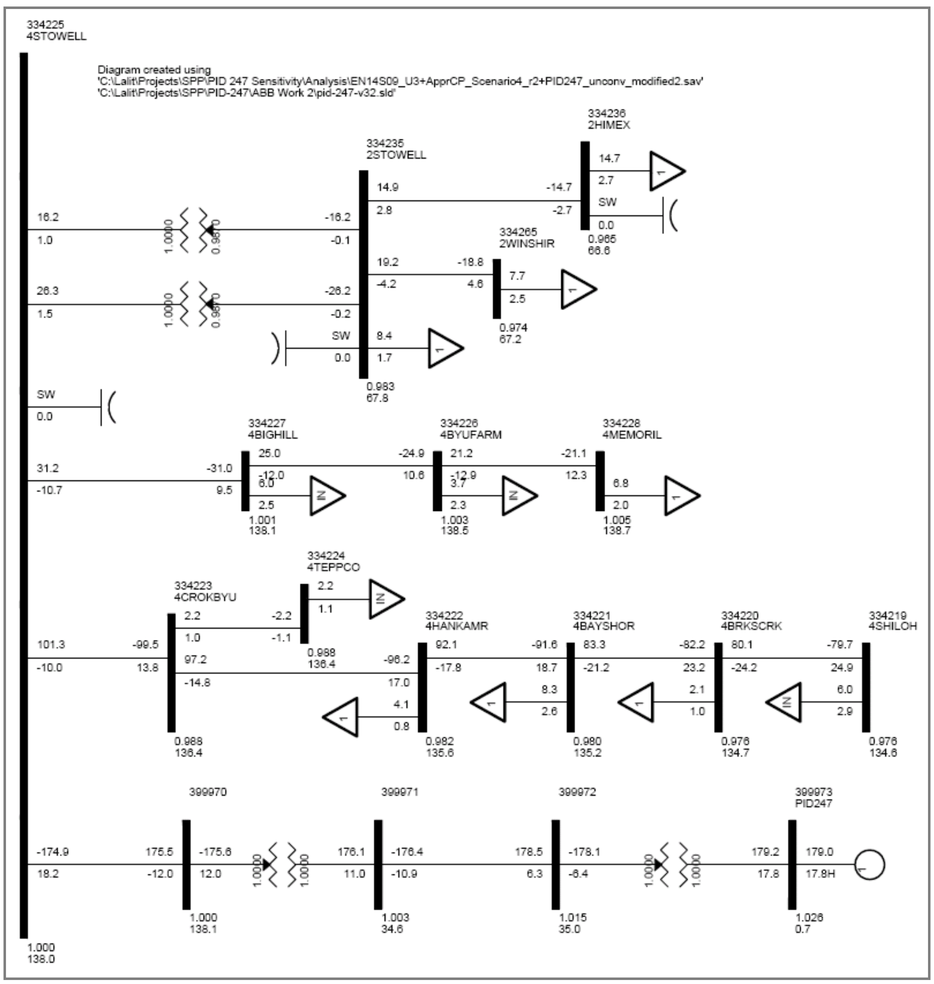


Figure A-1: 2014 Summer Peak Flows and Voltages with PID-247

Table A-1: Dynamic Data Parameters

Parameter	Description	Value for PID-247
<bus>	The generator bus number	399973
<mach>	The machine ID	1
<cmode>	0 is Q control, 1 is PF control	0
<WTGmode>	WTG control mode: 0 for Q control, 1 for PF control	0
<PPC>	Activation of power plant controller: 0 for deactivation, and 1 for activation	1
<Pctrl>	Active power control mode: 1 for active power control only, 2 for FSM control, 3 for LFSM control	1
<SCR>	Short circuit ratio is defined as the ratio of short circuit contribution of the grid at PCC in MVA and the rated capacity of the wind farm in MW (used for PPC).	5.6
<XpR>	Grid impedance to resistance ratio	3.16792
<FSMdbUp>	Upper limit of FSM frequency dead band, in Hz	0.015
<FSMdbLw>	Lower limit of FSM frequency dead band, in Hz	-0.015
<LFSMdbUp>	Upper limit of LFSM frequency dead band, in Hz	0.015
<LFSMdbLw>	Lower limit of LFSM frequency dead band, in Hz	-0.015
<FSMSlpOv>	Slope in FSM mode for over frequency, in dF/dP	10
<FSMSlpUd>	Slope in FSM mode for under frequency, in dF/dP	10
<LFSMSlpOv>	Slope in LFSM mode for over frequency, in dF/dP	10
<LFSMSlpUd>	Slope in LFSM mode for under frequency, in dF/dP	10
<Qctrl>	Type of reactive power control: 1 for reactive power control, 2 for power factor control, 3 for voltage droop control and 4 for voltage PI control	4
<PCCbus>	PSS/E bus at which the voltage, current and frequency will be monitored for control purposes	334225
<Statbus>	Bus at which the capacitor bus and /or STATCOMs are connected	399971[4]
<CapStatbus>	PSS/E bus at which the capacitor bank and/or STATCOMs is/are connected	399971[4]
<Vopt>	Vestas option: 1 for PPC controlling WTGs only, 2 for PPC controlling WTGs and MSCs, and 3 for PPC controlling WTGs and STATCOMS(which could include MSCs and MSRs)	1
<VCtrldb>	Dead band for voltage controller, in pu	0
<Vdroop>	Slope in percentage for voltage droop controller	5
<QCtrldb>	Dead band for reactive power controller, in pu (WTG MVA base)	0
<PCC_CktFromBus>*	Point of common coupling from Bus – Used for measuring P and Q at PCC	399970
<PCC_CktToBus>*	Point of common coupling to bus – Used for measuring P and Q at PCC	334225
<PCC_Ckt_ID>*	Circuit ID of the circuit used to measure the P and Q at PCC	1

[4] The user-written model for the Vestas WTGs requires the user to specify a bus number where capacitor banks/STATCOMs are installed in the wind farm. In this study, however, no capacitor banks/STATCOMs are modeled for PID-247. Bus 399971 is a dummy bus number with no capacitor banks or STATCOMs.

