System Impact Study
PID 287
340MW Plant

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Executive Summary

This System Impact Study is the second step of the interconnection process and is based on the PID 287 request for interconnection on Entergy's transmission system at the Lewis Creek 138 kV substation. This report is organized in three sections, namely: Network Resource Interconnection Service (NRIS), Short Circuit/Breaker Rating Analysis, and Stability Study.

Requestor for PID 287 requested NRIS only. The study evaluates the connection of 340 MW to the Entergy Transmission System. The load flow study was performed on the latest available 2017 – 2020 Summer Peak Cases and 2017 – 2020 Winter Peak Cases, 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 May 1, 2017.

Results of the System Impact Study indicated that under NRIS, the additional generation due to PID 287 generator **does** cause an increase in short circuit current such that it exceeds the fault interrupting capability of the high voltage circuit breakers within the vicinity of the PID 287 plant with priors and without priors. Results also indicated that the system is stable following all simulated three-phase normally cleared and stuck breaker faults. No dynamic voltage problems were noted. Estimated upgrade costs under NRIS with and without priors to replace the identified breakers is $2,000,000 as listed in the table below.

The estimated cost of interconnection facilities is $3.5 Million; which covers the cost of the interconnecting to the 138 kV Lewis Creek substation. The estimated costs of the interconnection facilities are planning estimates only. Detailed cost estimates, accelerated costs, and solutions for any identified limiting elements will be provided in the Facilities Study.

Estimated NRIS Project Planning Upgrade Cost

Limiting Element	Upgrade Estimate*
Caney Creek - Lewis Creek SES 138kV	$4,200,000
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	$91,259
Lewis Creek 138kV Substation	$2,000,000
Interconnection Facilities	$3,500,000

*The costs of the upgrades are planning estimates only. Detailed cost estimates and solutions will be provided in the Facilities Study.

Network Resource Interconnection Service

1. Introduction

A Network Resource Interconnection Services (NRIS) study was requested to serve 340 MW of Entergy network load. The expected in service date for this NRIS generator is May 1, 2017. The tests were performed with only confirmed transmission reservations and existing network generators and with transmission service requests in study mode.

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

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

2. Short Circuit/Breaker Rating Analysis

2.1 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.

2.2 Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID 287 generation is as follows:

> Three-phase and single-phase to ground faults were simulated on the Entergy base case short circuit model and the PID 287 generator was 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 287 generation. Any breakers identified to be upgraded through this comparison are mandatory upgrades.

2.3 Analysis Results

The results of the short circuit analysis indicated that the additional generation due to PID 287 generation caused an increase in short circuit current such that they exceeded the fault interrupting capability of the high voltage circuit breakers within the vicinity of the PID 287 plant **with and without priors**. Priors included are: 221, 231, 238, 240, 244, 247, 250, 256, 260, 261, 266 and 268.

Table 2.1 and Table 2.2 below illustrate the station name, worst case fault level, and the number of breakers that were found to be under-rated at the respective locations as a result of the additional short circuit current due to PID 287 generator with and without priors.

Table 2.1: Underrated Breakers Without Priors

Substation	Breaker	Max Fault w/o PID-287 (amps)	Max Fault with PID-287 (amps)	Interrupting Rating (amps)
Lewis Creek 138kV	1625-CO	28323.1	36989.5	37000
	1630-CBO	28323.1	36989.5	37000
	1635-CO	28323.1	36989.5	37000
	1650-CO	28323.1	36989.5	37000
	1660-CO	28323.1	36989.5	37000

Table 2.2: Underrated Breakers With Priors

Substation	Breaker	Max Fault w/o PID-287 (amps)	Max Fault with PID-287(amps)	Interrupting Rating (amps)
Lewis Creek 138kV	1625-CO	28357.5	37024.5	37000
	1630-CBO	28357.5	37024.5	37000
	1635-CO	28357.5	37024.5	37000
	1650-CO	28357.5	37024.5	37000
	1660-CO	28357.5	37024.5	37000

2.4 Problem Resolution

Table 2.3 below illustrates the station name, and the cost associated with upgrading the breakers at each station both for mandatory and optional breaker upgrades. The impact on breaker rating due to line upgrades will be evaluated during Facilities Sudy phase.

Table 2.3: Estimated Cost of Breaker Replacement

Substation	Number of Breakers	Estimated cost of Breaker Upgrades ($)
Lewis Creek 138kV	5	$2,000,000

3. Load Flow Analysis

3.1 Model Information

The models used for this analysis were the 2017 - 2020 summer and winter peak cases developed in 2010.

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 years 2017 - 2020.
- Approved transmission reliability upgrades for 2011 - 2013 were included in the base case. These upgrades can be found at Entergy's OASIS web page http://www.oatioasis.com/EES/EESDocs/Disclaimer.html under approved future projects.

3.2 Contingencies and Monitored Elements

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

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.

The customer meets the criteria as stated above.

3.3 Generation used for the transfer

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

3.4 Analysis Results

3.4.1 Deliverability to Generation (DFAX) Test

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

3.4.2 Constraints

Study Case	Study Case with Priors
Caney Creek - Lewis Creek SES 138kV	Caney Creek - Lewis Creek SES 138kV
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade

3.4.3 DFAX Study Case Results

Year	Limiting Element	Contingency Element	ATC (MW)
5/1/2017 – 5/1/2020	Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	-448
	Caney Creek - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV	296

3.4.4 DFAX Study with Priors Case Results

Year	Limiting Element	Contingency Element	ATC (MW)
5/1/2017 – 5/1/2020	Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	Franklin - Grand Gulf 500kV	-1127
	Caney Creek - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV	298

3.4.5 Deliverability to Load Test

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

A. Amite South: Passed

B. WOTAB: Passed

C. Western Region: Passed

4. Required Upgrades for NRIS

4.1 Preliminary Estimates of Direct Assignment of Facilities and Network Upgrades

Limiting Element	Upgrade Estimate*
Caney Creek - Lewis Creek SES 138kV	$4,200,000
Ray Braswell - Baxter Wilson 500kV - Supplemental Upgrade	$91,259
Lewis Creek 138kV Substation	$2,000,000

*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.

5. Interconnection Facilities

The Interconnection Customer's designated Point of Interconnection (POI) is the Lewis Creek 138 kV substation. The estimated cost of interconnection facilities is $3.5 Million. This cost is based on parametric estimating techniques for a "typical" site. Cost may significantly change based on specific project parameters that are not known at this time. Costs specific to this interconnection will be developed during the Facilities Study. The interconnection customer is responsible for constructing all facilities needed to deliver generation to the POI.

Stability Study

6. Executive Summary

Southwest Power Pool (SPP) requested ABB Power Systems Consulting to perform a stability analysis for PID 287, which is a 340 MW generating. The proposed project is a Combined Cycle Plant and is an interconnection request for the expansion of the existing Lewis Creek facility located at Lewis Creek 138 kV substation in Montgomery County, Texas in the Entergy service territory.

The objective of this study is to determine if the interconnection of PID 287 will cause any adverse stability impacts on the Entergy system. The study was performed on 2017 Summer Peak case, provided by SPP/Entergy.

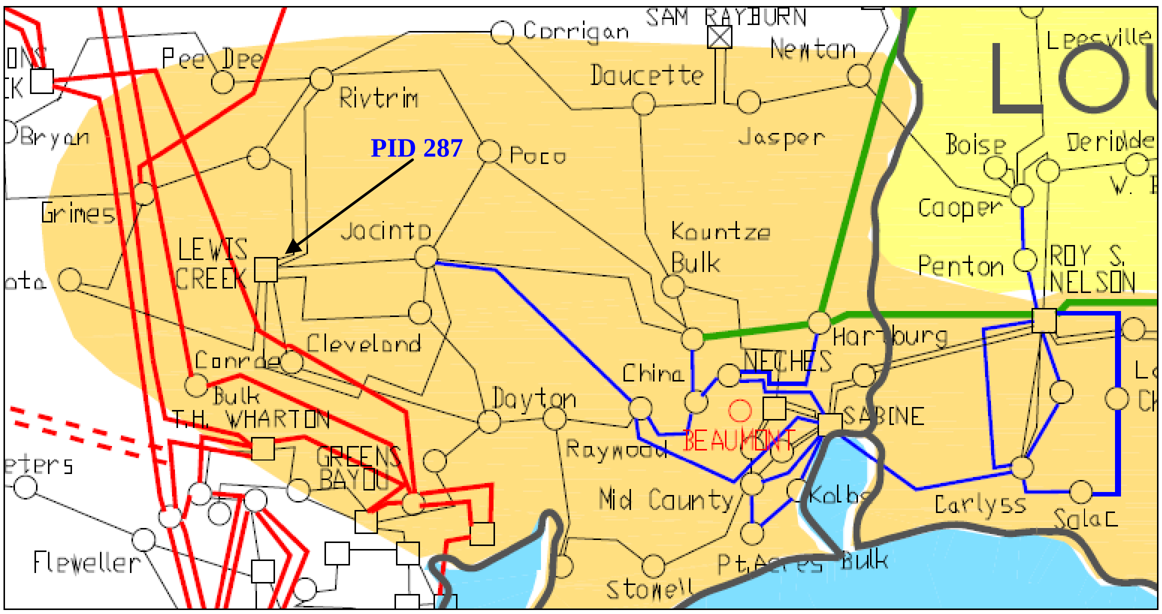


Figure 6.1: PID 287 Point of Interconnection

7. Final conclusions

Based on the results of stability analysis, it can be concluded that the proposed PID 287 project does not adversely impact the stability of the Entergy System in the local area. The system was stable following all simulated normally-cleared three-phase faults and single-line-to-ground (SLG) stuck-breaker faults. No angular instabilities were observed. Also, no voltage criteria violations were observed following the simulated faults.

8. Project Description

The proposed PID 287 project will be located in Montgomery County, Texas in the Entergy service territory. Power will be generated using a Combustion Turbine Generator (CTG) and a Steam Turbine Generator (STG) operating in a one-on-one configuration. The following list summarizes the major project parameters:

Interconnection: Lewis Creek 138 kV sub-station

CTG Data:

General:

- Gross MW: 192 MW
- Auxiliary Power Consumption: 10 MW

Generator Step-up Transformer (GSU):

- MVA: 236.2 MVA
- High voltage: 138 kV
- Low voltage: 18 kV
- Z: 8.75%, X/R = 30

Generator:

- Manufacturer: GE
- MVA: 229 MVA
- Rayed voltage: 18 kV
- Power Factor: 0.85
- Model: GENROU
- AVR: ESST4B
- Governor: GGOV1

STG Data:

General:

- Gross MW: 158 MW
- Auxiliary Power Consumption: All BOP Load is attributed to the CTG Auxiliary Transformer for the purpose of this request.

Generator Step-up Transformer (GSU):

- MVA: 183.4 MVA
- High voltage: 138 kV
- Low voltage: 18 kV
- Z: 8.75%, X/R = 30

Generator:

- Manufacturer: GE
- MVA: 180 MVA
- Rayed voltage: 18 kV
- Power Factor: 0.85
- Model: GENROU
- AVR: ESST4B
- Governor: TGOV1

9. Stability Analysis

9.1 Stability Analysis Methodology

The goal of the stability analysis is to verify that the response to dynamic events (e.g. faults) is acceptable (i.e. no out-of-step condition, acceptable voltage recovery, post-disturbance, damped oscillations) with the proposed PID 287 in service

Stability analysis was performed using Siemens-PTI's PSS/E^{TM} dynamics program V30.3.3. Three-phase and SLG with stuck breaker faults were simulated for the specified duration and synchronous machine rotor angles were monitored to check whether synchronism is maintained following fault removal. In addition, voltages were monitored on selected buses in the study area to check for voltage criteria violations (see below).

The following transient voltage criteria were used:

- Three-phase fault or single-line-ground (SLG) fault with normal clearing resulting in the loss of a single component (generator, transmission circuit or transformer) or a loss of a single component without fault:
  - Not to exceed 20% for more than 20 cycles at any bus
  - Not to exceed 25% at any load bus
  - Not to exceed 30% at any non-load bus
- Three-phase faults with normal clearing resulting in the loss of two (2) or more components (generator, transmission circuit or transformer), and SLG fault with delayed clearing resulting in the loss of one (1) 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 were monitored during each of the fault cases as appropriate.

