# System Impact Study Report
# PID 223
# 125MW Plant


## Prepared by:
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| Rev | Issue Date | Description of Revision | Revised By | Project Manager |
|---|---|---|---|---|
| 0 | 1/9/09 | Posted | HDE | JDH |
| 1 | 1/15/09 | Minor Revision & Repost | HDE | JDH |
| 2 | 1/23/09 | Cost Revision & Repost | HDE | JDH |

# Executive Summary:

This System Impact Study is the second step of the interconnection process and is based on the PID-223 request for interconnection on Entergy's transmission system 3.3 miles from Green Forest South. This report is organized in two sections, namely, Section – A, Energy Resource Interconnection Service (ERIS) and Section – B, Network Resource Interconnection Service (NRIS – Section B).

The Scope for the ERIS section (Section – A) includes load flow (steady state) analysis, transient stability analysis and short circuit analysis as defined in FERC orders 2003, 2003A and 2003B. The NRIS section (Section – B) contains details of load flow (steady state) analysis only, however, transient stability analysis and short circuit analysis of Section – A are also applicable to Section – B. Additional information on scope for NRIS study can be found in Section – B.

Requestor for PID-223 did request NRIS and ERIS, therefore, under Section - A (ERIS) a load flow analysis was performed. PID 223 will be a new facility. PID 223 intends to install (50) wind turbines on the 161 kV Green Forest South – Harrison West line. The study evaluates connection of 125 MW to the Entergy Transmission System. The load flow study was performed on the latest available 2011 Summer Peak case and 2015 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 October 1, 2010.

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

**Estimated Project Planning Upgrades for PID 223**

| Study | Estimated cost With Priors ($) | Estimated cost Without Priors ($) |
|---|---|---|
| ERIS | 0 | 0 |
| NRIS | TBD | $7,160,000 +TBD |

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

# TABLE OF CONTENTS FOR ERIS

# I. Introduction

This Energy Resource Interconnection Service (ERIS) is based on PID-223 request for interconnection on Entergy's transmission system between Green Forest South and Harrison West 161kV substations located approximately 3.3 miles from Green Forest South 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 PID-223 and assumptions made by Entergy's Transmission Technical System Planning group. All supplied information and assumptions are documented in this report. If the actual equipment installed is different from the supplied information or the assumptions made, the results outlined in this report are subject to change.

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

# II. Short Circuit Analysis / Breaker Rating Analysis

## A. Model Information

The short circuit analysis was performed on the Entergy system short circuit model using ASPEN software. This model includes all generators interconnected to the Entergy system or interconnected to an adjacent system and having an impact on this interconnection request, IPP's with signed IOAs, and approved future transmission projects on the Entergy transmission system including the proposed PID 223 unit.

## B. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID 223 generation is as follows:

1. Three phase and single phase to ground faults were simulated on the Entergy base case short circuit model and the worst case short circuit level was determined at each station. The PID 223 generator as well as the necessary NRIS upgrades shown in Section B, IV were then modeled in the base case to generate a revised short circuit model. The base case short circuit results were then compared with the results from the revised model to identify any breakers that were under-rated as a result of additional short circuit contribution from PID 223 generation. The breakers identified to be upgraded through this comparison are *mandatory* upgrades.

## C. Analysis Results

The results of the short circuit analysis indicates that the additional generation due to PID-223 **does not** cause an increase in short circuit current such that it exceed the fault interrupting capability of the high voltage circuit breakers within the vicinity of the PID-223 plant with priors and without priors.

# II. Load Flow Analysis

## A. Model Information

The load flow analysis was performed based on the projected 2011 and 2015 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 2011 and 2015 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 125MW PID-223 generation and the associated facilities were then modeled in the case to build a revised case for the load flow analysis. Transfers were simulated between thirteen (13) control areas and Entergy using requesting generator as the source and adjacent control area as sink. (Note: Refer to NRIS [Section – B] for details of dispatch within Entergy system)

This study considered the following four scenarios:

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

Prior transmission service requests that were included in this study:

| OASIS # | PSE | MW | Begin | End |
|---|---|---|---|---|
| 1460900 | Louisiana Energy & Power Authority | 116 | 1/1/2009 | 1/1/2030 |
| 1481059 | Constellation Energy Group | 60 | 2/1/2011 | 2/1/2030 |
| 1481111 | City of Conway | 50 | 2/1/2011 | 2/1/2046 |
| 1481119 | Constellation Energy Group | 30 | 2/1/2011 | 2/1/2030 |
| 1481235 | Louisiana Energy & Power Authority | 50 | 2/1/2011 | 2/1/2016 |
| 1481438 | NRG Power Marketing | 20 | 2/1/2011 | 2/1/2021 |
| 1483241 | NRG Power Marketing | 103 | 1/1/2010 | 1/1/2020 |

| OASIS # | PSE | MW | Begin | End |
|---|---|---|---|---|
| 1483243 | NRG Power Marketing | 206 | 1/1/2010 | 1/1/2020 |
| 1483244 | NRG Power Marketing | 309 | 1/1/2010 | 1/1/2020 |
| 1520043 | Municipal Energy Agency of Miss | 20 | 1/1/2011 | 1/1/2026 |
| ASA-2008-001 | TVA | 724 | 1/1/2009 | 1/1/2011 |
| ASA-2008-003 | Empire District Electric Co. | 100 | 11/1/2008 | 11/1/2028 |
| 1551562 | CLECO Power LLC | 11 | 6/1/2009 | 6/1/2018 |
| 1557602 | East Texas Electric Coop | 1 | 1/1/2009 | 1/1/2017 |
| 1558911 | NRG Power Marketing | 100 | 1/1/2009 | 1/1/2014 |
| 1559579 | NRG Power Marketing | 500 | 5/1/2010 | 5/1/2015 |
| 1559580 | NRG Power Marketing | 500 | 5/1/2010 | 5/1/2015 |
| 1559581 | NRG Power Marketing | 150 | 5/1/2010 | 5/1/2015 |
| 1562340 | Entergy Services (EMO) | 1 | 7/1/2008 | 7/1/2009 |
| 1562529 | Constellation Energy Grp | 123 | 1/1/2009 | 1/1/2010 |

Prior generator interconnection requests that were included for this study:

| PID | Substation | MW | In Service Date |
|---|---|---|---|
| 208 | Fancy Point | 1594 | 1/1/2015 |
| 211 | Lewis Creek | 570 | 6/1/2011 |
| 216 | Wilton 230kV | 251 | 1/1/2010 |
| 221 | Wolfcreek | 875 | In Service |
| 222 | Nine Mile | 570 | 10/1/2012 |

The generator step-up transformers, generators, and interconnecting lines were modeled according to the information provided by PID-223. Customer supplied data are shown in **Appendix A-A**. The data used to build the load flow and dynamic models are also shown in **Appendix A-A**. Stability issues in the Western Region of the Entergy System due to Merchant Generators are shown in **Appendix A-G**. All stability study plots are shown in **Appendix A-H**. Policy statement / guidelines for Power System Stabilizer is included as **Appendix A-I**.

## B. Load Flow Analyses

### i) 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.

### ii) 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.

### iii) Power Factor Consideration / Criteria

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

## C. Analysis Results

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

**Table II-C Summary of Results for Windfarm – ERIS Load Flow Study**

| Interface | | 2011 FCITC Available for Scenario 1 | 2015 FCITC Available for Scenario 1 | 2015 FCITC Available for Scenario 2 | 2011 FCITC Available for Scenario 3 | 2015 FCITC Available for Scenario 3 | 2015 FCITC Available for Scenario 4 |
|---|---|---|---|---|---|---|---|
| AECI | Associated Electric Cooperative, Inc. | 125 | 125 | 125 | 125 | 125 | 125 |
| AMRN | Ameren Transmission | 0 | 125 | 125 | 0 | 125 | 125 |
| AEP-W | American Electric Power - West | 0 | 125 | 125 | 0 | 125 | 125 |
| CLEC | CLECO | 0 | 0 | 0 | 0 | 0 | 0 |
| EES | Entergy | 0 | 0 | 0 | 0 | 0 | 0 |
| EMDE | Empire District Electric Co | 125 | 125 | 125 | 125 | 125 | 125 |
| LAF | Lafayette Utilities System | 0 | 0 | 0 | 0 | 0 | 0 |
| LAGN | Louisiana Generating, LLC | 0 | 125 | 125 | 0 | 0 | 0 |
| LEPA | Louisiana Energy & Power Authority | 0 | 0 | 0 | 0 | 0 | 0 |
| OKGE | Oklahoma Gas & Electric Company | 0 | 0 | 0 | 0 | 0 | 0 |
| SMEPA | South Mississippi Electric Power Assoc. | 0 | 0 | 125 | 0 | 0 | 0 |
| SOCO | Southern Company | 0 | 125 | 125 | 0 | 125 | 125 |
| SPA | Southwest Power Administration | 125 | 0 | 0 | 125 | 0 | 0 |
| TVA | Tennessee Valley Authority | 0 | 125 | 125 | 0 | 125 | 125 |

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

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

| 2011 Summer Peak | Interface | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| Acadia - Colonial Academy 138kV | $6,277,500 | | | | | | | X | | | | | | | |
| Acadia GSU - Scanlan 138kV | $1,455,000 | | | | | | | X | | | | | | | |
| Alchem - Monochem1 138kV | $7,601,200 | | | | | | | | | X | | | | | |
| Baxter Wilson - Ray Braswell 500kV | $144,900,000 | | | X | X | X | | X | X | X | | X | X | | X |
| Bonin - Cecelia 138kV | $4,792,500 | | | | | | | | | X | | | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Gibson - Humphrey 115kV | $47,327,390 | | | | X | | | X | | | | | | | |
| Greenwood - Humphrey 115kV | $3,838,000 | | | | X | | | X | | | | | | | |
| Greenwood - Terrebone 115kV | $22,850,381 | | | | X | | | X | | | | | | | |
| Habetz - Richard 138kV | $3,272,500 | | | | | | | X | | X | | | | | |
| Judice - Meaux 138kV | $12,600,000 | | | | | | | | | X | | | | | |
| Judice - Scott1 138kV | $10,000,000 | | | | | | | | | X | | | | | |
| Livonia - Wilbert 138kV | $41,123,000 | | | | | | | X | | | | | | | |
| 'MANSFLD4 138' TO BUS 'IPAPER 4 138' | TBD | | X | | | | | | | | | | | | |
| Moril - Cecelia 138kV | $6,182,500 | | | | | | | | | X | | | | | |
| North Crowley - Richard 138kV | $3,776,625 | | | | | | | X | | | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | X | | | X | | | | | | | |
| Raceland - Coteau 115kV | $3,065,000 | | | | | | | | | X | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | | | | X | | X | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |

| 2015 Summer Peak | Interface | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| A.A.C. - Licar 230kV | $6,500,000 | | | | | | | | | X | | | | | |
| A.A.C. - Polsky Carville 230kV | $6,000,000 | | | | | | | | | X | | | | | |
| Alchem - Monochem1 138kV | $7,601,200 | | | | | | | | | X | | | | | |
| Belle Helene - Licar 230kV | $3,187,500 | | | | | | | | | X | | | | | |
| Belle Helene - Woodstock 230kV | $2,840,000 | | | | | | | | | X | | | | | |
| Champagne - East Opelousas 138kV | $1,397,500 | | | | | | | X | | | | | | | |
| Champagne - Krotz Spring 138kV | $29,239,000 | | | | X | | | X | | | | | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Coly - Vignes 230kV | $13,350,000 | | | | | | | | | X | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Fairview - Gypsy 230kV | $15,775,000 | | | | | | | | | | | X | | | |
| French Settlement - Sorrento 230kV | $3,345,300 | | | | | | | | | | | X | | | |
| Gibson - Humphrey 115kV | $47,327,390 | | | | X | | | X | | | | | | | |
| Gibson - Ramos 138kV | $6,242,290 | | | | X | | | X | | | | | | | |
| Greenwood - Humphrey 115kV | $3,838,000 | | | | X | | | X | | | | | | | |
| Greenwood - Terrebone 115kV | $22,850,381 | | | | X | | | X | | | | | | | |
| Hartburg - Inland Orange 230kV | $2,985,000 | | | | | X | | | | | | | | | |
| Jonesboro - Jonesboro North (AECC) 161kV | $10,575,000 | | | | | | | | | | | | | X | |
| Judice - Scott1 138kV | $10,000,000 | | | | X | | | | | | | | | | |
| Krotz Spring - Line 642 Tap 138kV | $26,778,000 | | | | X | | | X | | | | | | | |
| Livonia - Line 642 Tap 138kV | $27,778,000 | | | | X | | | X | | | | | | | |
| Livonia - Wilbert 138kV | $41,123,000 | | | | X | | | X | | | | | | | |
| Louisiana Station - Thomas 138kV | $2,544,750 | | | | X | | | X | | X | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | | | | X | | | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | | | | X | | | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |
| Vulchlor - Woodstock 230kV | $8,120,000 | | | | | | | | | X | | | | | |