Table A-2: Voltage Protection Settings without Advanced Grid Option

Voltage limit	Setting	Timeout	Setting
UV1	0.9	t_{UV1}	60 s
UV2	0.85	t_{UV2}	0 .4 s
UV3	0.75	t_{UV3}	0 s
OV1	1.1	t_{OV1}	60 s
OV2	1.135	t_{OV2}	0.2 s
OV3	1.2	t_{OV3}	0.12 s

Table A-3: Voltage Protection Settings with Advanced Grid Option

Voltage limit	Setting	Timeout	Setting
U_{LVRT1}	0	t_{LVRT1}	0.2 s
U_{LVRT2}	0.7	t_{LVRT2}	2.65 s
U_{LVRT3}	0.85	t_{LVRT3}	11 s
U_{LVRT4}	0.9	t_{LVRT4}	60 s

Table A-4: Frequency Protection Settings with Advanced Grid Option

Frequency limit	Setting	Timeout	Setting
OF1	63.6 Hz	t_{OF1}	0.2 s
UF1	56.4 Hz	t_{UF1}	0.2 s

4. Transient Stability Analysis and Results

Stability simulations were run to examine the transient behavior of PID-247 and its impact on the Entergy system. Conventional generators near Stowell 138 kV were observed for rotor angle, voltage and frequency stability. For PID-247, modeled as a doubly fed induction generator, speed is generally accepted as the primary indicator of stability. The model, however, did not show dynamics in rotor speed and hence, indicators like terminal voltage, active and reactive power output were used to judge stability of PID-247 generator. Stability analysis was performed using the following procedure.

Three-phase faults were chosen in the vicinity of PID-247 and simulated as either normal clearing or stuck-breaker faults. As data for breaker configuration of PID-247 wind farm was unavailable, an assumption was made. PID-247 was connected to the existing system with a breaker at the low side of 34.5/138kV transformer as shown in Figure.

Since PID-247 is a wind farm, it should exhibit Low Voltage Ride-Through (LVRT) in the event of a fault. It implies that the wind farm should be able to ride through a fault for at least 9 cycles. PID-247 was first tested for this criterion.

Three-phase faults with normal clearing were then simulated. Next, three-phase stuck breaker faults were simulated. If a three-phase stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. The fault clearing times used for the simulations are given in Table.

Table A-5: Fault Clearing Times

Contingency at kV level	Normal Clearing	Delayed Clearing
138/69	6 cycles	6+9 cycles

Breaker failure scenarios were 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 and single-phase stuck-breakers.

3) The fault is then cleared by back-up clearing.

