Southwest Power Pool

System Impact Study Report
PID 211
537 MW (570 MW Gross) Plant
Lewis Creek S.E.S 138kV

Prepared by:

Southwest Power Pool, Independent Coordinator of Transmission (SPP ICT)

415 North McKinley, Suite 140

Little Rock, AR 72205

Revision: 0

Rev	Issue Date	Description of Revision	Revised By	Project Manager
0	6/26/2008	Final for Review	BEF	JDH

Objective:

This System Impact Study is the second step of the interconnection process and is based on PID-211 request for interconnection on Entergy's transmission system at Lewis Creek S.E.S. 138kV. 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, offsite nuclear 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, offsite nuclear 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 211 did request NRIS but did not request ERIS, therefore, under Section – A (ERIS) load flow analysis was not performed.

Requester for PID-211 intends to install a generating facility consisting of two (2) combustion turbine units tied to the Lewis Creek 138 kV station through two (2) 138/1 8 kV autotransformers and one (1) steam turbine unit tied to the Lewis Creek 138 kV station through one (1) 138/18 kV autotransformer.

The proposed in-service date for this facility is June 1, 2011.

Section – A

Energy Resource Interconnection Service

TABLE OF CONTENTS FOR ERIS (SECTION – A)

I. Introduction

This Energy Resource Interconnection Service (ERIS) is based on the PID-211 request for interconnection on Entergy's transmission system at Lewis Creek S.E.S. 138kV substation. The objective of this study is to assess the reliability impact of the new facility on the Entergy transmission system with respect to the steady state and transient stability performance of the system as well as its effects on the system's existing short circuit current capability. It is also intended to determine whether the transmission system meets standards established by NERC Reliability Standards and Entergy's planning guidelines when the 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 was 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-211 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-211 unit.

B. Short Circuit Analysis

The method used to determine if any short circuit problems would be caused by the addition of the PID-211 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-211 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-211 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-211 generators does cause an increase in short circuit current such that they exceed the fault interrupting capability of the high voltage circuit breakers within the vicinity of PID-211 plant.

Table I illustrates 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-211 generator and includes no priors.

Table I: Underrated Breakers Without Priors

Substation	Breaker	Max Fault w/o PID-211 (amps)	Max Fault with PID-211 (amps)	Interrupting Rating (amps)
Lewis Creek 138kV	1600-C	26298.3	40644.7	40000
	1605-C	26298.3	40644.7	40000
	1610-CO	26298.3	40644.7	37000
	1620-CO	26298.3	40644.7	40000
	1625-CO	26298.3	40644.7	37000
	1630-CBO	26298.3	40644.7	40000
	1635-CO	26298.3	40644.7	40000
	1640-C	26298.3	40644.7	40000
	1645-C	26298.3	40644.7	40000
	1650-CO	26298.3	40644.7	37000
	1655-CO	25584.4	40408.1	37000
	1660-CO	26298.3	40644.7	37000
	26225-C	26298.3	40644.7	40000

Table II illustrates 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-211 generator and includes prior PID's 206, 207, 208, 210 & 213.

Table II: Underrated Breakers With Priors

Substation	Breaker	Max Fault w/o PID-211 (amps)	Max Fault with PID-211 (amps)	Interrupting Rating (amps)
Lewis Creek 138kV	1600-C	36117.3	50465.0	40000
	1605-C	36117.3	50465.0	40000
	1610-CO	36117.3	50465.0	37000
	1615-C	34773.5	49156.7	40000
	1620-CO	36117.3	50465.0	40000
	1625-CO	36117.3	50465.0	37000
	1630-CBO	36117.3	50465.0	40000
	1635-CO	36117.3	50465.0	40000
	1640-C	36117.3	50465.0	40000
	1645-C	36117.3	50465.0	40000
	1650-CO	36117.3	50465.0	37000
	1660-CO	36117.3	50465.0	37000
	1665-CO	35369.3	49736.2	41000
	26225-C	36117.3	50465.0	40000
CONROE 138kV	6380-CO	12654.8	21668.0	21000
	6390-CO	13484.6	22367.5	21000

D. Problem Resolution

Table III & Table IV illustrates the station name, and the cost associated with upgrading the breakers at each station both for mandatory and optional breaker upgrades with Priors and without Priors.

Table III: Breaker Upgrade Costs without Priors

Substation	Number of Breakers	Estimated cost of Breaker Upgrades ($)
LEWIS CREEK 138kV	13	*$3,052,400

* Price based on 145kV with 50kA

Table IV: Breaker Upgrade Costs with Priors

Substation	Number of Breakers	Estimated cost of Breaker Upgrades ($)
LEWIS CREEK 138kV	14	*$4,002,600
CONROE 138kV	2	**$469,600

* Price based on 145kV with 63kA ** Price based on 145kV with 50kA

The impact on breaker rating due to line upgrades will be evaluated during facilities study phase.

The results of the short circuit analysis are subject to change. They are based upon the current configuration of the Entergy transmission system and Generation Interconnection Study queue.

II. Transient Stability Analysis

A. Model Information

When this study was performed the most realistic model available for the Entergy system was 2015 summer peak load conditions. Beyond the year 2015, the models will involve a number of uncertain projects and upgrades. Hence, the dynamic database representing 2015 summer peak load conditions was used in this analysis. The analysis was carried out on the power flow case without the upgrades identified for PID-211 in either the Power Flow or Short Circuit analysis. The reason for not including the upgrades identified in the Power Flow and Short Circuit analysis was, if the system was stable without the required upgrades the system performance would only improve with the upgrades. Figure IV-1 illustrates the changes implemented to the 2015 power flow case to connect the two new CT and one new ST units into the Lewis Creek 138 kV station.

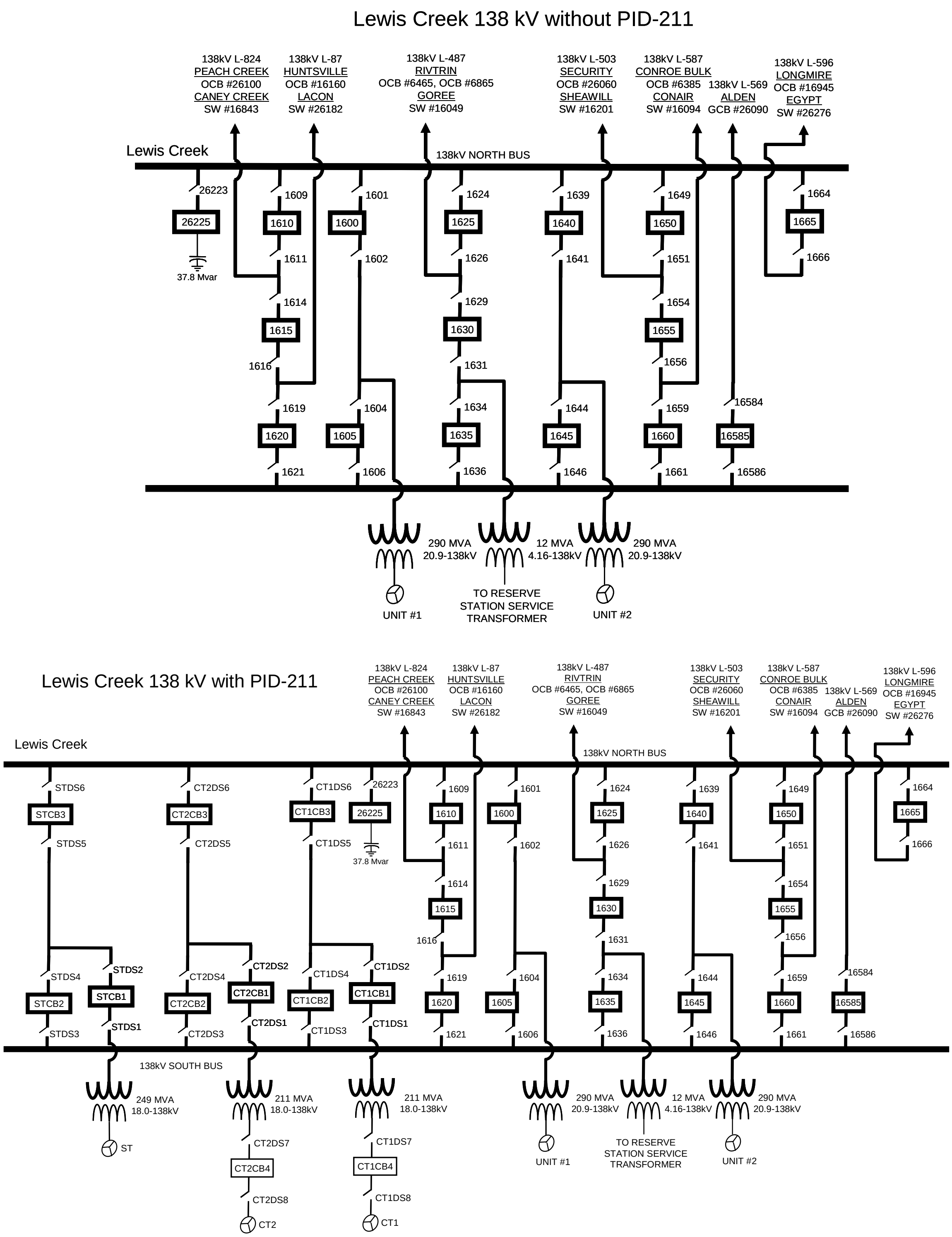


Figure IV-1. Transmission line configuration at Lewis Creek 138 kV with and without PID-211

The new PID-211 generation was added to the model at the proposed Lewis Creek S.E.S 138 kV bus. The stability studies were conducted to assess the impact of PID-211injectimg 570.35 MW of power into Entergy's system (179.35 MW x 2 CT units + 211.65 MW x 1 ST unit). The loads in the Entergy system were represented as follows: for the active part, 100% was modeled with a constant current model; all of the reactive part, on the other hand, was modeled with a constant impedance model.

PID-211 provided dynamic models of their generation equipment for use in this study. The generators were modeled using the standard PSS/E **GENROU** model.

PID-211 also provided data for the excitation system. The data for the two PID-211 combustion turbine excitation systems represents a static excitation system, and was modeled using the PSS/E **EXPIC1** model and the Power System Stabilizer (PSS) data was provided with the interconnection request. The PSS was modeled using the PSS/E **PSS2B** model. PID-211 provided the data for the turbine-governor controls. The combustion turbine generator governor model was modeled using the PSS/E **GAST2A** model. The data for the one PID-211 steam turbine excitation system represents a static excitation system, and was modeled using the PSS/E **EXPIC1** model. Also Power System Stabilizer (PSS) data was provided with the interconnection request. The PSS was modeled using the PSS/E **PSS2A** model. PID-211 provided the data for the turbine-governor controls. The steam turbine generator governor model was modeled using the PSS/E **ESST4B** model. The data used for the proposed PID-211 generator, exciter, and governor models are shown in **Appendix A.A.**

B. Transient Stability Analysis

Stability simulations were run to examine the transient behavior of the PID-211 generators and their effect on the Entergy system. Stability analysis was performed using the following procedure. Three-phase faults with normal clearing time and single-phase faults followed by breaker failure were simulated on the transmission lines connected to the Lewis Creek S.E.S. 138

kV station. The stability analysis was performed using the PSS/E dynamics program. The fault clearing times used for the simulations are given in Table IV-1.

Table IV-1 Fault Clearing Times

Contingency at kV level	Normal Clearing	Delayed Clearing
138	6 cycles	6+13 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. For single-phase faults the fault is appropriately adjusted to account for the line trip of step 1).

3) The fault is then cleared by back-up clearing. If the system is shown to be unstable for this condition, then stability of the system without the PID-211 plant needs to be verified.

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

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

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

Table IV-2A and Table IV-2B list all the fault cases that were simulated in this study. Fault scenarios were formulated by examining the system configuration shown in Figure IV-4. The substation configurations for the adjacent substations with the fault locations are included in the Appendix A.D for reference.

Faults 1 through 12 represent the normal clearing 3-phase faults. Faults 1a through 12a represent single-phase faults with stuck breakers with the appropriate delayed back-up clearing times.

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

Table IV-2A Fault Cases Simulated in this Study: 3 Phase Faults with Normal Clearing

	CASE	Prior Outage Element	LOCATION	TYPE	Clearing Time (cy)	PRIMARY BRK TRIP #	TRIPPED FACILITIES	Stable ?
	FAULT G1	--	Lewis Creek 138 kV	3 PH	6	CT1CB1	PID-211 (CT1 only)	Yes
	FAULT G2	--	Lewis Creek 138 kV	3 PH	6	CT2CB1	PID-211 (CT2 only)	Yes
	FAULT G3	--	Lewis Creek 138 kV	3 PH	6	STCB1	PID-211 (ST only)	Yes
	FAULT G4	--	Lewis Creek 138 kV	3 PH	6	1605, 1600	Unit #1	Yes
	FAULT G5	--	Lewis Creek 138 kV	3 PH	6	1645, 1640	Unit #2	Yes
	FAULT-1	--	Lewis Creek-Longmire 138 kV	3 PH	6	1665,16945	Lewis Creek-Longmire 138 kV	Yes
	FAULT-2	--	Lewis Creek-Alden 138 kV	3 PH	6	16585,26090	Lewis Creek-Alden 138 kV	Yes
	FAULT-3	--	Lewis Creek-Conroe Bulk 138 kV	3 PH	6	1655,1660,6385	Lewis Creek-Conroe Bulk 138 kV	Yes
	FAULT-4	--	Lewis Creek-Security 138 kV	3 PH	6	1650,1655, 26060	Lewis Creek-Security 138 kV	Yes
	FAULT-5	--	Lewis Creek – Rivtrin 138 kV	3 PH	6	1625,1630,6465, 6865	Lewis Creek – Rivtrin 138 kV	Yes
	FAULT-6	--	Lewis Creek – Huntsville 138 kV	3 PH	6	1615,1620, 16160	Lewis Creek – Huntsville 138 kV	Yes
	FAULT-7	--	Lewis Creek – Peach Creek 138 kV	3 PH	6	1615,1610, 26100	Lewis Creek – Peach Creek 138 kV	Yes