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

| 2015 Summer Peak | | | | | | | | Interface | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| Acadia - Colonial Academy 138kV | $6,277,500 | | | | | | | X | | | | | | | |
| Acadia GSU - Scanlan 138kV | $1,455,000 | | | | | | | X | | | | | | | |
| Addis - Big Cajun 1 230kV | $31,175,000 | | | | | | | | | X | | | | | |
| Alchem - Monochem1 138kV | $7,601,200 | | | | | | | | | X | | | | | |
| Cocodrie 230kV - Coughlin 138kV (CLECO) | TBD | | | | | | | | | X | | | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Fancy Point - Port Hudson 230kV ckt 1 | $20,072,500 | | | | | | | | | X | | | | | |
| Fancy Point - Port Hudson 230kV ckt 2 | $20,352,500 | | | | | | | | | X | | | | | |
| Habetz - Richard 138kV | $3,272,500 | | | | X | | | X | | | | | | | |
| Jonesboro - Jonesboro North (AECC) 161kV | $10,575,000 | | | | | | | | | | | | | X | |
| Judice - Meaux 138kV | $12,600,000 | | | | X | | | | | | | | | | |
| Judice - Scott1 138kV | $10,000,000 | | | | X | | | | | | | | | | |
| Louisiana Station - Thomas 138kV | $2,544,750 | | | | | | | X | | X | | | | | |
| North Crowley - Richard 138kV | $3,776,625 | | | | | | | X | | | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | X | | | X | | | | | | | |
| Port Hudson 230/138 transformer 1 | TBD | | | | | | | | | X | | | | | |
| Port Hudson 230/138 transformer 2 | TBD | | | | | | | | | X | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | X | | | X | | | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | X | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |

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

| 2011 Summer Peak | Interface | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| Acadia - Colonial Academy 138kV | $6,277,500 | | | | | | | X | | | | | | | |
| Acadia GSU - Scanlan 138kV | $1,455,000 | | | | | | | X | | | | | | | |
| Baxter Wilson - Ray Braswell 500kV | $144,900,000 | | | X | X | X | | X | X | X | | X | X | | X |
| Bonin - Cecelia 138kV | $4,792,500 | | | | | | | | | X | | | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Gibson - Humphrey 115kV | $47,327,390 | | | | X | | | X | | | | | | | |
| Greenwood - Humphrey 115kV | $3,838,000 | | | | X | | | X | | | | | | | |
| Greenwood - Terrebone 115kV | $22,850,381 | | | | X | | | X | | | | | | | |
| Habetz - Richard 138kV | $3,272,500 | | | | | | | X | | X | | | | | |
| Judice - Meaux 138kV | $12,600,000 | | | | | | | | | X | | | | | |
| Judice - Scott1 138kV | $10,000,000 | | | | | | | | | X | | | | | |
| Livonia - Wilbert 138kV | $41,123,000 | | | | | | | X | | | | | | | |
| 'MANSFLD4 138' TO BUS 'IPAPER 4 138' | TBD | | X | | | | | | | | | | | | |
| Moril - Cecelia 138kV | $6,182,500 | | | | | | | | | X | | | | | |
| North Crowley - Richard 138kV | $3,776,625 | | | | | | | X | | | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | X | | | X | | | | | | | |
| Raceland - Coteau 115kV | $3,065,000 | | | | | | | | | X | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | | | | X | | X | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |

| 2015 Summer Peak | Interface | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| A.A.C. - Licar 230kV | $6,500,000 | | | | | | | | | X | | X | | | |
| A.A.C. - Polsky Carville 230kV | $6,000,000 | | | | | | | | | X | | X | | | |
| Alchem - Monochem1 138kV | $7,601,200 | | | | | | | | | X | | | | | |
| Belle Helene - Licar 230kV | $3,187,500 | | | | | | | | | X | | X | | | |
| Champagne - East Opelousas 138kV | $1,397,500 | | | | | | | X | | | | | | | |
| Champagne - Krotz Spring 138kV | $29,239,000 | | | | X | | | X | | | | | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Fairview - Gypsy 230kV | $15,775,000 | | | | | | | | | | | X | | | |
| French Settlement - Sorrento 230kV | $3,345,300 | | | | | | | | | | | X | | | |
| Gibson - Humphrey 115kV | $47,327,390 | | | | X | | | X | | | | | | | |
| Gibson - Ramos 138kV | $6,242,290 | | | | X | | | X | | | | | | | |
| Greenwood - Humphrey 115kV | $3,838,000 | | | | X | | | X | | | | | | | |
| Greenwood - Terrebone 115kV | $22,850,381 | | | | X | | | X | | | | | | | |
| Hartburg - Inland Orange 230kV | $2,985,000 | | | | | X | | | | | | | | | |
| Jonesboro - Jonesboro North (AECC) 161kV | $10,575,000 | | | | | | | | | | | | | X | |
| Judice - Scott1 138kV | 10,000,000 | | | | X | | | | | | | | | | |
| Krotz Spring - Line 642 Tap 138kV | $26,778,000 | | | | X | | | X | | | | | | | |
| Livonia - Line 642 Tap 138kV | TBD | | | | X | | | X | | | | | | | |
| Livonia - Wilbert 138kV | $41,123,000 | | | | X | | | X | | | | | | | |
| Louisiana Station - Thomas 138kV | $2,544,750 | | | | X | | | X | | X | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | | | | X | | | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | | | | X | | | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |

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

| 2015 Summer Peak | Interface | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Limiting Element** | **Cost** | **AECI** | **AEPW** | **AMRN** | **CLECO** | **EES** | **EMDE** | **LAFA** | **LAGN** | **LEPA** | **OKGE** | **SMEPA** | **SOCO** | **SWPA** | **TVA** |
| A.A.C. - Licar 230kV | $6,500,000 | | | | | | | | | X | | X | | | |
| A.A.C. - Polsky Carville 230kV | $6,000,000 | | | | | | | | | X | | X | | | |
| Acadia - Colonial Academy 138kV | $6,277,500 | | | | | | | X | | | | | | | |
| Acadia GSU - Scanlan 138kV | $1,455,000 | | | | | | | X | | | | | | | |
| Addis - Big Cajun 1 230kV | $31,175,000 | | | | | | | | | X | | | | | |
| Alchem - Monochem1 138kV | $7,601,200 | | | | | | | | | X | | | | | |
| Belle Helene - Licar 230kV | $3,187,500 | | | | | | | | | X | | X | | | |
| Colonial Academy - Richard 138kV | $7,957,500 | | | | | | | X | | | | | | | |
| Danville - North Magazine REA 161kV | $10,530,000 | | | | | | | | | | X | | | | |
| Fancy Point - Port Hudson 230kV ckt 1 | $20,072,500 | | | | | | | | | X | | | | | |
| Fancy Point - Port Hudson 230kV ckt 2 | $20,352,500 | | | | | | | | | X | | | | | |
| French Settlement - Sorrento 230kV | $3,345,300 | | | | | | | | | | | X | | | |
| Habetz - Richard 138kV | $3,272,500 | | | | X | | | X | | | | | | | |
| Jonesboro - Jonesboro North (AECC) 161kV | $10,575,000 | | | | | | | | | | | | | X | |
| Judice - Meaux 138kV | $12,600,000 | | | | X | | | | | | | | | | |
| Judice - Scott1 138kV | 10,000,000 | | | | X | | | | | | | | | | |
| Lakeover 500/115kV transformer | $8,100,000 | | | | | | | | | | | X | | | |
| Louisiana Station - Thomas 138kV | $2,544,750 | | | | | | | X | | X | | | | | |
| McAdams 500/230kV transformer 1 | $6,560,004 | | | | X | X | | X | X | X | | | | | |
| North Crowley - Richard 138kV | $3,776,625 | | | | | | | X | | | | | | | |
| North Crowley - Scott1 138kV | $39,707,607 | | | | X | | | X | | | | | | | |
| Port Hudson 230/138 transformer 1 | TBD | | | | | | | | | X | | | | | |
| Port Hudson 230/138 transformer 2 | TBD | | | | | | | | | X | | | | | |
| Richard - Scott1 138kV | $68,006,984 | | | | X | | | X | | | | | | | |
| Scott1 - Bonin 138kV | $7,410,000 | | | | | | | X | | | | | | | |
| Semere - Scott2 138kV | $24,345,000 | | | | X | | | X | | | | | | | |
| Sterlington 500/115kV transformer 1 | $24,512,000 | | | | | X | | | | | | | | | |
| Sterlington 500/115kV transformer 2 | $18,737,621 | | | | | X | | | | | | | | | |

# DETAILS OF SCENARIO 1

## AECI
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AEP-W
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AMRN
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## CLECO
## 2011

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

| | | |
|---|---|---|
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton - Wells 230kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Terrebone 115kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 62 |

## CLECO
## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Livonia - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Krotz Spring - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Judice - Scott1 138kV | Greenwood - Terrebone 115kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Judice - Scott1 138kV | Greenwood - Humphrey 115kV | 0 |
| Judice - Scott1 138kV | Gibson - Humphrey 115kV | 5 |
| Gibson - Ramos 138kV | Webre - Wells 500kV | 68 |
| Judice - Scott1 138kV | Gibson 138/115kV transformer | 103 |
| Judice - Scott1 138kV | Gibson - Ramos 138kV | 103 |
| Champagne - Krotz Spring 138kV | Webre - Wells 500kV | 104 |

## EES
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 1 | 0 |
| Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 2 | 0 |
| Hartburg - Inland Orange 230kV | Cypress - Hartburg 500kV | 0 |

# EMDE
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

# LAFA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Baxter Wilson - Ray Braswell 500kV | Franklin - Grand Gulf 500kV | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Bonin - Cecelia 138kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Terrebone 115kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Acadia - Colonial Academy 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Greenwood - Terrebone 115kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 0 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 0 |
| Greenwood - Terrebone 115kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton - Wells 230kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Acadia GSU - Scanlan 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Acadia - Colonial Academy 138kV | Point Des Mouton - Wells 230kV | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 0 |

| | | |
|---|---|---|
| Acadia - Colonial Academy 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 3 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 10 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 12 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 18 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 27 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton - Wells 230kV | 32 |
| Habetz - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 43 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 61 |
| North Crowley - Richard 138kV | Point Des Mouton - Wells 230kV | 63 |
| North Crowley - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 91 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 101 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Livonia - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Krotz Spring - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Champagne - East Opelousas 138kV | Webre - Wells 500kV | 0 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 51 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 52 |
| Gibson - Ramos 138kV | Webre - Wells 500kV | 57 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 63 |
| Champagne - Krotz Spring 138kV | Webre - Wells 500kV | 72 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 87 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 87 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 96 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 98 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 120 |