9.2 Study Model Development

The PID 287 generation plant is modeled as a CTG of 192 MW and a STG of 158 MW. The voltage at the each generator terminal is 18 kV and is connected to the point of interconnection of PID 287 via two (2) 18/138 kV generator step-up transformers (one on each unit). Plant auxiliary load was modeled at 10 MW with an assumed power factor of 0.85 lag. Data for the proposed PID 287 project is included in Appendix A.

The study model consists of a power flow case and a dynamics database, developed as follows:

9.2.1 Power Flow Case

A powerflow case "EN17S10_U3_final_CP_V30_unconv.sav" representing 2017 Summer Peak conditions was provided by SPP/ Entergy.

A post-project power flow case with PID 287 was established and named as 'EN17S10_U3_final_CP_V30_unconv-PID287.sav'.

Figure 9.1 and Figure 9.2 show the PSS/E one-line diagrams for the local area without and with the PID 287 project, respectively.

9.2.2 Stability Database

A basecase stability database was provided by SPP/Entergy in a PSSE *.dyr and *.snp file format (red16S_newnum.dyr; drift.snp).

The stability data for PID 287 was appended to the above mentioned stability database to come up with a post-project stability database.

The data provided for the Interconnection Request for PID 287 is included in Appendix A. The PSS/E power flow and stability data for PID 287 are included in Appendix B.

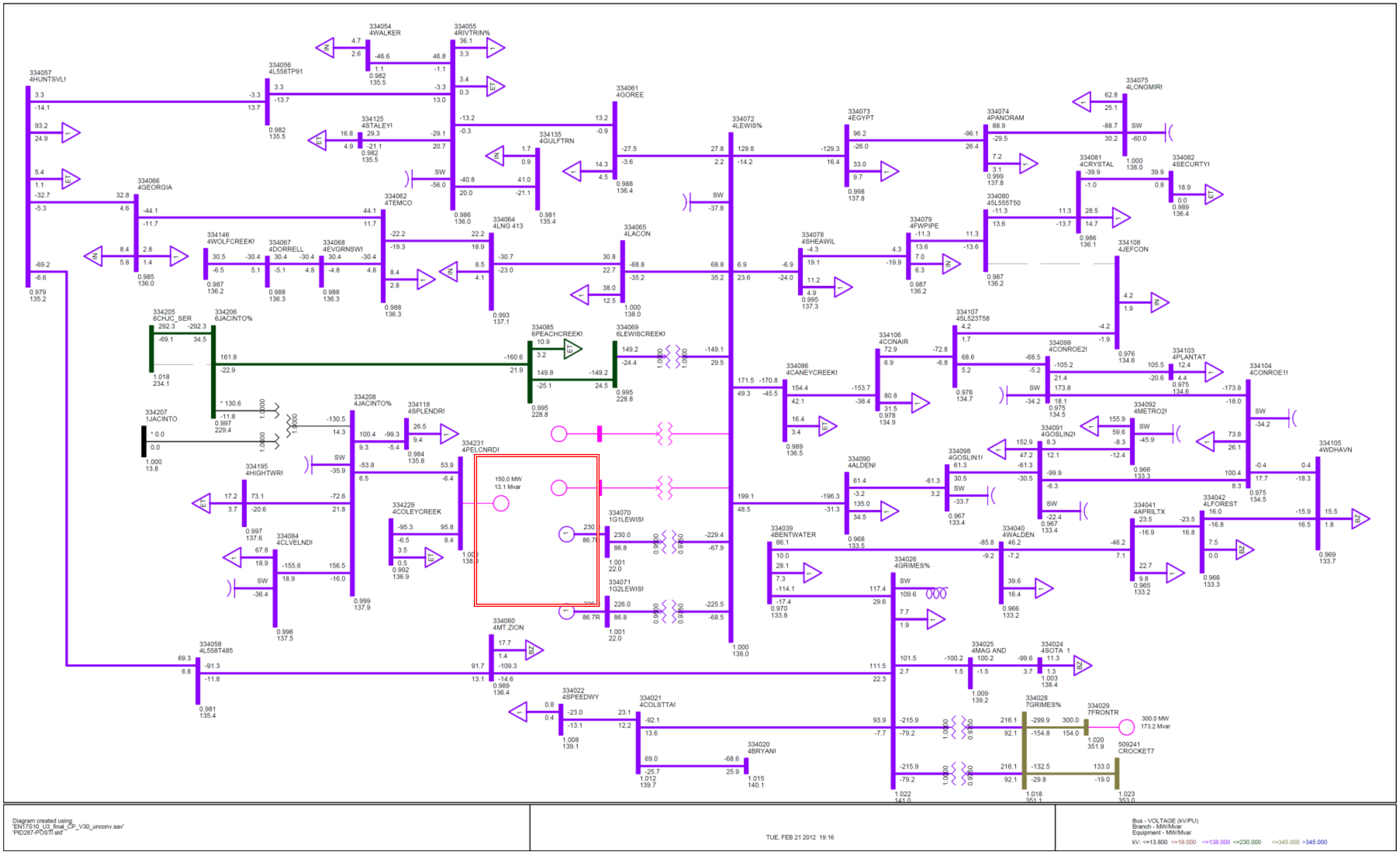


Figure 9.1: 2017 Summer Peak Flows and Voltages without PID 287

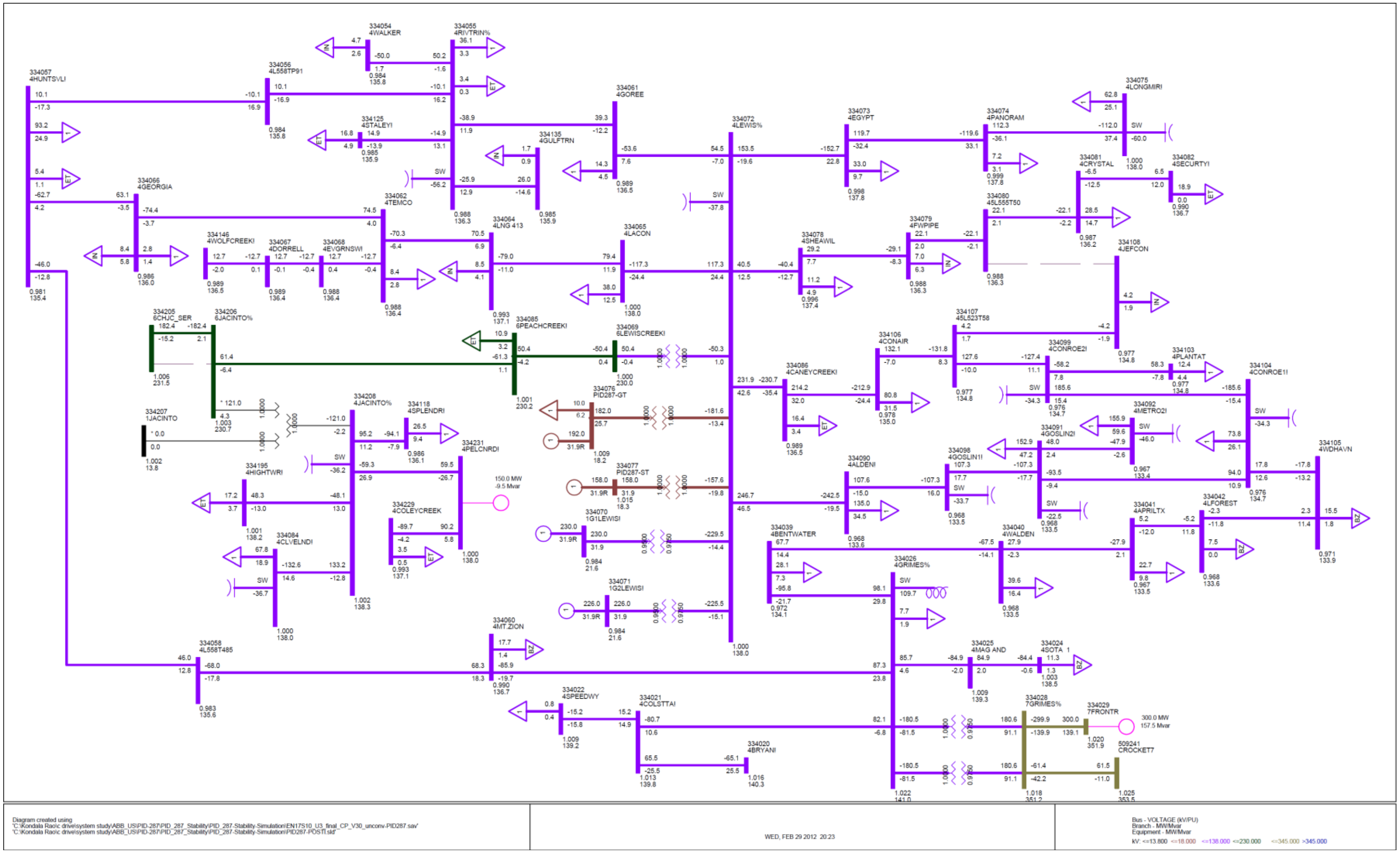


Figure 9.2: 2017 Summer Peak Flows and Voltages <u>with</u> PID 287

9.3 Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID 287 generation 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, SLG stuck-breaker faults were simulated. The fault clearing times used for the simulations are given in Table 9.1 below.

Table 9.1: Fault Clearing Times

Faulted bus kV level	Normal Clearing	Delayed Clearing
138	6 cycles	6+13 cycles
230	6 cycles	6+9 cycles
345	5 cycles	5+9 cycles

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

Table 9.2 and Table 9.3 list the fault cases that were simulated in this study for three-phase normal clearing and SLG with stuck breaker faults respectively. Twenty-three (23) three-phase normally cleared and eighteen (18) SLG stuck-breaker faults were simulated. Figure 9.3 through Figure 9.8 show the breaker layout diagrams for substations where faults were simulated.

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

Table 9.2: List of faults simulated for stability analysis (3-phase faults with normal clearing)

CASE	Line on which fault occurs	Clearing (cycles)	Primary Breakers	Tripped Facilities
FAULT-1	Lewis Creek-Longmire 138 kV	6	1665,16945	Lewis Creek-Longmire 138 kV
FAULT-2	Lewis Creek-Alden 138 kV	6	16585,26090	Lewis Creek-Alden 138 kV
FAULT-3	Lewis Creek-Conroe Bulk 138 kV	6	1655,1660,6385	Lewis Creek-Conroe Bulk 138 kV
FAULT-4	Lewis Creek-Security 138 kV	6	1650,1655, 26060	Lewis Creek-Security 138 kV
FAULT-5	Lewis Creek – Rivtrin 138 kV	6	1625,1630,6465,6865	Lewis Creek – Rivtrin 138 kV
FAULT-6	Lewis Creek – Huntsville 138 kV	6	1615,1620, 16160	Lewis Creek – Huntsville 138 kV
FAULT-7	Lewis Creek 230/138 kV Auto trafo	6	1615,1610, 1670	Lewis Creek 230/ 138 kV trafo
FAULT-8	Jacinto – Splendora 138 kV	6	16500, 16505, 26300	Jacinto – Splendora 138 kV
FAULT-9	Jacinto – Cleveland 138 kV	6	16515, 165251, 6495	Jacinto – Cleveland 138 kV
FAULT-10	Jacinto – Hightower 138 kV	6	16505, 16515, 26250	Jacinto – Hightower 138 kV
FAULT-11	Jacinto 230/138 kV trafo	6	16500, 16510, 26200, 26390	Jacinto 230/138 kV trafo
FAULT-12	Jacinto – Peach Creek 230 kV	6	26390, 26395, 26105	Jacinto – Peach Creek 230 kV
FAULT-13	Grimes – Huntsville 138 kV	6	16630, 16635, 16665	Grimes – Huntsville 138 kV
FAULT-14	Grimes – Conroe Bulk 138 kV	6	26280, 16250	Grimes – Conroe Bulk 138 kV
FAULT-15	Grimes – Navasota 138 kV	6	16630, 16625, 16430	Grimes – Navasota 138 kV
FAULT-16	Grimes – College Station Jn 138 kV	6	16610, 16615,26400, 26410	Grimes – College Station Jn 138 kV
FAULT-17	Grimes 345/138 kV auto trafo-1	6	16615, 16810, 26170, 26180	Grimes 345/138 kV auto trafo-1
FAULT-18	Grimes – Swepco Crockett 345 kV	5	16800, 26170, 12630	Grimes – Swepco Crockett 345 kV
FAULT-19	Porter– Splendora 138 kV	6	23065, 23070, 26305	Porter– Splendora 138 kV
FAULT-20	Porter– New Caney 138 kV	6	23080, 23085, 6980	Porter– New Caney 138 kV
FAULT-21	Porter– Tamina 138 kV	6	23085, 23090, 26075	Porter– Tamina 138 kV
FAULT-22	Porter– Oak Ridge 138 kV	6	23070, 23075, 16110	Porter– Oak Ridge 138 kV
FAULT-23	Porter 230/138 kV trafo	6	24000, 24005, 23050	Porter 230/138 kV trafo

