System Impact Study
PID 233
150MW Plant

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Contents

Executive Summary

This System Impact Study is the second step of the interconnection process and is based on the PID-233 request for interconnection on Entergy's transmission system at Marshall to Botkinburg near Canaan, AR. 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-233 did request NRIS and ERIS; therefore, under ERIS a load flow analysis was performed. PID-233 will be a new facility. PID 233 intends to install 83 wind turbines on the 161kV Entergy Marshall - Botkinburg line. The study evaluates connection of 150MW 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 31, 2013.

Results of the System Impact Study indicated that under ERIS the additional generation due to PID-233 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-233 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

Estimated cost With Priors*	Estimated cost Without Priors*
$0	$0

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.

Estimated NRIS Project Planning Upgrades

Limiting Element	Planning Estimate for Upgrade*
McAdams 500/230kV transformer 1	Included in 2010 ICT Base Plan
Bull Shoals - Bull Shoals Dam SPA 161kV	TBD - Other Ownership

*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 interconnection on Entergy's transmission system between Marshall and Botkinburg substations located at PID-233 161kV 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 150MW generation and the associated facilities were then modeled in the case to build a revised case for the load flow analysis. Transfers were simulated between thirteen (13) control areas and Entergy using requesting generator as the source and adjacent control area as sink. (Note: Refer to NRIS section for details of dispatch within Entergy system)

This study considered the following four scenarios:

Scenario No.	Approved Future Transmission Projects	Pending Transmission Service & Study Requests	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. The one-line diagram of Customer's facilities as modeled in the load flow analysis, and Customer supplied data are shown in Appendix A. The data used to build the load flow and dynamic models are shown in Appendix B. All stability study plots are shown in Appendix C.

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-233 – 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 summer peak	0	0	0	150
AMRN	Ameren Transmission	2014 summer peak	0	0	0	150
CLEC	CLECO	2014 summer peak	0	0	0	0
AEP-W	American Electric Power - West	2014 summer peak	0	150	0	150
EES	Entergy	2014 summer peak	0	0	0	0
EMDE	Empire District Electric Co	2014 summer peak	0	132	0	131
LAFA	Lafayette Utilities System	2014 summer peak	0	0	0	0
LAGN	Louisiana Generating, LLC	2014 summer peak	0	0	0	0
LEPA	Louisiana Energy & Power Authority	2014 summer peak	0	0	0	0
OKGE	Oklahoma Gas & Electric Company	2014 summer peak	0	150	0	150
SMEPA	South Mississippi Electric Power Assoc.	2014 summer peak	0	0	0	130
SOCO	Southern Company	2014 summer peak	0	0	0	150
SPA	Southwest Power Administration	2014 summer peak	0	150	0	150
TVA	Tennessee Valley Authority	2014 summer peak	0	0	0	150

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
Acadia GSU - Colonial Academy 138kV	Included in 2010 ICT Base Plan							X							
Baxter Wilson - Ray Braswell 500kV	Committed to by others							X	X	X		X	X		
Bismarck - Hot Springs EHV West 115kV CKT 1	Committed to by others		X												
Bonin - Cecelia 138kV	Included in 2010 ICT Base Plan									X					
Bull Shoals - Bull Shoals Dam SPA 161kV	Other Ownership	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Colonial Academy - Richard 138kV	Included in 2010 ICT Base Plan							X		X					
Greenwood - Terrebonne 115kV	33,226,332							X							
Harrison East - Summit 161kV	17,650,000						X								
Judice - Scott1 138kV	Included in 2010 ICT Base Plan									X					
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Other Ownership		X												
Melbourne - Sage 161kV	4,207,000						X							X	
North Crowley - Scott1 138kV	Included in 2010 ICT Base Plan							X		X					
Scott1 - Bonin 138kV	Included in 2010 ICT Base Plan							X		X					
Semere - Scott2 138kV	Included in 2010 ICT Base Plan							X		X					
Sterlington 500/115kV transformer 2	Committed to by others					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
Acadia GSU - Colonial Academy 138kV	Included in 2010 ICT Base Plan				X			X		X					
Acadia GSU - Scanlan 138kV	Included in 2010 ICT Base Plan				X			X		X					
Addis - Big Cajun 1 230kV	Included in 2010 ICT Base Plan									X					
Baxter Wilson - Ray Braswell 500kV	Committed to by others	X		X	X	X		X	X	X		X	X		X
Bogalusa - Adams Creek 230kV ckt 2	Included in 2010 ICT Base Plan				X	X		X	X	X					
Bonin - Cecelia 138kV	Included in 2010 ICT Base Plan									X					
Cecelia - Semere 138kV	Included in 2010 ICT Base Plan							X		X					
Colonial Academy - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					
Habetz - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					
Harrison East - Omaha 161kV	TBD						X								
Jaguar - Tap Point Esso 230kV	1,416,000					X				X					
Judice - Meaux 138kV	Included in 2010 ICT Base Plan				X					X					
Judice - Scott1 138kV	Included in 2010 ICT Base Plan				X					X					
Louisiana Station - Thomas 138kV	645,943									X					
McAdams 500/230kV transformer 1	Included in 2010 ICT Base Plan & Entergy's CP				X	X		X	X	X					
Moril - Cecelia 138kV	Included in 2010 ICT Base Plan				X					X					
North Crowley - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					
North Crowley - Scott1 138kV	Included in 2010 ICT Base Plan				X			X		X					
Port Hudson 230/138 transformer 1	TBD									X					
Port Hudson 230/138 transformer 2	TBD									X					
Richard - Scott1 138kV	Included in 2010 ICT Base Plan				X			X		X					

Limiting Elements	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
Scott1 - Bonin 138kV	Included in 2010 ICT Base Plan							X		X					
Semere - Scott2 138kV	Included in 2010 ICT Base Plan				X			X		X					
Sorrento - Vignes 230kV	Included in 2010 ICT Base Plan									X					
Sterlington 500/115kV transformer 2	Committed to by others					X									
Willow Glen - Willow Glen 2 500/138kV transformer 1	TBD					X				X					
Willow Glen 500/230kV Transformer	TBD					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
Bonin - Cecelia 138kV	Included in 2010 ICT Base Plan									X					
Bull Shoals - Bull Shoals Dam SPA 161kV	Other Ownership	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Colonial Academy - Richard 138kV	Included in 2010 ICT Base Plan							X		X					
Greenwood - Terrebonne 115kV	33,226,332							X							
Harrison East - Summit 161kV	17,650,000						X								
Judice - Scott1 138kV	Included in 2010 ICT Base Plan									X					
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Other Ownership		X												
Melbourne - Sage 161kV	4,207,000						X							X	
North Crowley - Scott1 138kV	Included in 2010 ICT Base Plan							X		X					
Scott1 - Bonin 138kV	Included in 2010 ICT Base Plan							X		X					
Semere - Scott2 138kV	Included in 2010 ICT Base Plan							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
Acadia GSU - Colonial Academy 138kV	Included in 2010 ICT Base Plan				X			X		X					
Acadia GSU - Scanlan 138kV	Included in 2010 ICT Base Plan				X			X		X					
Addis - Big Cajun 1 230kV	Included in 2010 ICT Base Plan									X					
Baxter Wilson - Ray Braswell 500kV	Committed to by others									X		X			
Bogalusa - Adams Creek 230kV ckt 2	Included in 2010 ICT Base Plan				X	X		X	X	X					
Bonin - Cecelia 138kV	Included in 2010 ICT Base Plan									X					
Cecelia - Semere 138kV	Included in 2010 ICT Base Plan							X		X					
Colonial Academy - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					
Habetz - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					
Harrison East - Omaha 161kV	TBD						X								
Judice - Meaux 138kV	Included in 2010 ICT Base Plan				X					X					
Judice - Scott1 138kV	Included in 2010 ICT Base Plan				X					X					
McAdams 500/230kV transformer 1	Included in 2010 ICT Base Plan				X	X		X	X	X					
Moril - Cecelia 138kV	Included in 2010 ICT Base Plan				X					X					
North Crowley - Richard 138kV	Included in 2010 ICT Base Plan				X			X		X					

Limiting Element	Est. Cost	AECI	AEPW	AMRN	CLECO	EES	EMDE	LAFA	LAGN	LEPA	OKGE	SMEPA	SOCO	SPA	TVA
North Crowley - Scott1 138kV	Included in 2010 ICT Base Plan				X			X		X					
Port Hudson 230/138 transformer 1	TBD									X					
Port Hudson 230/138 transformer 2	TBD									X					
Richard - Scott1 138kV	Included in 2010 ICT Base Plan				X			X		X					
Scott1 - Bonin 138kV	Included in 2010 ICT Base Plan							X		X					
Semere - Scott2 138kV	Included in 2010 ICT Base Plan				X			X		X					
Willow Glen - Willow Glen 2 500/138kV transformer 1	TBD					X				X					
Willow Glen 500/230kV Transformer	TBD					X				X					

2.3.1 DETAILS OF SCENARIO 1 - 2014

AECI

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

AEP-W

Limiting Element	Contingency Element	ATC
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Contingency of Flow Gate 5029 DOLHILL7 345 TO SW SHV 7 345	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Bismarck - Hot Springs EHV West 115kV CKT 1	El Dorado 500/345kV Transformer	110
Bismarck - Hot Springs EHV West 115kV CKT 1	El Dorado EHV - Longwood (SWEPCO) 345kV	110

AMRN

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

CLECO

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

EMDE

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Bull Shoals - Lead Hills 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Clevcov - Lead HL 161kV	0

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	ANO - Fort Smith 500kV	0
Melbourne - Sage 161kV	Marshall - PID 233 161kV	42
Melbourne - Sage 161kV	Marshall - Hilltop 161kV	78
Harrison East - Summit 161kV	St. Joe - Hilltop 161kV	132
Harrison East - Summit 161kV	Everton - St. Joe 161kV	143

LAFA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	2
Scott1 - Bonin 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	28
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	55
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	60
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	89
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	132
Greenwood - Terrebonne 115kV	Webre - Wells 500kV	142
Acadia GSU - Colonial Academy 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	150

LAGN

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	120

LEPA

Limiting Element	Contingency Element	ATC
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0

Limiting Element	Contingency Element	ATC
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Bonin - Cecelia 138kV	Acadia GSU - Colonial Academy 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	8
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	89
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	135

OKGE

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Bull Shoals - Lead Hills 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Clevcov - Lead HL 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

SMEPA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	77

SOCO

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	118

SPA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Melbourne - Sage 161kV	Marshall - PID 233 161kV	36
Melbourne - Sage 161kV	Marshall - Hilltop 161kV	65

TVA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

2.3.2 DETAILS OF SCENARIO 2

AECI

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

AEP-W

Limiting Element	Contingency Element	ATC
NONE	NONE	150

AMRN

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

CLECO

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Semere - Scott2 138kV	Wells 500/230kV transformer	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Wells 500/230kV transformer	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	Colonial Academy - Richard 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	0
Moril - Cecelia 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Richard - Scott1 138kV	Acadia GSU - Scanlan 138kV	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Acadia GSU - Scanlan 138kV	Wells 500/230kV transformer	0
North Crowley - Richard 138kV	Wells 500/230kV transformer	0

EES

Limiting Element	Contingency Element	ATC
Sterlington 500/115kV transformer 2	Sterlington 500/115kV transformer 1	0
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0