## LAGN
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LEPA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Polsky Carville 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Licar 230kV | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Licar 230kV | 0 |
| Judice - Meaux 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Baxter Wilson - Ray Braswell 500kV | Franklin - Grand Gulf 500kV | 0 |
| Judice - Scott1 138kV | Moril - Cecelia 138kV | 0 |
| Moril - Cecelia 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Woodstock 230kV | 0 |
| Alchem - Monochem1 138kV | Vulchlor - Woodstock 230kV | 0 |
| Bonin - Cecelia 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 58 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 62 |
| Raceland - Coteau 115kV | Terrebone 230/115kV transformer | 80 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 80 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Alchem - Monochem1 138kV | A.A.C. - Polsky Carville 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Licar 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Coly - Vignes 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Licar 230kV | 0 |
| A.A.C. - Licar 230kV | Coly - Vignes 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Tezcuco - Waterford 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Woodstock 230kV | 0 |
| Alchem - Monochem1 138kV | Vulchlor - Woodstock 230kV | 0 |
| Belle Helene - Licar 230kV | Coly - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Tezcuco - Waterford 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Webre - Wells 500kV | 0 |
| Belle Helene - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Webre - Wells 500kV | 0 |
| A.A.C. - Polsky Carville 230kV | Alchem - Monochem1 138kV | 0 |

| | | |
|---|---|---|
| A.A.C. - Licar 230kV | Alchem - Monochem1 138kV | 0 |
| Belle Helene - Licar 230kV | Tezcuco - Waterford 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Frisco - Tezcuco 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| A.A.C. - Licar 230kV | Frisco - Tezcuco 230kV | 0 |
| A.A.C. - Licar 230kV | Bogalusa - Franklin 500kV | 0 |
| Belle Helene - Licar 230kV | Alchem - Monochem1 138kV | 0 |
| Belle Helene - Licar 230kV | Webre - Wells 500kV | 0 |
| Belle Helene - Woodstock 230kV | Coly - Vignes 230kV | 0 |
| Vulchlor - Woodstock 230kV | Coly - Vignes 230kV | 0 |
| Coly - Vignes 230kV | A.A.C. - Polsky Carville 230kV | 0 |
| Alchem - Monochem1 138kV | Conway - Vulchlor 230kV | 0 |
| Coly - Vignes 230kV | A.A.C. - Licar 230kV | 0 |
| Coly - Vignes 230kV | Belle Helene - Licar 230kV | 0 |
| Belle Helene - Licar 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| Belle Helene - Licar 230kV | Bogalusa - Franklin 500kV | 0 |
| Belle Helene - Woodstock 230kV | Sorrento - Vignes 230kV | 0 |
| Vulchlor - Woodstock 230kV | Sorrento - Vignes 230kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |

## OKGE
## 2010

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

## 2015

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

## SMEPA
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Fairview - Gypsy 230kV | French Settlement - Sorrento 230kV | 0 |
| Fairview - Gypsy 230kV | Front Street - Slidell 230kV | 0 |
| French Settlement - Sorrento 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| French Settlement - Sorrento 230kV | Bogalusa - Franklin 500kV | 0 |
| Fairview - Gypsy 230kV | Bogalusa - Franklin 500kV | 0 |
| French Settlement - Sorrento 230kV | Fairview - Gypsy 230kV | 23 |

## SOCO
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## SWPA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Quitman 161 kV | 0 |
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Heber Industrial 161kV | 8 |

## TVA
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

# DETAILS OF SCENARIO 2

## 2015

## AECI

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AEP-W

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AMRN

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## CLECO

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Judice - Scott1 138kV | Greenwood - Terrebone 115kV | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Wells 500/230kV transformer | 0 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Judice - Scott1 138kV | Moril - Cecelia 138kV | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 0 |
| Judice - Scott1 138kV | Greenwood - Humphrey 115kV | 0 |
| Judice - Scott1 138kV | Gibson - Humphrey 115kV | 0 |
| Judice - Meaux 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 35 |
| Judice - Scott1 138kV | Gibson 138/115kV transformer | 79 |
| Judice - Scott1 138kV | Gibson - Ramos 138kV | 79 |

## EES

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 1 | 0 |
| Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 2 | 0 |

## EMDE

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LAFA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Bonin - Cecelia 138kV | 0 |
| Acadia - Colonial Academy 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Wells 500/230kV transformer | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Richard - Scott1 138kV | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 0 |
| Acadia GSU - Scanlan 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Acadia - Colonial Academy 138kV | Point Des Mouton - Wells 230kV | 0 |
| Louisiana Station - Thomas 138kV | Addis - Willow Glen 138kV | 17 |
| North Crowley - Richard 138kV | Point Des Mouton - Wells 230kV | 20 |
| Acadia - Colonial Academy 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 28 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 34 |
| North Crowley - Scott1 138kV | Bonin 230/138kV transformer (LAFA) | 39 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 41 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton - Wells 230kV | 49 |
| North Crowley - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 53 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 77 |
| Habetz - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 80 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 84 |
| Richard - Scott1 138kV | North Crowley - Richard 138kV | 96 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 110 |

## LAGN

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LEPA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Addis - Big Cajun 1 230kV | Enjay - Fancy 230kV | 0 |
| Addis - Big Cajun 1 230kV | Enjay - Jaguar 230kV | 0 |
| Addis - Big Cajun 1 230kV | Willow Glen - Webre 500kV | 0 |
| Addis - Big Cajun 1 230kV | Coly - McKnight 500kV | 0 |
| Addis - Big Cajun 1 230kV | Jaguar - Tap Point Esso 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Polsky Carville 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Licar 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Licar 230kV | 0 |
| Addis - Big Cajun 1 230kV | Willow Glen 500/230kV Transformer | 0 |
| Fancy Point - Port Hudson 230kV ckt 1 | Fancy Point - Port Hudson 230kV ckt 2 | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Woodstock 230kV | 0 |
| Alchem - Monochem1 138kV | Vulchlor - Woodstock 230kV | 0 |
| Fancy Point - Port Hudson 230kV ckt 2 | Fancy Point - Port Hudson 230kV ckt 1 | 0 |
| Addis - Big Cajun 1 230kV | Port Hudson - Thomas 138kV | 0 |
| Addis - Big Cajun 1 230kV | Louisiana Station - Thomas 138kV | 0 |
| Port Hudson 230/138 transformer 2 | Port Hudson 230/138 transformer 1 | 0 |
| Cocodrie 230kV - Coughlin 138kV (CLECO) | Cocodrie - Vil Plat 230kV | 0 |
| Port Hudson 230/138 transformer 1 | Port Hudson 230/138 transformer 2 | 0 |
| Addis - Big Cajun 1 230kV | Waterford 500/230 transformer kV | 0 |
| Addis - Big Cajun 1 230kV | Waterford - Willow Glen 500kV | 0 |
| Louisiana Station - Thomas 138kV | Big Cajun 2 - Webre 500kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Louisiana Station - Thomas 138kV | Enjay - Fancy 230kV | 0 |
| Louisiana Station - Thomas 138kV | Addis - Big Cajun 1 230kV | 0 |
| Louisiana Station - Thomas 138kV | Enjay - Jaguar 230kV | 0 |
| Louisiana Station - Thomas 138kV | Port Hudson - Zoar 230kV | 0 |

## OKGE

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

## SMEPA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## SOCO

| Limiting Element | Contingency Element | ATC |
| --- | --- | --- |
| NONE | NONE | 125 |

## SWPA

| Limiting Element | Contingency Element | ATC |
| --- | --- | --- |
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Quitman 161 kV | 0 |
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Heber Industrial 161kV | 65 |

## TVA

| Limiting Element | Contingency Element | ATC |
| --- | --- | --- |
| NONE | NONE | 125 |

# DETAILS OF SCENARIO 3

## AECI
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AEP-W
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AMRN
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

# CLECO
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Baxter Wilson - Ray Braswell 500kV | Franklin - Grand Gulf 500kV | 0 |
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton - Wells 230kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Terrebone 115kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 65 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Livonia - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Krotz Spring - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Judice - Scott1 138kV | Greenwood - Terrebone 115kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Judice - Scott1 138kV | Greenwood - Humphrey 115kV | 0 |
| Judice - Scott1 138kV | Gibson - Humphrey 115kV | 6 |
| Gibson - Ramos 138kV | Webre - Wells 500kV | 72 |
| Champagne - Krotz Spring 138kV | Webre - Wells 500kV | 97 |
| Judice - Scott1 138kV | Gibson 138/115kV transformer | 104 |
| Judice - Scott1 138kV | Gibson - Ramos 138kV | 104 |

# EES
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 1 | 0 |

| | | |
|---|---|---|
| Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 2 | 0 |
| Hartburg - Inland Orange 230kV | Cypress - Hartburg 500kV | 0 |

## EMDE
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LAFA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Baxter Wilson - Ray Braswell 500kV | Franklin - Grand Gulf 500kV | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Bonin - Cecelia 138kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Greenwood - Terrebone 115kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Acadia - Colonial Academy 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Greenwood - Terrebone 115kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 0 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton - Wells 230kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Greenwood - Terrebone 115kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Greenwood - Terrebone 115kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Acadia GSU - Scanlan 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Acadia - Colonial Academy 138kV | Point Des Mouton - Wells 230kV | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 0 |
| Acadia - Colonial Academy 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 2 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 10 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 12 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 18 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 26 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton - Wells 230kV | 31 |
| Habetz - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 42 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 60 |
| North Crowley - Richard 138kV | Point Des Mouton - Wells 230kV | 63 |
| North Crowley - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 91 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 92 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Greenwood - Terrebone 115kV | Webre - Wells 500kV | 0 |
| Livonia - Wilbert 138kV | Webre - Wells 500kV | 0 |
| Greenwood - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Gibson - Humphrey 115kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Livonia - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| Krotz Spring - Line 642 Tap 138kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Greenwood - Terrebone 115kV | Richard - Wells 500kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Champagne - East Opelousas 138kV | Webre - Wells 500kV | 0 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 50 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 52 |
| Gibson - Ramos 138kV | Webre - Wells 500kV | 60 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 64 |
| Champagne - Krotz Spring 138kV | Webre - Wells 500kV | 67 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 86 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 87 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 96 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 99 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 120 |

## LAGN
## 2011

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

## LAGN
## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LEPA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Judice - Meaux 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Baxter Wilson - Ray Braswell 500kV | Franklin - Grand Gulf 500kV | 0 |
| Judice - Scott1 138kV | Moril - Cecelia 138kV | 0 |
| Moril - Cecelia 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Bonin - Cecelia 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 49 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 61 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 75 |
| Raceland - Coteau 115kV | Terrebone 230/115kV transformer | 82 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| A.A.C. - Polsky Carville 230kV | Tezcuco - Waterford 230kV | 0 |
| A.A.C. - Licar 230kV | Tezcuco - Waterford 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Polsky Carville 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Licar 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Licar 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Coly - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Coly - Vignes 230kV | 0 |
| Belle Helene - Licar 230kV | Tezcuco - Waterford 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Sorrento - Vignes 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Woodstock 230kV | 0 |
| Alchem - Monochem1 138kV | Vulchlor - Woodstock 230kV | 0 |
| A.A.C. - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Frisco - Tezcuco 230kV | 0 |

| | | |
|---|---|---|
| Belle Helene - Licar 230kV | Coly - Vignes 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Webre - Wells 500kV | 0 |
| A.A.C. - Licar 230kV | Frisco - Tezcuco 230kV | 0 |
| Belle Helene - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Webre - Wells 500kV | 0 |
| A.A.C. - Polsky Carville 230kV | Alchem - Monochem1 138kV | 0 |
| A.A.C. - Licar 230kV | Alchem - Monochem1 138kV | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Franklin 500kV | 0 |
| A.A.C. - Licar 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| A.A.C. - Licar 230kV | Bogalusa - Franklin 500kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Belle Helene - Licar 230kV | Frisco - Tezcuco 230kV | 0 |
| Belle Helene - Licar 230kV | Alchem - Monochem1 138kV | 0 |
| Belle Helene - Licar 230kV | Webre - Wells 500kV | 0 |
| Alchem - Monochem1 138kV | Conway - Vulchlor 230kV | 30 |
| Belle Helene - Licar 230kV | Bogalusa - Adams Creek 500/230kV transformer | 40 |
| Belle Helene - Licar 230kV | Bogalusa - Franklin 500kV | 40 |

## OKGE
## 2011

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

## 2015

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

## SMEPA
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Fairview - Gypsy 230kV | French Settlement - Sorrento 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Franklin 500kV | 0 |
| A.A.C. - Licar 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| A.A.C. - Licar 230kV | Bogalusa - Franklin 500kV | 0 |
| French Settlement - Sorrento 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |

| | | |
|---|---|---|
| French Settlement - Sorrento 230kV | Bogalusa - Franklin 500kV | 0 |
| Fairview - Gypsy 230kV | Front Street - Slidell 230kV | 0 |
| French Settlement - Sorrento 230kV | Fairview - Gypsy 230kV | 0 |
| Fairview - Gypsy 230kV | French Settlement - Springfield 230kV | 0 |
| Belle Helene - Licar 230kV | Bogalusa - Adams Creek 500/230kV transformer | 98 |
| Belle Helene - Licar 230kV | Bogalusa - Franklin 500kV | 98 |

## SOCO
## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## SWPA
## 2011

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Quitman 161 kV | 0 |
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Heber Industrial 161kV | 10 |