Table 9.3: List of faults simulated for stability analysis (SLG faults with stuck breaker)

Case	Line on which fault occurs	Fault clearing					Tripped Facilities
		Primary (cy)	Back-up (cy)	Stuck Bkr	Primary Breaker(s)	Secondary Breaker(s)	
FAULT-1A	Lewis Creek-Longmire 138 kV	6	13	1665	16945	1650, 1640, 1625, 1600, 1610, 26225	Lewis Creek-Longmire 138kV
FAULT-2A	Lewis Creek-Alden 138 kV	6	13	16585	26090	1660, 1645, 1635, 1605, 1620	Lewis Creek-Alden 138kV
FAULT-3A	Lewis Creek-Conroe Bulk 138 kV	6	13	1655	1660, 6385	1650, 26060	Lewis Creek-Conroe Bulk 138kV, Lewis Creek-Security 138kV
FAULT-4A	Lewis Creek-Security 138 kV	6	13	1655	1650, 26060	1660, 6385	Lewis Creek-Security 138 kV, Lewis Creek-Conroe Bulk 138 kV
FAULT-5A	Lewis Creek – Rivtrin 138 kV	6	13	1630	1625, 6465, 6865	1635	Lewis Creek – Rivtrin 138 kV
FAULT-6A	Lewis Creek – Huntsville 138 kV	6	13	1615	1620, 16160	1610, 1670	Lewis Creek – Huntsville 138 kV, Lewis Creek 230/ 138 kV trafo
FAULT-7A	Lewis Creek 230/138 kV Auto trafo	6	13	1615	1610, 1670	1620, 16160	Lewis Creek 230/ 138 kV trafo, Lewis Creek – Huntsville 138 kV
FAULT-8A	Jacinto – Splendora 138 kV	6	13	16505	16500, 26300	16515, 26250	Jacinto – Splendora 138 kV, Jacinto – Hightower 138 kV
FAULT-9A	Jacinto – Cleveland 138 kV	6	13	16515	16515, 165251, 6495	16505, 26250	Jacinto – Cleveland 138 kV, Jacinto – Hightower 138 kV
FAULT-10A	Jacinto 230/138 kV trafo	6	13	16500	16510, 26200, 26390	16505, 26300	Jacinto 230/138 kV trafo, Jacinto – Splendora 138 kV

Case	Line on which fault occurs	Fault clearing					Tripped Facilities
		Primary (cy)	Back-up (cy)	Stuck Bkr	Primary Breaker(s)	Secondary Breaker(s)	
FAULT-11A	Jacinto – Peach Creek 230 kV	6	9	26390	26395, 26105	16500, 16510, 26200	Jacinto – Peach Creek 230 kV, Jacinto 230/138 kV trafo
FAULT-12A	Grimes – Huntsville 138 kV	6	13	16630	16635, 16665	16630, 16625, 16430	Grimes – Huntsville 138 kV, Grimes – Navasota 138 kV
FAULT-13A	Grimes – Conroe Bulk 138 kV	6	13	26280	16250	16610, 16615,26400, 26410, 16630, 16625, 16430	Grimes – Conroe Bulk 138 kV, Grimes – College Station Jn 138 kV , Grimes – Navasota 138 kV
FAULT-14A	Grimes 345/138 kV auto trafo-1	6	13	16615	16810, 26170, 26180	16610, 26400, 26410	Grimes 345/138 kV auto trafo-1, Grimes – College Station Jn 138 kV
FAULT-15A	Grimes – Swepco Crockett 345 kV	5	9	26170	16800, 12630	26180, 16615, 16810	Grimes – Swepco Crockett 345 kV, Grimes 345/138 kV auto trafo-1
FAULT-16A	Porter– Tamina 138 kV	6	13	23085	23090, 26075	23080, 6980	Porter– Tamina 138 kV, Porter– New Caney 138 kV
FAULT-17A	Porter– Oak Ridge 138 kV	6	13	23070	23075, 16110	23065, 26305	Porter– Oak Ridge 138 kV, Porter– Splendora 138 kV
FAULT-18A	Porter 230/138 kV trafo	6	13	24000	24005, 23050	23095	Porter 230/138 kV trafo, Porter - Dry creek 138 kV