Limiting Element	Contingency Element	ATC
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	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 - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	0
Willow Glen 500/230kV Transformer	Jaguar - Tap Point Esso 230kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Willow Glen 500/230kV Transformer	Addis - Big Cajun 1 230kV	82

EMDE

Limiting Element	Contingency Element	ATC
Harrison East - Omaha 161kV	Green Forest South - PID223TAP 161kV	132

LAFA

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Richard - Scott1 138kV	0
Semere - Scott2 138kV	Richard - Wells 500kV	0
Semere - Scott2 138kV	North Crowley - Richard 138kV	0
Colonial Academy - Richard 138kV	Bonin - Cecelia 138kV	0
Acadia GSU - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Richard - Wells 500kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Colonial Academy - Richard 138kV	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Colonial Academy - Richard 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
Colonial Academy - Richard 138kV	Richard - Scott1 138kV	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0

Limiting Element	Contingency Element	ATC
Richard - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Acadia GSU - Scanlan 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Richard - Scott1 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells 500/230kV transformer	0
Acadia GSU - Colonial Academy 138kV	Bonin - Cecelia 138kV	0
North Crowley - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Base Case	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Scanlan 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Acadia GSU - Scanlan 138kV	Wells 500/230kV transformer	0
North Crowley - Richard 138kV	Wells 500/230kV transformer	0
Acadia GSU - Scanlan 138kV	Richard - Scott1 138kV	3
Cecelia - Semere 138kV	Bonin - Labbe 230kV (LAFA)	4
Scott1 - Bonin 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	11
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	43
Acadia GSU - Scanlan 138kV	Habetz - Richard 138kV	46
Cecelia - Semere 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	59
North Crowley - Scott1 138kV	Base Case	63
Habetz - Richard 138kV	Wells 500/230kV transformer	75
Habetz - Richard 138kV	Flander - Acadian 230kV (LAFA)	88
North Crowley - Richard 138kV	Colonial Academy - Richard 138kV	91
Cecelia - Semere 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	93

LAGN

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0

LEPA

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
Addis - Big Cajun 1 230kV	Jaguar - Tap Point Esso 230kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0

Limiting Element	Contingency Element	ATC
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
Addis - Big Cajun 1 230kV	Willow Glen - Webre 500kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Semere - Scott2 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
North Crowley - Scott1 138kV	Coughlin - Plaisance 138kV (CLECO)	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Semere - Scott2 138kV	Richard - Wells 500kV	0
Acadia GSU - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Colonial Academy 138kV	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Acadia GSU - Colonial Academy 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Jaguar - Tap Point Esso 230kV	Addis - Big Cajun 1 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Acadia GSU - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Semere - Scott2 138kV	Terrebonne 230/115kV transformer	0
Colonial Academy - Richard 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Colonial Academy - Richard 138kV	Bonin - Cecelia 138kV	0
North Crowley - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Scanlan 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Richard - Wells 500kV	0
Acadia GSU - Scanlan 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	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
Acadia GSU - Colonial Academy 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Willow Glen - Willow Glen 2 500/138kV	Willow Glen 500/230kV Transformer	0

Limiting Element	Contingency Element	ATC
transformer 1		
Moril - Cecelia 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Acadia GSU - Colonial Academy 138kV	Bonin - Cecelia 138kV	0
Bonin - Cecelia 138kV	Scanlan - Scott2 138kV	0
Bonin - Cecelia 138kV	Semere - Scott2 138kV	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Willow Glen 500/230kV Transformer	Jaguar - Tap Point Esso 230kV	0
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	0
Acadia GSU - Colonial Academy 138kV	Richard - Wells 500kV	4
Cecelia - Semere 138kV	Bonin - Labbe 230kV (LAFA)	8
Judice - Scott1 138kV	Acadian - Bonin 230kV (LAFA)	9
Judice - Scott1 138kV	Moril - Cecelia 138kV	9
Willow Glen 500/230kV Transformer	Addis - Big Cajun 1 230kV	52
Judice - Scott1 138kV	Greenwood - Terrebonne 115kV	82
Judice - Scott1 138kV	Colonial Academy - Richard 138kV	88
Sorrento - Vignes 230kV	Polsky Carville - Willow Glen 230kV	114
Judice - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	116
Acadia GSU - Scanlan 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	118
Sorrento - Vignes 230kV	A.A.C. - Polsky Carville 230kV	121
Colonial Academy - Richard 138kV	Terrebonne 230/115kV transformer	122
Sorrento - Vignes 230kV	A.A.C. - Licar 230kV	144
Acadia GSU - Scanlan 138kV	Bonin - Cecelia 138kV	145
Louisiana Station - Thomas 138kV	Big Cajun 2 - Webre 500kV	147
Moril - Cecelia 138kV	Judice - Scott1 138kV	148

OKGE

Limiting Element	Contingency Element	ATC
NONE	NONE	150

SMEPA

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

SOCO

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

SPA

Limiting Element	Contingency Element	ATC
NONE	NONE	150

TVA

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

2.3.3 DETAILS OF SCENARIO 3 - 2014

AECI

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

AEP-W

Limiting Element	Contingency Element	ATC
'MANSFLD4 138' TO BUS 'IPAPER 4 138'	Contingency of Flow Gate 5029 DOLHILL7 345 TO SW SHV 7 345	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

AMRN

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

CLECO

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

EES

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

EMDE

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Bull Shoals - Lead Hills 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Clevcov - Lead HL 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	ANO - Fort Smith 500kV	0
Melbourne - Sage 161kV	Marshall - PID 233 161kV	42
Melbourne - Sage 161kV	Marshall - Hilltop 161kV	77
Harrison East - Summit 161kV	St. Joe - Hilltop 161kV	131
Harrison East - Summit 161kV	Everton - St. Joe 161kV	142

LAFA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	4
Scott1 - Bonin 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	28
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	57
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	60
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	90
Greenwood - Terrebonne 115kV	Webre - Wells 500kV	147

LAGN

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

LEPA

Limiting Element	Contingency Element	ATC
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0

Limiting Element	Contingency Element	ATC
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Bonin - Cecelia 138kV	Acadia GSU - Colonial Academy 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	19
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	140

OKGE

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	Bull Shoals - Lead Hills 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Clevcov - Lead HL 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

SMEPA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

SOCO

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

SPA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0
Melbourne - Sage 161kV	Marshall - PID 233 161kV	35
Melbourne - Sage 161kV	Marshall - Hilltop 161kV	65

TVA

Limiting Element	Contingency Element	ATC
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

2.3.4 DETAILS OF SCENARIO 4 - 2014

AECI

Limiting Element	Contingency Element	ATC
NONE	NONE	150

AEP-W

Limiting Element	Contingency Element	ATC
NONE	NONE	150

AMRN

Limiting Element	Contingency Element	ATC
NONE	NONE	150

CLECO

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Wells 500/230kV transformer	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	Colonial Academy - Richard 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells 500/230kV transformer	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Richard - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	0
Moril - Cecelia 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Richard - Scott1 138kV	Acadia GSU - Scanlan 138kV	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Acadia GSU - Scanlan 138kV	Wells 500/230kV transformer	9
North Crowley - Richard 138kV	Wells 500/230kV transformer	20

EES

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 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

Limiting Element	Contingency Element	ATC
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Willow Glen - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	119

EMDE

Limiting Element	Contingency Element	ATC
Harrison East - Omaha 161kV	Green Forest South - PID223TAP 161kV	131

LAGN

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0

LAFA

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Richard - Wells 500kV	0
Semere - Scott2 138kV	Richard - Scott1 138kV	0
Semere - Scott2 138kV	North Crowley - Richard 138kV	0
North Crowley - Scott1 138kV	Richard - Wells 500kV	0
Acadia GSU - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Bonin - Cecelia 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Colonial Academy - Richard 138kV	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	0
North Crowley - Scott1 138kV	Wells 500/230kV transformer	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Colonial Academy - Richard 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
Colonial Academy - Richard 138kV	Richard - Scott1 138kV	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Richard - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0

Limiting Element	Contingency Element	ATC
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Acadia GSU - Scanlan 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Richard - Scott1 138kV	0
Acadia GSU - Colonial Academy 138kV	Wells 500/230kV transformer	0
Acadia GSU - Colonial Academy 138kV	Bonin - Cecelia 138kV	0
North Crowley - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Base Case	0
Acadia GSU - Scanlan 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Acadia GSU - Scanlan 138kV	Wells 500/230kV transformer	4
Acadia GSU - Scanlan 138kV	Richard - Scott1 138kV	7
North Crowley - Richard 138kV	Wells 500/230kV transformer	7
Cecelia - Semere 138kV	Bonin - Labbe 230kV (LAFA)	8
Scott1 - Bonin 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	12
Scott1 - Bonin 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	44
Acadia GSU - Scanlan 138kV	Habetz - Richard 138kV	50
Cecelia - Semere 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	62
North Crowley - Scott1 138kV	Base Case	67
Habetz - Richard 138kV	Wells 500/230kV transformer	82
Habetz - Richard 138kV	Flander - Acadian 230kV (LAFA)	91
Cecelia - Semere 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	96

LEPA

Limiting Element	Contingency Element	ATC
McAdams 500/230kV transformer 1	Lakeover - McAdams 500kV	0
North Crowley - Scott1 138kV	Richard - Scott1 138kV	0
Addis - Big Cajun 1 230kV	Jaguar - Tap Point Esso 230kV	0
North Crowley - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Labbe 230kV (LAFA)	0
North Crowley - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Semere - Scott2 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Semere - Scott2 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Addis - Big Cajun 1 230kV	Coly - McKnight 500kV	0
Colonial Academy - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Addis - Big Cajun 1 230kV	Willow Glen - Webre 500kV	0
Richard - Scott1 138kV	North Crowley - Richard 138kV	0
Richard - Scott1 138kV	Bonin - Labbe 230kV (LAFA)	0
Semere - Scott2 138kV	Bonin - Cecelia 138kV	0
Semere - Scott2 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Colonial Academy - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0

Limiting Element	**Contingency Element**	**ATC**
Richard - Scott1 138kV	North Crowley - Scott1 138kV	0
Willow Glen 500/230kV Transformer	Coly 500/230kV transformer	0
North Crowley - Scott1 138kV	Coughlin - Plaisance 138kV (CLECO)	0
Semere - Scott2 138kV	Richard - Wells 500kV	0
Bonin - Cecelia 138kV	Colonial Academy - Richard 138kV	0
Colonial Academy - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
North Crowley - Richard 138kV	Richard - Scott1 138kV	0
Bonin - Cecelia 138kV	Acadia GSU - Colonial Academy 138kV	0
Habetz - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Richard - Scott1 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Richard 138kV	Bonin - Labbe 230kV (LAFA)	0
Acadia GSU - Colonial Academy 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Scott1 - Bonin 138kV	Bonin - Labbe 230kV (LAFA)	0
Bonin - Cecelia 138kV	Acadia GSU - Scanlan 138kV	0
Acadia GSU - Scanlan 138kV	Bonin - Labbe 230kV (LAFA)	0
Judice - Scott1 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Richard - Scott1 138kV	Wells 500/230kV transformer	0
Acadia GSU - Colonial Academy 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Semere - Scott2 138kV	Terrebonne 230/115kV transformer	0
Willow Glen 500/230kV Transformer	Willow Glen - Willow Glen 2 500/138kV transformer 1	0
Colonial Academy - Richard 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Colonial Academy - Richard 138kV	Bonin - Cecelia 138kV	0
North Crowley - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Habetz - Richard 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Acadia GSU - Scanlan 138kV	Wells (CLECO) - Point Mouton (LAFA) 230kV	0
Colonial Academy - Richard 138kV	Richard - Wells 500kV	0
Acadia GSU - Scanlan 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
North Crowley - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Habetz - Richard 138kV	Point Des Mouton (LAFA) - Labbe (LAFA) 230kV	0
Acadia GSU - Colonial Academy 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Moril - Cecelia 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Acadia GSU - Colonial Academy 138kV	Bonin - Cecelia 138kV	0
Bonin - Cecelia 138kV	Scanlan - Scott2 138kV	0
Bonin - Cecelia 138kV	Semere - Scott2 138kV	0
Port Hudson 230/138 transformer 2	Port Hudson 230/138 transformer 1	0
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Habetz - Richard 138kV	Acadian - Bonin 230kV (LAFA)	0
Judice - Meaux 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	0
Port Hudson 230/138 transformer 1	Port Hudson 230/138 transformer 2	0
Acadia GSU - Colonial Academy 138kV	Richard - Wells 500kV	0
Cecelia - Semere 138kV	Bonin - Labbe 230kV (LAFA)	16
Judice - Scott1 138kV	Acadian - Bonin 230kV (LAFA)	17
Judice - Scott1 138kV	Moril - Cecelia 138kV	17
Willow Glen - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	72