## TVA

## 2011

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

## 2015

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

# DETAILS OF SCENARIO 4

## 2015

## AECI

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AEP-W

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## AMRN

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## CLECO

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| McAdams 500/230kV transformer 1 | Lakeover - McAdams 500kV | 0 |
| Judice - Scott1 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Judice - Scott1 138kV | Greenwood - Terrebone 115kV | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Wells 500/230kV transformer | 0 |
| Judice - Scott1 138kV | Moril - Cecelia 138kV | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 0 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Judice - Scott1 138kV | Greenwood - Humphrey 115kV | 0 |
| Judice - Scott1 138kV | Gibson - Humphrey 115kV | 0 |
| Judice - Meaux 138kV | Flander - Hopkins 138kV (CLECO/LAFA) | 52 |
| Judice - Scott1 138kV | Gibson 138/115kV transformer | 74 |
| Judice - Scott1 138kV | Gibson - Ramos 138kV | 74 |

## EES

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

## EMDE

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## LAGN

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| McAdams 500/230kV transformer 1 | Lakeover - McAdams 500kV | 0 |

## LAFA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| McAdams 500/230kV transformer 1 | Lakeover - McAdams 500kV | 0 |
| Semere - Scott2 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Colonial Academy - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Point Des Mouton - Wells 230kV | 0 |
| Semere - Scott2 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| North Crowley - Scott1 138kV | Richard - Scott1 138kV | 0 |
| North Crowley - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Richard - Scott1 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Louisiana Station - Thomas 138kV | Addis - Willow Glen 138kV | 0 |
| Semere - Scott2 138kV | Bonin - Cecelia 138kV | 0 |
| Acadia - Colonial Academy 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton - Wells 230kV | 0 |
| Colonial Academy - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| North Crowley - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Semere - Scott2 138kV | Wells 500/230kV transformer | 0 |
| Richard - Scott1 138kV | Point Des Mouton - Wells 230kV | 0 |
| Habetz - Richard 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| North Crowley - Scott1 138kV | Wells 500/230kV transformer | 0 |
| Semere - Scott2 138kV | Richard - Scott1 138kV | 0 |
| Richard - Scott1 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 0 |
| Acadia GSU - Scanlan 138kV | Bonin - Labbe 230kV (LAFA) | 0 |
| Acadia - Colonial Academy 138kV | Point Des Mouton - Wells 230kV | 0 |
| North Crowley - Richard 138kV | Point Des Mouton - Wells 230kV | 27 |
| Scott1 - Bonin 138kV | Bonin - Labbe 230kV (LAFA) | 34 |
| Acadia - Colonial Academy 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 35 |
| Habetz - Richard 138kV | Point Des Mouton - Wells 230kV | 46 |
| North Crowley - Scott1 138kV | Bonin 230/138kV transformer (LAFA) | 50 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton - Wells 230kV | 55 |

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| North Crowley - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 60 |
| Scott1 - Bonin 138kV | Point Des Mouton - Wells 230kV | 77 |
| Habetz - Richard 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 85 |
| Acadia GSU - Scanlan 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 90 |
| Richard - Scott1 138kV | North Crowley - Richard 138kV | 105 |
| Scott1 - Bonin 138kV | Point Des Mouton (LAFA) - Labbe (LAFA) 230kV | 110 |

## LEPA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Addis - Big Cajun 1 230kV | Enjay - Fancy 230kV | 0 |
| Addis - Big Cajun 1 230kV | Enjay - Jaguar 230kV | 0 |
| Addis - Big Cajun 1 230kV | Jaguar - Tap Point Esso 230kV | 0 |
| Addis - Big Cajun 1 230kV | Willow Glen - Webre 500kV | 0 |
| Addis - Big Cajun 1 230kV | Coly - McKnight 500kV | 0 |
| Addis - Big Cajun 1 230kV | Willow Glen 500/230kV Transformer | 0 |
| McAdams 500/230kV transformer 1 | Lakeover - McAdams 500kV | 0 |
| Addis - Big Cajun 1 230kV | Port Hudson - Thomas 138kV | 0 |
| Addis - Big Cajun 1 230kV | Louisiana Station - Thomas 138kV | 0 |
| A.A.C. - Polsky Carville 230kV | Coly - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Coly - Vignes 230kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Polsky Carville 230kV | 0 |
| Addis - Big Cajun 1 230kV | Waterford - Willow Glen 500kV | 0 |
| Addis - Big Cajun 1 230kV | Waterford 500/230 transformer kV | 0 |
| Alchem - Monochem1 138kV | A.A.C. - Licar 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Sorrento - Vignes 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Licar 230kV | 0 |
| A.A.C. - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| Belle Helene - Licar 230kV | Coly - Vignes 230kV | 0 |
| Alchem - Monochem1 138kV | Belle Helene - Woodstock 230kV | 0 |
| Alchem - Monochem1 138kV | Vulchlor - Woodstock 230kV | 0 |
| A.A.C. - Polsky Carville 230kV | Tezcuco - Waterford 230kV | 0 |
| Belle Helene - Licar 230kV | Sorrento - Vignes 230kV | 0 |
| A.A.C. - Licar 230kV | Tezcuco - Waterford 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 |
| A.A.C. - Polsky Carville 230kV | Waterford - Willow Glen 500kV | 0 |
| A.A.C. - Polsky Carville 230kV | Waterford 500/230 transformer kV | 0 |
| A.A.C. - Licar 230kV | Waterford - Willow Glen 500kV | 0 |
| A.A.C. - Licar 230kV | Waterford 500/230 transformer kV | 0 |
| Louisiana Station - Thomas 138kV | Big Cajun 2 - Webre 500kV | 0 |
| Fancy Point - Port Hudson 230kV ckt 1 | Fancy Point - Port Hudson 230kV ckt 2 | 0 |
| Belle Helene - Licar 230kV | Tezcuco - Waterford 230kV | 0 |
| Louisiana Station - Thomas 138kV | Webre - Wells 500kV | 0 |
| Fancy Point - Port Hudson 230kV ckt 2 | Fancy Point - Port Hudson 230kV ckt 1 | 0 |

## OKGE

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

## SMEPA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| A.A.C. - Polsky Carville 230kV | Waterford - Willow Glen 500kV | 0 |
| A.A.C. - Polsky Carville 230kV | Waterford 500/230 transformer kV | 0 |
| A.A.C. - Licar 230kV | Waterford - Willow Glen 500kV | 0 |
| A.A.C. - Licar 230kV | Waterford 500/230 transformer kV | 0 |
| Belle Helene - Licar 230kV | Waterford - Willow Glen 500kV | 0 |
| Belle Helene - Licar 230kV | Waterford 500/230 transformer kV | 0 |
| French Settlement - Sorrento 230kV | Bogalusa - Adams Creek 500/230kV transformer | 0 |
| French Settlement - Sorrento 230kV | Bogalusa - Franklin 500kV | 0 |
| Lakeover 500/115kV transformer | Ray Braswell 500/115kV transformer 1 | 0 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Adams Creek 500/230kV transformer | 100 |
| A.A.C. - Polsky Carville 230kV | Bogalusa - Franklin 500kV | 100 |

## SOCO

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

## SWPA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Quitman 161 kV | 0 |
| Jonesboro - Jonesboro North (AECC) 161kV | Heber Springs South - Heber Industrial 161kV | 50 |

## TVA

| Limiting Element | Contingency Element | ATC |
|---|---|---|
| NONE | NONE | 125 |

# IV. Stability Analysis

# ABB Inc – Grid Systems Consulting    Technical Report

| | | |
|---|---|---|
| **Southwest Power Pool** | **No.** 2008-E0001432-R1 | |
| Stability Study for PID-223 | 12/12/2008 | # Pages<br>72 |


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


**Executive Summary**


SPP has commissioned ABB Inc. to perform a stability study for PID-223. PID-223 is a 125 MW of windfarm to be located in Carroll County, Arkansas with a point of interconnection on Entergy Green Forest South – Harrison West 161 kV transmission line approximately 3.3 miles from Green Forest South substation. The proposed in-service date for the Project is October 2010. As per the developer's request, the proposed PID-223 generation was studied using 2.5 MW wind turbines.

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

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

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

<u>FERC Order 661A Compliance</u> – 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-223) complies with the latest FERC order on low voltage ride through for wind farms. With this arrangement, these wind farms would not trip off line by voltage relay actuation for local faults near the POI.

**Final conclusions:**

1) The proposed PID-223 windfarm does not degrade the stability of the bulk power system in Entergy region.

2) The proposed PID-223 (125 MW) windfarm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

| Rev No. | Revision Description | Date | Authored by | Reviewed by | Approved by |
|---|---|---|---|---|---|
| 0 | Draft Report | 12/12/2008 | A. Kekare | S. Pillutla | W. Wong |
| 1 | FINAL REPORT | 1/7/2009 | A. Kekare | S. Pillutla | W. Wong |
| DISTRIBUTION:<br>Daniel Epperson – Southwest Power Pool<br>Brad Finkbeiner – Southwest Power Pool | | | | | |

# Introduction

SPP has commissioned ABB Inc. to perform a stability study for PID-223. PID-223 is a 125 MW of windfarm to be located in Carroll County, Arkansas with a point of interconnection on Entergy's Green Forest South – Harrison West 161 kV transmission line approximately 3.3 miles from Green Forest South substation. The proposed in-service date for the Project is October 2010.

The objective of this study is to evaluate the impact on system stability after connecting the additional 125 MW generation and its impact on the nearby transmission system and generating stations. The study is performed on 2015 Summer Peak case, provided by Entergy. Figure 0-1 shows the location of the proposed 125 MW generation interconnecting station. Section 0 includes a detailed description of the PID-223 project.

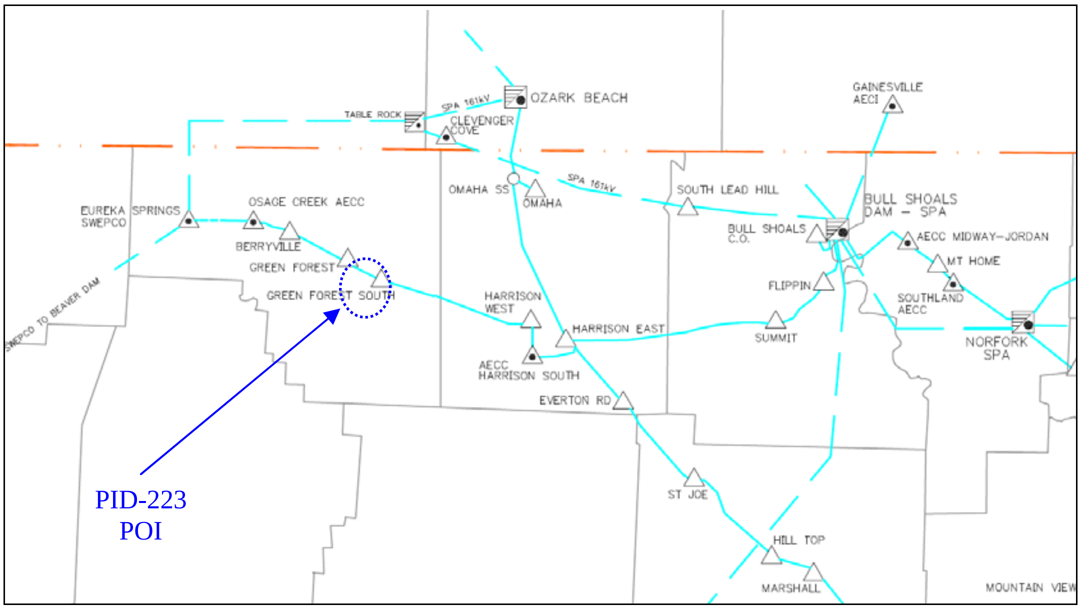

**Figure 0-1: PID-223 interconnecting substation**

## *PROJECT DESCRIPTION*

The proposed PID-223 project will be located in Carroll County, Arkansas. The power will be generated using fifty (50) 2.5 MW wind-turbine generators.

The following list summarizes the major project parameters:

- Wind field rating: 125.0 MW

- Interconnection:

  Voltage: 161 kV
  Location: Entergy Green Forest South – Harrison West 161 kV line. 3.3 miles from Green Forest South substation
  Transformer:
  MVA: 81/105/135 MVA
  High voltage: 161 kV
  Low Voltage: 34.5 kV
  Z: 9.5% on 81 MVA; X/R = 55

- Wind turbines:

  Number: Fifty (50)
  Manufacturer: Clipper
  Win turbine Generator: 2.5 MW
  Type: Synchronous generator
  Rated power: 2.5 MW
  Rated Terminal Voltage: 690 V
  Frequency: 60 Hz
  Generator Step-up Transformer (GSU):
  MVA: 2.75 MVA
  High voltage: 34.5 kV (Wye grounded)
  Low voltage: 0.690 kV (Wye grounded)
  Z: 5.75% on 2.75 MVA; X/R = 6.0

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

  A 30 Mvar shunt capacitor was added at 34.5 kV collector bus to maintain approximately unity p.f. at the POI

- Low Voltage Ride-through Capability: The manufacturer recommended Low Voltage Ride Through (LVRT) settings[1] were included (see Figure 0-2 and Figure 0-3).