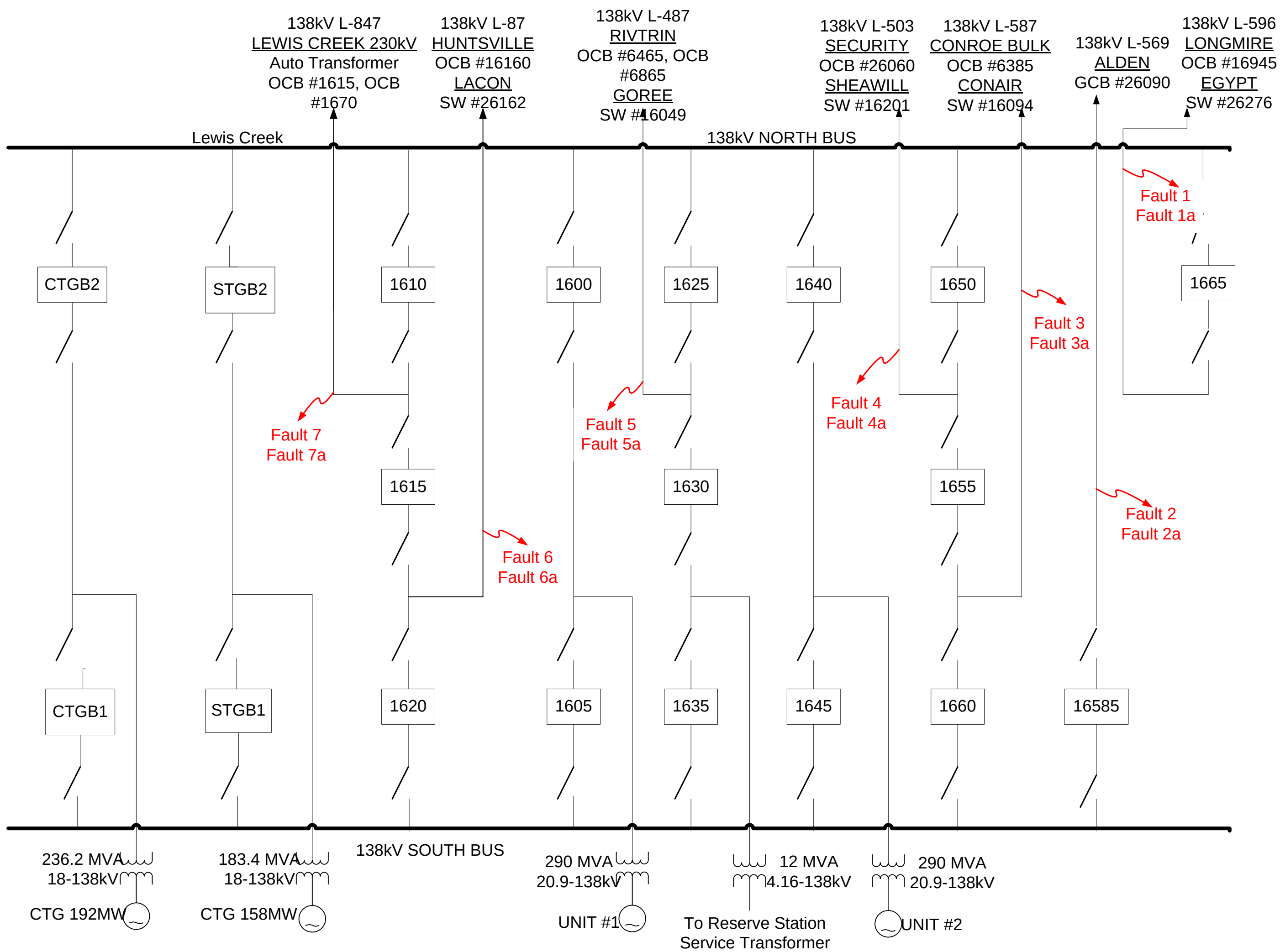


Figure 9.3: Lewis Creek 138 kV Substation with PID 287

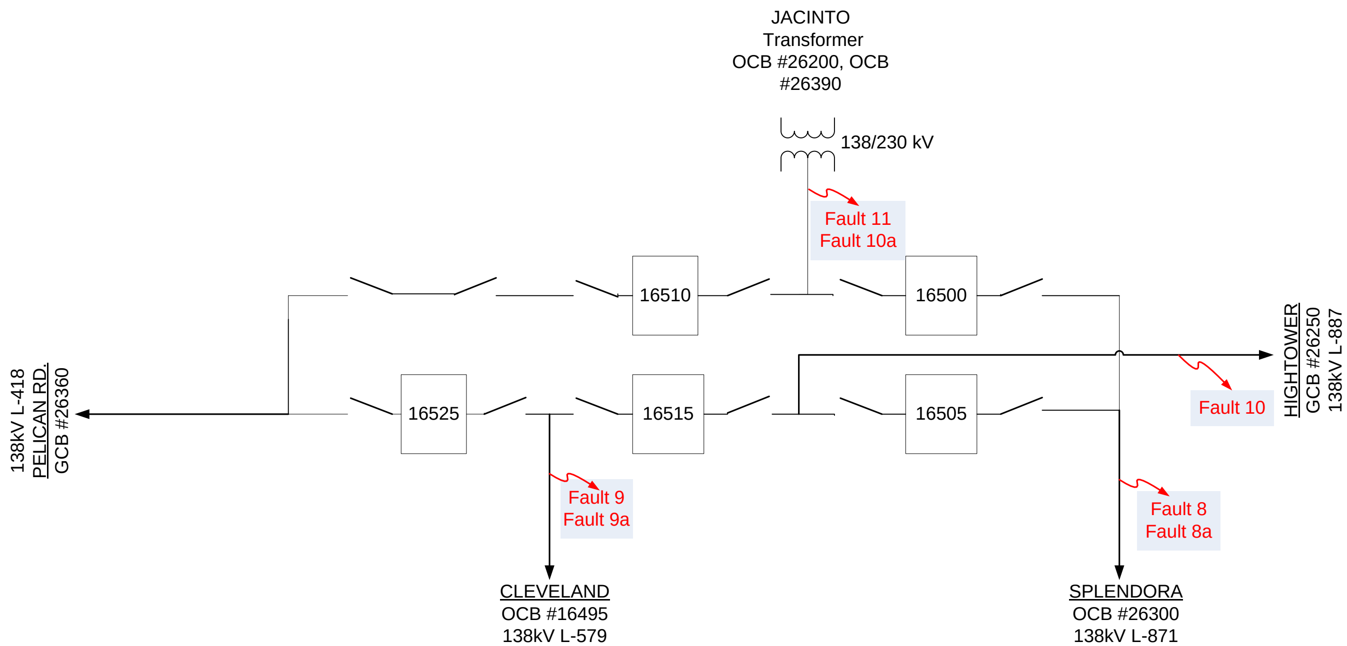


Figure 9.4: Jacinto 138 kV Substation

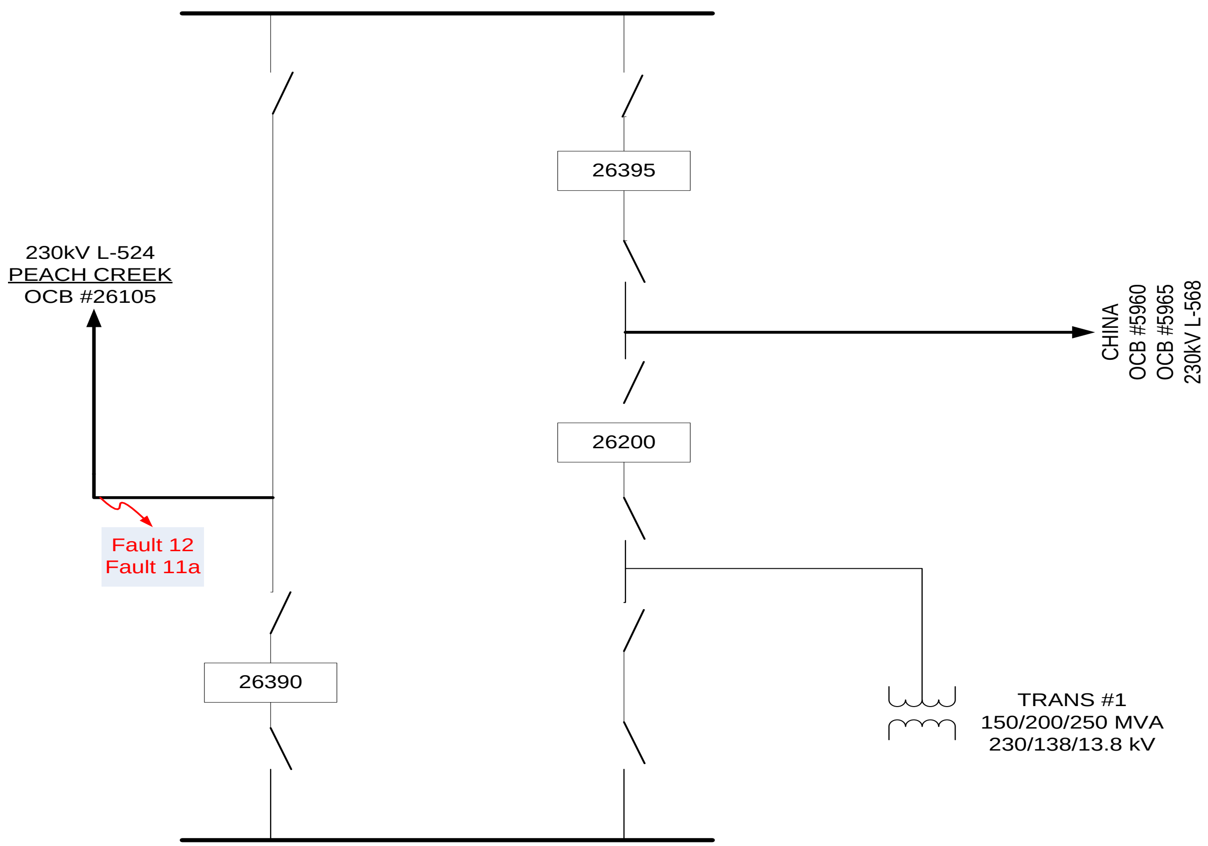


Figure 9.5: Jacinto 230 kV Substation

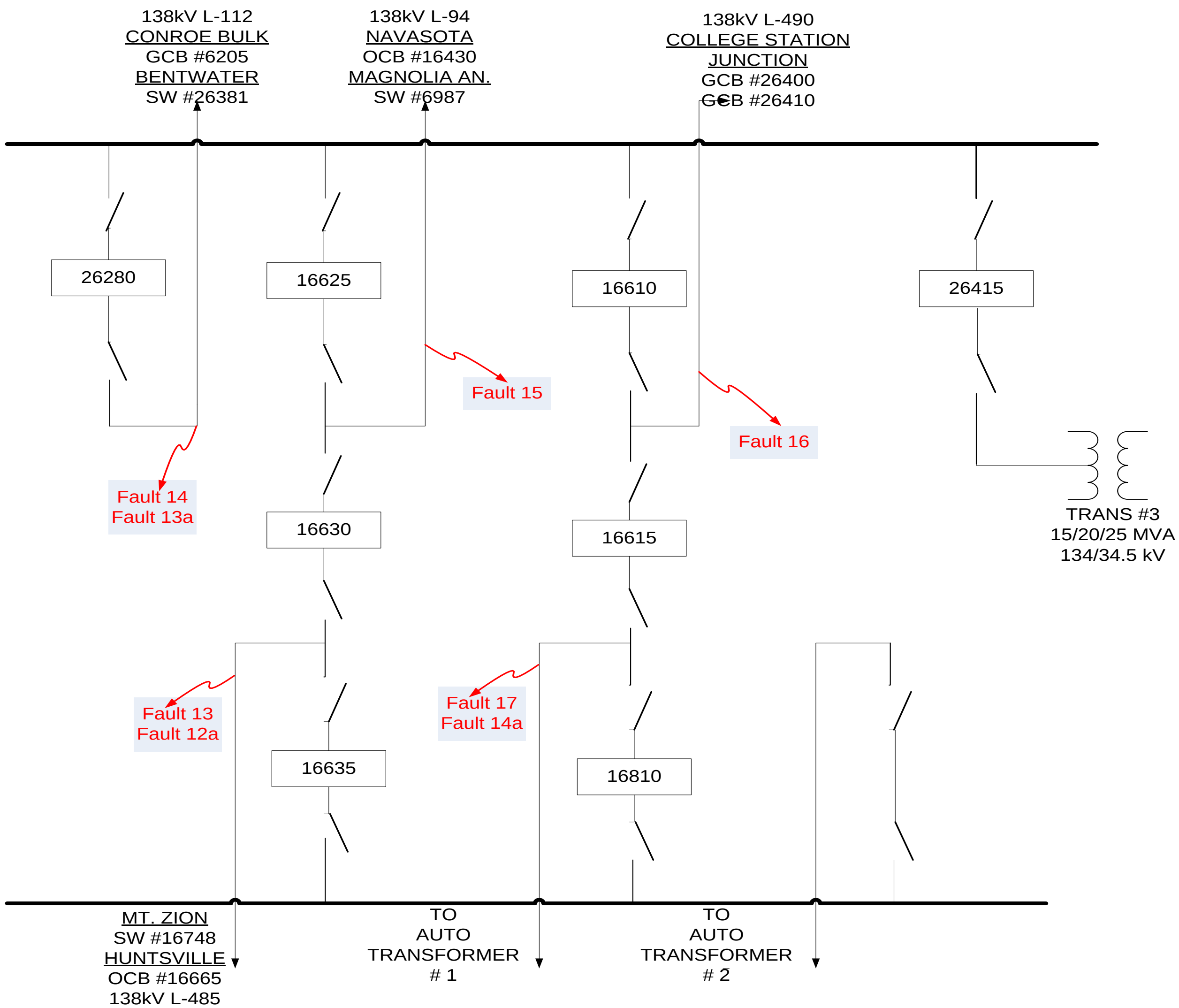


Figure 9.6: Grimes 138 kV Substation

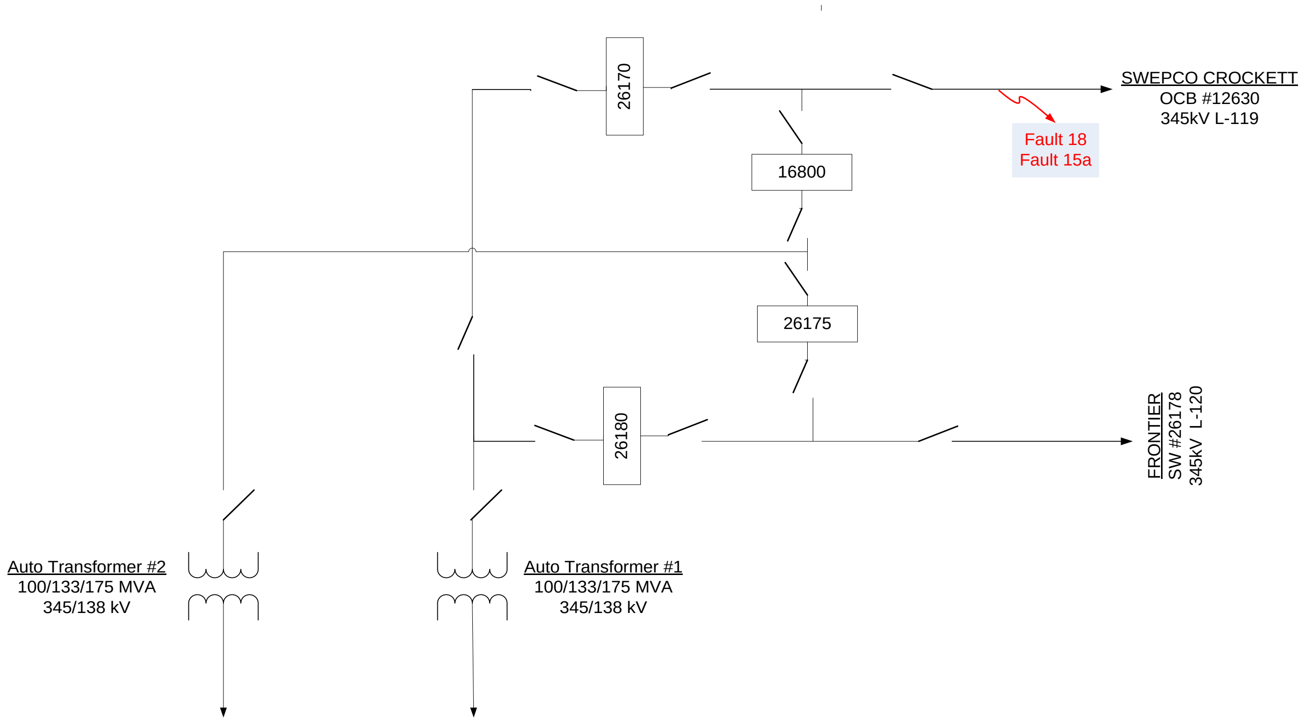


Figure 9.7: Grimes 345 kV Substation

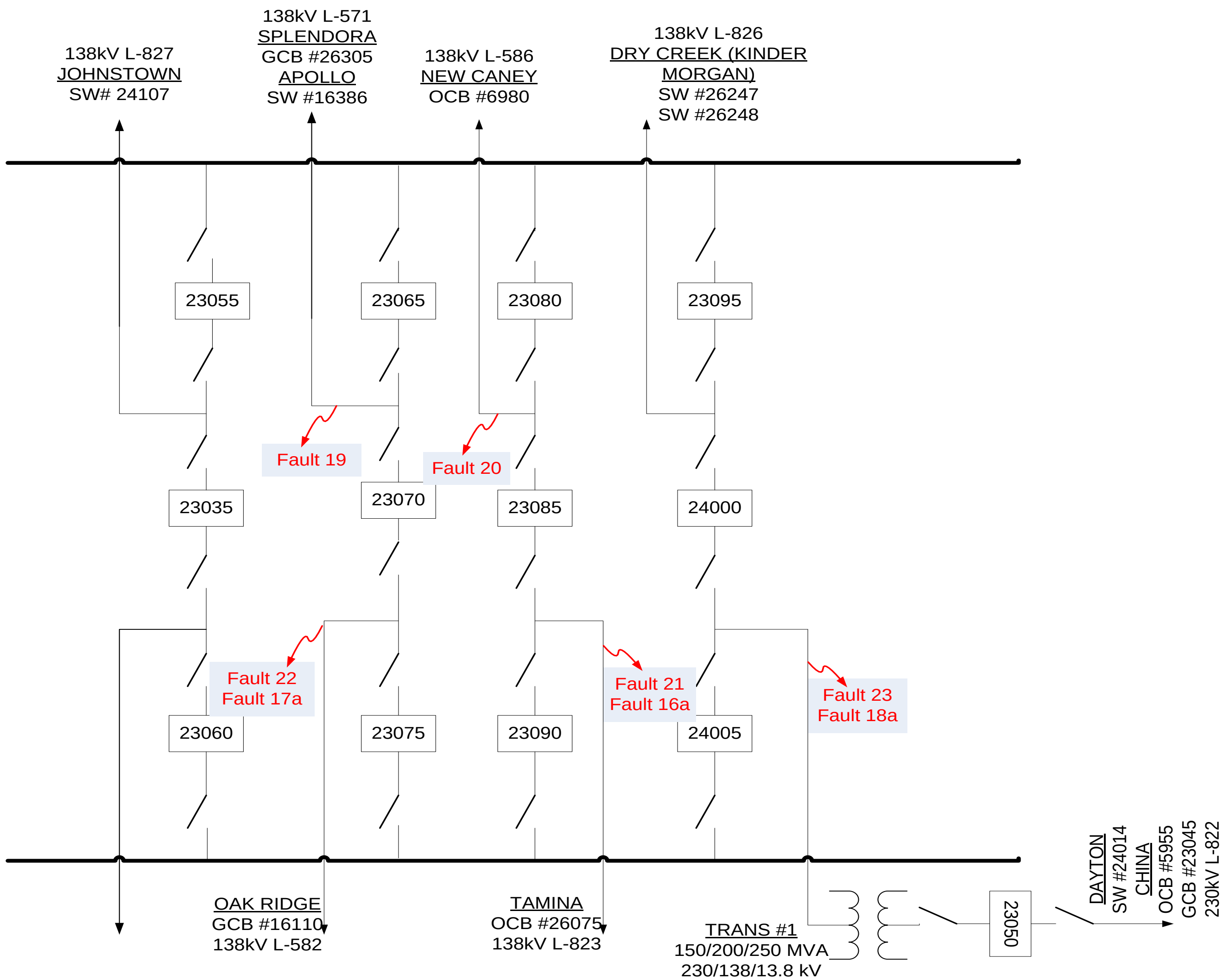


Figure 9.8: Porter 138 kV Substation

The system was found to be STABLE following all the simulated faults. Table 9.4 shows the simulation results for the three-phase normally cleared and stuck-breaker faults and the plots for the stability simulations are included in Appendix C.

Figure 9.9 and Figure 9.10 shows the CTG and STG quantities for Fault 1, which is a three-phase fault at the PID 287 POI bus on the Longmire 138 kV line.

9.3.1 Transient Voltage Recovery

No voltage criteria violations were observed following the simulated faults.

The voltages at all buses in the Entergy system in the vicinity of the project were monitored during each of the fault cases. No voltage criteria violations were observed following normally-cleared three-phase faults.

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

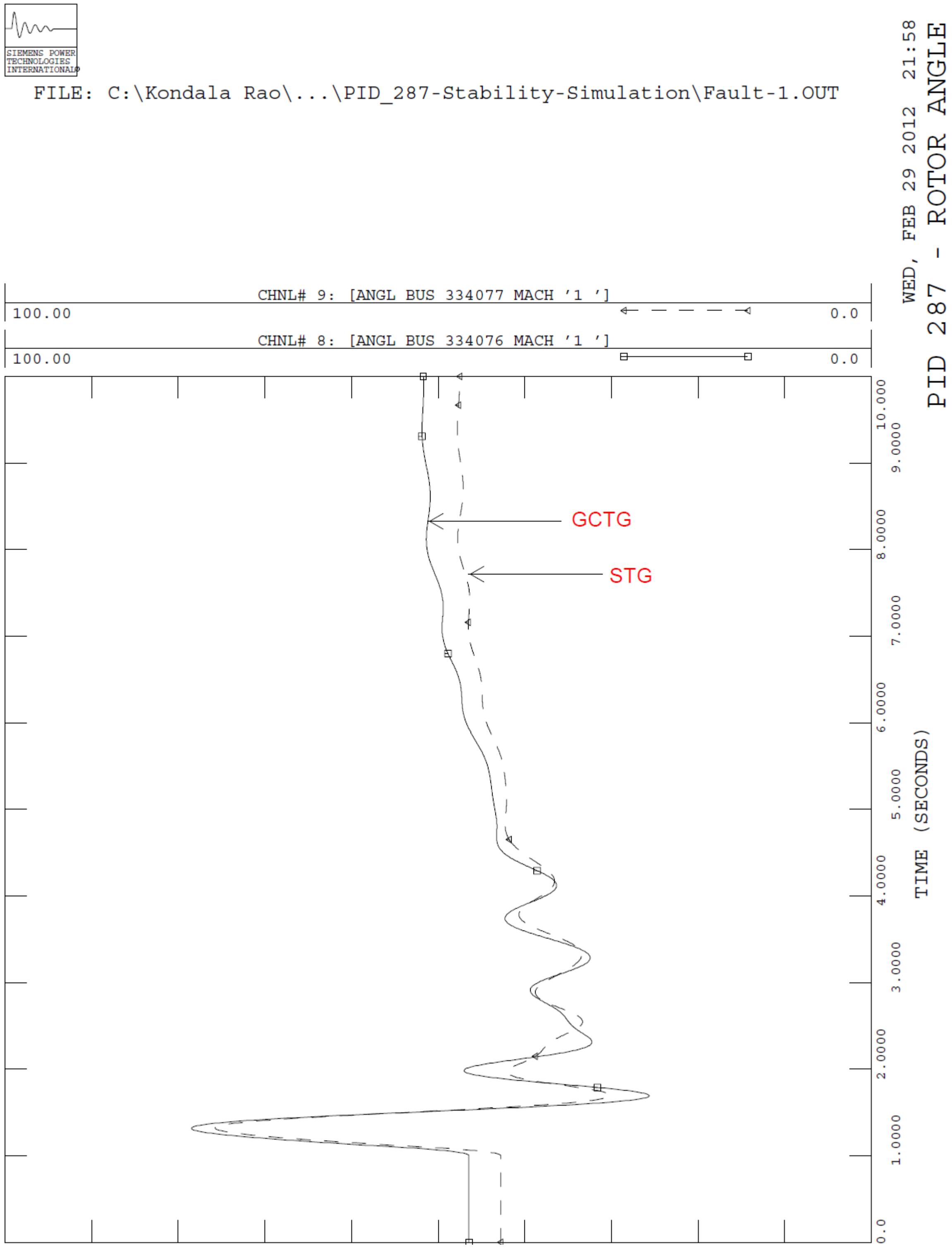