Limiting Element	Contingency Element	ATC
Judice - Scott1 138kV	Greenwood - Terrebonne 115kV	77
Judice - Scott1 138kV	Colonial Academy - Richard 138kV	96
Judice - Scott1 138kV	Acadia GSU - Colonial Academy 138kV	124
Acadia GSU - Scanlan 138kV	Flander - Hopkins 138kV (CLECO/LAFA)	127
Colonial Academy - Richard 138kV	Terrebonne 230/115kV transformer	128
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	149

OKGE

Limiting Element	Contingency Element	ATC
NONE	NONE	150

SMEPA

Limiting Element	Contingency Element	ATC
Baxter Wilson - Ray Braswell 500kV	Franklin - Grand Gulf 500kV	130

SOCO

Limiting Element	Contingency Element	ATC
NONE	NONE	150

SPA

Limiting Element	Contingency Element	ATC
NONE	NONE	150

TVA

Limiting Element	Contingency Element	ATC
NONE	NONE	150

Network Resource Interconnection Service

3. Introduction

A Network Resource Interconnection Services (NRIS) study was requested to serve 150MW of Entergy network load. The expected in service date for this NRIS generator is December 31, 2013. 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 2008.

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

- Non-Firm IPPs within the local region of the study generator were turned off and other non-firm IPPs outside the local area were increased to make up the difference.
- Confirmed firm transmission reservations were modeled for the year 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.

4.2 Contingencies and Monitored Elements

Single contingency analyses on Entergy's transmission facilities (including tie lines) 115kV and above were considered. All transmission facilities on Entergy transmission system above 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
Bull Shoals - Bull Shoals Dam SPA 161kV	McAdams 500/230kV transformer 1

6.3 DFAX Study Case Results

Limiting Element	Contingency Element	ATC(MW)
Bull Shoals - Bull Shoals Dam SPA 161kV	St. Joe - Hilltop 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Everton - St. Joe 161kV	0
Bull Shoals - Bull Shoals Dam SPA 161kV	Harrison East - Everton 161kV	0

6.4 DFAX Study Case with Priors Results

Limiting Element	Contingency Element	ATC(MW)
McAdams 500/230kV transformer 1	Lakeover - McAdams 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
Bogalusa - Adams Creek 230kV ckt 2	Bogalusa - Adams Creek 230kV ckt 1	0
Willow Glen - Willow Glen 2 500/138kV transformer 1	Willow Glen 500/230kV Transformer	119

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*
McAdams 500/230kV transformer 1	Included in 2010 ICT Base Plan
Bull Shoals - Bull Shoals Dam SPA 161kV	TBD

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

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-233 unit.

9. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID-233 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-233 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-233 generation.

10. Analysis Results

The results of the short circuit analysis indicates that the additional generation due to PID-233 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-233 plant with priors and without priors. The priors included 211, 221, 223, 224, and 228.

Stability Study

11. Executive Summary

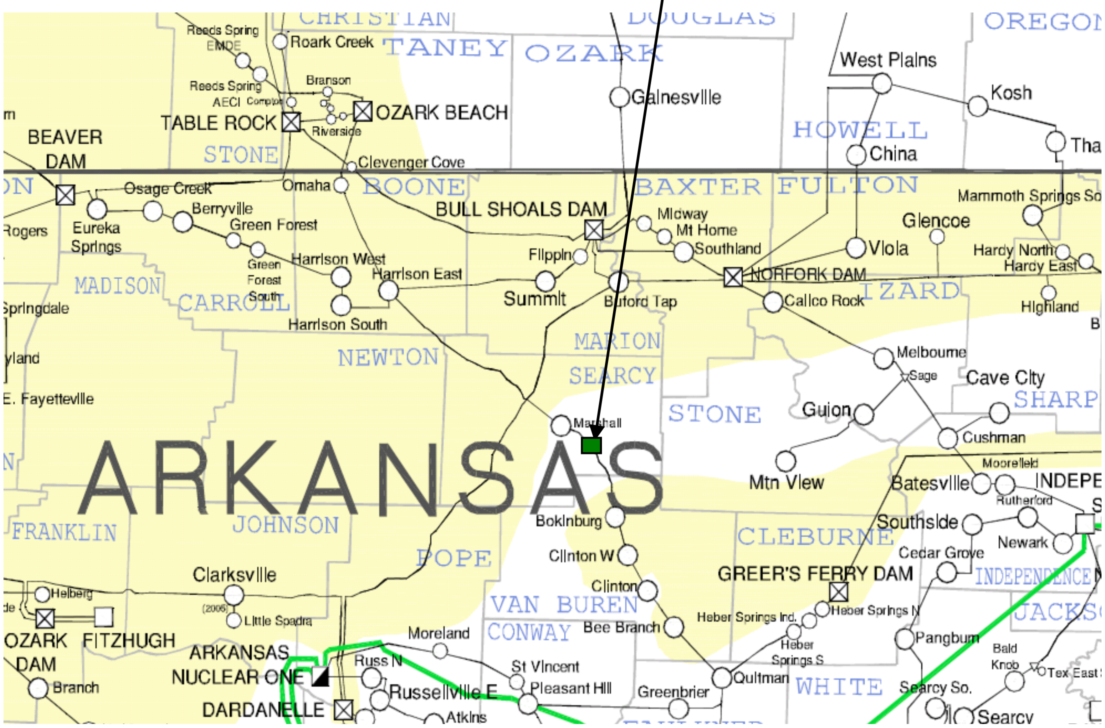
A stability study was performed for PID-233, which is an interconnection request for 149.4 MW of generation connected on the Marshall - Botkinburg 161kV line three miles away from Marshall 161kV substation in the Entergy transmission system. The feasibility (power flow) study was not performed as a part of this study.

The objective of this study was to evaluate the impact of proposed PID-233 (149.4MW) on system stability and the nearby transmission system and generating stations. The study was performed on 2014 Summer Peak case, provided by SPP/Entergy. Figure 11-1 shows the location of the proposed 149.4MW generation interconnecting point.

The system was stable following all simulated three-phase normally cleared and stuck-breaker faults. The proposed wind project will require 20MVAR shunt compensation (e.g. shunt capacitor) to maintain a unity p.f. at the POI.

Based on the results of stability analysis it, can be concluded that interconnection of the proposed PID-233 (149.4MW) generation Marshall-Botkinburg 161kV line does not adversely impact the stability of the Entergy System in the local area.

Figure 11-1: PID-233 interconnecting substation



12. FERC LVRT Compliance

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

The proposed project (PID-233) complies with the latest FERC order on low voltage ride through for wind farms. With this arrangement, these wind farms would not trip off line by voltage relay actuation for local faults near the POI.

13. Final conclusions

A. The proposed PID-233 wind farm does not degrade the stability of the bulk power system in Entergy region.

B. The proposed PID-233 (149.4MW) wind farm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

14. INTRODUCTION

A stability analysis was performed for the System Impact Study of PID-233, which is an interconnection request for 149.4MW of generation Marshall-Botkinburg 161kV line three (3) miles away from Marshall 161kV substation in the Entergy transmission system. The Feasibility (power flow) Study was not performed as a part of this study.

The objective of the impact study is to evaluate the impact on system stability after connecting the additional 149.4MW generation and its impact on the nearby transmission system and generating stations. The study was performed on 2014 Summer Peak case, provided by Entergy. Figure 11-1 shows the location of the proposed 149.4MW generation interconnecting point.

14.1 PROJECT DESCRIPTION

The proposed PID-233 project will be located in Searcy County, Arkansas. The power will be generated using eighty three (83) Vestas 1.8MW wind-turbine generators.

The following list summarizes the major project parameters:

- Wind field rating: 149.4MW

- Interconnection:

  Voltage: 161kV
  Location: Entergy Marshall– Botkinburg 161kV line. Three miles from Marshall Substation. The wind farm 161kV substation will be connected to POI through 6.56 miles 161kV line.
  Transformer:
    MVA: 99/132/165MVA
    High voltage: 161kV
    Low Voltage: 34.5kV
    Z: 12% on 99 MVA; X/R = 40

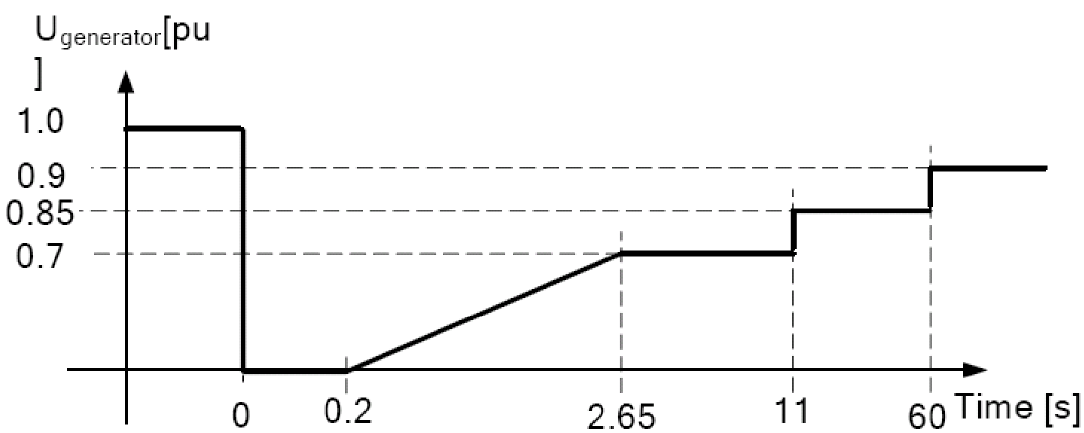
- Wind turbines:

    Number: Eighty Three (83)
    Manufacturer: Vestas

Win turbine Generator: V90 VCUS -1.8MW
Type: Asynchronous generator
Rated power: 1.86MW
Rated Terminal Voltage: 690V
Frequency: 60Hz
Generator Step-up Transformer (GSU):
MVA: 1.9MVA
High voltage: 34.5kV (Delta)
Low voltage: 0.690kV (Wye grounded)
Z: 7.5% on 1.9MVA