** FOR THIS FAULT NO FACILITY WAS TRIPPED

Table IV-2B Fault Cases Simulated in this Study: Faults with Stuck Breaker

	CASE	LOCATION	TYPE	CLEARING TIME (cycles)		STUCK BRK #	PRIMARY BRK TRIP #	SECONDARY BRK TRIP	TRIPPED FACILITIES	Stable ?
				PRIMARY	Back-up					
	FAULT G1	Lewis Creek 138 kV	1PH	6	13	CT1CB	CT1CB3	CT1CB1	PID-211 (CT1 only)	Yes
	FAULT G2	Lewis Creek 138 kV	1PH	6	13	CT2CB2	CT2CB3	CT2CB1	PID-211 (CT2 only)	Yes
	FAULT G3	Lewis Creek 138 kV	1PH	6	13	STCB2	STCB3	STCB1	PID-211 (ST only)	Yes
	FAULT G4	Lewis Creek 138 kV	1PH	6	13	1605	1600	‘’	Unit #1	Yes
	FAULT G5	Lewis Creek 138 kV	1PH	6	13	1645	1640	‘’	Unit #2	Yes
	FAULT-1A	Lewis Creek-Longmire 138 kV	1PH	6	13	1665	16945	1650, 1640, 1625, 1600, 1610, CT1CB3, CT2CB3, STCB3	Lewis Creek-Longmire 138 kV	Yes
	FAULT-2A	Lewis Creek-Alden 138 kV	1PH	6	13	16585	26090	1660, 1645, 1635, 1605, 1620, CT1CB2, CT2CB2, STCB2,	Lewis Creek-Alden 138 kV	Yes
	FAULT-3A	Lewis Creek-Conroe Bulk 138 kV	1PH	6	13	1655	1660,6385	1650, 26060	Lewis Creek-Conroe Bulk 138 kV, Lewis Creek-Security 138 kV	Yes
	FAULT-4A	Lewis Creek-Security 138 kV	1PH	6	13	1655	1650, 26060	1660, 6385	Lewis Creek-Security 138 kV, Lewis Creek-Conroe Bulk 138 kV	Yes
	FAULT-5A	Lewis Creek – Rivtrin 138 kV	1PH	6	13	1630	1625, 6465, 6865	1635	Lewis Creek – Rivtrin 138 kV	Yes
	FAULT-6A	Lewis Creek – Huntsville 138 kV	1PH	6	13	1615	1620, 16160	1610, 26100	Lewis Creek – Huntsville 138 kV, Lewis Creek – Peach Creek 138 kV	Yes
	FAULT-7A	Lewis Creek – Peach Creek 138 kV	1PH	6	13	1615	1610, 26100	1620, 16160	Lewis Creek – Peach Creek 138 kV, Lewis Creek – Huntsville 138 kV	Yes

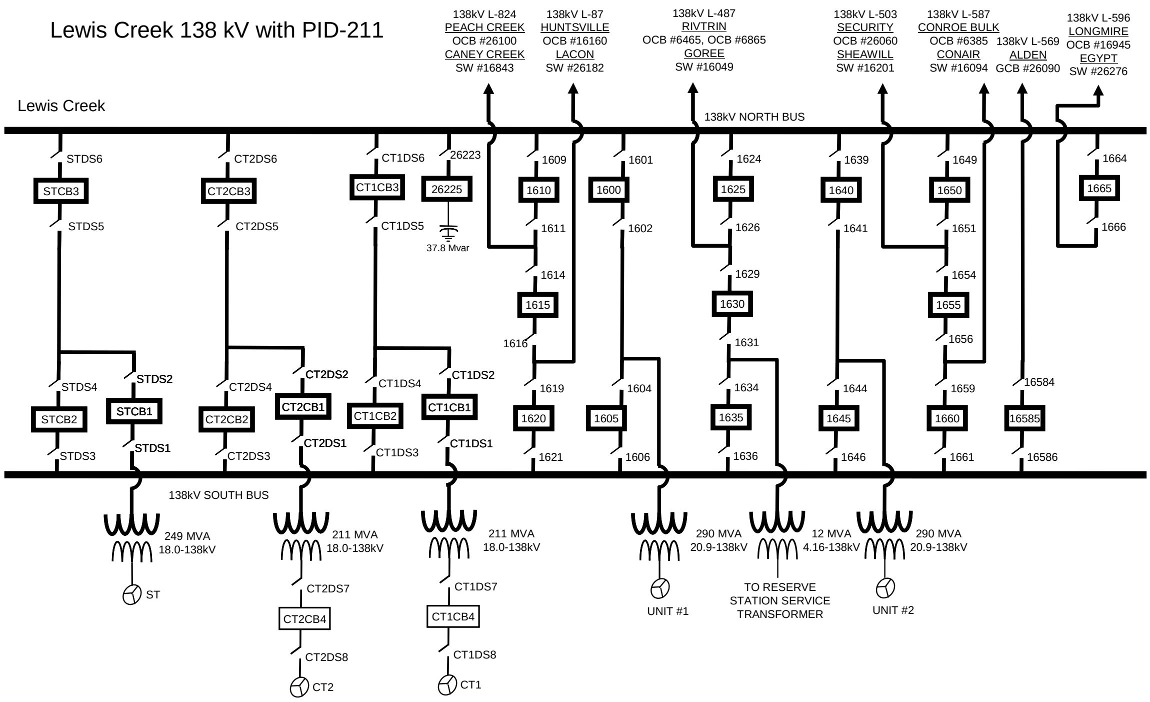


Figure IV-4. Bus/Breaker Configuration of the Lewis Creek S.E.S 138 kV Station

C. Analysis Results

All of the single-phase faults with stuck breaker conditions were stable. Even though none of these were unstable, three-phase faults with normal clearing were simulated as well, for completeness. All of the three-phase faults with normal clearing were stable as well. The plots are provided in Appendix A.C.

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

- 3-phase fault or single-line-ground fault with normal clearing resulting in the loss of a single component (generator, transmission, circuit, or transformer) or a loss of a single component without fault:

  Not to exceed 20% for more than 20 cycles at any bus

  Not to exceed 25% at any load bus

  Not to exceed 30% at any non-load bus

- 3-phase faults with normal clearing resulting in the loss of two or more components (generator, transmission circuit or transformer), and SLG fault with delayed clearing resulting in the loss of one or more components:

  Not to exceed 20% for more than 40 cycles at any bus

  Not to exceed 30% at any bus

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

The voltages at all buses in the Entergy system (138 kV and above) were monitored during each of the fault cases as appropriate. No voltage violations were observed for normally cleared three-phase faults.

As a next step, the same faults were repeated with stuck breaker single-line-to-ground (SLG) faults. The faults in Table IV-2B and Appendix A.D show the details of the fault. The results indicated that there are no voltage dip criteria violations following SLG stuck breaker faults. Hence, it can be concluded that the proposed PID-211 unit does not degrade the Entergy system performance.

The plots for voltages in the local area following Faults 3a, 4a, 6a, and 7a are shown in Figure IV-5 through Figure IV-8. Plots of relevant parameters (machine angles, frequencies, and bus voltages) are shown in Appendix A.C.