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

Table shows the faults simulated to test LVRT capability of PID-247. Table lists all the fault cases that were simulated in this study, including normally cleared three-phase faults and three-phase stuck breaker faults. Figure to Figure show the layout diagrams of the nearby 138 kV and 69 kV substations where faults were simulated, as well as fault locations.

For all cases analyzed, the initial disturbance was applied at t = 0.1 seconds.

PID-247 was found to satisfy LVRT requirements. The plots from LVRT simulations are shown in Appendix B.

Analyses on the post-project case showed the system to be stable following all three-phase normally cleared and stuck breaker faults.

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 are not applicable for three-phase stuck-breaker faults unless the determined impact is extremely widespread.

The voltages at all buses in the network were monitored during each of the fault cases as appropriate.

No voltage criteria violations were observed following normally cleared three-phase faults. For Fault_3, Fault_11 and Fault_13, it was observed that voltage at Himex 69 kV fell to 0.80 pu for many cycles and remained at that level till the end of simulation. This was further investigated and found to be a pre-project issue.

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 i.e., not to exceed 20% for more than 20 cycles. No voltage criteria violations were observed.

Table A-6: Faults to test LVRT Capability of PID-247

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_1b	Stowell - Shiloh 138kV	Stowell 138kV	3PH	9	None	None	5295, 5330 (Shiloh)	None	Stowell - Crooked Bayou, Crooked Bayou - Hankamer, Hankamer - Bay Shore, Bay Shore - Brooks Creek, Brooks Creek - Shiloh; All are 138kV facilities
FAULT_2b	Stowell - Big Hill 138kV	Stowell 138kV	3PH	9	None	None	5440, 22325 (Big Hill)	None	Stowell-Big Hill138 kV

3PH = Three-phase

Table A-7: List of Simulated Faults

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_1	Stowell - Shiloh 138kV	Stowell 138kV	3PH	6	None	None	5295, 5330 (Shiloh)	None	Stowell - Crooked Bayou, Crooked Bayou - Hankamer, Hankamer - Bay Shore, Bay Shore - Brooks Creek, Brooks Creek - Shiloh; All are 138kV facilities
FAULT_2	Stowell - Big Hill 138kV	Stowell 138kV	3PH	6	None	None	5440, 22325 (Big Hill)	None	Stowell-Big Hill138 kV
FAULT_3	Stowell 138/69 kV Transformers	Stowell 138kV	3PH	6	None	None	5245,5295, 5440,5290	None	Stowell - Big Hill, Stowell - Crooked Bayou, Stowell transformers 138/69 #3, #4. PID - 247 is isolated, hence it is disconnected also.
FAULT_4		Stowell 69kV	3PH	6	None	None	5245, 5240, 22165, 23010	None	Stowell-Winshire 69 kV, Stowell 138/69 kV Xmer #3
FAULT_5		Stowell 69kV	3PH	6	None	None	2485, 23010, 5290	None	Stowell-Himex 69 kV, Stowell 138/69 kV Xmer #4
FAULT_6	Big Hill - Bayou Farms - Memorial - 138kV	Big Hill 138kV	3PH	6	None	None	22335, 15660 (Memorial)	None	Big Hill- Bayou Farms 138 kV, Bayou Farms - Memorial 138kV
FAULT_7	Shiloh - White's Bayou Tap 138kV	Shiloh 138kV	3PH	6	None	None	5325, 5200 (White's Bayou)	None	Shiloh - White's Bayou, White's Bayou - Raywood
FAULT_8	Stowell - Winshire 69kV	Stowell 69kV	3PH	6	None	None	5240, 5210 (Winshire)	None	Stowell - Winshire 69kV
FAULT_9	Stowell - Himex 69kV	Stowell 69kV	3PH	6	None	None	2485	None	Stowell - Himex 69kV
FAULT_10	Stowell - Shiloh 138kV	Stowell 138kV	3PHSB	6	9	5295 (Stowell)	5330 (Shiloh)	5440, 5245, 5290	Brooks Creek - Shiloh 138kV Stowell 138/69 kV transformers #3 and #4, Stowell - Big Hill, disconnect PID-247
FAULT_11	Stowell - Big Hill 138kV	Stowell 138kV	3PHSB	6	9	5440 (Stowell)	22325 (Big Hill)	5295, 5290, 5245	Stowell - Big Hill Stowell 138/69 kV transformers #3 and #4, Stowell - Crooked Bayou, disconnect PID-247
FAULT_12	Stowell 138/69 kV Transformers	Stowell 138kV	3PHSB	6	9	5295 (Stowell 138)	5440, 5245, 5290	5330 (Shiloh)	Stowell 138/69 kV transformers #3 and #4, Stowell - Big Hill 138kV, disconnect PID-247 Brooks Creek - Shiloh 138kv
FAULT_13	Stowell 138/69 kV Transformers	Stowell 138kV	3PHSB	6	9	5440 (Stowell 138)	5295, 5245, 5290	22325 (Big Hill)	Stowell 138/69 kV transformers #3 and #4, Stowell - Crooked Bayou, disconnect PID-247 Stowell - Big Hill 138kv
FAULT_14	Stowell - Winshire 69kV	Stowell 69kV	3PHSB	6	9	5240 (Stowell 69)	5210 (Winshire)	5245, 22165, 223010	Stowell - Winshire 69kV Stowell 138/69kV transformer #3, Clear Fault