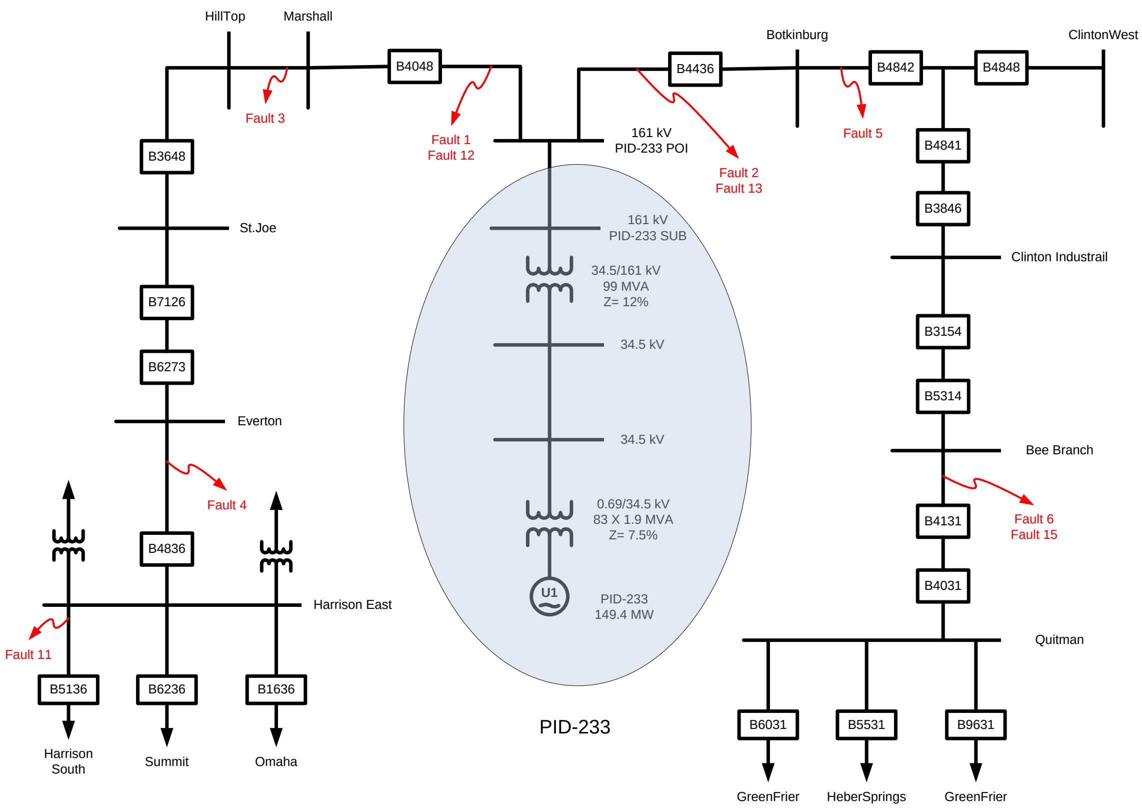
- Reactive power capability: The generator has fixed power factor (nominal unity). 20MVAR of shunt capacitor was added at 34.5kV collector bus to maintain the unity p.f. at the POI
- Low Voltage Ride through Capacity: The manufacturer recommended Low Voltage Ride Through (LVRT) settings[1] were included (see Figure 14-1).

Figure 14-1: Transient Low Voltage Ride Through Characteristics of Vestas 90 VCUS 1.8MW Wind Turbine Generators



[1] 'PSSE Model for Vestas V90-V100 1.8 MW VCUS 60 Hz Version 6.0.2'.

Figure 144-2: Layout of substations surrounding PID-233



15. STABILITY ANALYSIS

15.1 Stability Analysis Methodology

Using Planning Standards approved by NERC, the following stability definition was applied in the Transient Stability Analysis:

Power system stability is defined as that condition in which the differences of the angular positions of synchronous machine rotors become constant following an aperiodic system disturbance.

Stability analysis was performed using Siemens-PTI's PSS/E™ dynamics program V30.3.2. Three-phase and three-phase stuck breaker faults were simulated for the specified durations and the synchronous machine rotor angles were monitored to make sure they maintained synchronism following the fault removal.

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

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

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

15.2 FERC LVRT Criteria

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

- A wind generating plant must remain in-service during three-phase faults with normal clearing (maximum 9 cycles) and single-line-to-ground faults with delayed clearing, and have subsequent post-fault recovery to pre-fault voltage unless the clearing of the fault effectively disconnects the generator from the system.

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

The maximum clearing time the wind generating plant shall be required to withstand a three-phase fault shall be nine (9) cycles after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the wind generating plant may disconnect from the transmission system. A wind generating plant shall remain interconnected during such a fault on transmission system for a voltage level as low as zero volts, as measured at the high voltage side of the GSU.

15.3 Study Model Development

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

15.3.1 Power Flow Case

A Power flow case "EN14S08_Final_U3Ar2_Scenario4+PID233_unconv.sav" representing the 2014 Summer Peak conditions was provided by SPP/ Entergy.

Three prior-queued projects, PID-223 (125MW), PID-224 (100MW), and PID-228 (114.8MW) were added to the base case. The derived power flow case was saved as 'PRE-PID-233.sav'. This was considered as the Pre-PID-233 case.

The proposed PID-233 project will be connected on the Marshall – Botkinburg 161kV line three miles away from Marshall 161kV substation with one 161/34.5kV transformer. The proposed project was added to the pre-project "PRE-PID-233.sav" case and the generation was dispatched against the White Bluff Unit 1. Table 15.3-1 summarizes the dispatch. Thus a post-project power flow case with PID-233 was established and named as 'POST-PID-233.sav'.

Table 15.3-1: PID-233 project details

System condition	MW	Point of Interconnection	Sink
2014 Summer Peak	149.4	Line tap 3 miles from Marshall 161 kV substation on Marshall-Botkinburg 161 kV line (#338233)	White Bluff Unit 1 (#337652)

15.3.2 PID-233 Wind farm modeling

The proposed PID-233 wind farm was modeled as single equivalent generator representing eighty-three (83) wind turbine generators. The single equivalent generator was connected to the 34.5kV collector bus via an equivalent generator step-up transformer (0.690/34.5kV). The single equivalent collector system impedance was modeled based on the information provided by wind farm developer. The 34.5kV collector system is connected to the 161kV via a step-up transformer (34.5/161kV). The wind farm 161kV substation is connected to POI through a 6.56 miles 161kV line. Figure shows the one-line diagram for the PID-233 project.

15.3.3 Stability Database

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

To create a dynamic database (a snapshot file) for Pre-PID-233 power flow case, stability data for PID-223, PID-224 and PID-228 was appended to the base case stability database. Thus a *.dyr file for the pre project case 'PRE-PID-233.dyr' is developed.

SPP provided a dynamic model for V90 1.8MW VCUS wind turbine generators ('V90VCUS_6_0_2_PSSE_package'). The stability data for PID-233 was appended to the pre-project stability database to create dynamic database for Post-PID-233 power flow case.

The data provided at the Interconnection Request for PID-233 is included in Appendix A. The PSS/E power flow and stability data for PID-233, used for this study, are included in Appendix B.

Figure 15.3-1: 2014 Summer Peak Flows and Voltages <u>without</u> PID-233

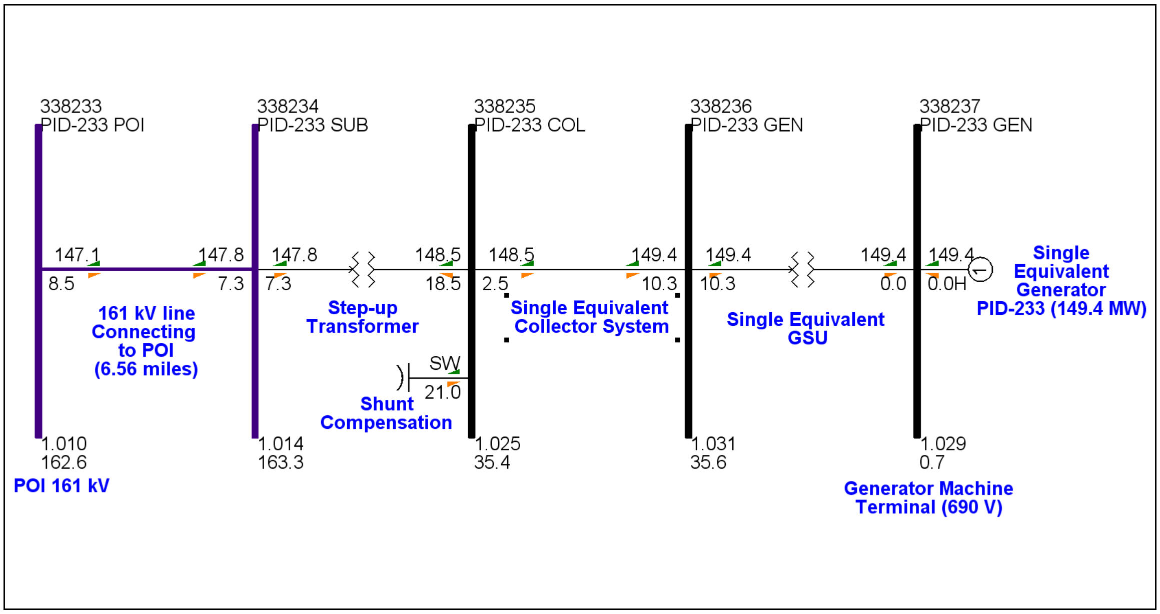


Figure 15.3-2 and figure 15.3-3 show the PSS/E one-line diagrams for the local area WITHOUT and WITH the PID-233 project, respectively, for 2014 Summer Peak system conditions.