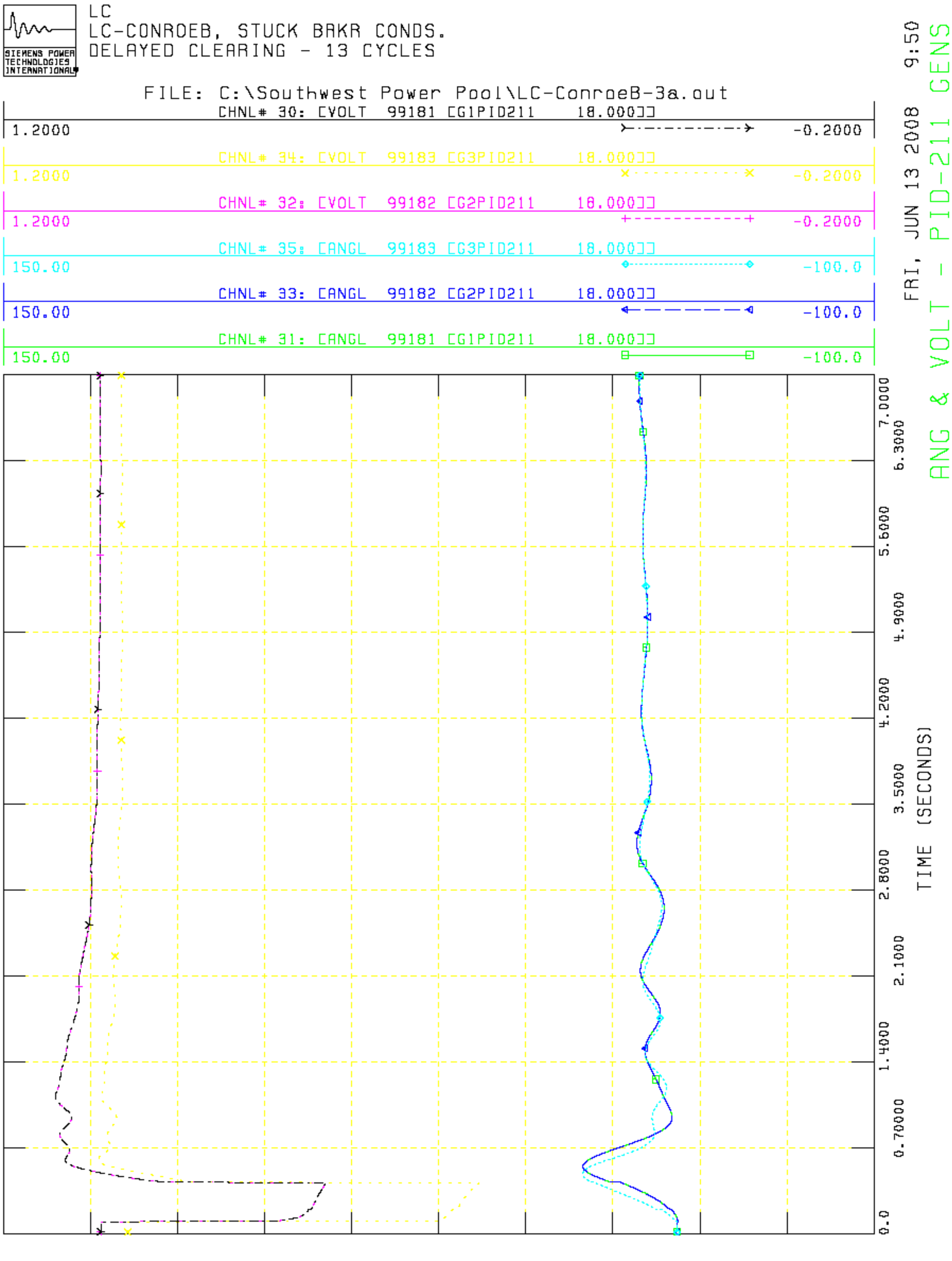


Figure IV-5: Local area voltages following Fault-3a with PID-211

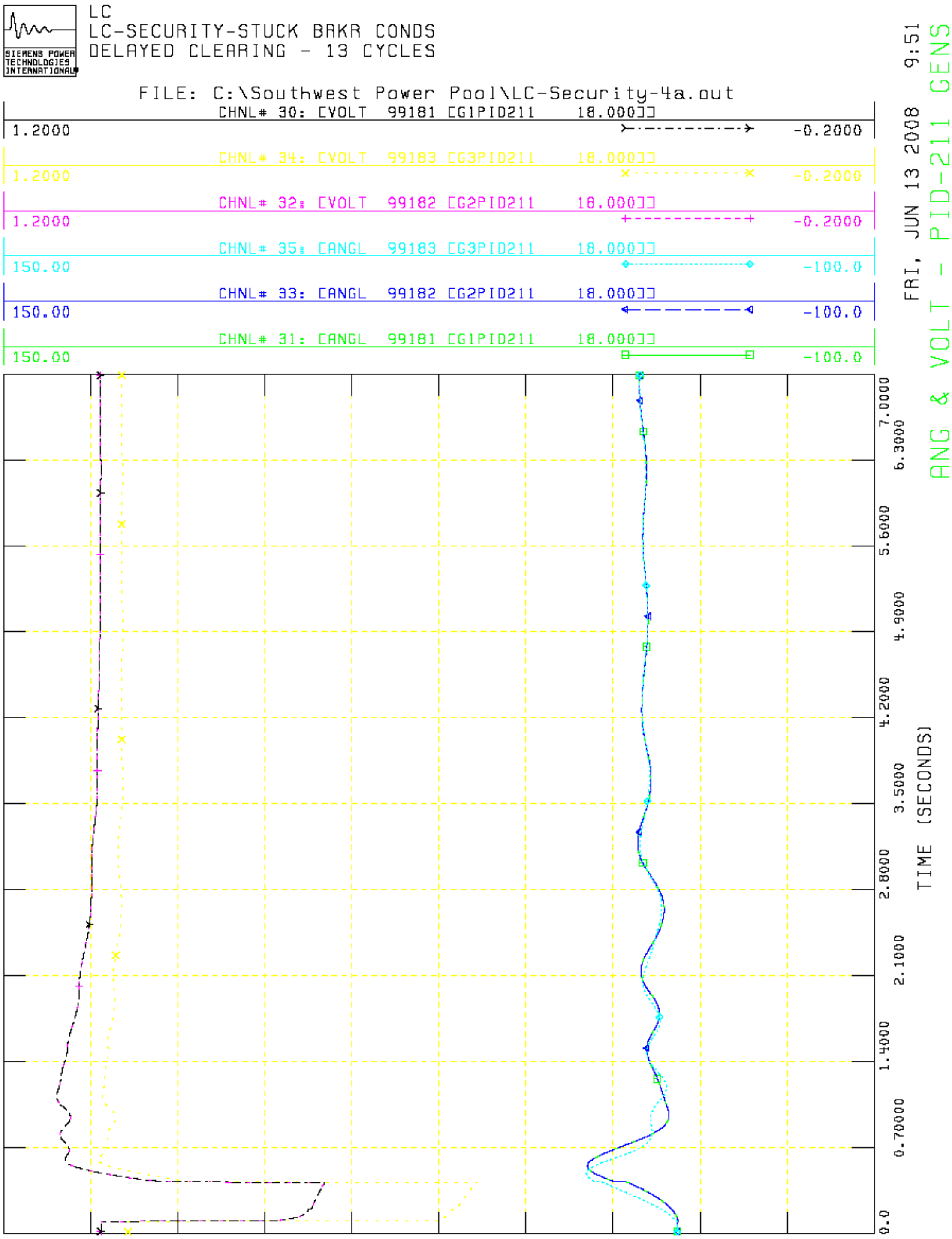


Figure IV-6: Local area voltages following Fault-4a with PID-211

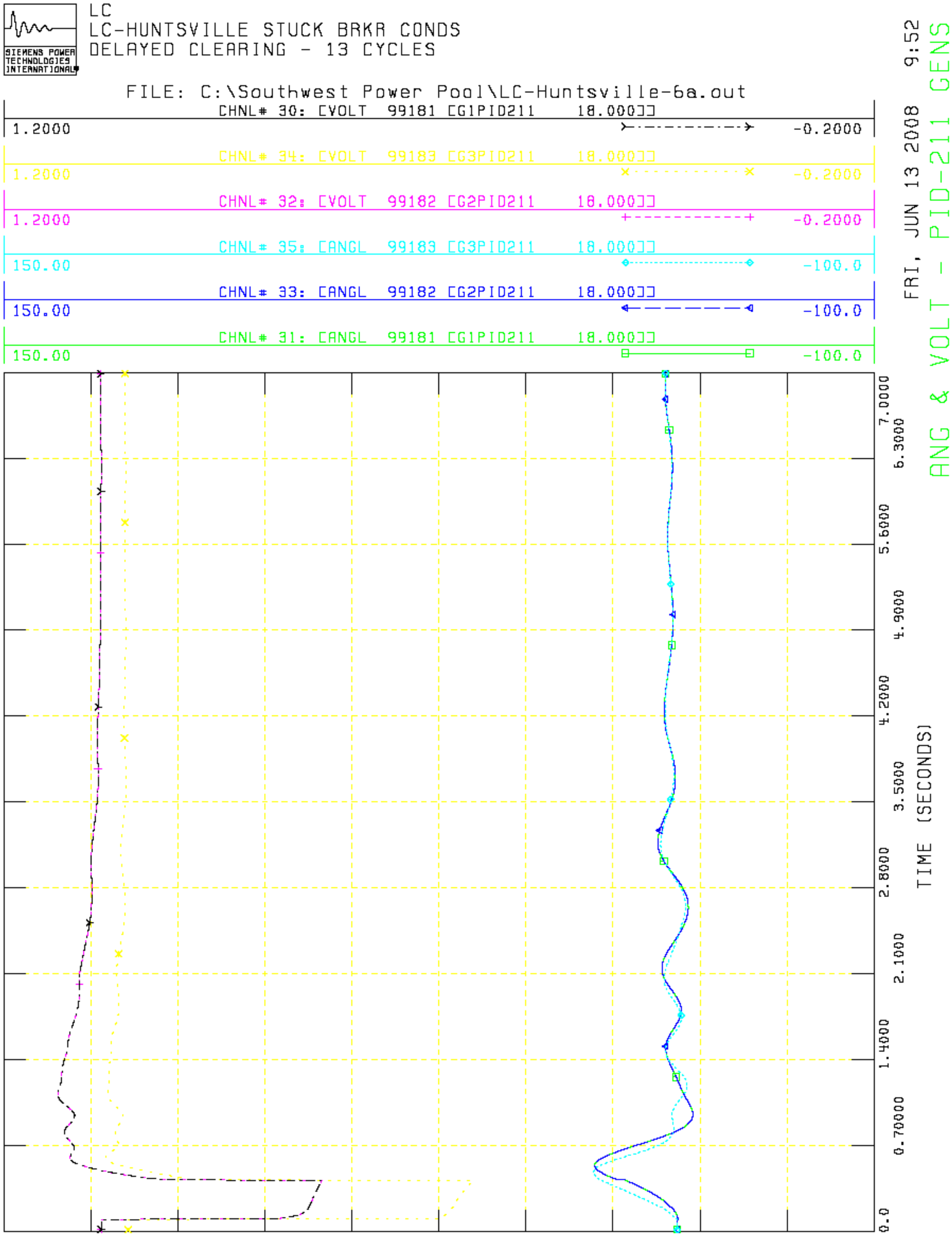


Figure IV-7: Local area voltages following Fault-6a with PID-211

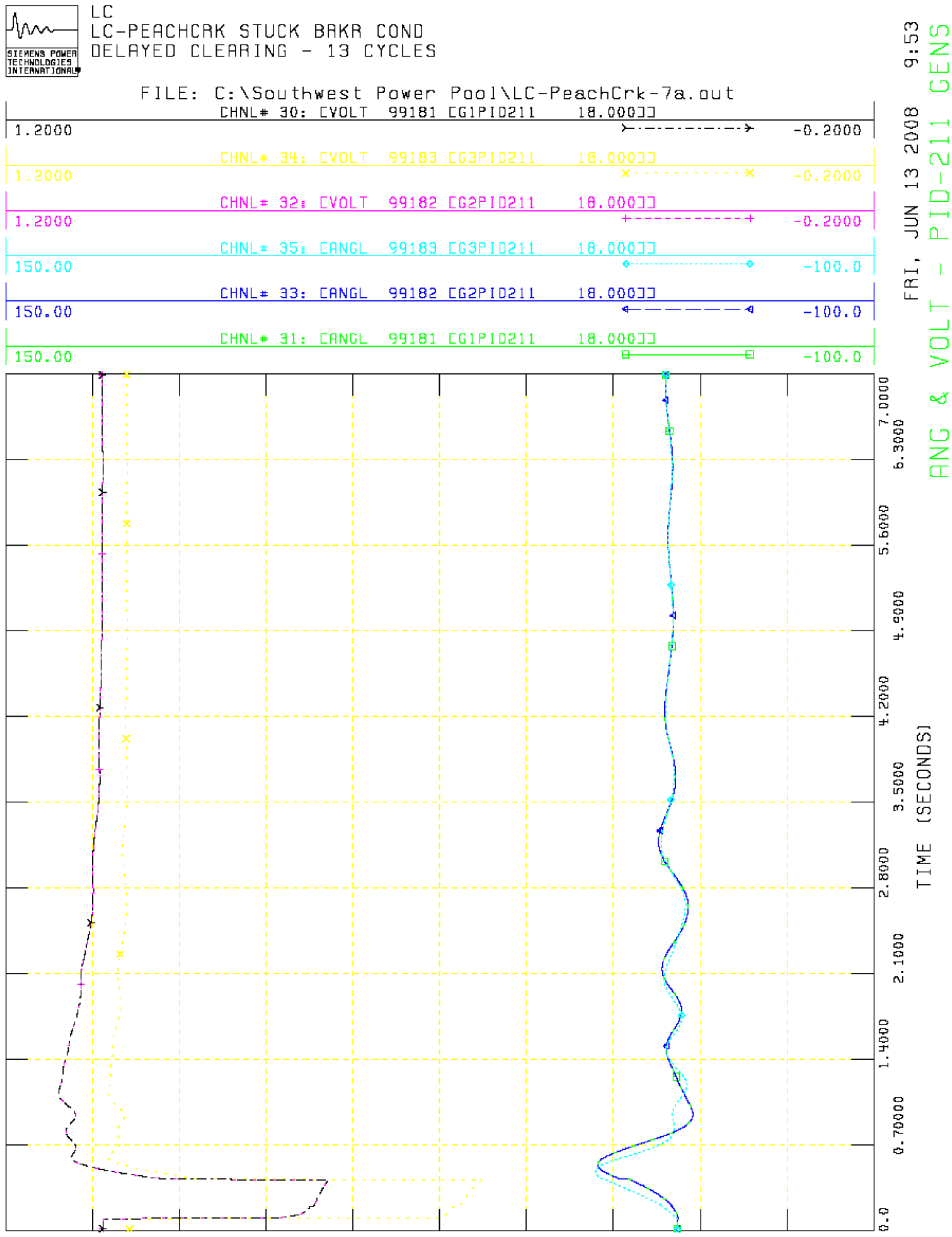


Figure IV-8: Local area voltages following Fault-7a with PID-211

In summary, when considering the new PID-211 (570.35 MW) generation at the Lewis Creek S.E.S. 138 kV bus, all the simulated faults are stable. No violations of the voltage dip criteria were observed. This meets Entergy’s performance criteria when the PID-211 plant is in-service.

Due to restructuring of the utility industry, there has been a large increase of merchant generation activity on the Entergy system. These generators are equipped with modern exciters that have a high gain and a fast response to enhance transient stability. However, these fast response exciters, if used without stabilizers, can lead to oscillatory instability affecting local or regional reliability. This problem is exacerbated particularly in areas where there is a large amount of generation with limited transmission available for exporting power. Stability studies carried out at Entergy have validated this concern. Furthermore, based on the understanding of operational problems experienced in the WECC area over the last several years and the opinion of leading experts in the stability area, Power System Stabilizers (PSS) are an effective and a low cost means of mitigating dynamic stability problems. In particular, PSS cost can be low if it is included in power plant procurement specifications.

Therefore, as a pre-emptive measure, Entergy requires all generation intending to interconnect to its transmission system to install PSS on their respective units. Please refer to Appendix A.B for Entergy’s Policy Statement on PSS Requirements.

APPENDIX A.A
DATA PROVIDED BY CUSTOMER

A.A.1 LARGE GENERATING FACILITY DATA

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 S.E.S 138 kV bus , Montgomery County, Texas

   b. Summer and Winter electrical output
   Maximum summer at 35(179.35 MW x 2 units + 211.65 MW x 1 unit = 570.35 MW) degrees C and winter at 15(179.35 MW x 2 units + 211.65 MW x 1 unit = 570.35 MW) degrees C megawatt electrical output of the proposed 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;
   Two (2) combustion turbine units tied to the Lewis Creek 138 kV station through two (2) 138/18 kV autotransformers and one (1) steam turbine unit tied to the Lewis Creek 138 kV station through one (1) 138/18 kV autotransformer. Please see one-line for electrical connection to the grid.

d. Commercial Operation Date (Day, Month, and Year);
June 1, 2011

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: _Engineer ______________________

Date: 3/16/07

LARGE GENERATING FACILITY DATA (CT units)

UNIT RATINGS

kVA 211000 °F 104 Voltage 18000 V
Power Factor 0.85
Speed (RPM) 3600 **Connection (e.g.** Wye) WYE
Short Circuit Ratio 0.54 Frequency, Hertz 60
Stator Amperes at Rated kVA 6768 **Field Volts** 295V
Max Turbine MW 179.3 °F 104

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 5.372 kW sec/kVA
Moment-of-Inertia, WR^2 = N/A lb. ft.^{2}

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	1.929	X_{qv}	1.841
Synchronous – unsaturated	X_{di}	1.929	X_{qi}	1.841
Transient – saturated	X'_{dv}	0.215	X'_{qv}	N/A
Transient – unsaturated	X'_{di}	0.291	X'_{qi}	0.466
Subtransient – saturated	X''_{dv}	0.149	X''_{qv}	0.146
Subtransient – unsaturated	X''_{di}	0.206	X''_{qi}	0.199
Negative Sequence – saturated	$X2_v$	0.143		
Negative Sequence – unsaturated	$X2_i$	0.196		
Zero Sequence – saturated	$X0_v$	0.096		
Zero Sequence – unsaturated	$X0_i$	0.127		
Leakage Reactance	Xl_m	0.171		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	4.767	T'_{qo}	0.395
Three-Phase Short Circuit Transient	T'_{d3}	0.53	T'_{q}	0.395
Line to Line Short Circuit Transient	T'_{d2}	0.823		
Line to Neutral Short Circuit Transient	T'_{d1}	0.998		
Short Circuit Subtransient	T''_{d}	0.023	T''_{q}	0.023
Open Circuit Subtransient	T''_{do}	0.033	T''_{qo}	0.074

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.349
Line to Line Short Circuit	T_{a2}	0.349
Line to Neutral Short Circuit	T_{a1}	0.311

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	0.003
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 = 1498.6 amps
Field Current at Rated kVA and Armature Voltage, 0 PF = 1747.8 amps
Three Phase Armature Winding Capacitance = 1.103 microfarad
Field Winding Resistance = 0.199 ohms 125 °C
Armature Winding Resistance (Per Phase) = 0.00167 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

_126.6 / 211___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

_±5%, ±2.5____________________

Present Tap Setting

___138 KV____________________________

IMPEDANCE

Positive Z_1 (on self-cooled kVA rating) 9.5 % _approx 30_X/R

Zero Z_0 (on self-cooled kVA rating)_8.4%_ % _approx 27_ 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 EXPIC1. 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 GAST2A. 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.

INDUCTION GENERATORS

(*) 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.

LARGE GENERATING FACILITY DATA (ST unit)

UNIT RATINGS

kVA 249000 °F 104 Voltage 18000 V
Power Factor 0.85
Speed (RPM) 3600 Connection (e.g. Wye) WYE
Short Circuit Ratio 0.498 Frequency, Hertz 60
Stator Amperes at Rated kVA 7986 Field Volts 385V
Max Turbine MW 211.65 °F 104

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = 4.2446 kW sec/kVA
Moment-of-Inertia, WR^2 = N/A lb. ft.^{2}

REACTANCE DATA (PER UNIT-RATED KVA)

	DIRECT AXIS		QUADRATURE AXIS	
Synchronous – saturated	X_{dv}	2.11	X_{qv}	2.01
Synchronous – unsaturated	X_{di}	2.11	X_{qi}	2.01
Transient – saturated	X'_{dv}	0.235	X'_{qv}	N/A
Transient – unsaturated	X'_{di}	0.265	X'_{qi}	0.465
Subtransient – saturated	X''_{dv}	0.155	X''_{qv}	0.155
Subtransient – unsaturated	X''_{di}	0.2	X''_{qi}	0.2
Negative Sequence – saturated	$X2_v$	0.155		
Negative Sequence – unsaturated	$X2_i$	0.2		
Zero Sequence – saturated	$X0_v$	0.105		
Zero Sequence – unsaturated	$X0_i$	0.105		
Leakage Reactance	Xl_m	0.135/ 0.15		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'_{do}	7.7	T'_{qo}	0.59
Three-Phase Short Circuit Transient	T'_{d3}	0.77	T'_{q}	0.14
Line to Line Short Circuit Transient	T'_{d2}	1.32		
Line to Neutral Short Circuit Transient	T'_{d1}	1.6		
Short Circuit Subtransient	T''_{d}	0.026	T''_{q}	0.026
Open Circuit Subtransient	T''_{do}	0.039	T''_{qo}	0.078

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	T_{a3}	0.4
Line to Line Short Circuit	T_{a2}	0.4
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	0.003
Negative	R_2	0.0202
Zero	R_0	0.0089

Rotor Short Time Thermal Capacity I_2^2t = 10s
Field Current at Rated kVA, Armature Voltage and PF = 1744 amps
Field Current at Rated kVA and Armature Voltage, 0 PF = 2194 amps
Three Phase Armature Winding Capacitance = 0.898 microfarad
Field Winding Resistance = 0.1808 ohms 125°C
Armature Winding Resistance (Per Phase) = 0.0015 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
149.4 / 249 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
±5%, ±2.5