Fault #	Line on which Fault occurs	Fault Location	Fault Type	Fault Clearing (CY)		Stuck Breaker	Breaker Clearing		Tripped Facilities
				Primary	Back-up		Primary	Back-up	
FAULT_15	Stowell - Himex 69kV	Stowell 69kV	3PHSB	6	9	2485 (Stowell 69)		5290, 223010	No action Stowell 138/69kV transformer #4, Clear Fault
FAULT_16		Stowell 69kV	3PHSB	6	9	5245 (Stowell 69)	23010, 5240, 22165	5295, 5440, 5290	Stowell - Winshire 69kV, Split Stowell 69kV bus Stowell - Crooked Bayou 138kV, Stowell - Big Hill, Stowell 138/69kV transformer #4, disconnect PID-247
FAULT_17		Stowell 69kV	3PHSB	6	9	5240 (Stowell 69)	5245, 22165, 23010	5210 (Winshire)	Stowell 138/69kV transformer #3, Split Stowell 69kV bus Stowell - Winshire 69kv
FAULT_18		Stowell 69kV	3PHSB	6	9	23010 (Stowell 69)	5245, 5240, 22165	5290, 2485	Stowell 138/69kV transformer #3, Stowell - Winshire 69kV Stowell 138/69kV transformer #4, Stowell - Himex 69kV
FAULT_19		Stowell 69kV	3PHSB	6	9	5290 (Stowell 69)	23010, 2485	5295, 5440, 5245	Stowell - Himex 69kV, Split Stowell 69kV bus Stowell 138/69kV transformer #3, Stowell - Crooked Bayou 138kV, Stowell - Big Hill 138kV, disconnect PID-247
FAULT_20		Stowell 69kV	3PHSB	6	9	2485 (Stowell 69)	23010, 5290		Stowell 138/69kV transformer #4, Split Stowell 69kV bus No secondary action
FAULT_21		Stowell 69kV	3PHSB	6	9	23010 (Stowell 69)	5290, 2485	5245, 5240, 22165	Stowell 138/69kV transformer #4, Stowell - Himex 69kV Stowell 138/69kV transformer #3, Stowell - Winshire 69kV
FAULT_22	Shiloh - White's Bayou Tap 138kV	Shiloh 138kV	3PHSB	6	9	5325 (Shiloh 138)	5200 (Raywood)	5330	White's Bayou - Raywood 138 kV Shiloh - Brook's Creek 138 kV
FAULT_23	Big Hill - Bayou Farms - Memorial - 138kV	Big Hill 138kV	3PHSB	6	9	22335 (Big Hill)	15660 (Memorial)	4002, 22330	Bayou Farms - Memorial 138kV Clear Fault, Trip transformer #1 at Big Hill