Figure 15.3-2: 2014 Summer Peak Flows and Voltages without PID-233

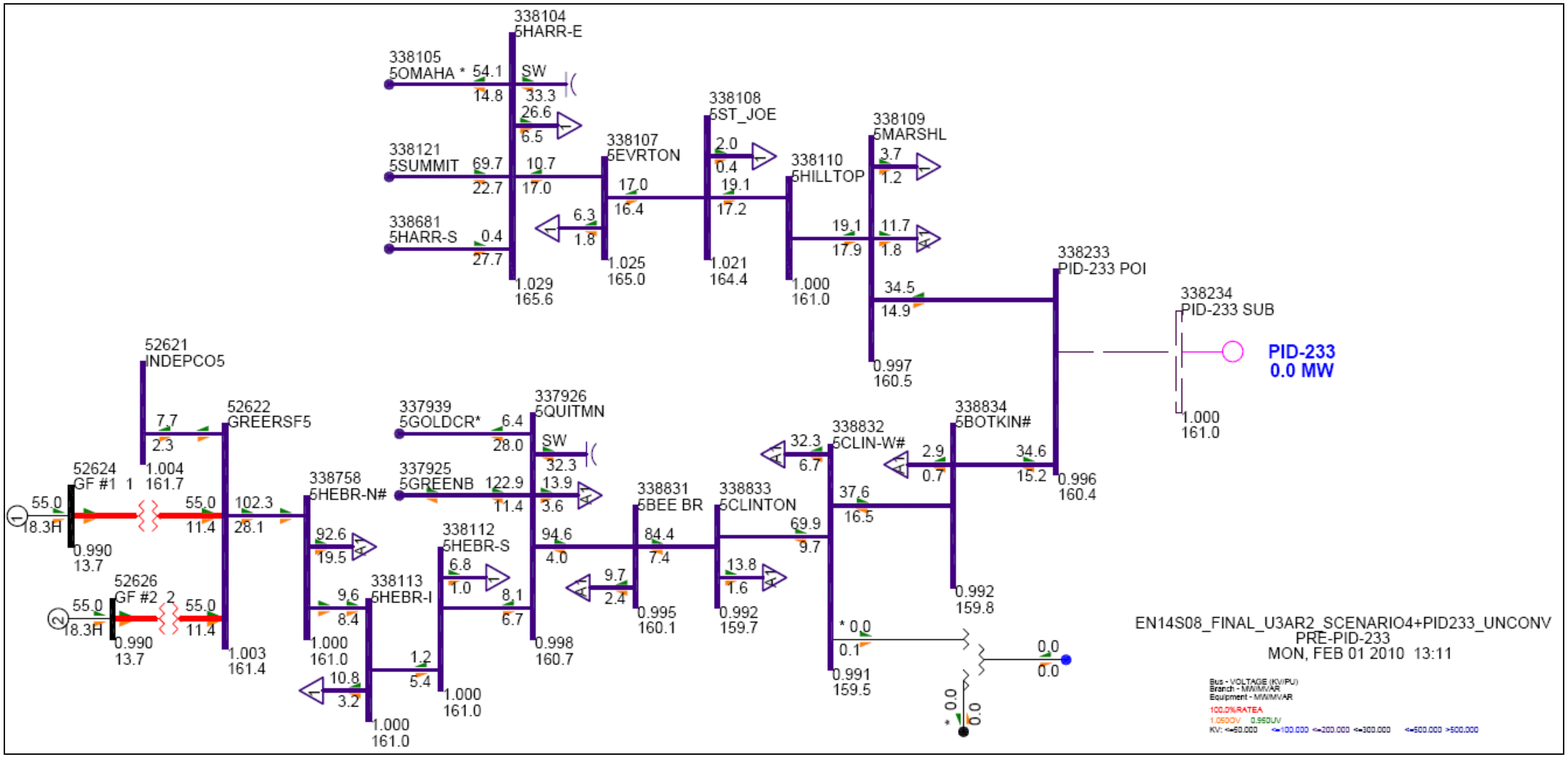
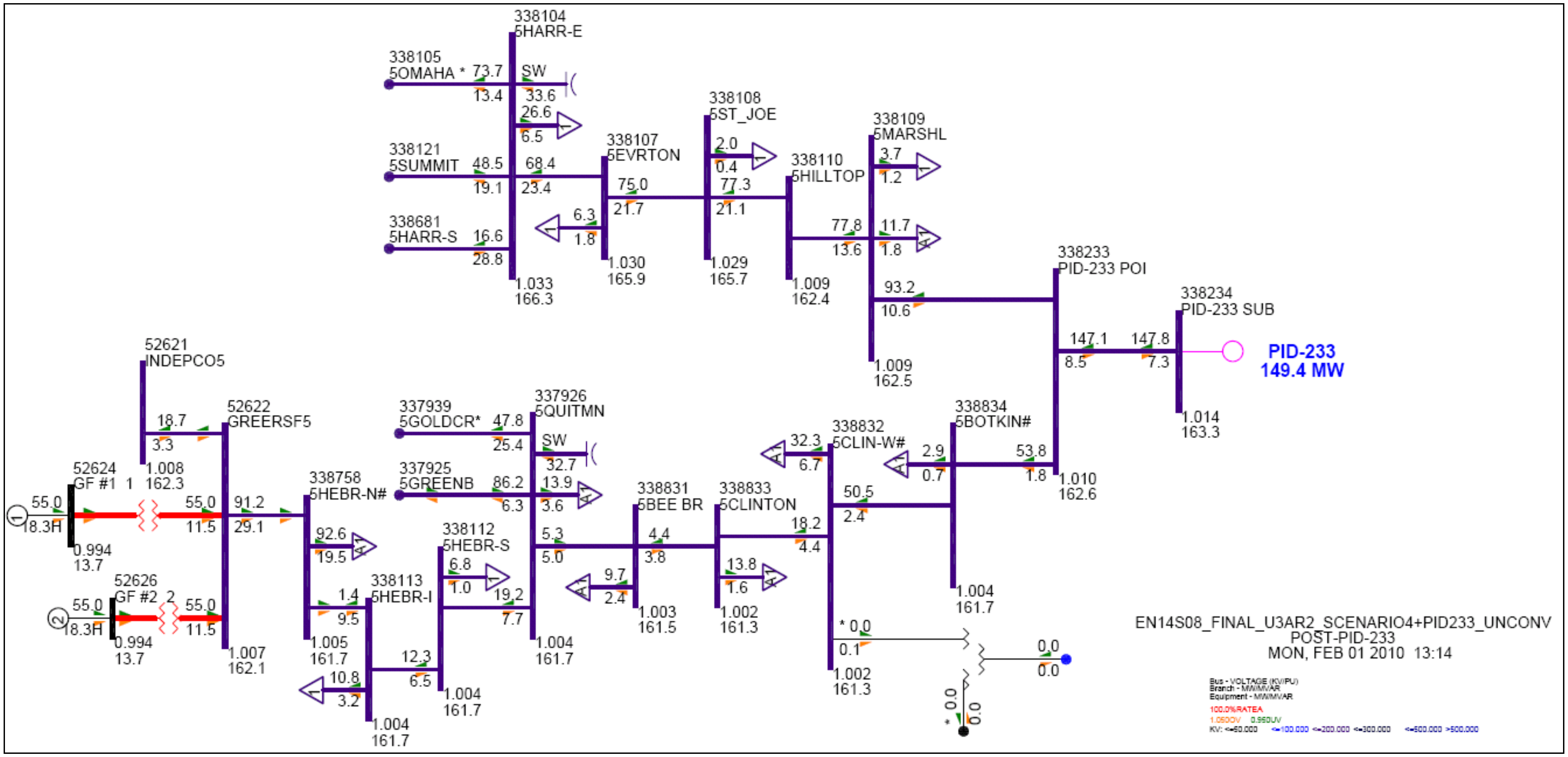


Figure 15.3-3: 2014 Summer Peak Flows and Voltages with PID-233



15.4 Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID-233 generator and its impact on the Entergy system. Stability analysis was performed using the following procedure. First, three-phase faults with normal clearing were simulated. Next, the stuck breaker three-phase fault conditions were simulated. If a stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. This procedure is being followed since if the units are stable for a more severe fault (such as three phase fault with breaker failure) then the need to study stability for a less severe fault (such as SLG fault with breaker failure) does not arise. The fault clearing times used for the simulations are given inTable 15.4-1.

Table 15.4-1: Fault Clearing Times

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

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

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

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

3) The fault is then cleared by back-up clearing. If the system was found to be unstable, then the fault was repeated without the proposed PID-233 plant.

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

Table 15.4-2 lists all the fault cases that were simulated in this study.

FLT_1_3PH to FLT_11_3PH represent the normally cleared three-phase faults. FLT_12_3PH and FLT_15_3PH Faults represent the three-phase stuck breaker faults.

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

Table 15.4-2: Faults Simulated for PID-233 Stability Analysis

Fault Name	Fault description
FLT_1_3PH	6 cycles 3 Phase Fault POI - Marshall 161 kV line; Cleared by tripping POI - Marshall 161 kV
FLT_2_3PH	6 cycles 3 Phase Fault POI - Botkinburg 161 kV line; Cleared by tripping POI - Botkinburg 161 kV
FLT_3_3PH	6 cycles 3 Phase Fault Marshall - Hill Top 161 kV; Cleared by tripping Marshall - Hill Top 161kV
FLT_4_3PH	6 cycles 3 Phase Fault Everton Road - Harrison East 161 kV; Cleared by tripping Everton Road - Harrison East 161 kV
FLT_5_3PH	6 cycles 3 Phase Fault Botkinburg - Clinton West 161 kV; Cleared by tripping Botkinburg - Clinton West 16 kV

Fault Name	Fault description
FLT_6_3PH	6 cycles 3 Phase Fault Bee Branch - Quitman 161 kV; Cleared by tripping BEE Branch - Quitman 161 kV
FLT_7_3PH	6 cycles 3 Phase Fault Quitman - Greenbrier 161 kV; Cleared by tripping Quitman - Greenbrier 161 kV
FLT_8_3PH	6 cycles 3 Phase Fault Quitman - Heber Springs South 161 kV; Cleared Quitman - Heber Springs South 161 kV
FLT_9_3PH	6 cycles 3 Phase Fault Quitman - Gold Creek 161 kV; Cleared by tripping Quitman - Gold Creek 161 kV
FLT_10_3PH	6 cycles 3 Phase Fault Greer - HEBER N# 161 kV; Cleared by tripping Greer - HEBER N# 161 kV
FLT_11_3PH	6 cycles 3 Phase Fault Harrison E - Harrison S 161 kV; Cleared by tripping Harrison E - Harrison S 161 kV
FLT_12_3PH	6+9 cycles 3 Phase stuck breaker Fault POI - Marshall 161 kV; Cleared by tripping POI - Marshall 161 kV
FLT_13_3PH	6+9 cycles 3 Phase stuck breaker Fault POI - Botkinburg 161 kV; Cleared by tripping POI - Botkinburg 161 kV
FLT_14_3PH	6+9 cycles 3 Phase stuck breaker Fault Harrison East - Everton RD 161 kV; Cleared by tripping Harrison East - Everton RD 161 kV (6 cy); Trip Harrison E 161 kV substation (9 cy)
FLT_15_3PH	6+9 cycles 3 Phase stuck breaker Fault Bee Branch - Quitman 161 kV; Cleared by tripping Bee Branch - Quitman 161 kV (6 cy); Trip Quitman 161 kV substation (9 cy)

Table 15.4-3 Results for PID-233 Stability Analysis

Fault ID	PRE-PID233	POST-PID233
FLT_1_3PH	---	Stable
FLT_2_3PH	---	Stable
FLT_3_3PH	---	Stable
FLT_4_3PH	---	Stable
FLT_5_3PH	---	Stable
FLT_6_3PH	---	Stable
FLT_7_3PH	---	Stable
FLT_8_3PH	---	Stable
FLT_9_3PH	---	Stable
FLT_10_3PH	---	Stable
FLT_11_3PH	Stable*	Stable*
FLT_12_3PH	---	Stable
FLT_13_3PH	---	Stable
FLT_14_3PH	Stable*	Stable*
FLT_15_3PH	Stable**	Stable**

* PID223 machines tripped
** Green Forest units tripped

The system was found to be STABLE following all the normally cleared three-phase faults and all stuck breaker three-phase faults. Figure 15.4-1 and Figure 15.4-2 show plot for PID-233 following FLT_1_3PH and FLT_11_3PH respectively.

Following the 6+9 cycle three-phase stuck breaker faults FLT_11_3PH and FLT_14_3PH, the prior queued project PID223 tripped. Following FLT_15_3PH, the units at Green Forest tripped. The trippings were observed in both, WITH and WITHOUT PID-233 project. Hence, the trippings are not attributable to the proposed PID-233 project.