Present Tap Setting
138 KV

IMPEDANCE

Positive Z_1 (on self-cooled kVA rating) 9.5 % approx 30 X/R

Zero Z_0 (on self-cooled kVA rating) 8.4% % approx 27 X/R

INDUCTION GENERATORS

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

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

Appendix A: Attachment 3 - Interconnection Study Data Requirement

GE 7FA CT

ENTERGY

Data Sheet for Interconnection Studies		
	For each set of generators (steam/gas)	
General	**Required for Load Flow Analysis**	**Required for Stability Analysis**
Maximum Gross MW (per set)	179 MW x 2 unit	
Aux Power Requirement (per set)	See ST unit	
One Line Diagram for the Plant	Attached	
Step-Up Transformer/Autotransformer (two wdg xfmrs)		
Rated Voltage HV	138	
Rated Voltage LV1	18	
MVA rating	126.6/211	
Taps HV side	+/-2 steps of 2.5% above and below nominal	
Taps LV Side	None	
Z1 (positive sequence impedance)	9.5%	
X / R ratio	30	
Generator (p. u. reactances are on rated MVA, KV values)		
Manufacturer	GE 7FA	
Rated MVA	211	
Rated KV	18 kV	
Power factor	0.85	
Reactive Capability Curves or QMAX/QMIN	Attached under separate cover	
Parameters for PTI-compatible Generator model		Attached under separate cover
(See datasheet for PTI-compatible generator models)		
Automatic Voltage Regulator and Excitation System		
Type (e.g., static, brushless, etc.)		Static
Model (Control Block Diagram)		EXPIC1
Parameters - (See datasheet for PTI-compatible exciter models)		Attached under separate cover
Power System Stabilizer		
Model (Control Block Diagram)		S2B (Similar to PSS2A)
		See attachment
Turbine and Governor (Steam Turbine)	N/A	
Model (Control Block Diagram)		
Parameters - (See datasheet for PTI-compatible governor models)		
Turbine and Governor (Gas Turbine)		
Model (Control Block Diagram)		Attached under separate cover
Parameters - (See datasheet for PTI-compatible governor models)		Attached under separate cover
(Note: Need PTI compatible models for generator, exciter, governor and stabiliser)		
Line Data (in per unit on 100MVA base)		
From Bus:______ positive sequence	r = ____pu, x = ____pu	charging = ____pu, line rating = ____mva
To Bus:______ zero sequence	r = ____pu, x = ____pu	line length = ____miles
Load Data	p = ____mw, q = ____mvar	

GAST2A

Gas 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.

CONs	#	Value	Description
J		25	W - governor gain (1/droop) (on turbine rating)
J+1		0	X (sec) governor lead time constant
J+2		0.02	Y (sec) (>0.) governor lag time constant
J+3		1	Z - governor mode: 1 - Droop 0 - ISO
J+4		0.04	E_{TD} (sec)
J+5		0.2	T_{CD} (sec)
J+6		171.7	T_{RATE} turbine rating (MW)
J+7		0.0625	T (sec)
J+8		1.0	MAX (pu) limit (on turbine rating)
J+9		0.0	MIN (pu) limit (on turbine rating)
J+10		0.01	E_{CR} (sec)
J+11		0.77	K_3
J+12		1.0	a (>0.) valve positioner
J+13		0.05	b (sec) (>0.) valve positioner
J+14		1.0	c valve positioner
J+15		0.4	τ_f (sec) (>0.)
J+16		0	K_f
J+17		0.2	K_5
J+18		0.8	K_4
J+19		15	T_3 (sec) (>0.)
J+20		2.5	T_4 (sec) (>0.)
J+21		1650	τ_t (>0.)
J+22		3.3	T_5 (sec) (>0.)
J+23		597	a_{f1}
J+24		550	b_{f1}
J+25		-0.299	a_{f2}
J+26		1.3	b_{f2}
J+27		0.5	c_{f2}
J+28		1116	Rated temperature, T_R* (degree)
J+29		0.23	Minimum fuel flow, K_6 (pu)
J+30		1116	Temperature control, T_C* (degree)

*Units can be °F or °C depending on constants a_{f1} and b_{f1}.

STATEs	#	Description
K		Speed governor
K+1		Valve positioner
K+2		Fuel system
K+3		Radiation shield
K+4		Thermocouple
K+5		Temperature control
K+6		Gas turbine dynamics
K+7		Combustor
K+8		Combustor
K+9		Turbine/exhaust
K+10		Turbine/exhaust
K+11		Fuel controller delay
K+12		Fuel controller delay

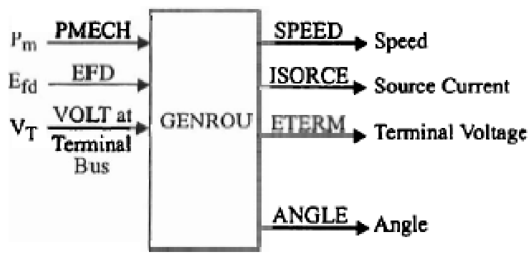
VARs	#	Description
L		Governor reference
L+1		Temperature reference flag
L+2		Low value select output
L+3		Output of temperature control

IBUS, 'GAST2A', I, W, X, Y, Z, E_{TD}, T_{CD}, T_{RATE}, T, MAX, MIN, E_{CR}, K_3, a, b, c, τ_f, K_f, K_5, K_4, T_3, T_4, τ_t, T_5, a_{f1}, b_{f1}, a_{f2}, b_{f2}, c_{f2}, T_R, K_6, T_C/

GENROU

Round Rotor Generator Model (Quadratic Saturation)

This model is located at system bus #_______ IBUS,
machine #_______ I.
This model uses CONs starting with #_______ J,
and STATEs starting with #_______ K,
The machine MVA is ________ for each of__________ units = ________ MBASE.
ZSORCE for this machine is ________ + j _______ on the above MBASE



CONs	#	Value	Description
J		4.767	T'_{do} (>0) (sec)
J+1		0.033	T''_{do} (>0) (sec)
J+2		0.395	T'_{qo} (>0) (sec)
J+3		0.074	T''_{qo} (>0) (sec)
J+4		5.372	Inertia, H
J+5		0	Speed damping, D
J+6		1.929	X_d
J+7		1.841	X_q
J+8		0.291	X'_d
J+9		0.466	X'_q
J+10		0.206	$X''_d = X''_q$
J+11		0.171	X_l
J+12		0.0357	S(1.0)
J+13		0.242	S(1.2)

STATEs	#	Description
K		E'_q
K+1		E'_d
K+2		ψkd
K+3		ψkq
K+4		Δ speed (pu)
K+5		Angle (radians)

Note: X_d, X_q, X'_d, X'_q, X''_d, X''_q, X_l, H, and D are in pu, 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)/

Power System Stabilizer (PSS) Parameters
EX2000 Excitation System

IEEE Type PSS2B (Note similar model in IEEE Standards 421.5 which is IEEE Type PSS2A - does not have constants T5,T10, and Input Limits)

Note: Parameters shown with ranges give the typical or useful ranges, actual setting ranges are usually much wider.

VSI1 = speed
VSI2 = elect rical power
VSI1max, VSI1min - input #1 limits - +/- 0.08 pu
VSI2max, VSI2min - input #2 limits - +/- 1.25 pu
T1 = lead #1 - 0.1-2.0 sec (Note:Lead/Lags Determined by Studies)
T2 = lag #1 - 0.01 -1.0 sec
T3 = lead #2 - 0.1-2.0 sec
T4 = lag #2 - 0.01 -1.0 sec
T5 = lag #3 - can be used if there are three lead lags (not GE design) or for equivalent torsional filter time constant which may be required for some units (determined by studies)
T6 = 0.0
T7 = TW - 2-15 sec -10.0 typical
T8 = 0.5 sec - fixed
T9 = 0.1 sec - fixed
T10 = Lag #3 - not in GE design
N = 1
M = 5
KS1 = PSS gain - 5-20 typical
KS2 = TW/2H - where H=combined turbine-gen.inertia constant
KS3 = 1.0
VSTmax = 0.05 to 0.1
VSTmin = -0.05 to -0.1
TW1 = TW - see note on T7 above
TW2 = TW
TW3 = TW
TW4 = 0.0

PSS2A

IEEE Dual-Input Stabilizer Model

This model is located at system bus #_______ IBUS,

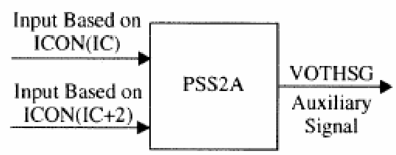
machine #_______ I.

This model uses CONs starting with #_______ J,

and STATEs starting with #_______ K,

and VARs starting with #_______ L,

and ICONs starting with #_______ IC.



ICONs	#	Value	Description
IC		1	ICS1, first stabilizer input code: 1 - rotor speed deviation (pu) 2 - bus frequency deviation (pu) 3 - generator electrical power on MBASE base (pu) 4 - generator accelerating power (pu) 5 - bus voltage (pu) 6 - derivative of pu bus voltage
IC+1		0	REMBUS1, first remote bus number
IC+2		3	ICS2, second stabilizer input code: 1 - rotor speed deviation (pu) 2 - bus frequency deviation (pu) 3 - generator electrical power on MBASE base (pu) 4 - generator accelerating power (pu) 5 - bus voltage (pu) 6 - derivative of pu bus voltage
IC+3		0	REMBUS2, second remote bus number
IC+4		5	M, ramp tracking filter
IC+5		1	N, ramp tracking filter

CONs	#	Value	Description
J		10	T_{w1} (>0)
J+1		10	T_{w2}
J+2		0	T_6
J+3		10	T_{w3} (>0)
J+4		0	T_{w4}
J+5		10	T_7
J+6		0.93	K_{S2}
J+7		1.0	K_{S3}
J+8		0.5	T_8

CONs	#	Value	Description
J+9		0.1	T_9 (>0)
J+10		6.0	K_{S1}
J+11		0.12	T_1
J+12		0.035	T_2
J+13		0.1	T_3
J+14		0.02	T_4
J+15		0.10	V_{STMAX}
J+16	-	0.10	V_{STMIN}

STATEs	#	Description
K		Washout - first signal
K+1		Washout - first signal
K+2		Transducer - first signal
K+3		Washout - second signal
K+4		Washout - second signal
K+5		Transducer - second signal
K+6 . . . K+13		Ramp Tracking Filter
K+14		First lead-lag
K+15		Second lead-lag

VARs	#	Description
L		Memory
L+1		Derivative of pu bus voltage - first bus
L+2		Memory
L+3		Derivative of pu bus voltage - second bus

MGD309 GEN DES NO 90228G DATE 3-FEB-00

ATB-2-211000 KVA 3600 RPM 18000 VOLTS 0.85 PF 30.0 PSIG 40.0 C H2
179350 KW 6768 AMPS 0.54 SCR 295 FLD VOLTS 0 FT ALT WYE CONN

REACTANCE DATA - (PER UNIT)	DIRECT AXIS		QUADRATURE AXIS	
SATURATED SYNCHRONOUS	X/DV	1.929	X/QV	1.841
UNSATURATED SYNCHRONOUS	X/DI	1.929	X/QI	1.841
SATURATED TRANSIENT	XP/DV	0.215		
UNSATURATED TRANSIENT	XP/DI	0.291	XP/Q	0.466
SATURATED SUBTRANSIENT	XPP/DV	0.149	XPP/QV	0.146
UNSATURATED SUBTRANSIENT	XPP/DI	0.206	XPP/QI	0.199
SATURATED NEGATIVE SEQUENCE	X/2V	0.143		
UNSATURATED NEGATIVE SEQUENCE	X/2I	0.196		
SATURATED ZERO SEQUENCE	X/0V	0.096		
UNSATURATED ZERO SEQUENCE	X/0I	0.127		
LEAKAGE REACTANCE, OVEREXCITED	X/LM,OEX	0.171		
LEAKAGE REACTANCE, UNDEREXCITED	X/LM,UEX	0.171		

FIELD TIME CONSTANT DATA - (SEC AT 125C)

OPEN CIRCUIT	TP/D0	4.767	TP/Q0	0.395
THREE PHASE SHORT CIRCUIT TRANSIENT	TP/D3	0.530	TP/Q	0.395
LINE TO LINE SHORT CIRCUIT TRANSIENT	TP/D2	0.823		
LINE TO NEUTRAL SHORT CIRCUIT TRANSIENT	TP/D1	0.998		
SHORT CIRCUIT SUBTRANSIENT	TPP/D	0.023	TPP/Q	0.023
OPEN CIRCUIT SUBTRANSIENT	TPP/D0	0.033	TPP/Q0	0.074

ARMATURE DC COMPONENT TIME CONSTANT DATA - (SEC AT 100C)

THREE PHASE SHORT CIRCUIT	T/A3	0.349
LINE TO LINE SHORT CIRCUIT	T/A2	0.349
LINE TO NEUTRAL SHORT CIRCUIT	T/A1	0.311

ARMATURE WINDING SEQUENCE RESISTANCE DATA - (PER UNIT)