3PH = Three-phase
3PHSB = Three-phase stuck breaker faults

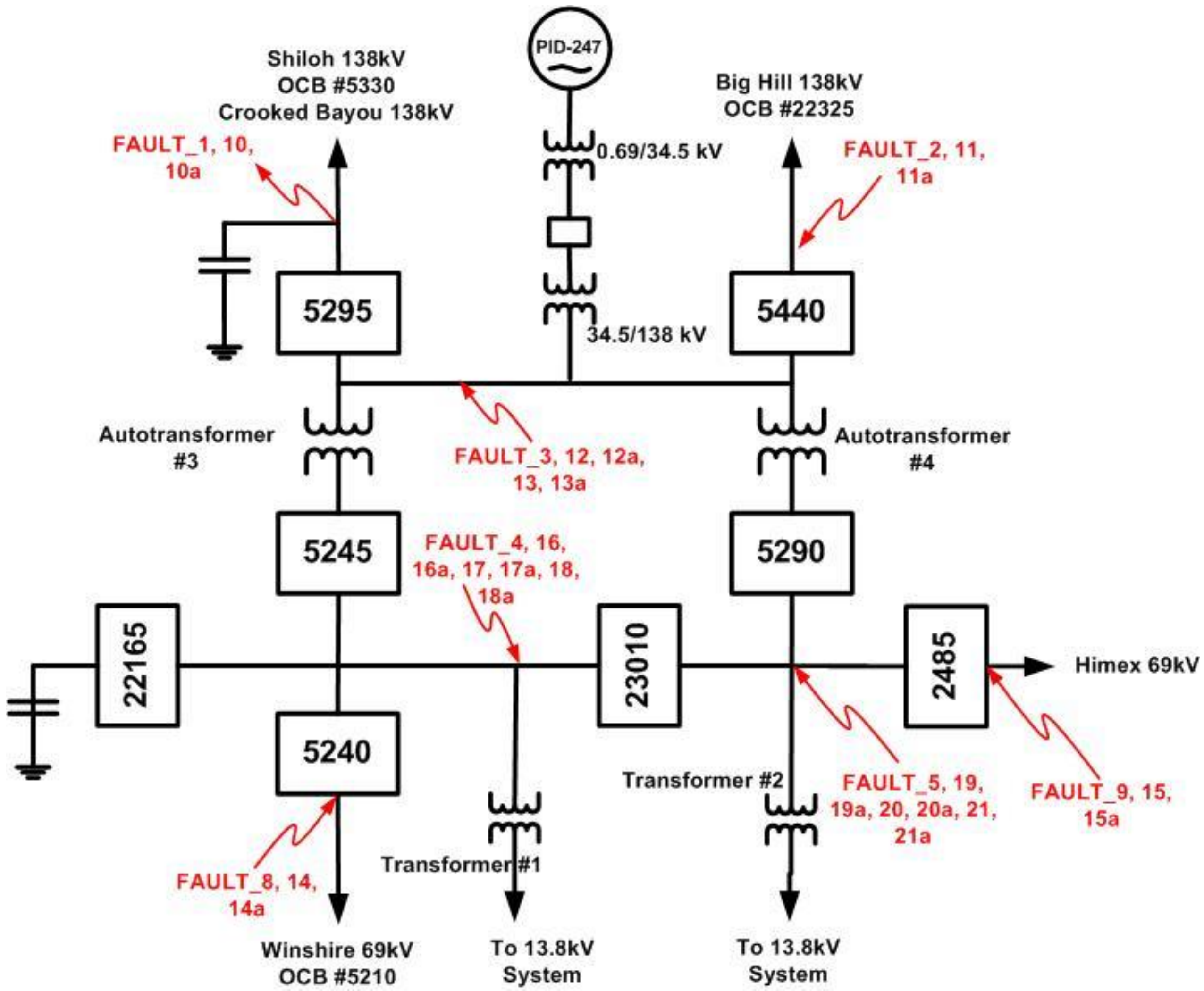


Figure A-2: One-line diagram for Stowell 138 and 69 kV substation

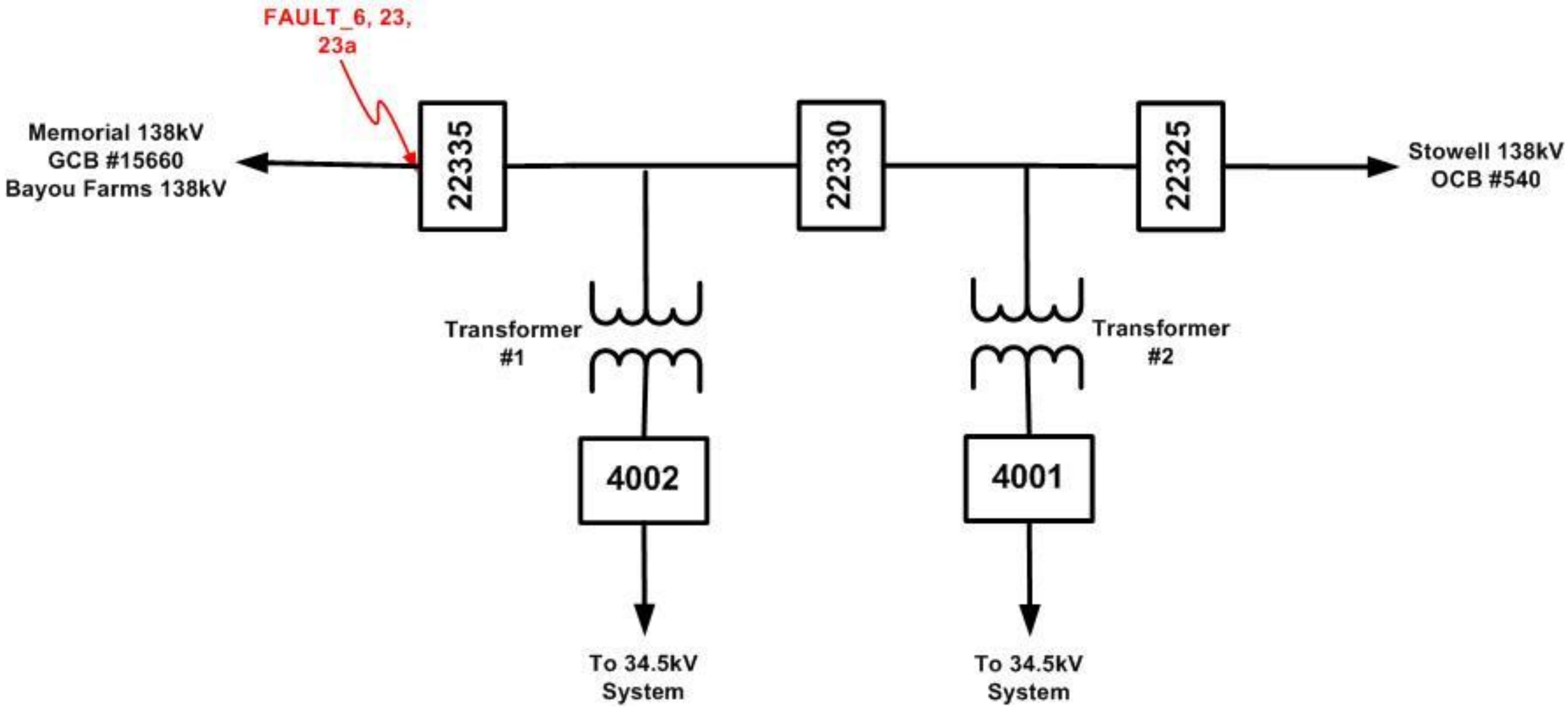


Figure A-3: One-line diagram for Big Hill 138kV substation

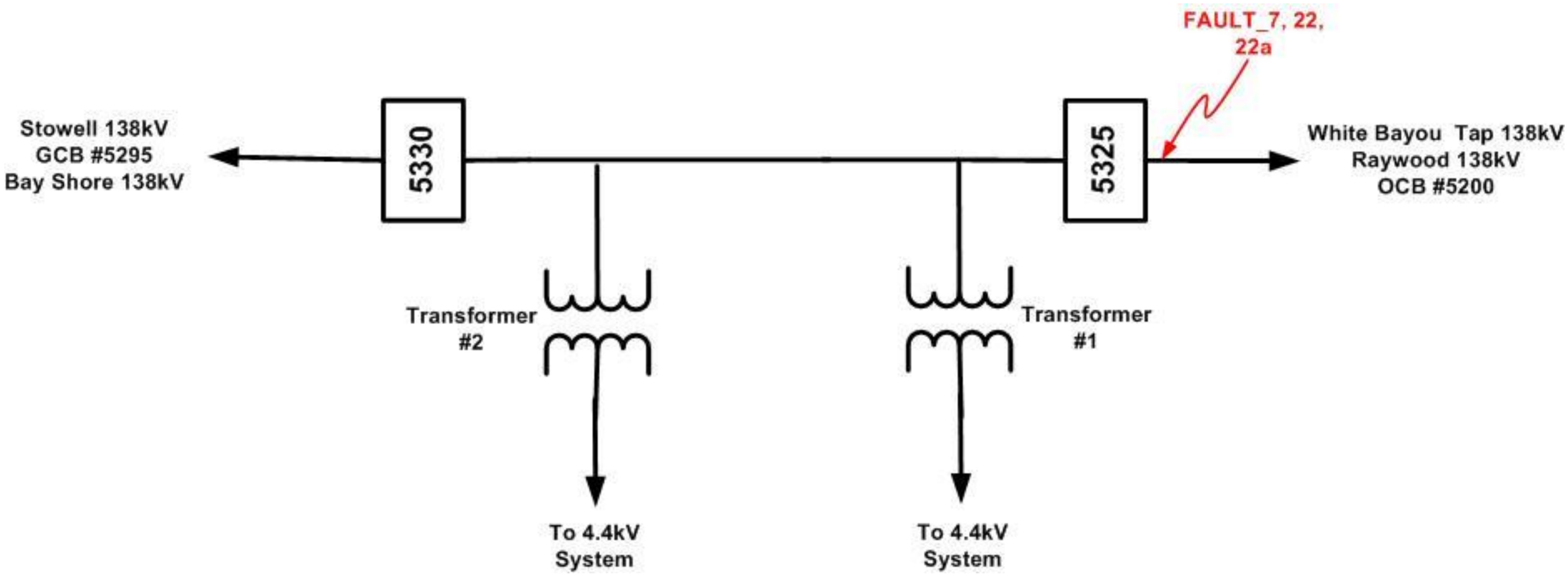


Figure A-4: One-line diagram for Shiloh 138kV substation

Table A-8: Three-Phase Normally Cleared and Stuck Breaker Faults Simulation Results

Fault #	Comments
FAULT_1	STABLE
FAULT_2	STABLE
FAULT_3	STABLE
FAULT_4	STABLE
FAULT_5	STABLE
FAULT_6	STABLE
FAULT_7	STABLE
FAULT_8	STABLE
FAULT_9	STABLE
FAULT_10	STABLE
FAULT_11	STABLE
FAULT_12	STABLE
FAULT_13	STABLE
FAULT_14	STABLE
FAULT_15	STABLE
FAULT_16	STABLE
FAULT_17	STABLE
FAULT_18	STABLE
FAULT_19	STABLE
FAULT_20	STABLE
FAULT_21	STABLE
FAULT_22	STABLE
FAULT_23	STABLE

REFERENCES

[1] "Stability Analysis for PID-247 System Impact Study," ABB Inc., Feb 23, 2011