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

- Three-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

- Three-phase faults with normal clearing resulting in the loss of two or more components (generator, transmission circuit or transformer), and SLG fault with delayed clearing resulting in the loss of one or more components:
  Not to exceed 20% for more than 40 cycles at any bus
  Not to exceed 30% at any bus

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

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

As there is no specific voltage dip criteria for three-phase stuck breaker faults, the results of these faults were compared with the most stringent voltage dip criteria of - not to exceed 20 % for more than 20 cycles. After comparison against the voltage-criteria, no faults were found to be in violation WITH PID-233 case.

Figure 15.4-1: Fault_1_3PH with PID-233

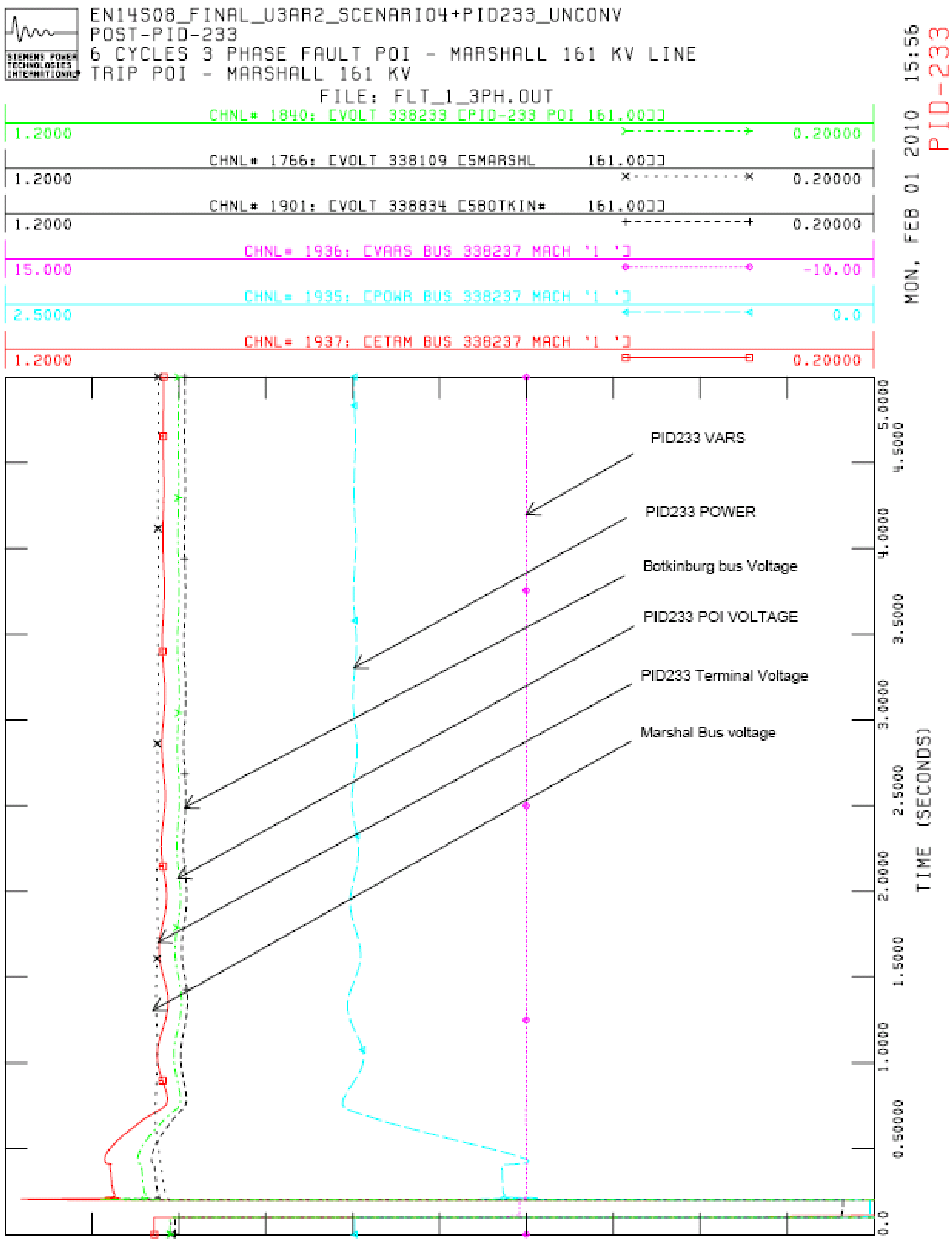
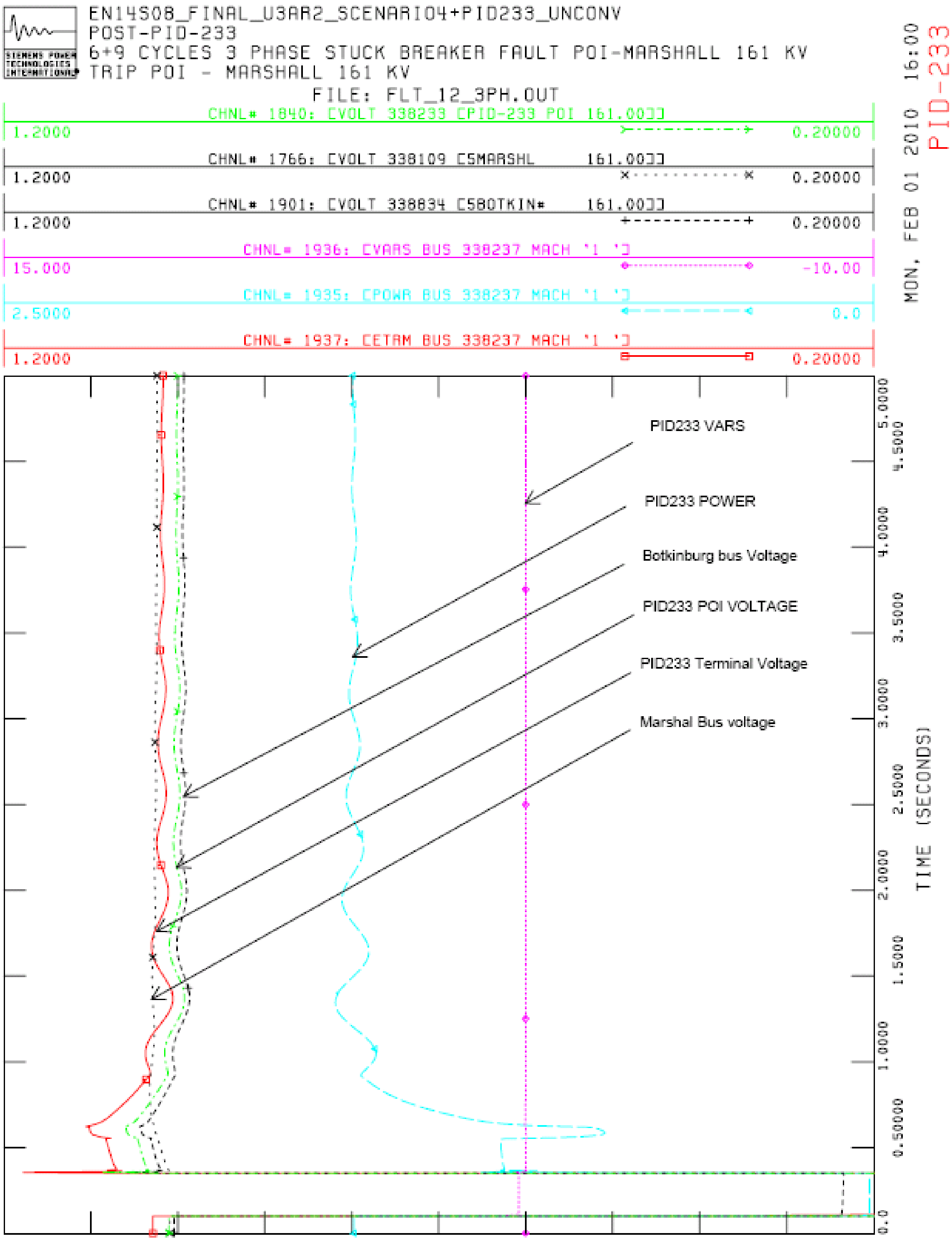


Figure 15.4-2: Fault_11_3PH with PID-233



15.5 Low Voltage Ride Through (LVRT)

As discussed in section 14.1, the proposed project was modeled with low voltage ride through capability. The PID-233 Project Point-of-Interconnection (POI) is on Marshall - Botkinburg 161kV line. As discussed in section 15.1, the post-transition period LVRT capability of the Project was verified by simulating two (2) separate three-phase faults at POI 161kV clearing one line at a time.

- LVRT_PID233_1: 9 cycle, 3 Phase fault at POI 161kV and cleared by tripping POI – Marshall 161kV line
- LVRT_ PID233_2: 9 cycle, 3 Phase fault at POI 161kV and cleared by tripping POI – Botkinburg 161kV line

As shown in Figure 15.5-1 and Figure 15.5-2, the wind turbine generator remains on-line for both fault cases. Therefore, the LVRT requirement is met.

Figure 15.5-1: LVRT capability of PID-233 for (LVRT_PID-233_1)