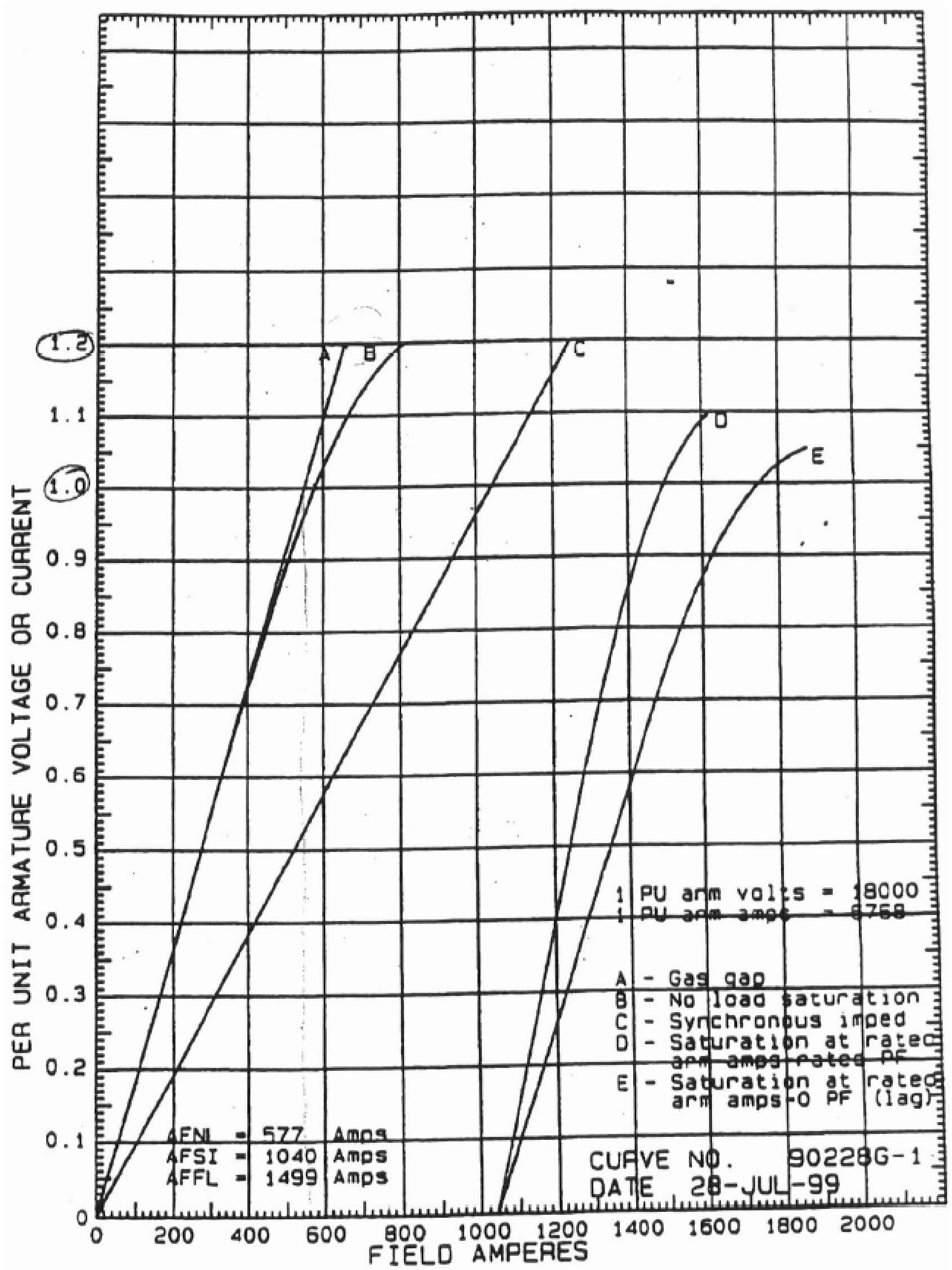
POSITIVE	R/1	0.003
NEGATIVE	R/2	0.013
ZERO	R/0	0.007

ANSI ROTOR SHORT-TIME THERMAL CAPACITY, I2SQT = 10.0
TURBINE-GENERATOR COMBINED INERTIA CONSTANT, H = 5.372 KW SEC/KVA
THREE PHASE ARMATURE WINDING CAPACITANCE = 1.103 MICROFARADS
ARMATURE WINDING DC RESISTANCE (PER PHASE) = 0.00167 OHMS (100 C)
FIELD WINDING DC RESISTANCE = 0.199 OHMS (125 C)
FIELD CURRENT AT RATED KVA, ARM VOLTAGE, AND PF = 1498.6 AMPS
FIELD CURRENT AT RATED KVA AND ARM VOLTAGE, 0PF LAGGING (FOR SYSTEMS STUDY ONLY - NOT ALLOWABLE OPERATING POINT) = 1747.8 AMPS

GAS TURBINE DRIVEN GENERATOR - PROPOSAL DATA FOR PROP. NUMBER: 90228

```
DATE  3-FEB-00 CUSTOMER                    DESIGN NUMBER 90228G

GENERATOR RATING

  BASE AT      0 FT ALTITUDE, 40 DEG C AMBIENT-
   211000 KVA - 0.85 PF - 179350 KW - 3600 RPM - 2 POLE - 3 PHASE
   60 HERTZ - 18000 A.C. VOLTS -  6768 A.C. AMPS -   WYE CONNECTED
   0.54 SCR -   30.0 PSIG

TOTAL TEMPERATURES ARE GUARANTEED NOT TO EXCEED-      INSULATION MATERIAL
   STATOR COILS-  100. DEG C BY EMBEDDED DETECTOR     ARMATURE - CLASS F
   COLLECTOR-     125. DEG C BY THERMOMETER           FIELD    - CLASS F
   FIELD COILS-   110. DEG C BY RESISTANCE

DIELECTRIC TESTS - BETWEEN COILS AND GROUND, 60 HERTZ AC FOR 1 MIN-

   STATOR -  37000 VOLTS
    ROTOR -  2950 VOLTS
```

ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES
211000 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF
295 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2

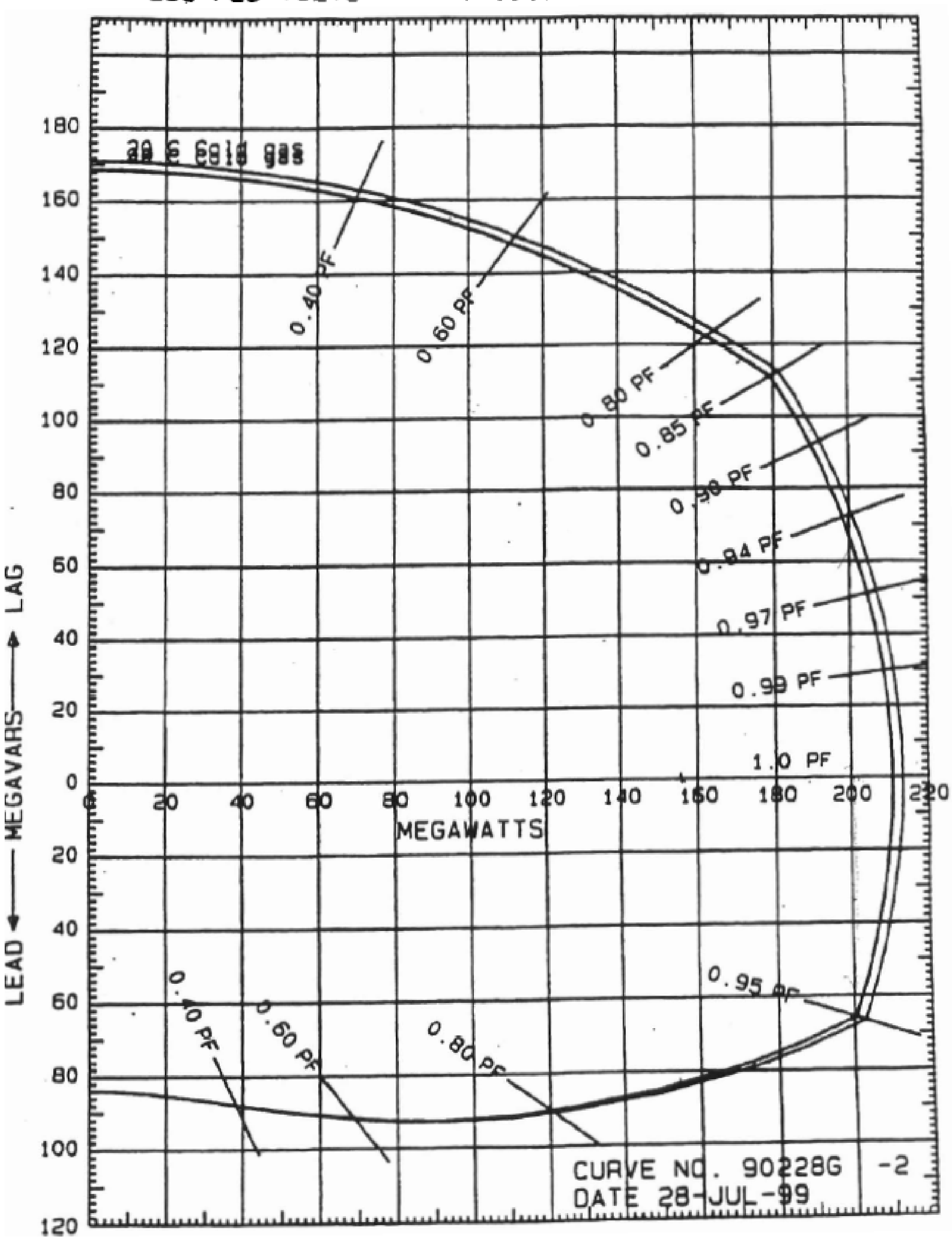


$$S(1.0) = \frac{B_{1.0} - A_{1.0}}{A_{1.0}} = \frac{580 - 560}{560}$$

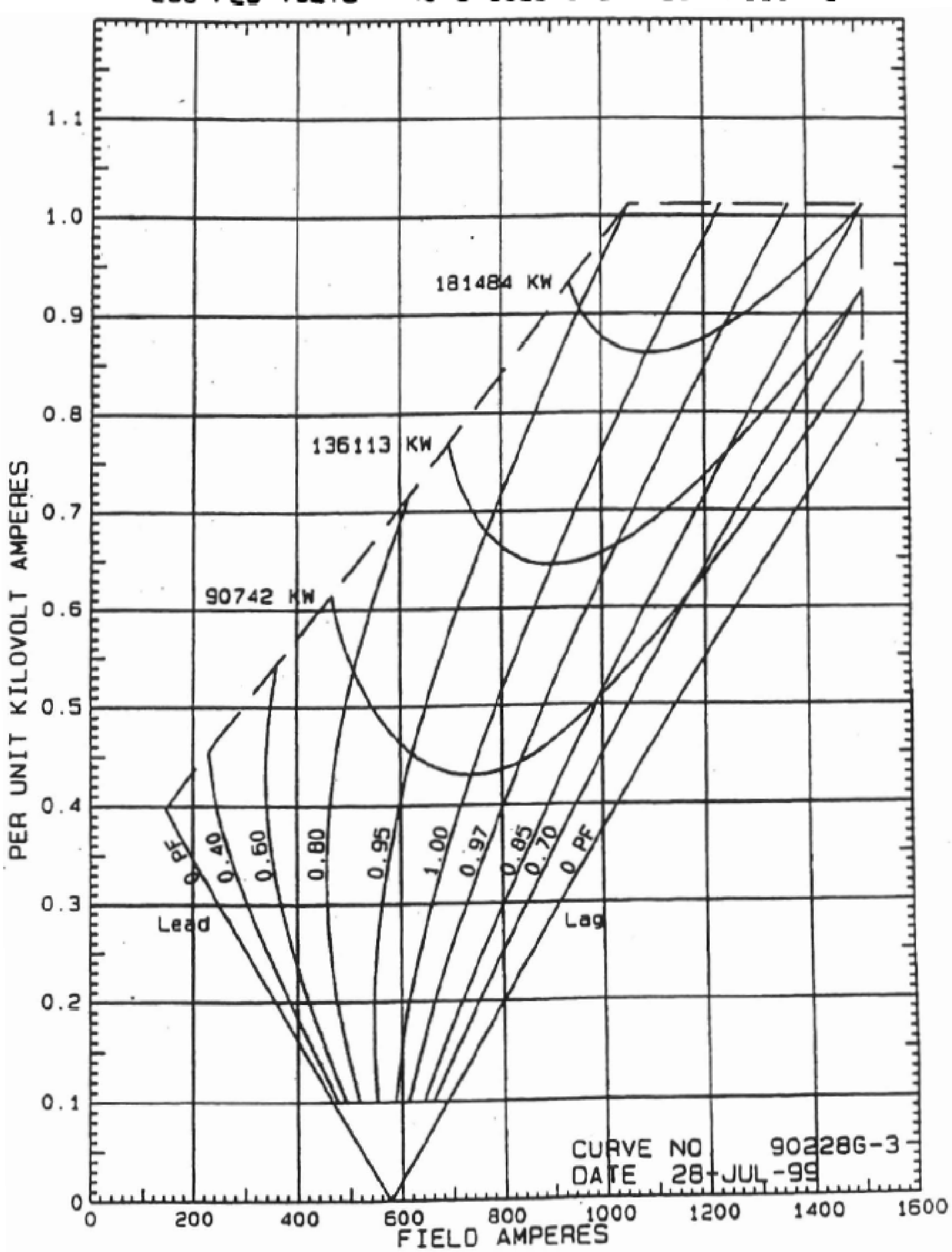
$$S(1.2) = \frac{B_{1.2} - A_{1.2}}{A_{1.2}} = \frac{800 - 660}{660}$$

ESTIMATED REACTIVE CAPABILITY CURVES

211000 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF
295 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



ESTIMATED EXCITATION V CURVES
211000 KVA - 3600 RPM - 18000 VOLTS - 0.85 PF
295 FLD VOLTS - 40 C COLD GAS - 30 PSIG H2



Appendix A: Attachment 3 - Interconnection Study Data Requirement

7FH2B ST

ENTERGY

Data Sheet for Interconnection Studies		
	For each set of generators (steam/gas)	
General	**Required for Load Flow Analysis**	**Required for Stability Analysis**
Maximum Gross MW (per set)	211.65 MW	
Aux Power Requirement (per set)	2.5 MW total for CCGT	
One Line Diagram for the Plant	Attached	
Step-Up Transformer/Autotransformer (two wdg xfmrs)		
Rated Voltage HV	138	
Rated Voltage LV	18	
MVA rating	149.4/249	
Taps HV side	+/-2 steps of 2.5% above and below nominal	
Taps LV Side	None	
Z1 (positive sequence impedance)	9.5%	
X / R ratio	30	
Generator (p.u. reactances are on rated MVA, KV values)		
Manufacturer	GE	
Rated MVA	249	
Rated KV	18	
Power factor	0.85	
Reactive Capability Curves or QMAX/QMIN	Attached under separate cover	
Parameters for PTI-compatible Generator model		Attached under separate cover
(See datasheet for PTI-compatible generator models)		
Automatic Voltage Regulator and Excitation System		
Type (e.g., static, brushless, etc.)		Static
Model (Control Block Diagram)		IEEE ST4B
Parameters - (See datasheet for PTI-compatible exciter models)		Attached under separate cover
Power System Stabilizer		
Model (Control Block Diagram)		PSS2A
		See attachment
Turbine and Governor (Steam Turbine)		
Model (Control Block Diagram)		Attached under separate cover
Parameters - (See datasheet for PTI-compatible governor models)		Attached under separate cover
Turbine and Governor (Gas Turbine)		
Model (Control Block Diagram)		
Parameters - (See datasheet for PTI-compatible governor models)		
(Note: Need PTI compatile models for generator, exciter, governor and stabilizer)		
Line Data (in per unit on 100MVA base)		
From Bus:________ positive sequence	r = ____pu, x = ____pu,	charging = ____pu, line rating = ____mva
To Bus:________ zero sequence	r = ____pu, x = ____pu,	line length = _____miles
Load Data	p = ____mw, q = ____mvar	

GENROU

Round Rotor Generator Model (Quadratic Saturation)

This model is located at system bus #_______ IBUS,

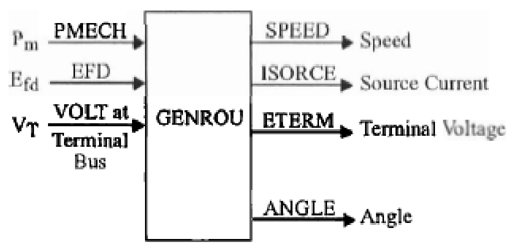
machine #_______ I.