[1] 'Liberty Series PSSE Model Version G' – Modeling the Wind Turbine for Load flow, Short Circuit, and stability studies using PSS/E ver 30, 3/23/2007.

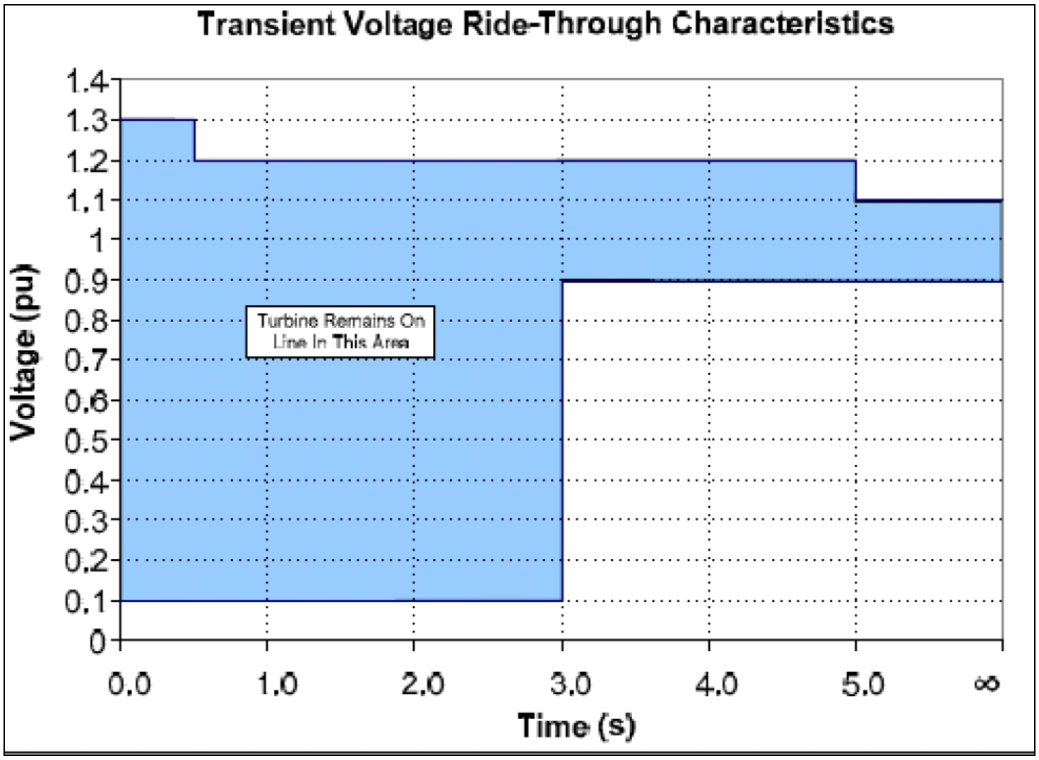


**Figure 0-2: Transient Voltage Ride Through Characteristics of 2.5 MW wind turbine generators**

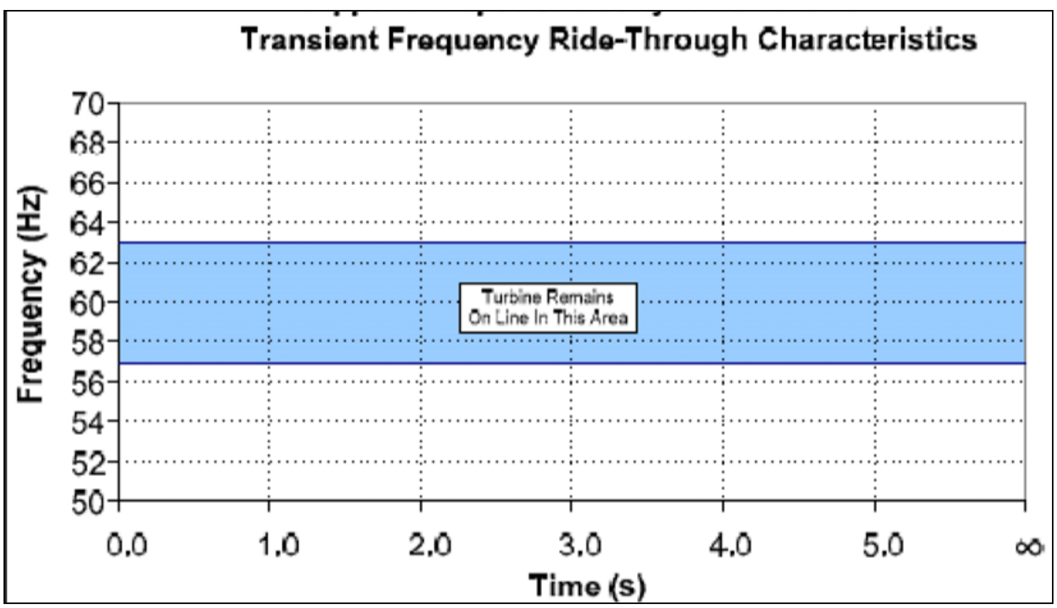


**Figure 0-3: Transient Frequency Ride Through Characteristics of 2.5 MW wind turbine generators**

# Stability analysis

## Stability Analysis Methodology

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

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

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

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

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

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

**FERC LVRT Criteria**

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

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

**Transient Voltage Criteria**

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

- 3-phase fault or single-line-ground fault with normal clearing resulting in the loss of a single component (generator, transmission circuit or transformer) or a loss of a single component without fault:
  Not to exceed 20% for more than 20 cycles at any bus

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

Not to exceed 25% at any load bus
Not to exceed 30% at any non-load bus

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

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

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

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

# Study Model Development

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

***Power Flow Case***

A Powerflow case '*EN15S07_final u3_r4+AppUpgd+PID223_125+P4-uncov.sav*' representing the 2015 Summer Peak conditions was provided by SPP/ Entergy. This powerflow model was saved as the Pre-PID-223 case.

It was assumed that the proposed PID-223 project will be connected to the Green Forest South – Harrison West 161 kV line through a three breaker ring bus arrangement. The proposed project was added to the pre-project (PRE-PID-223) case and the generation (125 MW) was dispatched against the White Bluff Unit 1. Table 2-1 summarizes the dispatch. Thus a post-project power flow case with PID-223 was established and named as 'POST-PID-223.sav'.

**Table 0-1: PID-223 project details**

| System condition | MW | Point of Interconnection | Sink |
|---|---|---|---|
| 2015 Summer Peak | 125 | Green Forest South – Harrison West 161 kV line | White Bluff Unit 1 (#337652) |

**PID-223 Windfarm modeling**

The proposed windfarm was modeled as a single equivalent generator representing fifty (50) wind turbine generators. The single equivalent wind turbine generator was connected to the 34.5 kV collector bus via an equivalent generator step-up transformer (GSU). Details of the collector bus system were not available at the time of study hence were not modeled. The 34.5 kV collector bus was connected to the 161 kV Point of Interconnection (POI) through one 34.5/161 kV step-up transformer. Figure 0-4 shows the one-line diagram for the PID-223 windfarm. A 30 Mvar shunt capacitor was added to the 34.5 kV collector bus system to maintain a power factor of near unity at the point of interconnection.

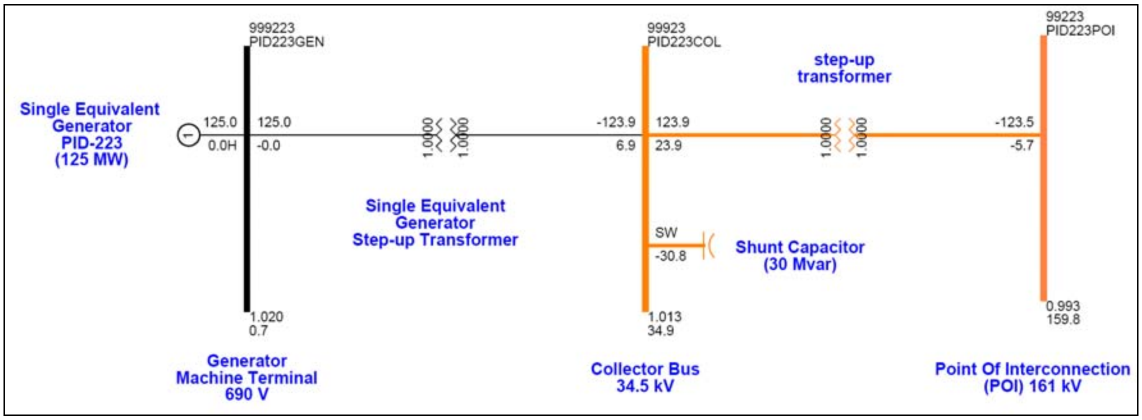


**Figure 0-4: One Diagram for PID-223 windfarm**

***Stability Database***

A basecase stability database was provided by SPP/Entergy in a PSSE *.dyr file format ('red11S_newnum.dyr'). A snapshot file corresponding to the Pre-PID-223 case was created.

Then, the stability data for PID-223 was appended to the pre-project stability database to create dynamic database for Post-PID-223 powerflow case.

SPP provided a dynamic model for 2.5 MW wind turbine generators ('Liberty Series PSSE Model Version F'). The '*C93TUR*' – turbine model – produces a blade pitch angle that maintains the rotor speed near its rated value during wind excess of that which results in rated turbine output power. The '*C93GEN*' – torque control model – represents nearly instantaneous torque response of the generator/inverter subsystem in response to the torque commands generated by the torque controller. The model assumes that the available wind power (i.e. wind speed) is constant over the period of the simulations. The over/under voltage and frequency protection settings have been included in the model with fixed setpoints and time delays as shown in Figure 0-2 and Figure 0-3.

Figure 2-1 and Figure 2-2 show the PSS/E one-line diagrams for the local area WITHOUT and WITH the PID-223 project, respectively, for 2015 Summer Peak system conditions. The power flow and stability model representation of PID-223 project is shown in Appendix B.