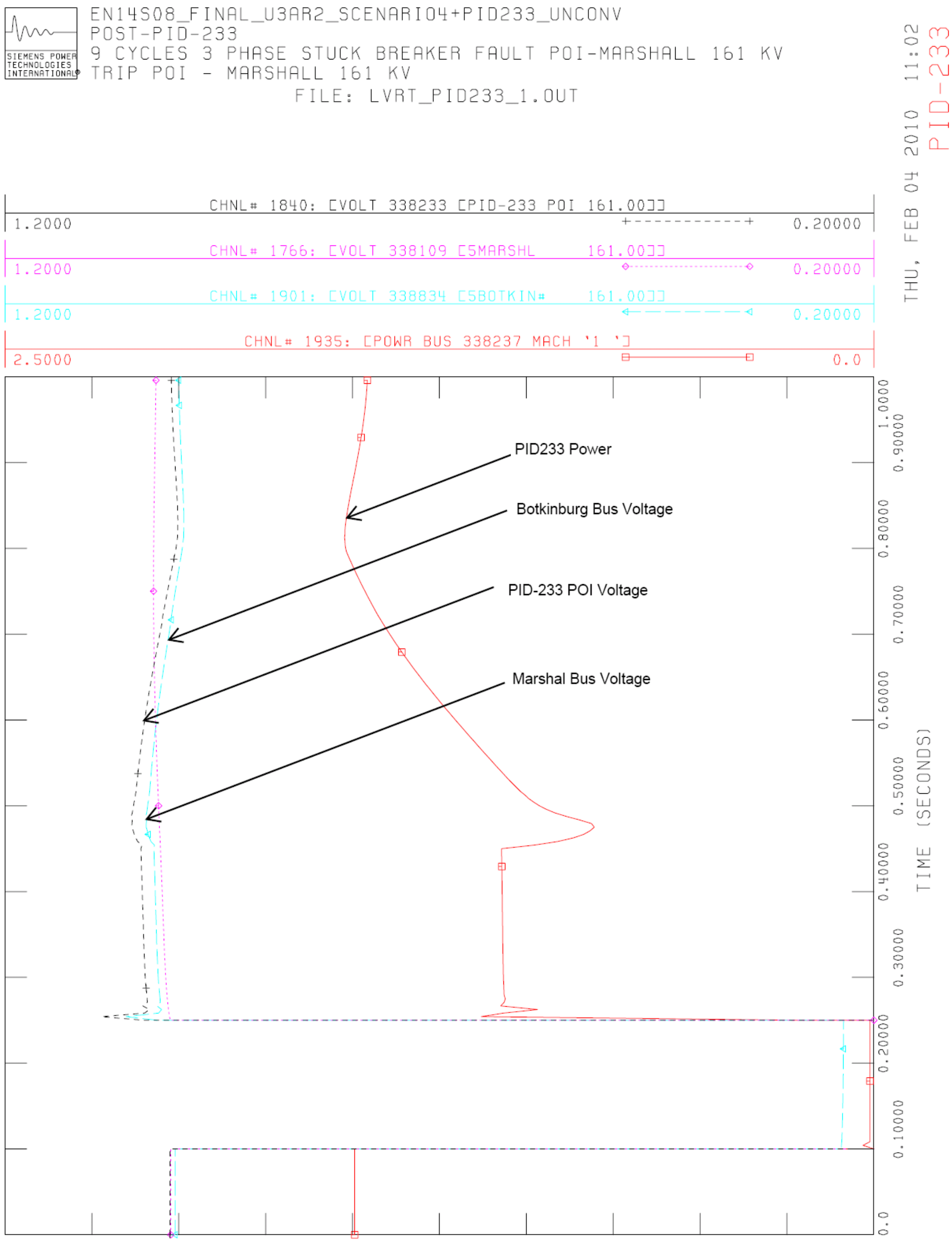
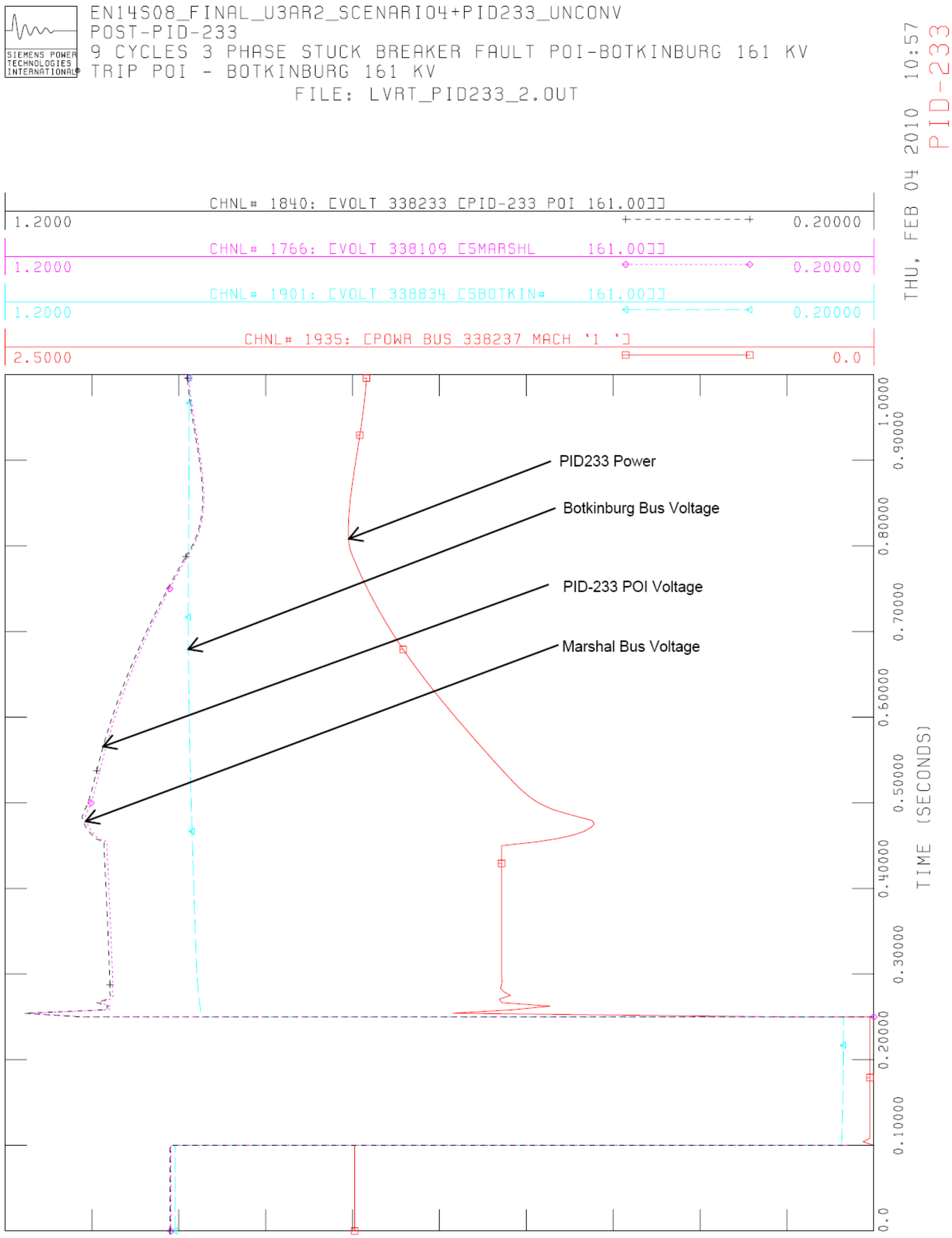


Figure 15.5-2: LVRT capability of PID-233 for (LVRT_PID-233_2)



16. CONCLUSIONS

The objective of this study was to evaluate the impact of proposed PID-233 (149.4MW) on system stability and the nearby transmission system and generating stations. The study was performed on 2014 Summer Peak case, provided by SPP/Entergy.

The system was stable following all simulated three-phase normally cleared and stuck-breaker faults. The proposed wind project will require 20MVAR shunt compensation (e.g. shunt capacitor) to maintain a unity p.f. at the POI.

No voltage criteria violation was observed following simulated faults.

Based on the results of stability analysis it can be concluded that interconnection of the proposed PID-233 (149.4MW) generation connected on the Marshall-Botkinburg 161kV line does not adversely impact the stability of the Entergy System in the local area.

17. FERC LVRT compliance

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

The proposed project (PID-233) complies with the latest FERC order on low voltage ride through for wind farms. With this arrangement, these wind farms would not trip off line by voltage relay actuation for local faults near the POI.

18. Final conclusions

A. The proposed PID-233 wind farm does not degrade the stability of the bulk power system in Entergy Region

B. The proposed PID-233 (149.4MW) wind farm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

APPENDIX A: DATA PROVIDED BY CUSTOMER

Attachment A to Appendix 1
Interconnection Request

LARGE GENERATING FACILITY DATA

UNIT RATINGS

kVA __2086____________ °F ___104________ Voltage ___690_______
Power Factor __1.0 (unity)_____
Speed (RPM) __1056_______ Connection (e.g. Wye) _Delta________
Short Circuit Ratio __5.75______ Frequency, Hertz ___60_________
Stator Amperes at Rated kVA __1519 A________ Field Volts ____N/A______
Max Turbine MW __1.816_______°F __104____

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = ________2.91 sec_______ kW sec/kVA
Moment-of-Inertia, WR^2 = ______12742_________ lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)

		DIRECT AXIS		QUADRATURE AXIS
Synchronous – saturated	X_{dv}	N/A	X_{qv}	N/A
Synchronous – unsaturated	X_{di}	2.3194	X_{qi}	2.3194
Transient – saturated	X'_{dv}	N/A	X'_{qv}	N/A
Transient – unsaturated	X'_{di}	0.1293	X'_{qi}	0.1293
Subtransient – saturated	X''_{dv}	N/A	X''_{qv}	N/A
Subtransient – unsaturated	X''_{di}	0.0905	X''_{qi}	0.0905
Negative Sequence – saturated	$X2_v$	N/A		
Negative Sequence – unsaturated	$X2_i$	0.1293		
Zero Sequence – saturated	$X0_v$	N/A		
Zero Sequence – unsaturated	$X0_i$	0.2802		
Leakage Reactance	Xl_m	0.0537		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	1.309	T'_{qo}	1.309
Three-Phase Short Circuit Transient	T'_{d3}	0.073	T'_{q}	0.073
Line to Line Short Circuit Transient	T'_{d2}	N/A		
Line to Neutral Short Circuit Transient	T'_{d1}	N/A		
Short Circuit Subtransient	T''_{d}	0.01548	T''_{q}	0.01548
Open Circuit Subtransient	T''_{do}	0.02122	T''_{qo}	0.02122

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	N/A
Line to Line Short Circuit	T_{a2}	N/A
Line to Neutral Short Circuit	T_{a1}	N/A

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

MW CAPABILITY AND PLANT CONFIGURATION LARGE GENERATING FACILITY DATA

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

N/A for Wind Generators

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

N/A for Wind Generators

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
_________________________/_____1900 FA______kVA

Voltage Ratio(Generator Side/System side/Tertiary)
_____0.690__________/______34.5__________/______________kV

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

Fixed Taps Available - Yes, +/- 5% in 2.5% steps___________

Present Tap Setting ____0.0% (Center Tap)_________

IMPEDANCE

Positive Z_1 (on self-cooled kVA rating)_____7.8__________ % __10.4__ X/R

Zero Z_0 (on self-cooled kVA rating)_____7.2__________ % ___9.9__ X/R

EXCITATION SYSTEM DATA

N/A for Wind Generators

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

GOVERNOR SYSTEM DATA

N/A for Wind Generators

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:
____83_________

Elevation: ____1850' ASL_________ _____ Single Phase __X___ Three Phase

Inverter manufacturer, model name, number, and version:
______N/A____

List of adjustable setpoints for the protective equipment or software:
______See below____

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

INDUCTION GENERATORS

(*) Field Volts: _____480____________
(*) Field Amperes: _____576_________
(*) Motoring Power (kW): ___0_____
(*) Neutral Grounding Resistor (If Applicable): ____N/A________
(*) I_2^2t or K (Heating Time Constant): ____N/A________
(*) Rotor Resistance: ___0.0014 ohms_________
(*) Stator Resistance: ___0.0018 ohms_________
(*) Stator Reactance: ___0.016 ohms__________
(*) Rotor Reactance: ___0.0233 ohms__________
(*) Magnetizing Reactance: ___0.675 ohms________
(*) Short Circuit Reactance: ___0.016 ohms________
(*) Exciting Current: _____576 amps___________
(*) Temperature Rise: ___Class H_____________
(*) Frame Size: ____IEC 560___________
(*) Design Letter: ___N/A__________
(*) Reactive Power Required In Vars (No Load): __687000______
(*) Reactive Power Required In Vars (Full Load): _1020000_______
(*) Total Rotating Inertia, H: _0.5487___Per Unit on KVA Base