This model uses CONs starting with #_______ J,

and STATEs starting with #_______ K,

The machine MVA is ________ for each of ________ units = ________ MBASE.

ZSORCE for this machine is ________ + j ________ on the above MBASE



CONs	#	Value	Description
J		7.7	T'_{do} (>0) (sec)
J+1		0.039	T''_{do} (>0) (sec)
J+2		0.59	T'_{qo} (>0) (sec)
J+3		0.078	T''_{qo} (>0) (sec)
J+4		4.2446	Inertia, H
J+5			Speed damping, D
J+6		2.11	X_d
J+7		2.01	X_q
J+8		0.265	X'_d
J+9		0.465	X'_q
J+10		0.2	$X''_d = X''_q$
J+11		0.15	X_l
J+12	see	curve	S(1.0)
J+13	see	curve	S(1.2)

STATEs	#	Description
K		E'_q
K+1		E'_d
K+2		ψkd
K+3		ψkq
K+4		Δ speed (pu)
K+5		Angle (radians)

Note: X_d, X_q, X'_d, X'_q, X''_d, X''_q, X_l, H, and D are in pu, machine MVA base.

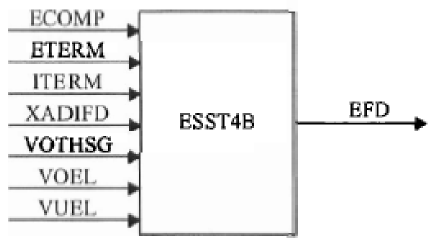
X''_q must be equal to X''_d.

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)/

ESST4B

IEEE Type ST4B Potential or Compounded Source-Controlled Rectifier 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		3.30	K_{PR}
J+2		3.30	K_{IR}
J+3		1.00	V_{RMAX}
J+4		-0.87	V_{RMIN}
J+5		0.01	T_A (sec)
J+6		1.00	K_{PM}
J+7		0	K_{IM}
J+8		1.00	V_{MMAX}
J+9		-0.87	V_{MMIN}
J+10		0	K_G
J+11		6.05	K_P
J+12		0	K_I
J+13		7.56	V_{BMAX}
J+14		0.09	K_C
J+15		0	X_L
J+16			THETAP

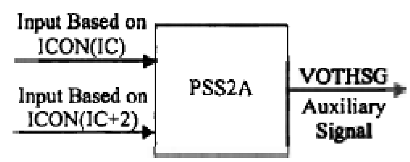
STATEs	#	Description
K		Sensed V_T
K+1		Regulator integrator
K+2		Regulator output, V_R
K+3		V_M

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/

PSS2A

IEEE Dual-Input Stabilizer 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 #_______ IC.



ICONs	#	Value	Description
IC			ICS1, first stabilizer input code: 1 - rotor speed deviation (pu) 2 - bus frequency deviation (pu) 3 - generator electrical power on MBASE base (pu) 4 - generator accelerating power (pu 5 - bus voltage (pu) 6 - derivative of pu bus voltage
IC+1			REMBUS1, first remote bus number
IC+2			ICS2, second stabilizer input code: 1 - rotor speed deviation (pu) 2 - bus frequency deviation (pu) 3 - generator electrical power on MBASE base (pu) 4 - generator accelerating power (pu 5 - bus voltage (pu) 6 - derivative of pu bus voltage
IC+3			REMBUS2, second remote bus number
IC+4			M, ramp tracking filter
IC+5			N, ramp tracking filter

CONs	#	Value	Description
J			T_{w1} (>0)
J+1			T_{w2}
J+2			T_6
J+3			T_{w3} (>0)
J+4			T_{w4}
J+5			T_7
J+6			K_{S2}
J+7			K_{S3}
J+8			T_8

CONs	#	Value	Description
J+9			T_9 (>0)
J+10			K_{S1}
J+11			T_1
J+12			T_2
J+13			T_3
J+14			T_4
J+15			V_{STMAX}
J+16			V_{STMIN}

STATEs	#	Description
K		Washout - first signal
K+1		Washout - first signal
K+2		Transducer - first signal
K+3		Washout - second signal
K+4		Washout - second signal
K+5		Transducer - second signal
K+6 . . . K+13		Ramp Tracking Filter
K+14		First lead-lag
K+15		Second lead-lag

VARs	#	Description
L		Memory
L+1		Derivative of pu bus voltage - first bus
L+2		Memory
L+3		Derivative of pu bus voltage - second bus

Please see datasheet.

ESTIMATED GENERATOR DATA

Customer: -99999
Station/Project:
Generator Number:
Generator Type:

GENERATOR RATING

Data for Proposal No/Electrical Design: 90995G Run Date : 6/14/02

ATB 2 249000 kVA 3600 RPM 18000 Volts 0.85 PF 45 psig -99999 °C Gas 211650 kW 7986 Amps
385 Field Volts 597 Ft Alt 0.498 SCR 60 Hz 3 Phase WYE Connection

Exciter Rating

Type Static

840 kW 385 Volts 2181 D.C.Amps Field Amps @ Generator rated Load 1744

Total temperatures are guaranteed not to exceed:	**Insulation Class**		**Temperature Rise**
Stator coils: 100 °C by embedded detector	Armature	F	B
Field coils 110 °C by Resistance	Field class	F	B
Collector Gas Rise 20 °C by RTD			

Cooling water Requirements @ Generator Rating (C901 - Data)

(Data not applicable for Open Ventilated Units. Air cooled OV units, values will be shown as –99999)

Generator Output:	249000	Kva
Loss to Coolers:	Kw	
Inlet Water Temperature:	°C	
Outlet Cold Gas Temperature	-99999	°C
Coolant		
Maximum Fouling Factor:	0.0005	1/(btu / (hours*footsquared*F))
Total Water Flow Required:	GPM	(total for all coolers)
Coolant temperature Max	°C	
Head Loss Per Cooler:	Feet of Water	
Maximum Operating Pressure:	125 psig	
	8.6184	bar

Dielectric tests (Between coils and ground, 50/60 hertz AC for 1 min)

Stator 37000V

Rotor 3153V

REACTANCES (Per Unit):	Direct Axis		Quadrature Axis	
Saturated Synchronous	X_{dv}	2.11	X_{qv}	2.01
Unsaturated Synchronous	X_{di}	2.11	X_{qi}	2.01
Saturated Transient	X'_{dv}	0.235		
Unsaturated Transient	X'_{di}	0.265	X'_{q}	0.465
Saturated Sub transient	X''_{dv}	0.155	X''_{qv}	0.155
Unsaturated Sub transient	X''_{di}	0.2	X''_{qi}	0.2
Saturated Negative Sequence	X_{2v}	0.155		
Unsaturated Negative Sequence	X_{2i}	0.2		
Saturated Zero Sequence	X_{0v}	0.105		
Unsaturated Zero Sequence	X_{0I}	0.105		
Saturated Leakage Reactance	X_{lv}	0.135		
Unsaturated Leakage Reactance	X_{li}	0.15		

FIELD TIME CONSTANTS (Seconds @ 125 °C)				
Open Circuit	T'_{d0}	7.7	T'_{q0}	0.59
Three Phase Short Circuit Transient	T'_{d3}	0.77	T'_{q}	0.14
Line To Line Short Circuit Transient	T'_{d2}	1.32		
Line To Neutral Short Circuit Transient	T'_{d1}	1.6		
Short Circuit Sub transient	T''_{d}	0.026	T''_{q}	0.026
Open Circuit Sub transient	T''_{d0}	0.039	T''_{q0}	0.078

ARMATURE DC COMPONENT TIME CONSTANTS (Seconds@ 100 °C)

Three Phase Short Circuit	T_{a3}	0.4
Line To Line Short Circuit	T_{a2}	0.4
Line To Neutral Short Circuit	T_{a1}	0.31

ARMATURE WINDING SEQUENCE RESISTANCES (Per Unit)

Positive	R_1	0.003
Negative	R_2	0.0202
Zero	R_0	0.0089

Reactance, Resistance and Time Constant data may be interpreted per IEEE 115, section VII.

The base reactance (" UNIT") is calculated by the armature kV squared / MVA.

Base reactance = 1.3012 Ohms

Rotor Short-Time Thermal Capacity, $(I_2)^2t$	10 s
Turbine-Generator Combined Inertia Constant, H	kW-s/kVA
Three Phase Armature Winding Capacitance	0.898 μF
Armature Winding DC Resistance (Per Phase)	0.0015 Ω (100 °C)
Field Winding DC Resistance	0.1808 Ω (125 °C)
Field Current At Rated Kva, Armature Voltage, & PF	1744 A
Field Current At Rated Kva, Armature Voltage, 0 PF Lagging	2194 A

(For Systems Study Only - Not Allowable Operating Point)

X/R RATIO

X/R = 130 X/R ratio equals "XPP/DV" * base reactance / armature DC resistance at 100 C

Customer

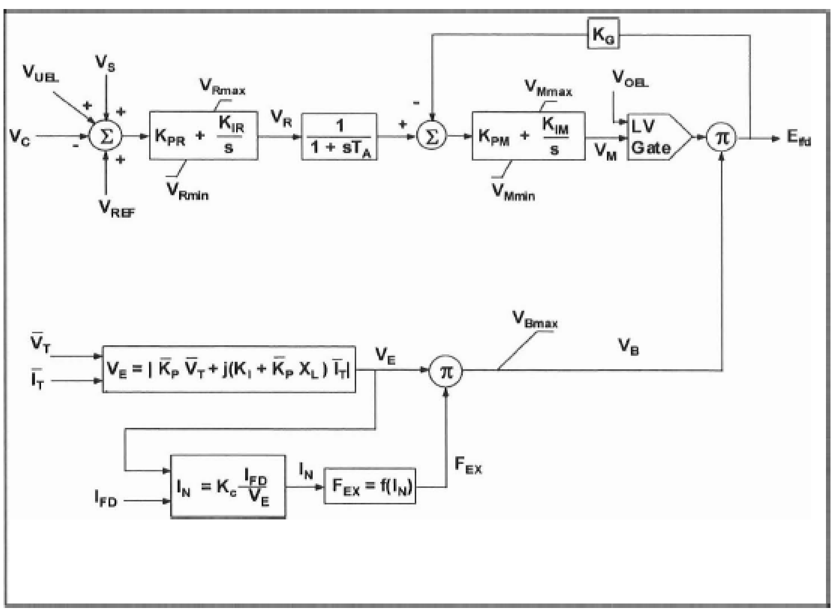
Generator Design	90995G
Generator Type	7FH2B

MVA Rating	249	KV Rating	18
RPM	3600	PF	0.85
SCR	0.498	H2PSI	45
Volts DC	385	RFG at 100 C	0.1682
AFAG amps	544	AFFL amps	1744

EX2000 Standard Busfed Static Exciter Model Parameters
IEEE ST4B Model Format
TYPICAL DATA, NOT FOR DESIGN PURPOSES

Exciter Nominal Response at rated inpu 2.0

TR	0	KC	0.09
KPR	3.30	KIR	3.30
VRMAX	1.00	VRMIN	-0.87
TA	0.01	KG	0
KPM	1.00	KIM	0
VMMAX	1.00	VMIMIN	-0.87
KP	6.05	KI	0
VBMAX	7.56	XL	0

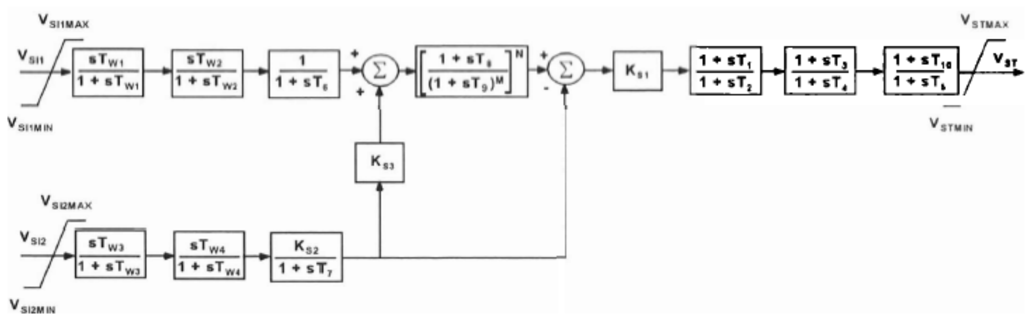


Harold C. Sanderson
GE Excitation/Controls Engineering
ex2000/

5/24/2007 15:09

TR	AC sensor time constant
KPR	AVR proportional gain
KIR	AVR integral gain
VRMAX	Maximum AVR Output
VRMIN	Minimum AVR output
TA	AVR time constant
KG	Field voltage feedback gain
KPM	Inner loop proportional gain
KIM	Inner loop integral gain
VMMAX	Maximum inner loop output
VMIMIN	Minimum inner loop output
VBMAX	Maximum source voltage
KP	Potential source constant
KI	Current source constant
XL	Source leakage reactance
KC	Rectifier loading factor
VS	Stabilizing input
VOEL	Over Excitation limit input
VUEL	Under excitation limit input
VC	Compensated terminal voltage
VREF	Terminal voltage setpoint
EFD	Field voltage
IFD	Field current
VT	Terminal voltage
IT	Terminal current

TYPICAL EX2000 Power System Stabilizer (PSS)
IPS90995GD
TYPICAL DATA, NOT FOR DESIGN PURPOSES



Ref. IEEE 421.5-1992 Type PSS2A

Note: Parameters shown with ranges give the typical or useful ranges actual setting ranges are usually much wider.