Figure 9.9: PID 287 Machine rotor angle for Fault-1_3PH

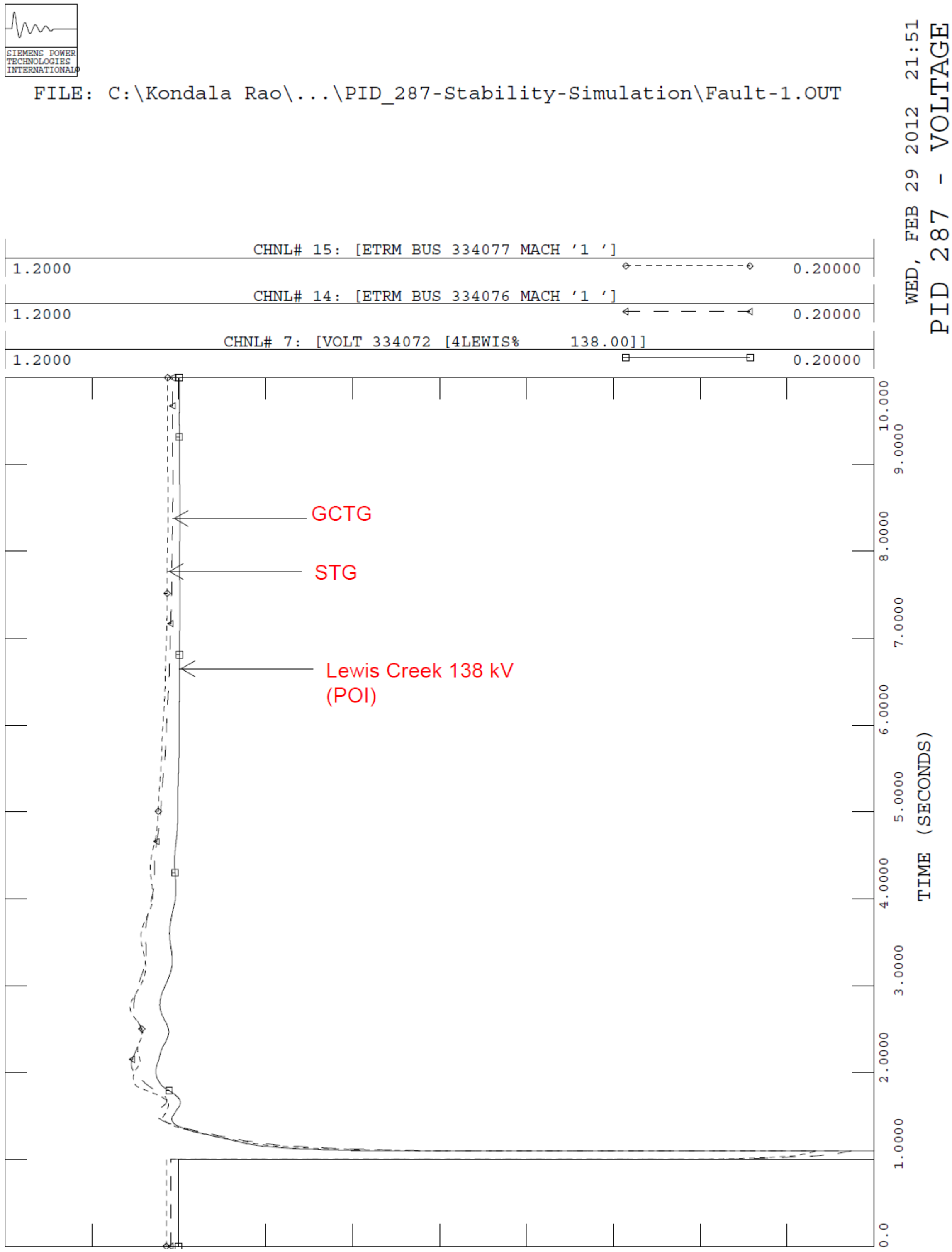


Figure 9.10: PID 287 and POI voltage for Fault-1_3PH

Table 9.4: Normally Cleared and Stuck-breaker Faults Simulation Results

Fault #	Stable?	Acceptable Voltages?
Fault-1	YES	YES
Fault-2	YES	YES
Fault-3	YES	YES
Fault-4	YES	YES
Fault-5	YES	YES
Fault-6	YES	YES
Fault-7	YES	YES
Fault-8	YES	YES
Fault-9	YES	YES
Fault-10	YES	YES
Fault-11	YES	YES
Fault-12	YES	YES
Fault-13	YES	YES
Fault-14	YES	YES
Fault-15	YES	YES
Fault-16	YES	YES
Fault-17	YES	YES
Fault-18	YES	YES
Fault-19	YES	YES
Fault-20	YES	YES
Fault-21	YES	YES
Fault-22	YES	YES
Fault-23	YES	YES
Fault-1A	YES	YES
Fault-2A	YES	YES
Fault-3A	YES	YES
Fault-4A	YES	YES
Fault-5A	YES	YES
Fault-6A	YES	YES
Fault-7A	YES	YES
Fault-8A	YES	YES
Fault-9A	YES	YES
Fault-10A	YES	YES
Fault-11A	YES	YES

Fault #	Stable?	Acceptable Voltages?
Fault-12A	YES	YES
Fault-13A	YES	YES
Fault-14A	YES	YES
Fault-15A	YES	YES
Fault-16A	YES	YES
Fault-17A	YES	YES
Fault-18A	YES	YES

APPENDIX A: Data Provided by Customer

APPENDIX 1 to LGIP
INTERCONNECTION REQUEST FOR A
LARGE GENERATING FACILITY

1. The undersigned Interconnection Customer submits this request to interconnect its Large Generating Facility with Transmission Provider's Transmission System pursuant to a Tariff.