[2] "Model User Manual Generic PSS/E Model for Vestas Wind Turbines," Version 7.4, Vestas Wind Systems A/S, May 27, 2011.

APPENDIX A Powerflow and Stability Data

Powerflow Data

Following data is presented in PSS/E Version 30.3.3 format

```
--------------------------------------------------------------------------------

1,   100.00         / PSS/E-30.3    THU, SEP 29 2011  14:19

399970,'            ', 138.0000,1,     0.000,     0.000, 351, 105,1.00038, -50.7980,   1
399971,'            ',  34.5000,1,     0.000,     0.000, 351, 105,1.00311, -43.3118,   1
399972,'            ',  34.5000,1,     0.000,     0.000, 351, 105,1.01541, -42.5455,   1
399973,'PID247      ',   0.6900,2,     0.000,     0.000, 351, 105,1.02585, -38.9321,   1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
399973,'1 ',   179.000,    17.780,    17.780,    17.780,1.00000,334225,   180.000,   0.00570,   0.16540,   0.00000,
0.00000,1.00000,1,  100.0,   180.000,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
399971, 399972,'1 ',   0.00660,   0.00800,   0.06960,  210.00,  210.00,  210.00,  0.00000,  0.00000,  0.00000,  0.00000,1,
0.00,   1,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
399970,399971,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.00214,   0.08997,   121.00
1.00000, 138.000,   0.000,   200.00,   200.00,   200.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000,
0.00000
1.00000,  34.500
399972,399973,     0,'1 ',1,2,1,   0.00000,   0.00000,1,'            ',1,   1,1.0000
   0.00728,   0.07766,   210.00
1.00000,  34.500,   0.000,   210.00,   210.00,   210.00, 0,      0, 1.05000, 0.95000, 1.05000, 0.95000,   5, 0, 0.00000,
0.00000
1.00000,   0.690
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
 351,337653,  -863.871,    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
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
 105,'GSTBMR      '
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
   1,'OTHERS      '
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA
```