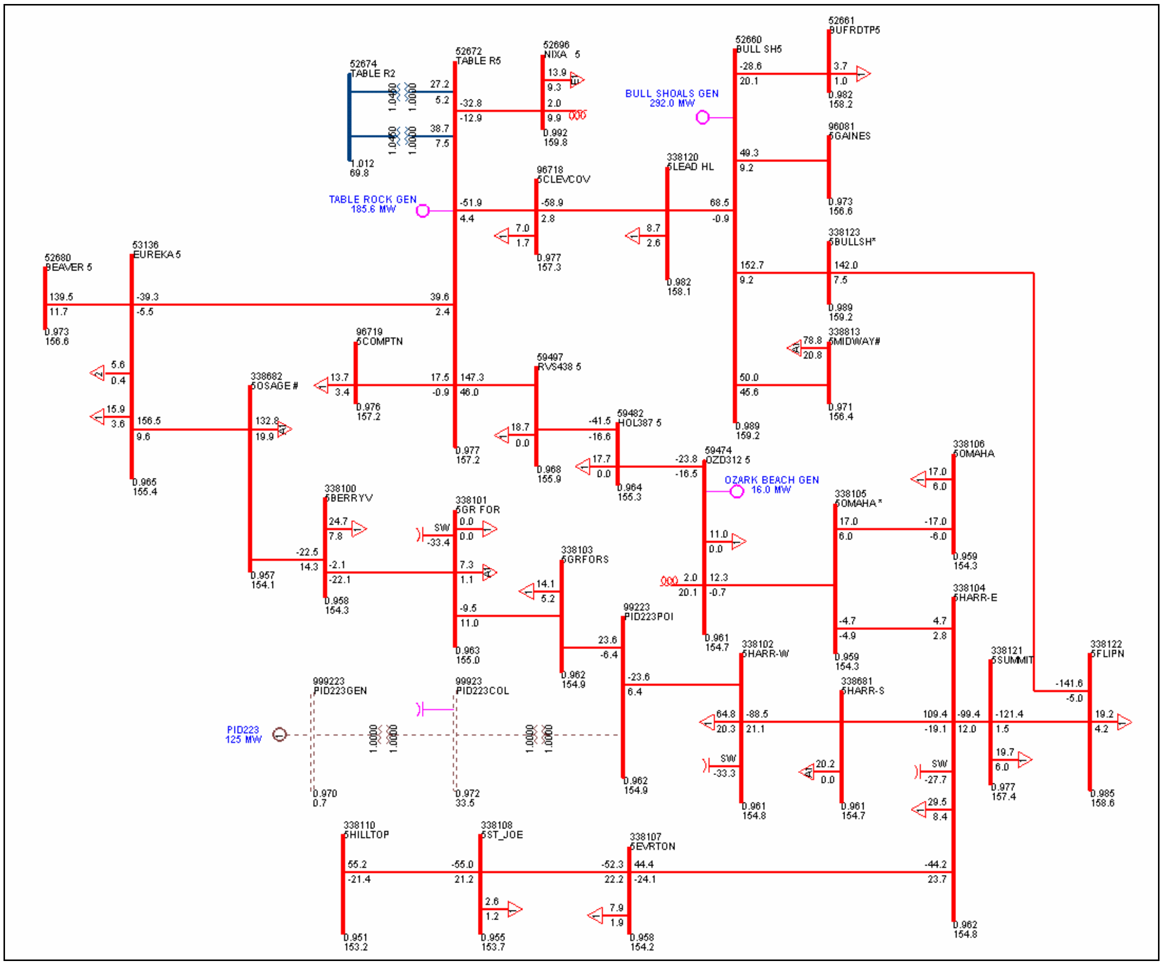


**Figure 0-5: Powerflow diagram without PID-223 (2015 summer peak)**

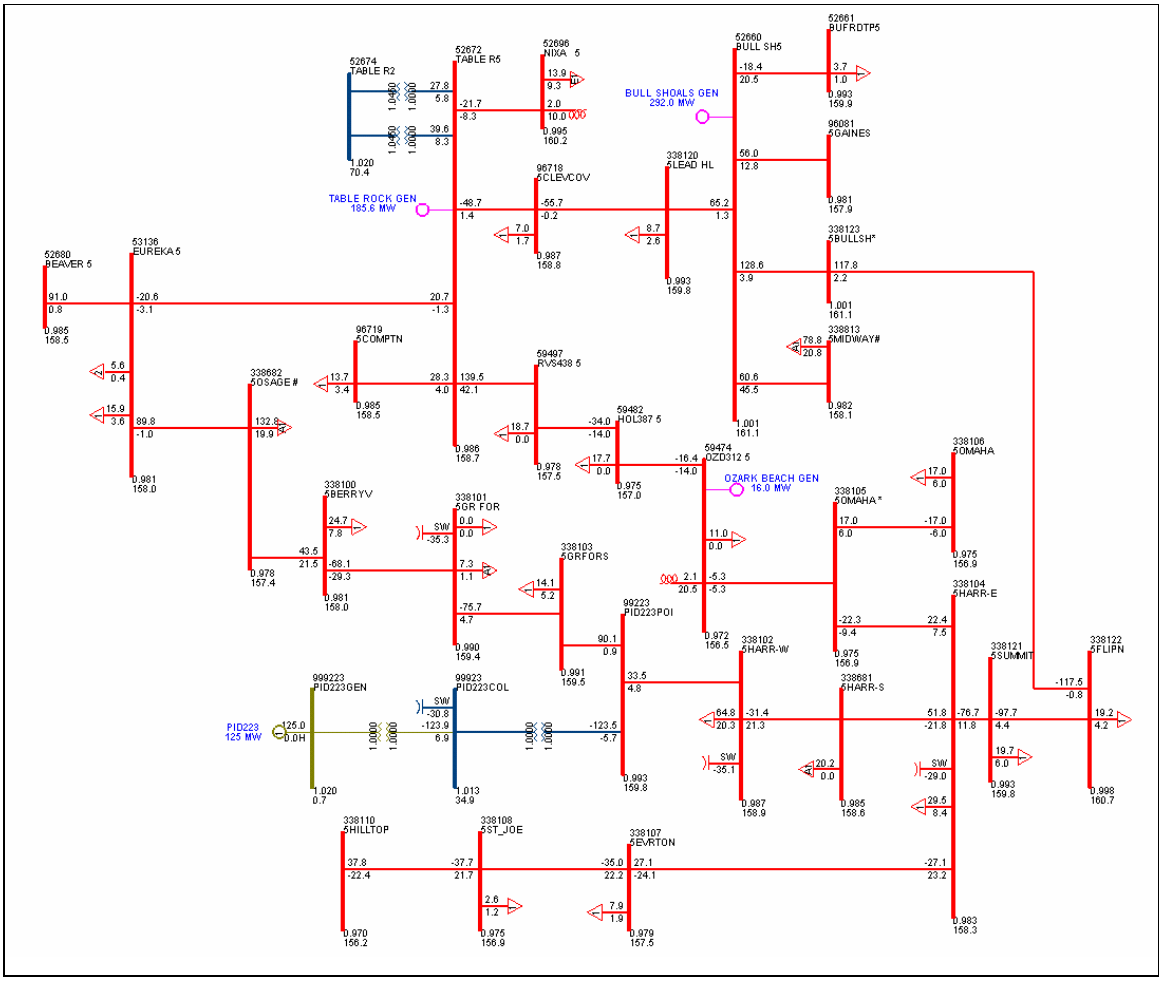

**Figure 0-6: Powerflow diagram with PID-223 (2015 summer peak)**

## Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID-223 wind turbine generator and its impact on the Entergy system. Stability analysis was performed using the following procedure. First, three-phase faults with normal clearing were simulated. Next, the stuck breaker three phase fault conditions were simulated. If a stuck breaker fault was found to be unstable, then a single-line-to-ground (SLG) fault followed by breaker failure was studied. This procedure is being followed since if the units are stable for a more severe fault (such as three phase fault with breaker failure) then the need to study stability for a less severe fault (such as SLG fault with breaker failure) does not arise. The fault clearing times used for the simulations are given inTable 0-2.

**Table 0-2: 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-223 plant.

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

Table 0-3 lists all the fault cases that were simulated in this study.

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

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

**Table 0-3: List of faults simulated for PID-223 stability analysis**

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

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

The system was found to be STABLE following all the normally cleared three-phase faults and all stuck breaker three-phase faults. Figure 0-7 and Figure 0-8 shows plot for PID-223 following FLT_8_3PH and FLT_9_3PH.