2. This Interconnection Request is for (check one):
   _X_ A proposed new Large Generating Facility.
   __ An increase in the generating capacity or a Material Modification of an existing Generating Facility.

3. The type of interconnection service requested (check one):
   _____ Energy Resource Interconnection Service
   _X_ Network Resource Interconnection Service

4. _____ Check here only if Interconnection Customer requesting Network Resource Interconnection Service also seeks to have its Generating Facility studied for Energy Resource Interconnection Service

5. Interconnection Customer provides the following information:

   a. Address or location or the proposed new Large Generating Facility site (to the extent known) or, in the case of an existing Generating Facility, the name and specific location of the existing Generating Facility;
   Lewis Creek 138kV bus, Montgomery County, Texas

   b. Summer and Winter electrical output
   Maximum summer at 36˚C (163 MW + 157 MW– 10 MW= **310 MW**) and winter at -1˚C (192 MW + 158 MW -10 MW = **340 MW**) degrees C megawatt electrical output of the new Large Generating Facility or the amount of megawatt increase in the generating capacity of an existing Generating Facility;`

   c. General description of the equipment configuration;
   A combustion turbine unit tied to the Lewis Creek 138kV station trough a 138/18kV auto transformer and a steam turbine unit tied to the Lewis Creek 138kV station through a 138/18kV autotransformer. Please see one-line for electrical connection to the grid.

d. Commercial Operation Date (Day, Month, and Year);
May 1, 2017

e. Name, address, telephone number, and e-mail address of Interconnection Customer's contact person;

f. Approximate location of the proposed Point of Interconnection (optional); and

g. Interconnection Customer Data (set forth in Attachment A)

6. Applicable deposit amount as specified in the LGIP.

7. Evidence of Site Control as specified in the LGIP (check one)
_X_ Is attached to this Interconnection Request
___ Will be provided at a later date in accordance with this LGIP

8. This Interconnection Request shall be submitted to the representative indicated below:

[To be completed by Transmission Provider]

9. Representative of Interconnection Customer to contact:

10. This Interconnection Request is submitted by:

Name of Interconnection Customer:

By (signature): ____

Name (type or print):

Title:
Date: ____________________

LARGE GENERATING FACILITY DATA (CT units)

UNIT RATINGS

kVA 229000 °F 104 Voltage 18000 V
Power Factor 0.85
Speed (RPM) 3600 Connection (e.g. Wye) WYE
Short Circuit Ratio 0.5 Frequency, Hertz 60
Stator Amperes at Rated kVA 7345 Field Volts 375V
Max Turbine MW 163 °F 97
Max Turbine MW 192 °F 30

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 5.0378 kW sec/kVA
Moment-of-Inertia, WR^2 = 378620 lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	2.06	X_{qv}	1.95
Synchronous – unsaturated	X_{di}	2.06	X_{qi}	1.95
Transient – saturated	X'_{dv}	0.23	X'_{qv}	N/A
Transient – unsaturated	X'_{di}	0.26	X'_{qi}	0.455
Subtransient – saturated	X''_{dv}	0.15	X''_{qv}	0.15
Subtransient – unsaturated	X''_{di}	0.19	X''_{qi}	0.19
Negative Sequence – saturated	$X2_v$	0.15		
Negative Sequence – unsaturated	$X2_i$	0.19		
Zero Sequence – saturated	$X0_v$	0.12		
Zero Sequence – unsaturated	$X0_i$	0.12		
Leakage Reactance	Xl_m	0.13		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	7.0	T'_{qo}	0.57
Three-Phase Short Circuit Transient	T'_{d3}	0.7	T'_{q}	0.13
Line to Line Short Circuit Transient	T'_{d2}	1.2		
Line to Neutral Short Circuit Transient	T'_{d1}	1.5		
Short Circuit Subtransient	T''_{d}	0.026	T''_{q}	0.026
Open Circuit Subtransient	T''_{do}	0.040	T''_{qo}	0.079

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.39
Line to Line Short Circuit	T_{a2}	0.39
Line to Neutral Short Circuit	T_{a1}	0.31

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

MW CAPABILITY AND PLANT CONFIGURATION
LARGE GENERATING FACILITY DATA

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Positive	R_1	0.0029
Negative	R_2	0.0138
Zero	R_0	0.0073

Rotor Short Time Thermal Capacity I_2^2t = 10.0
Field Current at Rated kVA, Armature Voltage and PF = 1644 amps
Field Current at Rated kVA and Armature Voltage, 0 PF = 2021 amps
Three Phase Armature Winding Capacitance = 0.8156 microfarad
Field Winding Resistance = 0.1934 ohms 125 °C
Armature Winding Resistance (Per Phase) = 0.0017 ohms 100 °C

CURVES

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

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Capacity Self-cooled / Maximum Nameplate
141700 / 236200 kVA

Voltage Ratio(Generator Side/System side/Tertiary)
18 / 138 / none kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
delta / wye / none

Fixed Taps Available
±2 of 2.5%

Present Tap Setting
138 kV

IMPEDANCE

Positive	Z_1 (on self-cooled kVA rating)	8.75 %	approx 30 X/R
Zero	Z_0 (on self-cooled kVA rating)	8.75 %	approx 30 X/R

EXCITATION SYSTEM DATA

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

Excitation system model is ESST4B. See attached for constants.
PSS system model is PSS2B (Similar to PSS2A). See attached for constants.

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.

Governor model is GGOV1. See attached for constants.

WIND GENERATORS

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

____

Elevation: ______________ _____ Single Phase _____ Three Phase

Inverter manufacturer, model name, number, and version:

____

List of adjustable setpoints for the protective equipment or software:

____

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

CTG Data for Interconnection Study

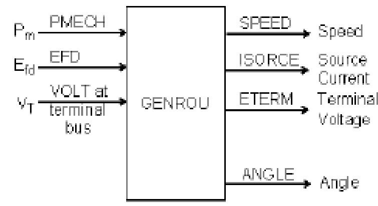
General	
Gross MW	192MW
Aux Power Consumption	10MW
One Line (Attached)	(Attached)
Step Up Transformer	
HV	138
LV	18
MVA Rating	141.7/189/236.2
Taps (High Side)	2 steps of 2.5% above and below
Taps (Low Side)	None
%Z	8.75%
X/R Ratio	30
Generator	
Manufacturer	GE
Rated MVA	229
kV	18
Power Factor	0.85
Reactive Capability Curve	101T7032 (Attached)
Generator Model (Control Block Diagram)	GENROU
AVR	
Type	Static
Control Block Diagram	ESST4B
Turbine and Governer	
Governor Model (Control Block Diagram)	GGOV1
Power System Stabilizer	
Model (Control Block Diagram)	S2B

Created: ________
Reviewed: ________
Approved: ________

GENROU
Lewis Creek Request
Round Rotor Generator Model (Quadratic Saturation)

This model is located at system bus # ______ IBUS,
machine # ______ I.
This model uses CONs starting with # ______ J,

The machine MVA base is 229.000 for each of 1 units = 229.000 MBASE.
ZSORCE for this machine is 0.000 +j 0.200 on the above MBASE.



CONs	#	Value	Description
J		7.000	T'_{do} (>0)(Seconds)
J+1		0.040	T''_{do}(>0)(Seconds)
J+2		0.570	T'_{qo}(>0)(Seconds)
J+3		0.079	T''_{qo}(>0)(Seconds)
J+4		5.038	Inerial H
J+5		0.000	Speed Damping D
J+6		2.060	X_d
J+7		1.950	X_q
J+8		0.230	X'_d
J+9		0.455	X'_q
J+10		0.150	X''_d=X''_q
J+11		0.130	X_l
J+12		0.056	S(1.0)
J+13		0.550	S(1.2)

X_d, X_q, X'_d,X'_q, X''_d, X''_q, X_l, H and D are in p.u., machine MVA base.

X''_q must be equal to X''_d

IBUS, 'GENROU', I, T'_{do}, T''_{do}, T'_{qo}, T''_{qo}, H, D, X_d, X_q, X'_d, X'_q, X''_d, X_l, S(1.0), S(1.2)/

File: Part 03 CTG GENROU ESST4B TGOV.xls Tab: GENROU

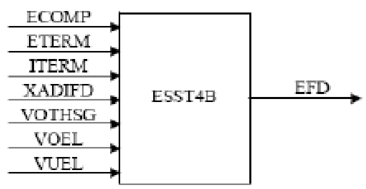
Created: ________
Reviewed: ________
Approved: ________

ESST4B
Lewis Creek Request
IEEE Type ST4B Potential or Compounded Source-Controlled Rectifier Exciter
EX2100 Feeding Generator Field Directly (Static Exciter)

This model is located at system bus # ________ IBUS,
machine # ________ I.
This model uses CONs starting with # ________ J,
and STATEs starting with # ________ K,

CONs	#	Value	Description
J		0	T_R (sec)
J+1		3.57	K_{PR}
J+2		3.57	K_{IR}
J+3		0.96	V_{RMAX}
J+4		-0.83	V_{RMIN}
J+5		0.01	T_A (sec)
J+6		1	K_{PM}
J+7		0	K_{IM}
J+8		0.96	V_{MMAX}
J+9		-0.83	V_{MMIN}
J+10		0	K_G
J+11		6.19	K_P
J+12		0	K_I
J+13		7.75	V_{BMAX}
J+14		0.08	K_C
J+15		0	X_L
J+16		0	THETAP

STATEs	#	Description
K		Sensed V_T
K+1		Regulator integrator
K+2		Regulator output, V_R
K+3		V_M



Created: ________
Reviewed: ________
Approved: ________

ESST4B

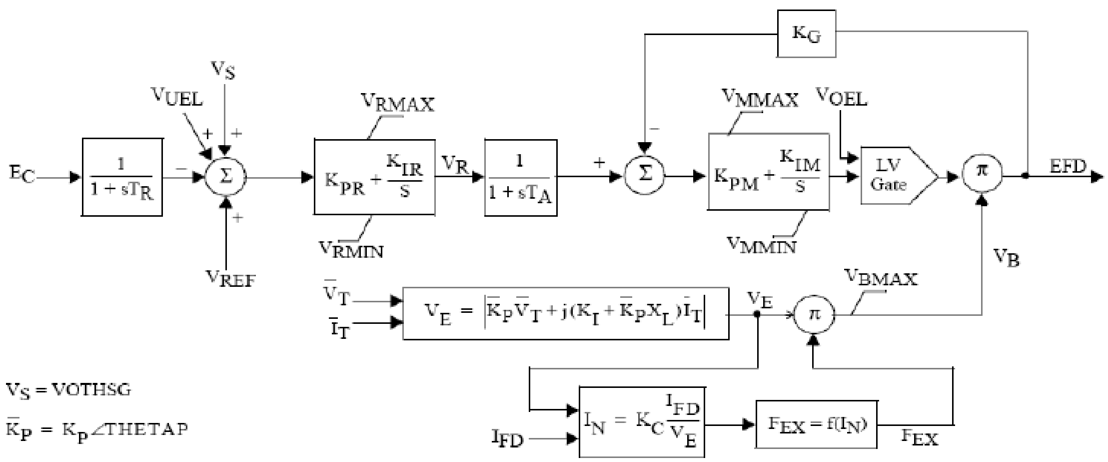
Lewis Creek Request

IEEE Type ST4B Potential or Compounded Source-Controlled Rectifier Exciter

EX2100 Feeding Generator Field Directly (Static Exciter)

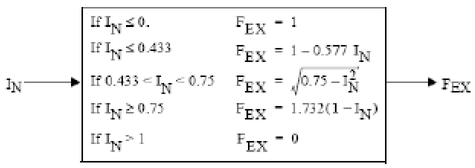
This model is located at system bus	#________	IBUS,
machine	#________	I,
This model uses CONs starting with	#________	J,
and STATEs starting with	#________	K,

IBUS, 'ESST4B', I, T_R, K_{PR}, K_{IR}, V_{RMAX}, V_{RMIN}, T_A, K_{PM}, K_{IM}, V_{MMAX}, V_{MMIN}, K_G, K_P, K_I, V_{BMAX}, K_C, X_L, THETAP/