VSI1 = speed input VSI2 = electrical power input

VSI1max, VSI1min - input #1 limits +/- 0.08 pu (fixed)

VSI2max, VSI2min - input #2 limits +/- 1.25 pu (fixed)

*T1 = lead #1 0.15 (range 0.1 - 2.0 sec) *T2 = lag #1 0.03 (range 0.01 - 1.0 sec)

*T3 = lead #2 0.15 (range 0.1 - 2.0 sec) *T4 = lag #2 0.03 (range 0.01 - 1.0 sec)

T5 = lag #3 0.0 (fixed not used in GE design) can be used if there are three lead lags or for equivalent torsional filter time constant which may be required for some units (determined by studies)

T6 = 0.0 (fixed) T7 = TW 2.0 sec (range 2 - 15 sec)

T8 = 0.5 sec (fixed) T9 = 0.1 sec (fixed)

T10 = Lag #3 = 0.0 (fixed not used in GE design)

N = 1 (fixed) M = 5 (fixed)

*KS1 = PSS gain = 8 - (range 3 - 20 typical)

KS2 = 0.202 = TW/(2H) - where H = combined turbine-gen. Inertia constant

KS3 = 1.0

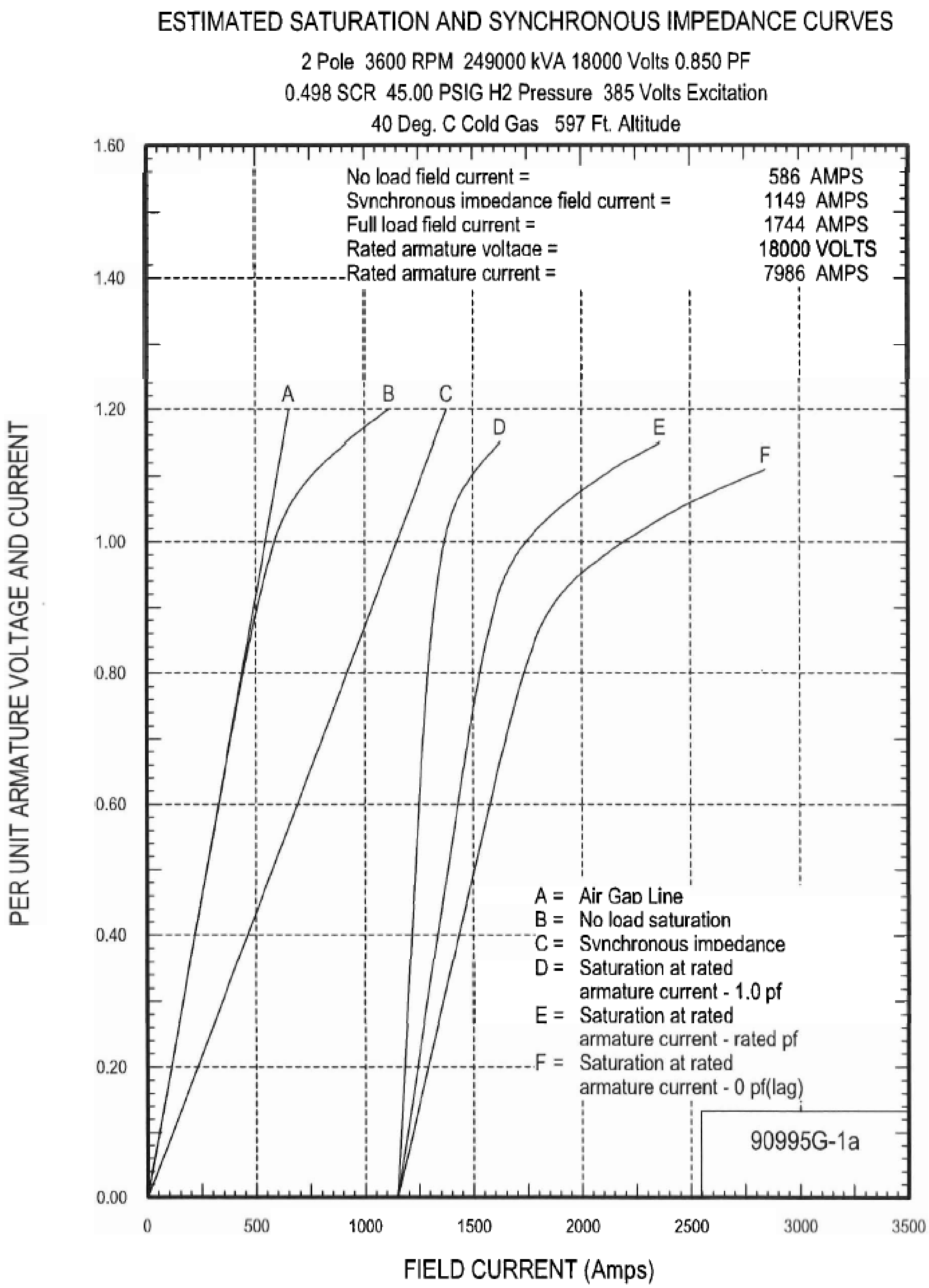
VSTmax = (range 0.05 to 0.1) VSTmin = (range -0.05 to -0.1)

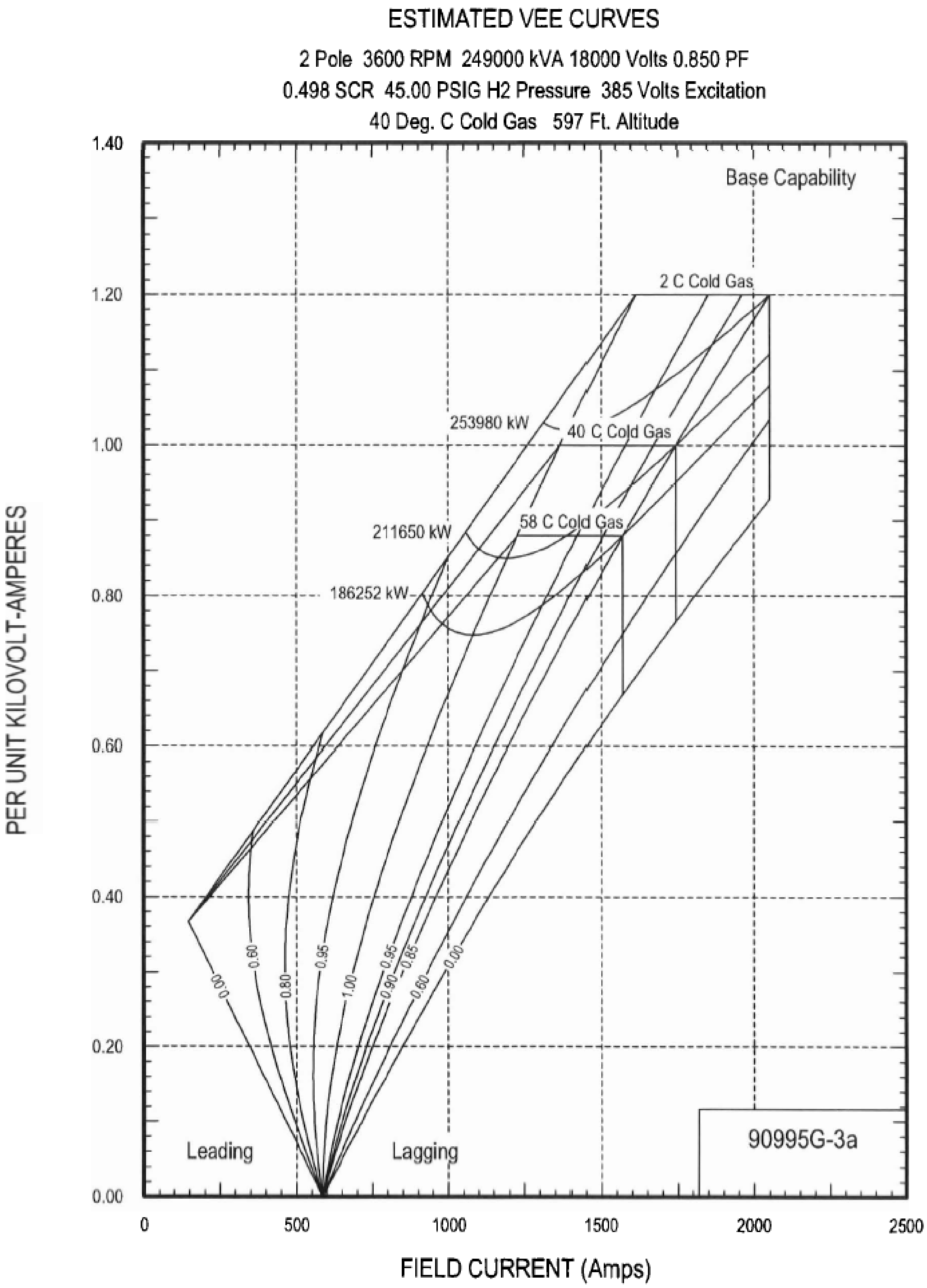
TW1 = TW see note on T7 above TW2 = TW see note on T7 above

TW3 = TW see note on T7 above TW4 = 0.0 (fixed)

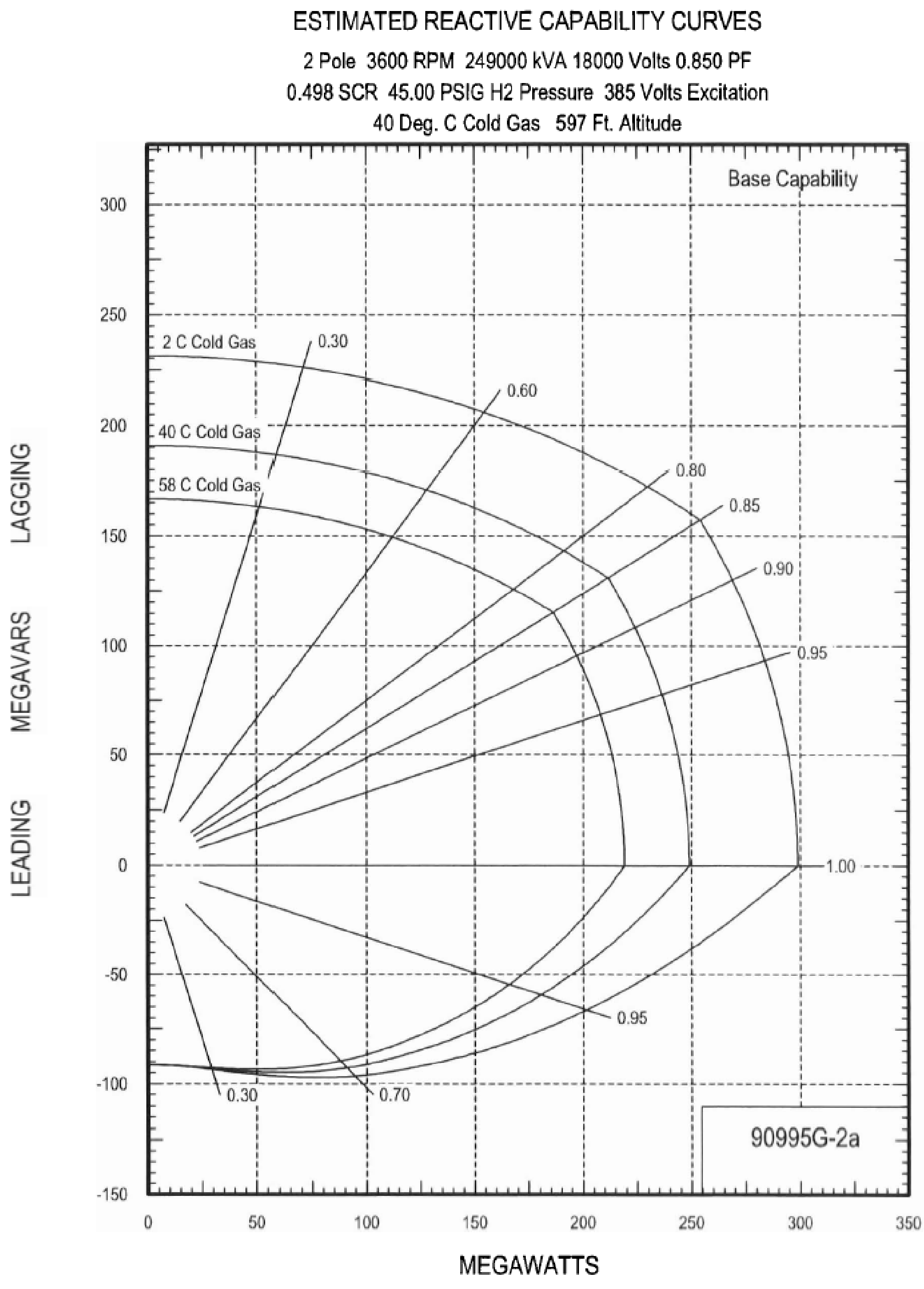
* Note:Lead/Lags and Gain must be Determined by Studies