**Transient Voltage Recovery**

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

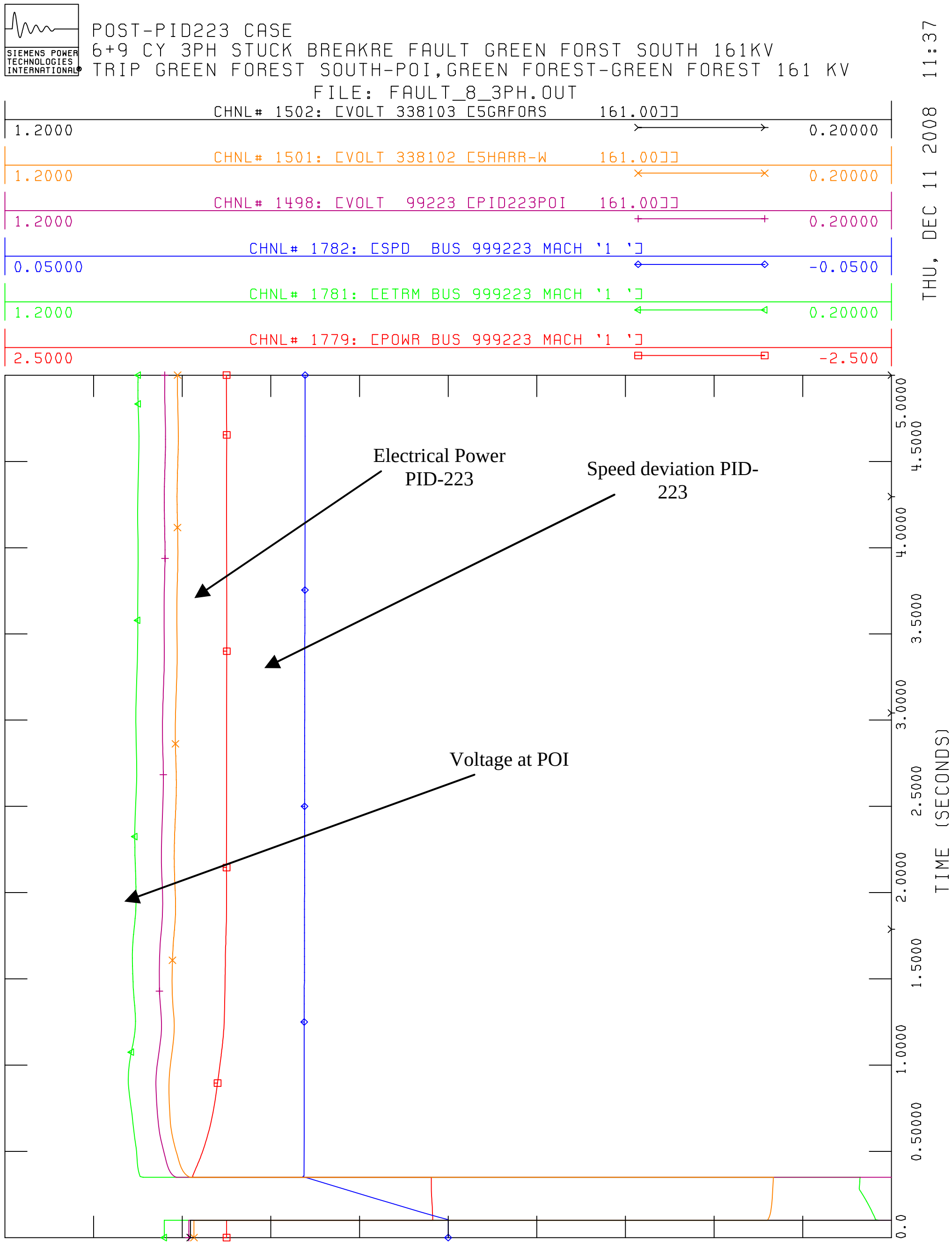


**Figure 0-7: Fault_8_3PH with PID-223**

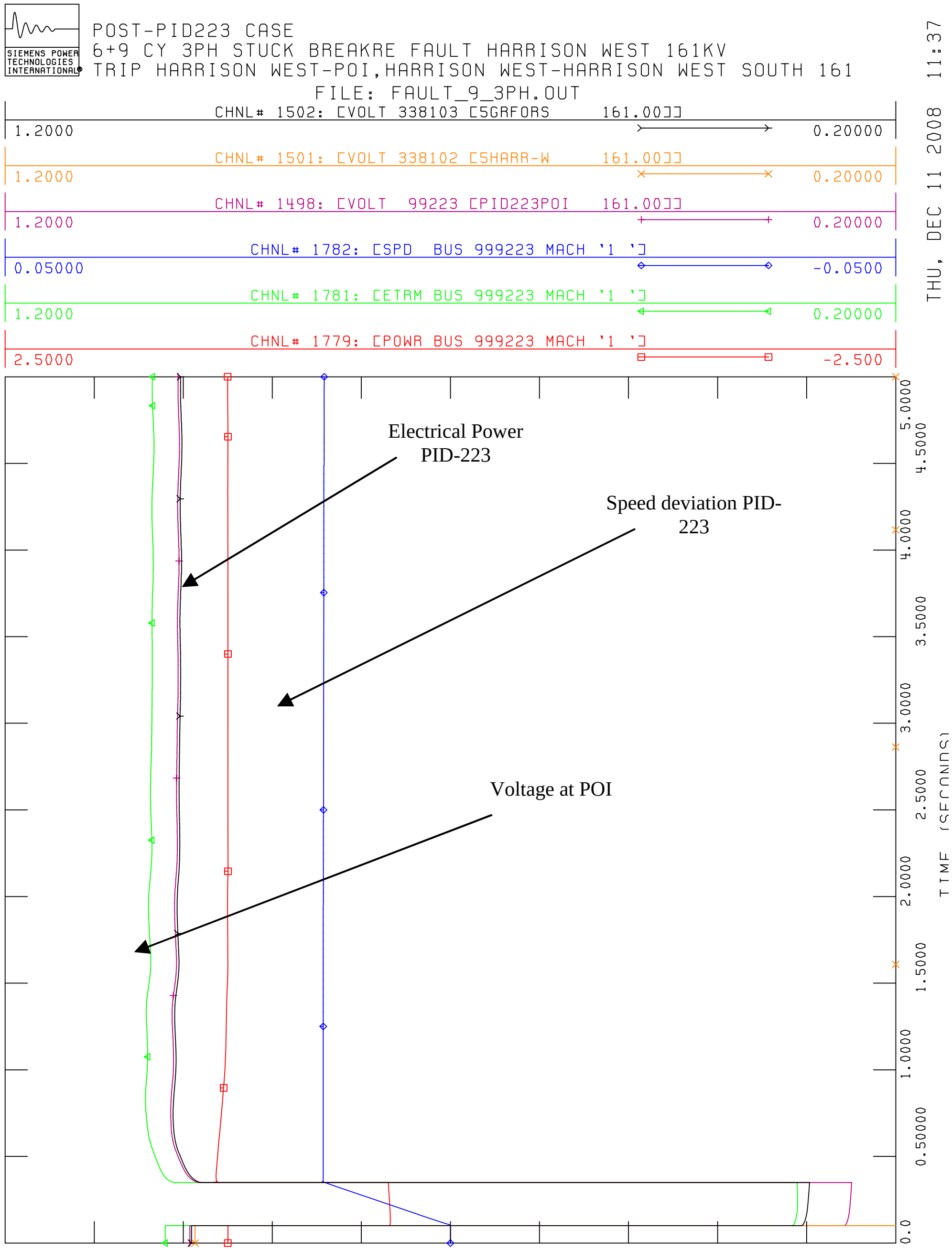


**Figure 0-8: Fault_9_3PH with PID-223**

# Low Voltage Ride Through (LVRT)

As discussed in Section 0, the proposed project was modeled with low voltage ride through capability. The PID-223 Project Point-of-Interconnection (POI) is on Green Forest South – Harrison West 161 kV line. As discussed in section 0, the post-transition period LVRT capability of the Project was verified by simulating two (2) separate three-phase faults at POI 161 kV clearing one line at a time.

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

As shown in Figure 0-9 and Figure 0-10, the wind turbine generator remains on-line for both fault cases. Therefore, the LVRT requirement is met.

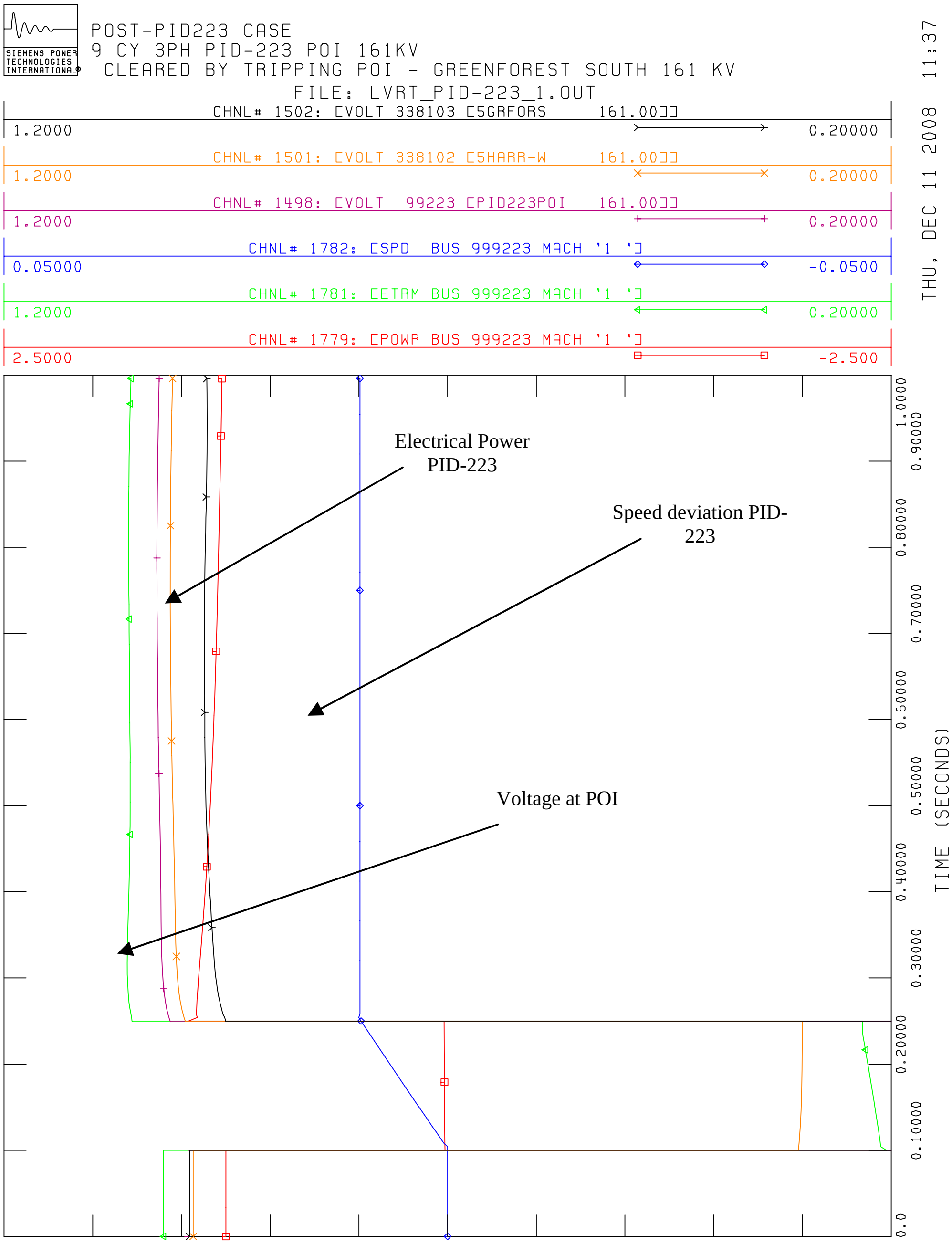


**Figure 0-9: LVRT capability of PID-223 for (LVRT_PID-223_1)**

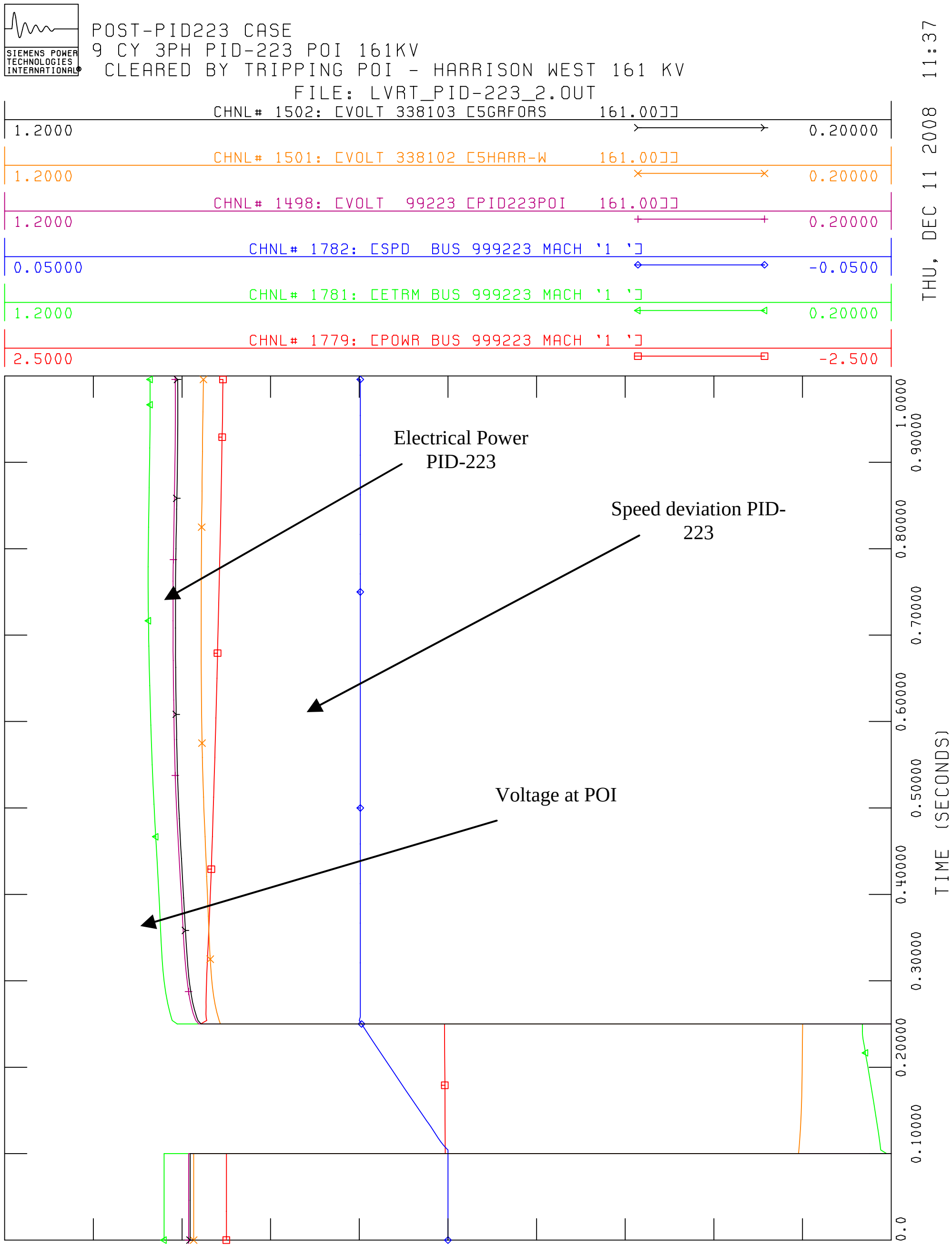


**Figure 0-10: LVRT capability of PID-223 for (LVRT_PID-223_2)**

# Conclusions

SPP has commissioned ABB Inc. to perform a stability study for PID-223. PID-223 is a 125 MW windfarm to be located in Carroll County, Arkansas with a point of interconnection on Entergy's Green Forest South – Harrison West 161 kV transmission line approximately 3.3 miles from Green Forest South substation. The proposed in-service date for the Project is October 2010. As per the developer's request, the proposed PID-223 generation was studied using 2.5 MW wind turbines.

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

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

<u>FERC Order 661A Compliance</u> – 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-223) 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.

**<u>Final conclusions:</u>**

1) The proposed PID-223 windfarm does not degrade the stability of the bulk power system in Entergy region.

2) The proposed PID-223 (125 MW) windfarm meets the FERC post-transition period LVRT standard and remains online for the simulated faults at or near the Point of Interconnection (POI).