Dynamics Data

Following data is taken from file, *'pid-247-v100.dyr,'* prepared for the study.

```
399973 'USRMDL' '1'  'VWCORE' 1 1 2 37 23 104 1 0
 1800.0000 692.8203 809.6643 700.0000 2.6200 0.6750 0.0160
 1.5013 8.3264 1.5013 8.3264 30.0000 0.2000 1.2000
 0.1000 0.0018 0.6983 0.0385 1.2774 0.0000 422.2301
 161.5343 0.0300 0.0000 0.0300 0.3000 0.0000 0.0000
 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
 0.0000 0.0000 /
0 'USRMDL' 0 'VWVARS' 8 0 2 0 0 25 399973 '1' /
0 'USRMDL' 0 'VWLVRT' 8 0 3 33 10 35 399973 '1' 1
 0.8500 0.0010 0.2000 12.5000 50.0000 0.0000 0.0000
 0.5000 1.0000 2.6200 0.6750 1.2000 0.5000 692.8203
 809.6643 0.3500 0.0500 0.2500 0.0200 3.0000 4.0000
 60.0000 0.0160 1.1700 0.8500 0.0500 0.0000 0.0200
 0.0000 0.0000 0.0000 0.0000 0.0000/
0 'USRMDL' 0 'VWPWRC' 8 0 3 21 7 5 399973 '1' 0
 1.0000 0.5556 -0.5556 0.7567 0.9372 0.9500 0.9000
 0.2000 0.2000 1.0000 0.0000 0.0000 0.0000 0.1000
 0.1000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 /
0 'USRMDL' 0 'VWMECH' 8 0 2 7 8 0 399973 '1'
 1800.0000 422.2301 4263.0788 574.0000 68.5000 9743.0000 38.3000 /
0 'USRMDL' 0 'VWMEAS' 8 0 2 4 8 5 399973 '1'
 0.1000 0.1000 0.1000 0.0000/
0 'USRMDL' 0 'VWVPRT' 0 2 7 20 0 11 399973 '1'  1 1 0 0 0
 0.7500 0.0001 0.8500 0.4000 0.9000 60.0000 1.1000
 60.0000 1.1350 0.2000 1.2000 0.1200 0.0000 0.2000
 0.7000 2.6500 0.8500 11.0000 0.9000 60.0000 /
0 'USRMDL' 0 'VWFPRT' 0 2 3 4 0 1 399973 '1'  0
 56.4000 0.2000 63.6000 0.2000 /
/GOVERNOR Model
399973,'USRMDL',1,'VWGOV',5,0,5,14,6,45,
1,399970,334225,1,1,
0.015, -0.015, 0.015, -0.015, 10, 10, 10, 10,
0.06,    0.1,    1.0,   0.2, 1.0, 0.95/
/STATCOM Model
399971,'USRLOD',1,'VWSCBL',12,1,2,2,0,1,0
10,1,0.054,0.054/
/AVR Model
399973,'USRMDL',1,'VWEX1',4,0,23,28,7,59,
4,3,1,1,5, 334225,399971,1,1,1,
1,1,1,1,0, 0,  0,0,0,0,399970,334225,1,
0.02,  0,  0.5, 0.5, 5,
0.02,  0.02, 0, 1.0, 5.6,
3.16792, 0.4,  0.1, 0.2, 0.1,
0.25,  0.1,  1.1, 0.7,    0.054,
0.054, 0.5,  0.2, 2.0,    0.2,
0.3,  0.08, 0.06/
```

APPENDIX B STABILITY PLOTS FOR LVRT TESTING

APPENDIX C DATA ASSUMPTIONS

Powerflow Data

Generator and 138/34.5kV transformer powerflow data was taken from a file provided by SPP called ‘Sample Data for Wind Generatorsrev4 - Sea Breeze 180 MW.doc’ dated July 28, 2011.

Dynamic Data

Dynamic modeling was done per Vestas Model User Guide, “Model User Manual Generic PSS/E Model for Vestas Wind Turbines,” Version 7.4, Vestas Wind Systems A/S, May 27, 2011.

Dynamic model parameters for the proposed wind farm were obtained from the Vestas Model User Guide mentioned above and file *‘V100VCS_1800_60_param.dyr’* dated January 15, 2011 provided by SPP.