V_S = VOTHSG

$\bar{K}_P = K_P \angle$THETAP

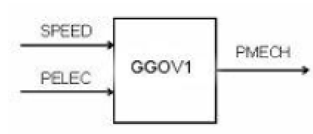


File: Part 03 CTG GENROU ESST4B TGOV.xls   Tab: ESST4B

Created: ______
Reviewed: ______
Approved: ______

GGOV1
Lewis Creek Request
GE General Governor Turbine Model

This model is located at system bus # ______ IBUS,
machine # ______ I.
This model uses CONs starting with # ______ J,
and STATEs starting with # ______ K
and VARs starting with # ______ L
and ICONs starting with # ______ M



CONs	#	Value	Description
J		0.04	R Permanent droop, pu
J+1		1	T_{pelec} Electrical power transducer time constrant, sec
J+2		0.05	Maxerr Maximum value for speed error signal
J+3		-0.05	Minerr Minimum value for speed error signal
J+4		10	K_{pgov} Governor proportional gain
J+5		2	K_{igov} Governor integral gain
J+6		0	K_{dgov} Governor derivative gain
J+7		1	T_{dgov} Governor derivative controller time constant, sec
J+8		1	V_{max} Maximum valve positon limit
J+9		0.15	V_{min} Minimum valve position lmit
J+10		0.5	T_{act} Actuator time constant, sec
J+11		1.5	K_{turb} Turbine gain
J+12		0.2	W_{fnl} No load fuel flow, pu
J+13		0.1	T_b Turbine lag time constant, sec
J+14		0	T_c Turbine lead time constant, sec
J+15		0	T_{eng} Transport lag time constant for diesel engine, sec
J+16		3	T_{fload} Load Limiter time constant, sec
J+17		2	K_{pload} Load limiter proportional gain for PI controller
J+18		0.67	Ki_{load} Load limiter integral gain for PI controller
J+19		1.062	L_{dref} Load limiter reference value pu

CONs	#	Value	Description
J+20		0	D_m Mechanical damping coefficient, pu
J+21		0.1	R_{open} Maximum valve opening rate, pu/sec
J+22		-0.1	R_{close} Maximum valve closing rate, pu/sec
J+23		0	K_{imw} Power controller(reset) gain
J+24		0.01	A_{set} Acceleration limiter setpoint, pu/sec
J+25		10	K_a Acceleration limiter gain
J+26		0.1	T_a Acceleration limiter time constant, sec
J+27		166	T_{rate} Turbine rating (MW)
J+28		0	db Speed governor deadband
J+29		4	T_{sa} Temperature detection lead time constant, sec
J+30		5	T_{sb} Temperature detection lag time constant, sec
J+31		99	R_{up} Maximum rate of load limit increase
J+32		-99	R_{down} Maximum rate of load limit decrease

File: Part 03 CTG GENROU ESST4B TGOV.xls Tab: GGOV1

Created: ________

Reviewed: ________

Approved: ________

GGOV1

Lewis Creek Request

GE General Governor Turbine Model

This model is located at system bus # ________ IBUS,

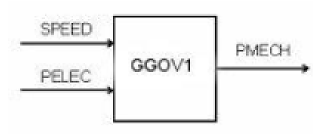
machine # ________ I.

This model uses CONs starting with # ________ J,

and STATEs starting with # ________ K

and VARs starting with # ________ L

and ICONs starting with # ________ M



ICON	#	Value	Description
M		1	Rselect Feedback signal for governor droop = 1 electrical power = 0 none (isochronous governor) = -1 governor output (requested stroke) = -2 fuel valve stroke (true stroke)
M+1		0	Flag Switch fur fuel source characteristic = 0 fuel flow independent of speed = 1 fuel flow proportional to speed

STATEs	#	Description
K		Machine Electrical Power Measurement
K+1		Governor Differential Control
K+2		Governor Integral Control
K+3		Turbine Actuator
K+4		Turbine Lead-Lag
K+5		Turbine load limiter measurement
K+6		Turbine Load Limiter Integral Control
K+7		Supervisory Load Control
K+8		Acceleration Control
K+9		Temperature Detection Lead-Lag

VARs	#	Description
L		
L+1		
L+2		
L+3		
L+4		
L+5		
L+6		
L+7 . . . L+19		
L+20		

LARGE GENERATING FACILITY DATA (CT units)

UNIT RATINGS

kVA __180000________ °F ___104_____ Voltage __18000 V_______
Power Factor ___0.85____
Speed (RPM) ___3600_____ Connection (e.g. Wye) ___WYE___
Short Circuit Ratio _0.5___ Frequency, Hertz _____60_____
Stator Amperes at Rated kVA __5773_____ Field Volts __375V_______
Max Turbine MW ____157______°F _97__
Max Turbine MW ____158______°F _30__

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = ____5.0378_____________ kW sec/kVA
Moment-of-Inertia, WR^2 = ____378620_____________ lb. $ft.^2$

REACTANCE DATA (PER UNIT-RATED KVA)

		DIRECT AXIS		QUADRATURE AXIS
Synchronous – saturated	X_{dv}	1.744	X_{qv}	1.674
Synchronous – unsaturated	X_{di}	1.744	X_{qi}	1.674
Transient – saturated	X'_{dv}	0.187	X'_{qv}	N/A
Transient – unsaturated	X'_{di}	0.256	X'_{qi}	0.411
Subtransient – saturated	X''_{dv}	0.134	X''_{qv}	0.131
Subtransient – unsaturated	X''_{di}	0.184	X''_{qi}	0.182
Negative Sequence – saturated	$X2_v$	0.128		
Negative Sequence – unsaturated	$X2_i$	0.177		
Zero Sequence – saturated	$X0_v$	0.084		
Zero Sequence – unsaturated	$X0_i$	0.106		
Leakage Reactance	Xl_m	0.154		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	4.576	T'_{qo}	0.416
Three-Phase Short Circuit Transient	T'_{d3}	0.490	T'_{q}	0.416
Line to Line Short Circuit Transient	T'_{d2}	0.770		
Line to Neutral Short Circuit Transient	T'_{d1}	0.933		
Short Circuit Subtransient	T''_{d}	0.015	T''_{q}	0.015
Open Circuit Subtransient	T''_{do}	0.021	T''_{qo}	0.047

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.32
Line to Line Short Circuit	T_{a2}	0.32
Line to Neutral Short Circuit	T_{a1}	0.31

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

MW CAPABILITY AND PLANT CONFIGURATION LARGE GENERATING FACILITY DATA

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Positive	R_1	0.004
Negative	R_2	0.013
Zero	R_0	0.007

Rotor Short Time Thermal Capacity I_2^2t = 10.0

Field Current at Rated kVA, Armature Voltage and PF = 1644 amps

Field Current at Rated kVA and Armature Voltage, 0 PF = 2021 amps

Three Phase Armature Winding Capacitance = 0.8156 microfarad

Field Winding Resistance = 0.1934 ohms 125 °C

Armature Winding Resistance (Per Phase) = 0.0017 ohms 100 °C

CURVES

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

GENERATOR STEP-UP TRANSFORMER DATA RATINGS

Capacity Self-cooled / Maximum Nameplate
110000 / 183400 kVA

Voltage Ratio(Generator Side/System side/Tertiary)
18 / 138 / none kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))
delta / wye / none

Fixed Taps Available
±2 of 2.5%

Present Tap Setting
138 kV

IMPEDANCE

Positive	Z_1 (on self-cooled kVA rating) 8.75 %	approx 30	X/R
Zero	Z_0 (on self-cooled kVA rating) 8.75 %	approx 30	X/R

EXCITATION SYSTEM DATA

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

Excitation system model is ESST4B. See attached for constants.
PSS system model is PSS2A. See attached for constants.

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.

Governor model is TGOV1. See attached for constants.

WIND GENERATORS

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

____

Elevation: ______________ _____ Single Phase _____ Three Phase

Inverter manufacturer, model name, number, and version:

____

List of adjustable setpoints for the protective equipment or software:

____

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

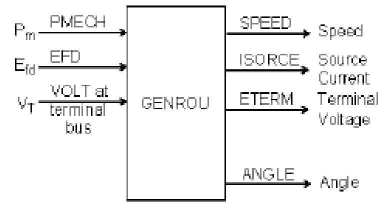
STG Data for Interconnection Study

General	
Gross MW	158MW
Aux Power Consumption	All BOP Load is attributed to the CTG Auxiliary Transformer for the purpose of this request. (See CTG Data)
One Line (Attached)	(Attached)
Step Up Transformer	
HV	138
LV	18
MVA Rating	110/146.7/183.4
Taps (High Side)	2 steps of 2.5% above and below
Taps (Low Side)	None
%Z	8.75%
X/R Ratio	30
Generator	
Manufacturer	GE
Rated MVA	180
kV	18
Power Factor	0.85
Reactive Capability Curve	STG CURVE 3 (Attached)
Generator Model (Control Block Diagram)	GENROU
AVR	
Type	Static
Control Block Diagram	ESST4B
Turbine and Governer	
Governor Model (Control Block Diagram)	TGOV1
Power System Stabilizer	
Model (Control Block Diagram)	S2A

Created: ____________
Reviewed: ____________
Approved: ____________

GENROU
Lewis Creek Request
Round Rotor Generator Model (Quadratic Saturation)

This model is located at system bus # ________ IBUS,
machine # ________ I.
This model uses CONs starting with # ________ J,



The machine MVA base is 180.000 for each of
1 units = 180.000 MBASE.
ZSORCE for this machine is 0.000 +j 0.210 on
the above MBASE.

CONs	#	Value	Description
J		4.575	T'_{do} (>0)(Seconds)
J+1		0.021	T''_{do}(>0)(Seconds)
J+2		0.416	T'_{qo}(>0)(Seconds)
J+3		0.047	T''_{qo}(>0)(Seconds)
J+4		5.038	Inerial H
J+5		0.000	Speed Damping D
J+6		1.744	X_d
J+7		1.674	X_q
J+8		0.187	X'_d
J+9		0.411	X'_q
J+10		0.131	$X''_d=X''_q$
J+11		0.154	X_l
J+12		0.056	S(1.0)
J+13		0.600	S(1.2)

X_d, X_q, X'_d, X'_q, X''_d, X''_q, X_l, H and D are in p.u., machine MVA base.

X''_q must be equal to X''_d.