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

# DATA PROVIDED BY CUSTOMER

**Attachment A**
**To Appendix 1**
**Interconnection Request**

**LARGE GENERATING FACILITY DATA**

**UNIT RATINGS**

kVA _2500_ @ °F _-40 to 122_ Voltage _690VAC_
Power Factor _1.0 *_
Speed (RPM) _Variable (see Exhibit D)_ Connection (e.g. Wye) _Wye_
Short Circuit Ratio _1.11 (see Exhibit D)_ Frequency, Hertz _60_
Stator Amperes at Rated kVA _2,092 A_ Field Volts _N/A (see Exhibit D)_
Max Turbine MW _2.5_ @ °F _-40 to 122_

** Dynamic power factor control at the wind plant level provided by separate CVAR reactive power management system, if required by Interconnection Studies.*

**COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA**

***Not applicable (see Exhibit D)***

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

**REACTANCE DATA (PER UNIT-RATED KVA)**

***Not applicable (see Exhibit D)***

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

**FIELD TIME CONSTANT DATA (SEC)**

***Not applicable (see Exhibit D)***

Open Circuit $T'_{do}$ ________ $T'_{qo}$ ________

1



ABB

| | | | | |
|---|---|---|---|---|
| Three-Phase Short Circuit Transient | $T'_{d3}$ | ________ | $T'_q$ | ________ |
| Line to Line Short Circuit Transient | $T'_{d2}$ | ________ | | |
| Line to Neutral Short Circuit Transient | $T'_{d1}$ | ________ | | |
| Short Circuit Subtransient | $T''_d$ | ________ | $T''_q$ | ________ |
| Open Circuit Subtransient | $T''_{do}$ | ________ | $T''_{qo}$ | ________ |

## ARMATURE TIME CONSTANT DATA (SEC)

***Not applicable (see Exhibit D)***

| | | |
|---|---|---|
| Three Phase Short Circuit | $T_{a3}$ | ________ |
| Line to Line Short Circuit | $T_{a2}$ | ________ |
| Line to Neutral Short Circuit | $T_{a1}$ | ________ |

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

## MW CAPABILITY AND PLANT CONFIGURATION LARGE GENERATING FACILITY DATA

## ARMATURE WINDING RESISTANCE DATA (PER UNIT)

***Not applicable (see Exhibit D)***

| | | |
|---|---|---|
| Positive | $R_1$ | ______ |
| Negative | $R_2$ | ______ |
| Zero | $R_0$ | ______ |

Rotor Short Time Thermal Capacity $I^2t$ = __________
Field Current at Rated kVA, Armature Voltage and PF = ________ amps
Field Current at Rated kVA and Armature Voltage, 0 PF = ________ amps
Three Phase Armature Winding Capacitance = ________ microfarad
Field Winding Resistance = _______ ohms _____ °C
Armature Winding Resistance (Per Phase) = _______ ohms _____ °C

## CURVES

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

***Not applicable (see Exhibit D)***

## GENERATOR STEP-UP TRANSFORMER DATA

## RATINGS

Capacity (self-cooled/maximum nameplate): *2750* / *2750* kVA

2

Voltage Ratio (generator side/system side): _690 V_ / _34.5_ kV
Winding Connections (Low V/High V): _Grounded Wye_ / _Grounded Wye_
Fixed Taps Available: _± 2.5%, ± 5.0%_
Present Tap Setting: _Nominal_

## IMPEDANCE

| | | | | | |
|---|---|---|---|---|---|
| Positive | Z1 (on self-cooled kVA rating) | _5.75_ | % | _6.0_ | X/R |
| Zero | Z0 (on self-cooled kVA rating) | _5.75_ | % | _6.0_ | X/R |

*Note: This data is for the individual turbine step-up transformers. The substation transformer at the HV point of connection has not yet been specified.*

## EXCITATION SYSTEM DATA

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

Standard IEEE models for machines with the topology of the Liberty series turbine do not exist. Please see modeling details in Exhibit D.

## GOVERNOR SYSTEM DATA

Identify appropriate IEEE model block diagram of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

Standard IEEE models for machines with the topology of the Liberty series turbine do not exist. Please see modeling details in Exhibit D.

## WIND GENERATORS

Number of generators to be interconnected pursuant to this Interconnection Request: 50

Elevation: ____________ _____ Single Phase __X__ Three Phase

Inverter manufacturer, model name, number, and version:
Manufacturer is Magnetek Power Systems and/or Xantrex Technology. Inverters are OEM products for the Clipper Liberty series wind turbine and do not have manufacturer model names or numbers.

List of adjustable setpoints for the protective equipment or software:

3

***Protective equipment with setpoints adjustable by the interconnecting Transmission Owner will be provided at the wind plant interconnection substation switchgear.***

Note: A completed GE PSLF or PTI PSS/E data sheet 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.

Standard data sheets for PSLF or PSS/E turbine-generator models are not appropriate to the topology of the Clipper Liberty series turbine. Clipper Windpower has "user defined" models available for both PSLF and PSS/E.

## INDUCTION GENERATORS

***Not applicable.***

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

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

4

# LOAD FLOW AND STABILITY DATA

## Loadflow Data

```
99223,'PID223POI   ', 161.0000,1,     0.000,     0.000, 351, 163,0.99234, -59.2099,   1
 99923,'PID223COL   ',  34.5000,1,     0.000,     0.000, 351, 163,1.01225, -50.9260,   1
999223,'PID223GEN   ',   0.6900,2,     0.000,     0.000,   1,   1,1.02002, -47.7553,   1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
999223,'1 ',   125.000,     0.000,     0.000,     0.000,1.00000,     0,   125.000,
0.00000,9999.00000,   0.00000,   0.00000,1.00000,1,  100.0,   125.000,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
 99223, 338102,'1 ',   0.00948,   0.04507,   0.02218,  223.00,  223.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,  16.98,   1,1.0000
 99223,-338103,'1 ',   0.00181,   0.00859,   0.00423,  223.00,  223.00,    0.00,  0.00000,
0.00000,  0.00000,  0.00000,1,   3.23,   1,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
 99223, 99923,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'PID223SUB   ',1,   1,1.0000
   0.00173,   0.09498,    81.00
1.00000,   0.000,   0.000,   135.00,   135.00,   135.00, 0,      0, 1.10000, 0.90000, 1.10000,
0.90000,  33, 0, 0.00000, 0.00000
1.00000,   0.000
 99923,999223,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'PID223GSU   ',1,   1,1.0000
   0.00950,   0.05711,   125.00
1.00000,   0.000,   0.000,   125.00,   125.00,   125.00, 0,      0, 1.10000, 0.90000, 1.10000,
0.90000,  33, 0, 0.00000, 0.00000
1.00000,   0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
 351,337653,   542.000,    10.000,'EES         '
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
 99923,0,1.00000,1.00000,     0,  100.0,'            ',   30.00, 1,  30.00
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA
```

## Dynamics Data

```
POST-PID223 CASE

 PLANT MODELS

 REPORT FOR ALL MODELS                    BUS 999223 [PID223GEN   0.6900] MODELS


     ** C93GEN **  BUS  MACH        C O N S       S T A T E S
                 999223   1     130159-130163  51105- 51108

                     H     MBASE    KPLL   TAUPLL   ISPD
                    5.69  125.00    0.10    0.03    1.00


     ** C93TUR **  BUS  MACH        C O N S       S T A T E S
                 999223   1     130164-130169  51109- 51109

                   KPP      KPI    PAMIN   PAMAX    PAINIT   MBASE
                   63.50    6.95    0.00   90.00     0.00  125.00
```

# Section – B

## Network Resource Interconnection Service

# TABLE OF CONTENTS FOR NRIS

## Introduction:

A Network Resource Interconnection Services (NRIS) study was requested by PID 223 to serve 125 MW of Entergy network load. The expected in service date for this NRIS generator is 10/1/2010. The tests were performed with only confirmed transmission reservations and existing network generators and with transmission service requests in study mode.

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

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

# Analysis:

## Models

The models used for this analysis is the 2011 and 2015 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 2011 – 2015.
- Approved transmission reliability upgrades for 2008 – 2010 were included in the base case. These upgrades can be found at Entergy's OASIS web page, http://www.entergy.com/etroasis/, under approved future projects.

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

| Year | Proposed Projects for prior generator interconnection requests |
|---|---|
| 2015 | Webre – Richard 500kV transmission line (56 miles triple bundled 954) |
| | Fancy Point – Hartburg/Mount Olive line tap 500kV transmission line |
| | Cypress – Jacinto 230kV transmission line |
| | Hartburg – Sabine 230kV transmission line |
| | Lewis Creek – Conroe 230kV transmission line |
| | BP08-038 - Loblolly-Hammond Build 230kv Line_R2Corrected.idv Upgraded to 954 DB |
| | Upgrade Fairview – Gypsy 230kV to 700MVA 34.33 miles<br>Upgrade Madisonville – Mandeville 230kV (CLECO)10 miles<br>Upgrade Front Street – Michoud to 800MVA<br>Upgrade Front Street – Slidell to 800MVA<br>Build Slidell – Michoud 230kV to 600MVA 30 miles<br>Build Nine Mile – Michoud 230kV to 600MVA 22 miles<br>Upgrade LaBarre – South Port 230kV to 700MVA 2.1 miles<br>Add 3rd South Port – Nine Mile river crossing |

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

| PID | Substation | MW | In Service Date |
|---|---|---|---|
| PID 208 | Fancy Point | 1594 | 1/1/2015 |
| PID 211 | Lewis Creek | 570 | 6/1/2011 |
| PID 216 | Wilton 230kV | 251 | 1/1/2010 |
| PID 221 | Wolfcreek | 875 | In Service |
| PID 222 | Nine Mile | 570 | 10/1/2012 |

Prior transmission service requests that were included in this study:

| OASIS # | PSE | MW | Begin | End |
|---|---|---|---|---|
| 1460900 | Louisiana Energy & Power Authority | 116 | 1/1/2009 | 1/1/2030 |
| 1481059 | Constellation Energy Group | 60 | 2/1/2011 | 2/1/2030 |
| 1481111 | City of Conway | 50 | 2/1/2011 | 2/1/2046 |
| 1481119 | Constellation Energy Group | 30 | 2/1/2011 | 2/1/2030 |
| 1481235 | Louisiana Energy & Power Authority | 50 | 2/1/2011 | 2/1/2016 |
| 1481438 | NRG Power Marketing | 20 | 2/1/2011 | 2/1/2021 |
| 1483241 | NRG Power Marketing | 103 | 1/1/2010 | 1/1/2020 |
| 1483243 | NRG Power Marketing | 206 | 1/1/2010 | 1/1/2020 |
| 1483244 | NRG Power Marketing | 309 | 1/1/2010 | 1/1/2020 |
| 1520043 | Municipal Energy Agency of Miss | 20 | 1/1/2011 | 1/1/2026 |
| ASA-2008-001 | TVA | 724 | 1/1/2009 | 1/1/2013 |
| ASA-2008-003 | Empire District Electric Co. | 100 | 11/1/2008 | 11/1/2028 |
| 1551562 | CLECO Power LLC | 11 | 6/1/2009 | 6/1/2018 |
| 1557602 | East Texas Electric Coop | 1 | 1/1/2009 | 1/1/2017 |
| 1558911 | NRG Power Marketing | 100 | 1/1/2009 | 1/1/2014 |
| 1559579 | NRG Power Marketing | 500 | 5/1/2010 | 5/1/2015 |
| 1559580 | NRG Power Marketing | 500 | 5/1/2010 | 5/1/2015 |
| 1559581 | NRG Power Marketing | 150 | 5/1/2010 | 5/1/2015 |
| 1562340 | Entergy Services (EMO) | 1 | 7/1/2008 | 7/1/2009 |
| 1562529 | Constellation Energy Grp | 123 | 1/1/2009 | 1/1/2010 |

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

## Generation used for the transfer

The 125MW generators were used as the source for the deliverability to generation test.

# Results

**Deliverability to Generation (DFAX) Test:**

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

Constraints:

| 2011 Study Case | 2015 Study Case | 2015 Study Case with Priors |
|---|---|---|
| Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 2 |
| Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 1 |
| Baxter Wilson - Ray Braswell 500kV | Hartburg - Inland Orange 230kV | McAdams 500/230kV transformer 1 |

DFAX Study Case Results:

2011

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

2015

| Limiting Element | Contingency Element | ATC(MW) |
|---|---|---|
| Sterlington 500/115kV transformer 2 | Sterlington 500/115kV transformer 1 | 0 |
| Sterlington 500/115kV transformer 1 | Sterlington 500/115kV transformer 2 | 0 |
| Hartburg - Inland Orange 230kV | Cypress - Hartburg 500kV | 0 |

**DFAX Study Case with Priors Results:**

2015

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

**Deliverability to Load Test:**

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

**Amite South: Passed**

**WOTAB: Passed**

**Western Region: Passed**

# Required Upgrades for NRIS

Preliminary Estimates of Direct Assignment of Facilities and Network Upgrades

**Confirmed Case:**
**Without Priors**

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

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

**With priors:**
In addition to the approved upgrades for the construction plan and proposed upgrades for prior generation interconnection request, the following upgrades have been identified for this study:

| Limiting Element | Planning Estimate for Upgrade |
|---|---|
| Sterlington 500/115kV transformer 2 | Supplemental Upgrade: TBD |
| Sterlington 500/115kV transformer 1 | |
| McAdams 500/230kV transformer 1 | Potentially a Supplemental Upgrade: TBD |

# APPENDIX B-A: Deliverability Test for Network Resource Interconnection Service Resources

## 1. Overview

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

### 1.1 The "From Generation" Test for Deliverability

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

### 1.2 The "To Load" Test for Deliverability

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

### 1.3 Required Upgrades.

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

## Appendix B-B – NRIS Deliverability Test

Description of Deliverability Test

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

Deliverability Test Procedure:

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

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

1) Deliverability of Generation

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

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

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

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

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

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

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

2) Deliverability to Load

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

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

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

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

Other Modeling Assumptions:

1) Modeling of Other Resources

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

2) Must-run Units

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

3) Base-line Transmission Model

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