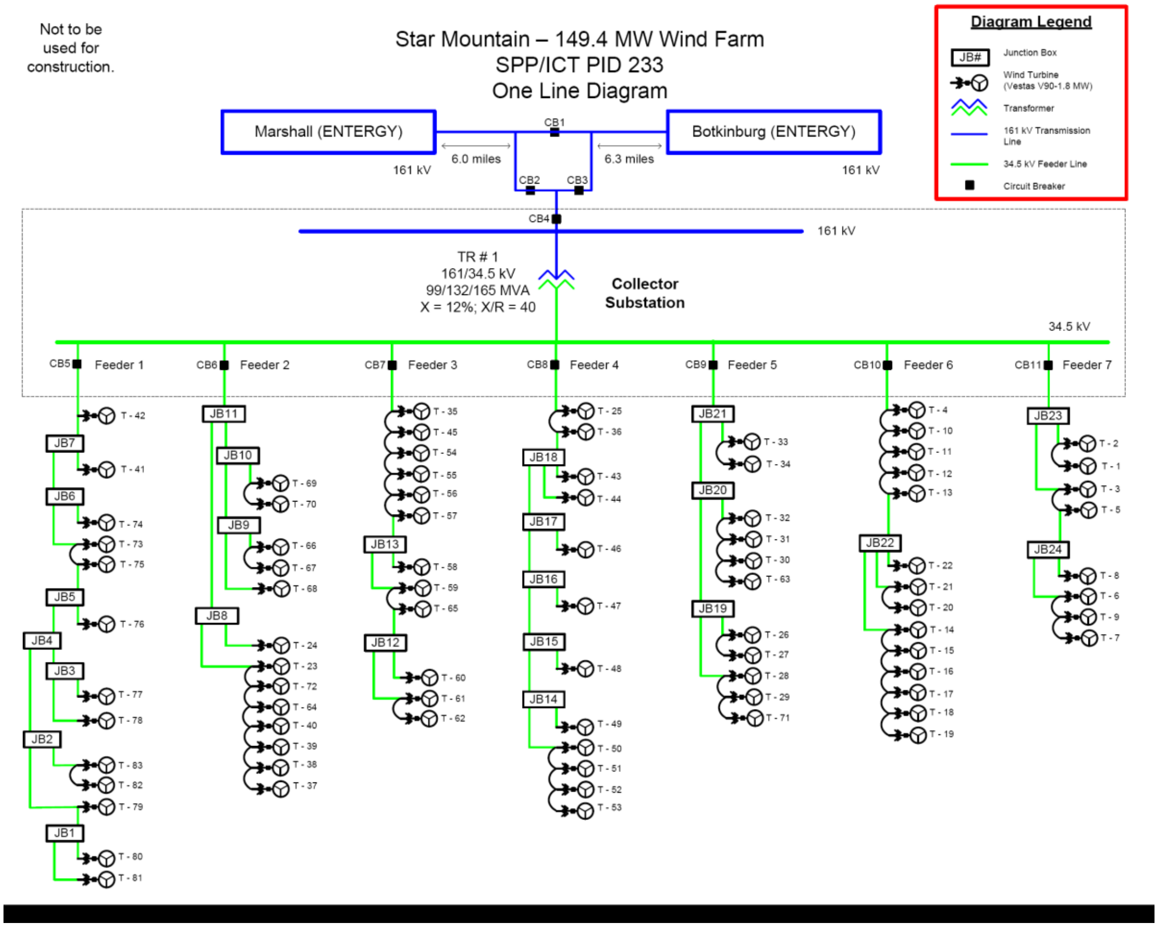
Note: Please consult Transmission Provider prior to submitting the Interconnection Request to determine if the information designated by (*) is required

The Generator and the converter will be disconnected if:

	U_P	U_N
Voltage above 110 % of nominal for 60 sec.	440 V	759 V
Voltage above 113.5 % of nominal for 0.2 sec.	454 V	783 V
Voltage above 120 % of nominal for 0.08 sec.	480 V	828 V
Voltage below 90 % of nominal for 60 sec.	360 V	621 V
Voltage below 85 % of nominal for 0.4 sec.	340 V	586 V
Voltage below 75 % of nominal for 0.08 sec.	300 V	517 V
Frequency is above [Hz] for 0.2 sec.	62 Hz	
Frequency is below [Hz] for 0.2 sec.	57 Hz	

Table 9-5: Generator and converter disconnecting values

* Over the lifetime of the turbine, grid dropouts are to be limited to no more than once a month on average as calculated over one year.



Not to be used for construction.
Star Mountain – 149.4 MW Wind Farm
SPP/ICT PID 233
One Line Diagram
Diagram Legend
Junction Box
Wind Turbine (Vestas V90-1.8 MW)
Transformer
161 kV Transmission Line
34.5 kV Feeder Line
Circuit Breaker
Marshall (ENTERGY)
Botkinburg (ENTERGY)
CB1
CB2
CB3
CB4
6.0 miles
6.3 miles
161 kV
TR # 1
161/34.5 kV
99/132/165 MVA
X = 12%; X/R = 40
Collector Substation
34.5 kV
CB5 Feeder 1
CB6 Feeder 2
CB7 Feeder 3
CB8 Feeder 4
CB9 Feeder 5
CB10 Feeder 6
CB11 Feeder 7

APPENDIX B: POWER FLOW AND STABILITY DATA

Following data is presented in PSS/E VER 30.3.2 format

Power flow Data

PID-233

```
338233, 'PID-233 POI', 161.00, 1,  ,  , 351,163, , -42 ,
338234, 'PID-233 SUB', 161.00, 4,  ,  , 351,163, , -42,
338235, 'PID-233 COL',  34.50, 4,  ,  , 351,163, , -42,
338236, 'PID-233 GEN',  34.50, 4,  ,  , 351,163, , -42,
338237, 'PID-233 GEN',  0.690, 4,  ,  , 351,163, , -42,
0          /* BUS DATA
0          /* LOAD DATA
338237, 1, 149.4, 0.00 , 0.00, 0.00,  ,  , 149.4, 0.00, 1.00, , , , 0,100,149.4, 0.00
0          /* GEN DATA
338233, 338234,'1 ',   0.006725,   0.0034911,   0.0101591,  251.00,  251.00,   251.00,  0.00000,  0.00000,  0.00000,
0.00000, 0,   11.00,   1,1.0000
338235, 338236,'1 ',   0.004377,   0.0098463,        0.0934000,  251.00,  251.00,   251.00,  0.00000,  0.00000,  0.00000,
0.00000, 0,        ,   1,1.0000
0          /* BRANCH DATA
338234,338235,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'           ',0,   1,1.0000
   0.00000,   0.08000,    99.00
1.00000,   0.000,   0.000,   165.00,   165.00,   165.00, 0,      0, 1.07500, 0.92500, 1.10000, 0.90000,   7, 0, 0.00000,
0.00000
1.00000,   0.000
338237,338236,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'GSU        ',0,   1,1.0000
   0.00000,   0.07580,   166.00
1.00000,   0.000,   0.000,   166.00,   166.00,   166.00, 0,      0, 1.05000, 0.95000, 1.10000, 0.90000,   5, 0, 0.00000,
0.00000
1.00000,   0.000
0          /* TRANSFORMER DATA
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
338235, 0,1.01000,1.00000,     0,  100.0,'           ',   20.00, 4,  5.00
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA
Q
```

Dynamics Data
PID-233

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E MON, FEB 01 2010 14:53
EN14S08_FINAL_U3AR2_SCENARIO4+PID233_UNCONV
PRE-PID-233

CONEC MODELS

REPORT FOR ALL MODELS BUS 338237 [PID-233 GEN 0.6900] MODELS

** VWVARS ** at bus 338237 machine 1

Uses ICONs 5423-5424 VARs 9411-9428

** VWLVRT ** at bus 338237 machine 1

Uses CONs 131089-131109 ICONs 5425-5427 VARs 9429-9438

** VWPWRC ** at bus 338237 machine 1

Uses CONs 131110-131130 ICONs 5428-5430 STATEs 51373-51374 VARs 9439-9443

** VWMECH ** at bus 338237 machine 1

Uses CONs 131131-131137 ICONs 5431-5432 STATEs 51375-51377

** VWMEAS ** at bus 338237 machine 1

Uses CONs 131138-131140 ICONs 5433-5434 STATEs 51378-51380

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E MON, FEB 01 2010 14:53
EN14S08_FINAL_U3AR2_SCENARIO4+PID233_UNCONV
PRE-PID-233

CONET MODELS

REPORT FOR ALL MODELS BUS 338237 [PID-233 GEN 0.6900] MODELS

** VWVPRT ** Uses CONs 131141-131160 ICONs 5435-5441 VARs 9444-9454

Vestas voltage relay monitoring bus 338237

** VWFPRT ** Uses CONs 131161-131164 ICONs 5442-5444 VAR 9455

Vestas frequency relay monitoring bus 338237

APPENDIX C: PLOTS FOR STABILITY SIMULATIONS

Plots will be posted in a separate posting titled *System Impact Study Report Stability Plots*.

The plots can be viewed at the following link:

http://www.oatioasis.com/EES/EESDocs/interconnection_studies_ICT.htm

APPENDIX D: Approved Projects and Transactions in Study Mode

Year	Approved Future Projects
2009 – 2013	EAI 2009S Conway West – Donaghey
	EAI 2009S Danville – Magazine
	EAI 2009S Gillett Capacitor Bank Approved
	EAI 2009W Donaghey - Conway South
	EAI 2010S SMEPA Approved
	EAI 2011W Aquilla Facility Study
	EAI 2012S Warren East Cap
	EGSL 2009S Install 37.7MVAR Cap Bank at Acadia 138kV Sub
	ELL 2009S Amite_South_Area_Improvements_Phase_III
	ELL 2011S Sarepta+Additions
	ELL 2012S Ouachita-To Run First-upg-1478781-3SterlAutos+2BWAutos+splitbus
	ELL 2012S Ouachita-To Run Second Sterlington to NorthBastropVERSION1-Updated
	ELL 2013S Coly-Hammond_230kV
	ELL 2013S Loblolly-Hammond_230kV
	EMI 2008S Liberty-Gloster_Uprate_Line_To_190MVA_newnum
	EMI 2009S Indianola-Greenwood Upgrade Jumpers-Bus
	EMI 2010S Magee_XFMRs_2000A_switches
	ENOI 2009S Paterson Restore Breakers
	ETI 2009F Porter_Tamina_138kV_Replace_Breaker
	ETI 2009S Beaumont_69kV_Improvement_Plan
	ETI 2009S Close_College_Station_138kV_NO_Switch
	ETI 2009S Retap_Newton_Bulk_CT
	ETI 2009W Upgrade_Fawil_Auto
	ETI 2010S WRRIP_Ph_3_Interim_Lewis_Creek_Jacinto_Conversion
	ETI 2011S WRRIP_Ph_3_Interim_Add_Alden_SVC
	ETI 2011S WRRIP_Ph_3_Interim_Upgrade_South_Beaumont_Fontenots_Corner_138kV
	Solution Set-TVA Affected System

Year	Proposed Projects for prior generator interconnection requests
2012	New Lewis Creek – Conroe 230kV transmission line

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

PID	Substation	MW	In Service Date
PID 211	Lewis Creek	570	6/1/2011
PID 221	Wolfcreek	875	In Service
PID 223	PID-223 Tap	125	10/1/2010
PID 224	PID-224 Tap	100	12/1/2009
PID 228	PID-228 Tap	115	4/30/2011

Prior transmission service requests that were included in this study:

OASIS #	PSE	MW	Begin	End
1658087	Entergy Services (SPO)	1	6/1/2012	6/1/2042
1658088	SMEPA	21	6/1/2012	6/1/2042
1665288	Merrill Lynch Commodities	15	1/1/2011	1/1/2017
1668165	Entergy Services (SPO)	600	1/1/2013	1/1/2043
1669330	NRG Power Marketing	206	1/1/2013	1/1/2018
1675861	NRG Power Marketing	100	1/1/2011	1/1/2016
1686850	NRG Power Marketing	75	4/1/2010	4/1/2015

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.