IBUS, 'GENROU', I, T'_{do}, T''_{do}, T'_{qo}, T''_{qo}, H, D, X_d, X_q, X'_d, X'_q, X''_d, X_l, S(1.0), S(1.2)/

S(1.0)	S(1.2)
0.0944	0.2690

File: Part 10 STG GENROU ESST4B TGOV.xls Tab: GENROU

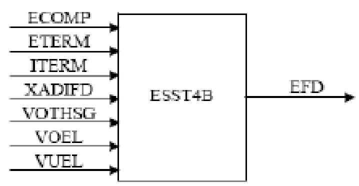
Created: ________
Reviewed: ________
Approved: ________

ESST4B
Lewis Creek Request
IEEE Type ST4B Potential or Compounded Source-Controlled Rectifier Exciter
EX2100 Feeding Generator Field Directly (Static Exciter)

This model is located at system bus # ________ IBUS,
machine # ________ I.
This model uses CONs starting with # ________ J,
and STATEs starting with # ________ K,

CONs	#	Value	Description
J		0	T_R (sec)
J+1		3.26	K_{PR}
J+2		3.26	K_{IR}
J+3		0.96	V_{RMAX}
J+4		-0.83	V_{RMIN}
J+5		0.01	T_A (sec)
J+6		1	K_{PM}
J+7		0	K_{IM}
J+8		0.96	V_{MMAX}
J+9		-0.83	V_{MMIN}
J+10		0	K_G
J+11		6.13	K_P
J+12		0	K_I
J+13		7.75	V_{BMAX}
J+14		0.08	K_C
J+15		0	X_L
J+16		0	THETAP

STATEs	#	Description
K		Sensed V_T
K+1		Regulator integrator
K+2		Regulator output, V_R
K+3		V_M



IBUS, 'ESST4B', I, T_R, K_{PR}, K_{IR}, V_{RMAX}, V_{RMIN}, T_A, K_{PM}, K_{IM}, V_{MMAX}, V_{MMIN}, K_G, K_P, K_I, V_{BMAX}, K_C, X_L, THETAP/

File: Part 10 STG GENROU ESST4B TGOV.xls Tab: ESST4B

Created: ________
Reviewed: ________
Approved: ________

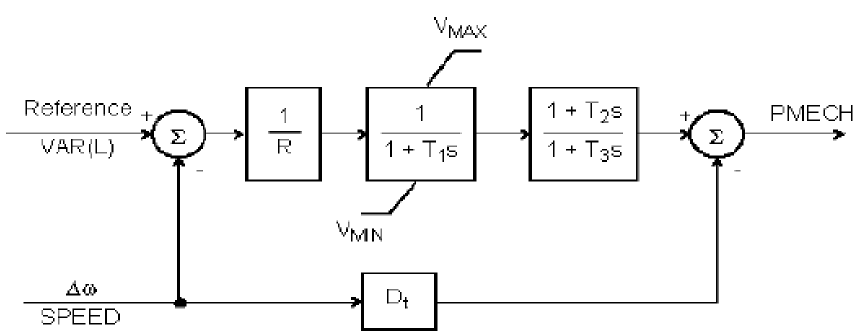
TGOV1
Lewis Creek Request
Steam Turbine Governor
Steam Turbines on Combined Cycles

This model is located at system bus # ________ IBUS,
machine # ________ I.
This model uses CONs starting with # ________ J,

CONs	#	Value	Description
J		0.05	R
J+1		999	T_1(>0)(Seconds)
J+2		1	V_{MAX}
J+3		0	V_{MIN}
J+4		2.1	T_2(Seconds)
J+5		7	T_3(>0)(Seconds)
J+6		0	D_t

Note: V_{MAX}, V_{MIN}, D_t are in per unit on generator base. T_2/T_3 = "high pressure fraction," T_3 = reheater time constant.

IBUS, 'TGOV1', I, R, T_1, V_{MAX}, V_{MIN}, T_2, T_3, D_t/



Units:

File: Part 10 STG GENROU ESST4B TGOV.xls Tab: TGOV1

APPENDIX B: Power flow and Stability Data

Loadflow Data

```
0,   100.00          / PSS/E-30.3    WED, FEB 29 2012  18:12


334076,'PID287-GT   ',  18.0000,2,     0.000,     0.000, 351, 103,1.00911,  -3.3336,   1
334077,'PID287-ST   ',  18.0000,2,     0.000,     0.000, 351, 103,1.01432,  -2.9133,   1
0 / END OF BUS DATA, BEGIN LOAD DATA
334076,'1 ',1, 351, 103,    10.000,     6.200,     0.000,     0.000,     0.000,
0.000,   1
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
334076,'1 ',   192.000,    31.030,   125.000,   -65.000,1.00000,334072,   229.000,
0.00000,   0.15000,   0.00000,   0.00000,1.00000,1,  100.0,   192.000,    28.800,
1,1.0000
334077,'1 ',   158.000,    31.030,    78.000,   -42.000,1.00000,334072,   180.000,
0.00000,   0.13100,   0.00000,   0.00000,1.00000,1,  100.0,   260.000,    65.000,
1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
334076,334072,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.00290,   0.08745,   236.20
1.00000,   0.000,   0.000,   236.20,   236.20,     0.00, 0,      0, 1.05000, 0.95000,
1.05000, 0.95000,   5, 0, 0.00000, 0.00000
1.00000,   0.000
334077,334072,     0,'1 ',1,2,1,   0.00000,   0.00000,2,'            ',1,   1,1.0000
   0.00290,   0.08745,   183.40
1.00000,   0.000,   0.000,   183.40,   183.40,     0.00, 0,      0, 1.05000, 0.95000,
1.05000, 0.95000,   5, 0, 0.00000, 0.00000
1.00000,   0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
 351,336153,  -573.900,    10.000,'EES         '
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
 103,'GSTCNR      '
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
   1,'DEFAULT     '
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA
```

Dynamics Data

```
      PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      WED, FEB 29 2012  18:31



 PLANT MODELS

 REPORT FOR ALL MODELS                    BUS 334076 [PID287-GT   18.000] MODELS


 ** GENROU **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
            334076 PID287-GT    18.000 1  154845-154858  59694-59699

             MBASE     Z S O R C E        X T R A N       GENTAP
             229.0  0.00000+J 0.15000  0.00000+J 0.00000  1.00000

  T'D0 T''D0  T'Q0 T''Q0     H   DAMP   XD     XQ     X'D    X'Q   X''D    XL
  7.00 0.040  0.57 0.079   5.04  0.00 2.0600 1.9500 0.2300 0.4550 0.1500 0.1300
```

```
                              S(1.0)  S(1.2)
                              0.0560  0.5500


 ** ESST4B **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
           334076 PID287-GT    18.000 1  154890-154906  59722-59725

    TR    KPR     KIR     VRMAX    VRMIN    TA     KPM     KIM    VMMAX   VMMIN
  0.000   3.570   3.570   0.960  -0.830   0.010   1.000   0.000   0.960  -0.830

          KG      KP      KI   VBMAX     KC      XL    THETAP
        0.000   6.190   0.000   7.750   0.080  0.0000   0.000


 **  GGOV1 ** BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S
ICONS
           334076 PID287-GT    18.000 1  154924-154956  59730-59739   14391-14410
7130-7131

    R    TPELEC   MAXERR  MINERR  KPGOV   KIGOV   KDGOV   TDGOV    VMAX    VMIN
  0.040   1.000   0.050  -0.050  10.000   2.000   0.000   1.000   1.000   0.150

   TACT   KTURB    WFNL     TB      TC     TENG   TFLOAD  KPLOAD   KILOAD  LDREF
  0.500   1.500   0.200   0.100   0.000   0.000   3.000   2.000   0.670   1.062

    DM    ROPEN  RCLOSE    KIMW    ASET      KA      TA    TRATE    DB
  0.000   0.100  -0.100   0.000   0.010  10.000   0.100 192.000   0.000

   TSA     TSB     RUP    RDOWN
  4.000   5.000  99.000 -99.000


                 ICON(M)= 1 (Feedback signal for governor droop)
                 ICON(M+1)= 0 (Switch for fuel source characteristic)

      PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      WED, FEB 29 2012  18:31


 PLANT MODELS

 REPORT FOR ALL MODELS                    BUS 334077 [PID287-ST   18.000] MODELS


 ** GENROU **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
           334077 PID287-ST    18.000 1  154859-154872  59700-59705

            MBASE     Z S O R C E         X T R A N       GENTAP
            180.0  0.00000+J 0.13100  0.00000+J 0.00000  1.00000

  T'D0 T''D0  T'Q0 T''Q0     H   DAMP   XD      XQ     X'D     X'Q   X''D    XL
  4.57 0.021  0.42 0.047   5.04  0.00 1.7440 1.6740 0.1870 0.4110 0.1310 0.1540

                              S(1.0)  S(1.2)
                              0.0560  0.6000


 ** PSS2A **   BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     V A R S      I C
O N S
           334077 PID287-ST    18.000 1  154873-154889  59706-59721   14387-14390
7124-7129

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

      TW1      TW2      T6       TW3      TW4      T7       KS2      KS3
     2.000    2.000    0.000    2.000    0.000    2.000    0.340    1.000

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

```
** ESST4B **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S
           334077 PID287-ST    18.000 1  154907-154923  59726-59729

    TR    KPR     KIR     VRMAX    VRMIN    TA     KPM     KIM    VMMAX   VMMIN
  0.000   3.260   3.260   0.960  -0.830   0.010   1.000   0.000   0.960  -0.830

          KG      KP      KI   VBMAX     KC      XL    THETAP
        0.000   6.130   0.000   7.750   0.080  0.0000   0.000

** TGOV1 **   BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S     VAR
           334077 PID287-ST    18.000 1  154957-154963  59740-59741   14412

       R         T1       VMAX      VMIN       T2        T3        DT
     0.050   999.000     1.000     0.000     2.100     7.000     0.000
```

APPENDIX C: Plots for Stability Simulations

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

The plots can be viewed at the following link:

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

APPENDIX D: Prior Generation Interconnection and Transmission Service Requests in Study Models

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

PID	Substation	MW	In Service Date
	NONE		

Prior transmission service requests that were included in this study:

OASIS #		PSE	MW	Begin	End
74846159		AEPM	65	1/1/2015	1/1/2020
75206836		ETEC	125	1/1/2015	2/1/2020
75259845		SMEPA	2	1/1/2012	1/1/2040
75460486		NRG Power Marketing	20	4/1/2012	4/1/2037
75564309		ETEC	50	5/1/2014	5/1/2044
75821264		ETEC	75	1/1/2015	1/1/2020
75823926		Cargill Power Markets	98	12/1/2012	12/1/2017
75821393		NRG Power Marketing	600	1/1/2014	1/1/2024
75862786		FPLP (NextEra Energy)	100	1/1/2012	1/1/2032
76045343		Horizon Wind	100	7/1/2012	7/1/2017
SPP 75108838		Tenaska Power Services	6	8/1/2011	6/1/2014
SPP 75108845		Tenaska Power Services	44	8/1/2011	6/1/2014
SPP 75191922		AEP	70-73	8/1/2011	6/1/2014
SPP 75197442		AECC	170	8/1/2011	6/1/2014
76143038		FPLP (NextEra Energy)	100	1/1/2013	1/1/2033
76143046		FPLP (NextEra Energy)	100	1/1/2013	1/1/2033
76178017		Horizon Wind	100	7/1/2012	7/1/2017
76178031		Horizon Wind	100	7/1/2012	7/1/2017
76234876		Entergy Services (SPO)	1	6/1/2012	6/1/2042
76234879		Entergy Services (SPO)	194	6/1/2012	6/1/2042
76234889		Entergy Services (SPO)	256	1/1/2016	1/1/2043
76234897		Entergy Services (SPO)	35	1/1/2016	1/1/2043
76234904		Entergy Services (SPO)	1	6/1/2012	6/1/2042
76234916		Entergy Services (SPO)	140	6/1/2012	6/1/2042
76234922		Entergy Services (SPO)	1	5/1/2013	5/1/2042
76234951		Entergy Services (SPO)	5	5/1/2013	5/1/2042
76234980		Entergy Services (SPO)	1	1/1/2014	1/1/2043
76234993 76235000 76235003		Entergy Services (SPO)	475	1/1/2014	1/1/2043
76235101		NRG Power Marketing	450	1/1/2014	1/1/2024
76235158		NRG Power Marketing	650	1/1/2014	1/1/2024
76238089		Entergy Services (SPO)	20	1/1/2014	1/1/2043
76272244		Entegra Power (PUPP)	550	5/1/2012	5/1/2017
76289311		Constellation Commodities Group (CCG)	700	5/1/2012	5/1/2017
76336174		NRG Power Marketing	206	6/1/2013	6/1/2017

APPENDIX E: Deliverability Tests for Network Resource Interconnection Service Resources

Overview

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

The "From Generation" Test for Deliverability

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

The "To Load" Test for Deliverability

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

Required Upgrades

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

Description of Deliverability Test

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

Deliverability Test Procedure

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

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

Deliverability of Generation

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

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

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

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

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

For each transmission facility, the units on the DFAX list with the greatest impact are modeled as operating at 100% of their rated output in the DC load flow until, working down the DFAX list, a 20% probability of all units being available at full output is reached (e.g. for 15 generators with a Forced Outage Rate of 10%, the probability of all 15 being available at 100% of their rated output is 20.6%). Other NRIS and NITS resources on the system are modeled at a level sufficient to serve load and net interchange. From this new baseline, if the addition of the generator being considered (coupled with the matching generation reduction on the system) results in overloads on a particular transmission facility being examined, then it is not "deliverable" under the test.

Deliverability to Load

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

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

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

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

Other Modeling Assumptions

Modeling of Other Resources

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

Must-run Units

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

Base-line Transmission Model

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