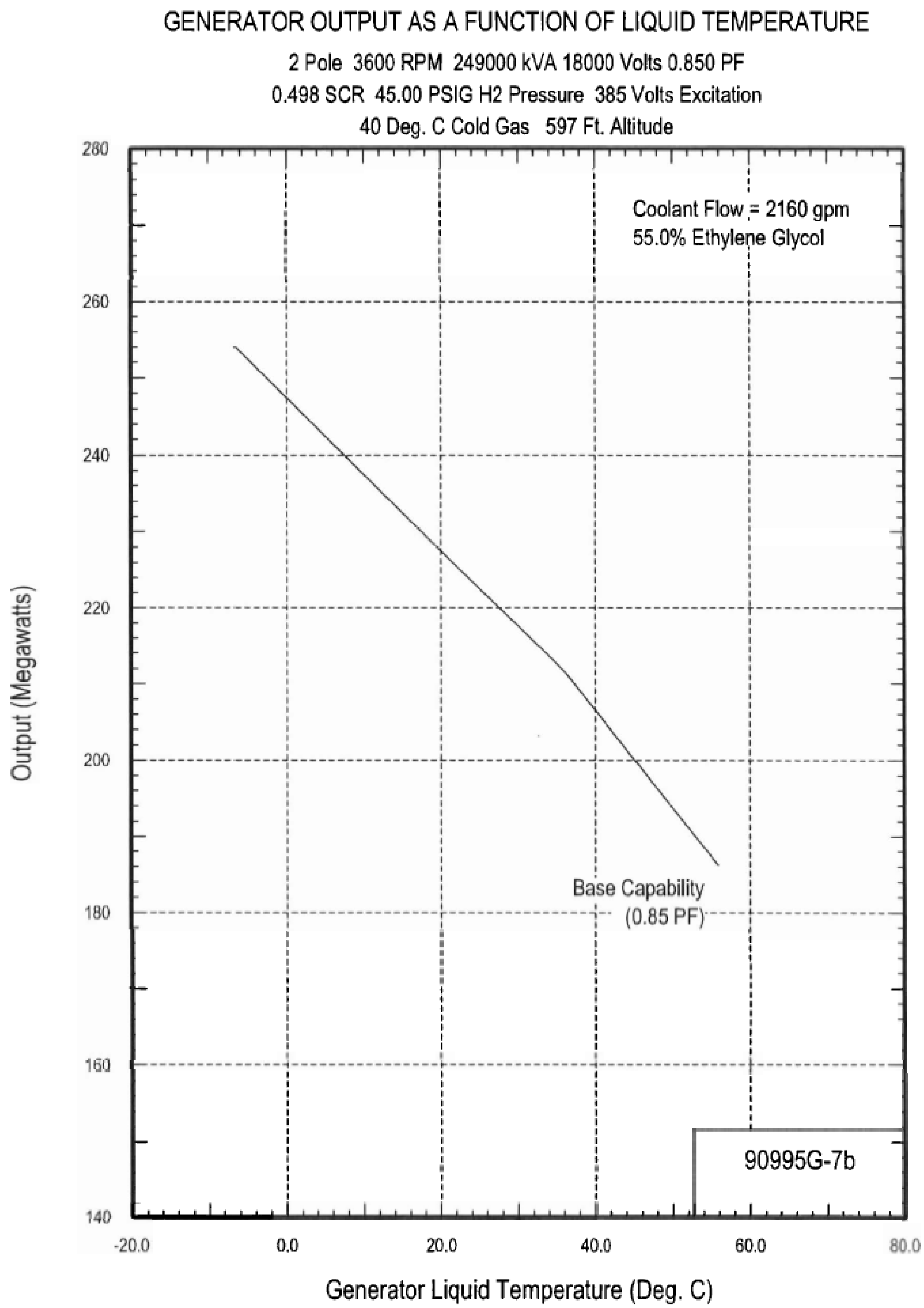
HCS 3-19-2002

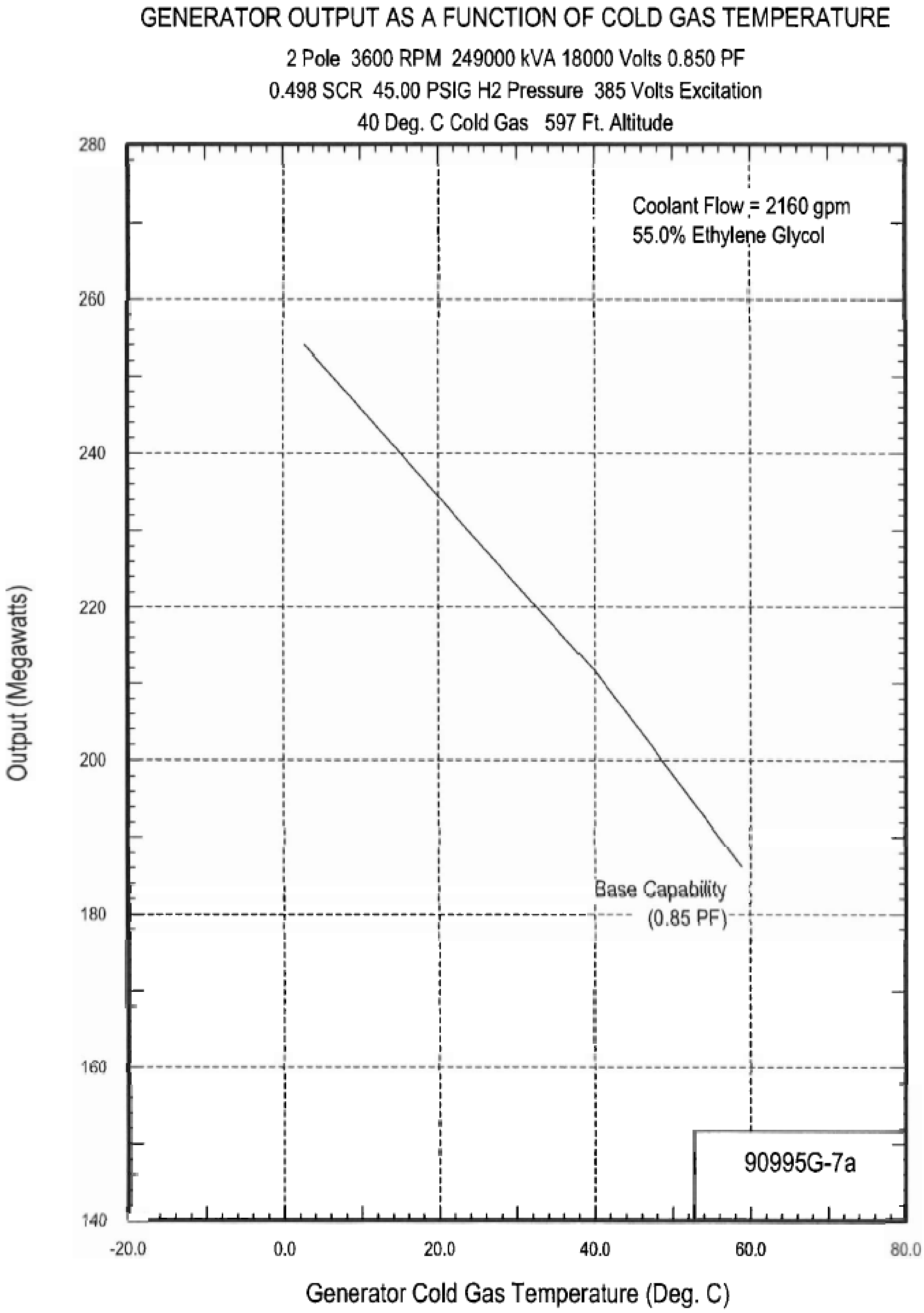

ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES
2 Pole 3600 RPM 249000 kVA 18000 Volts 0.850 PF
0.498 SCR 45.00 PSIG H2 Pressure 385 Volts Excitation
40 Deg. C Cold Gas 597 Ft. Altitude
No load field current = 586 AMPS
Synchronous impedance field current = 1149 AMPS
Full load field current = 1744 AMPS
Rated armature voltage = 18000 VOLTS
Rated armature current = 7986 AMPS
A = Air Gap Line
B = No load saturation
C = Synchronous impedance
D = Saturation at rated armature current - 1.0 pf
E = Saturation at rated armature current - rated pf
F = Saturation at rated armature current - 0 pf(lag)
90995G-1a
PER UNIT ARMATURE VOLTAGE AND CURRENT
FIELD CURRENT (Amps)



ESTIMATED VEE CURVES
2 Pole 3600 RPM 249000 kVA 18000 Volts 0.850 PF
0.498 SCR 45.00 PSIG H2 Pressure 385 Volts Excitation
40 Deg. C Cold Gas 597 Ft. Altitude
Base Capability
2 C Cold Gas
253980 kW
40 C Cold Gas
211650 kW
58 C Cold Gas
186252 kW
PER UNIT KILOVOLT-AMPERES
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.60
0.80
0.95
1.00
0.95
0.90
0.85
0.80
0.00
Leading
Lagging
90995G-3a
0
500
1000
1500
2000
2500
FIELD CURRENT (Amps)


ESTIMATED REACTIVE CAPABILITY CURVES
2 Pole 3600 RPM 249000 kVA 18000 Volts 0.850 PF
0.498 SCR 45.00 PSIG H2 Pressure 385 Volts Excitation
40 Deg. C Cold Gas 597 Ft. Altitude
Base Capability
2 C Cold Gas
40 C Cold Gas
58 C Cold Gas
0.30
0.60
0.80
0.85
0.90
0.95
1.00
0.95
0.30
0.70
90995G-2a
LAGGING
MEGAVARS
LEADING
MEGAWATTS
300
250
200
150
100
50
0
-50
-100
-150
0
50
100
150
200
250
300
350


GENERATOR OUTPUT AS A FUNCTION OF LIQUID TEMPERATURE
2 Pole 3600 RPM 249000 kVA 18000 Volts 0.850 PF
0.498 SCR 45.00 PSIG H2 Pressure 385 Volts Excitation
40 Deg. C Cold Gas 597 Ft. Altitude
Coolant Flow = 2160 gpm
55.0% Ethylene Glycol
Base Capability
(0.85 PF)
90995G-7b
Output (Megawatts)
280
260
240
220
200
180
160
140
-20.0
0.0
20.0
40.0
60.0
80.0
Generator Liquid Temperature (Deg. C)


GENERATOR OUTPUT AS A FUNCTION OF COLD GAS TEMPERATURE
2 Pole 3600 RPM 249000 kVA 18000 Volts 0.850 PF
0.498 SCR 45.00 PSIG H2 Pressure 385 Volts Excitation
40 Deg. C Cold Gas 597 Ft. Altitude
Coolant Flow = 2160 gpm
55.0% Ethylene Glycol
Base Capability
(0.85 PF)
90995G-7a
Output (Megawatts)
280
260
240
220
200
180
160
140
-20.0
0.0
20.0
40.0
60.0
80.0
Generator Cold Gas Temperature (Deg. C)

A.A.2 DATA USED IN STABILITY MODEL

Load Flow Models

The **PID-211** plant equipment data are listed in Appendix A.A. No other elements were added to the Entergy system.

Stability Models

The **PID-211** plant equipment stability model data are listed in Appendix A.A. The resulting PSS/E model data is a follows:

Load Flow data in Stability Models

```
 99181,'G1PID211    ',  18.0000, 2,  0,  0,  351,  103, 1.00000, -43.4, 1
 99182,'G2PID211    ',  18.0000, 2,  0,  0,  351,  103, 1.00000, -43.4, 1
 99183,'G3PID211    ',  18.0000, 2,  0,  0,  351,  103, 1.00000, -43.4, 1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
 99181,'1 ',       0.0,       0.0,   110.000,   -80.000,1.00000,334072,   211.000,   0.00000,     0.206,
0.00000,   0.00000,1.00000,0,  100.0,   179.350,     0.000,   1,1.0000
 99182,'2 ',       0.0,       0.0,   110.000,   -80.000,1.00000,334072,   211.000,   0.00000,     0.206,
0.00000,   0.00000,1.00000,0,  100.0,   179.350,     0.000,   1,1.0000
 99183,'3 ',       0.0,       0.0,   130.000,   -80.000,1.00000,334072,   249.000,   0.00000,     0.200,
0.00000,   0.00000,1.00000,0,  100.0,   211.650,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
334072, 99181,     0,'1 ',2,2,1,   0.00000,   0.00000,2,'TX LEWIS CT1',1,   1,1.0000
   0.00316,     0.095,    126.6
138.000,  0.000,   0.000,    126.60,   126.60,   126.60, 0,      0,   144.9,   131.1,   144.9,   131.1, 33,
0, 0.00000, 0.00000
18.0000,  0.000
334072, 99182,     0,'2 ',2,2,1,   0.00000,   0.00000,2,'TX LEWIS CT2',1,   1,1.0000
   0.00316,     0.095,    126.6
138.000,  0.000,   0.000,    126.60,   126.60,   126.60, 0,      0,   144.9,   131.1,   144.9,   131.1, 33,
0, 0.00000, 0.00000
18.0000,  0.000
334072, 99183,     0,'3 ',2,2,1,   0.00000,   0.00000,2,'TX LEWIS ST1',1,   1,1.0000
   0.00316,     0.095,    149.4
138.000,  0.000,   0.000,    149.40,   149.40,   149.40, 0,      0,   144.9,   131.1,   144.9,   131.1, 33,
0, 0.00000, 0.00000
18.0000,  0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
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 in Stability Models

```
// MACHINE CT1
99181 'GENROU'  1         4.767       0.033       0.395       0.074
                5.372     0.0         1.929       1.841       0.291
                0.466     0.206       0.171       0.0357      0.242      / CT1_PID211 18.0 \ RTH_28April08

99181 'EXPIC1'  1         0.0         3.96        1.0         1.0
                -0.87     0.01        0.0         0.0         1.0
                -0.87     0.0         1.0         1.0         6.31
                0.0       0.0         0.0         0.0         0.0
                0.0       0.0         6.05        0.0         0.13       / CT1_PID211 18.0 \ RTH_28April08


99181 'PSS2B'   1         0.0         3.00        0.0         5.0
                1         10.0        10.0        0.0        10.0
                0.0       10.0       0.931        1.0         0.5
                0.1       6.0         0.12      0.035         0.1
                0.02     0.10       -0.10                                / CT1_PID211 18.0 \ EMC_22May08

99181 'GAST2A'  1         25.0        0.0         0.02        1.0
                0.04      0.2         171.7       0.0625      1.00
                0.0       0.01        0.77        1.0         0.05
                1.0       0.4         0.0         0.2         0.8
                15.0      2.5         1650.0      3.3         597.0
                550.0     -0.299      1.3         0.5         1116.0
                0.23      1116.0                                         / CT1_PID211 18.0 \ RTH_29April08

// MACHINE CT2
99182 'GENROU'  2         4.767       0.033       0.395       0.074
                5.372     0.0         1.929       1.841       0.291
                0.466     0.206       0.171       0.0357      0.242      / CT2_PID211 18.0 \ RTH_28April08

99182 'EXPIC1'  2         0.0         3.96        1.0         1.0
                -0.87     0.01        0.0         0.0         1.0
                -0.87     0.0         1.0         1.0         6.31
                0.0       0.0         0.0         0.0         0.0
                0.0       0.0         6.05        0.0         0.13       / CT2_PID211 18.0 \ RTH_28April08

99182 'PSS2B'   1         0.0         3.00        0.0         5.0
                1         10.0        10.0        0.0        10.0
                0.0       10.0       0.931        1.0         0.5
                0.1       6.0         0.12      0.035         0.1
                0.02     0.10       -0.10                                / CT1_PID211 18.0 \ EMC_22May08

99182 'GAST2A'  2         25.0        0.0         0.02        1.0
                0.04      0.2         171.7       0.0625      1.00
                0.0       0.01        0.77        1.0         0.05
                1.0       0.4         0.0         0.2         0.8
                15.0      2.5         1650.0      3.3         597.0
                550.0     -0.299      1.3         0.5         1116.0
                0.23      1116.0                                          / CT2_PID211 18.0 \ RTH_29April08

// MACHINE ST1
99183 'GENROU'  3         7.7         0.039       0.59        0.078
                4.2446    0.0         2.11        2.01        0.265
                0.465     0.2         0.15        0.0385      0.143      / ST1_PID211 18.0 \ RTH_28April08

99183 'PSS2A'   3         1           0           3           0
                5         1           2           2           0
                2         0           2           0.202       1.0
                0.5       0.10        8.0         0.15        0.03
                0.15      0.03        0.1         -0.1                    / ST1_PID211 18.0 \ RTH_29April08

99183 'ESST4B'  3         0.0         3.3         3.3         1.0
                -0.87     0.01        1.0         0.0         1.0
                -0.87     0.0         6.05        0.0         7.56
                0.09      0.0         0.0                                / ST1_PID211 18.0 \ RTH_29April08


99183 'GGOV1'   0.04      1.0         0.05       -0.05       10.0
                2.00      0.0         1.0         1.0        0.15
                 0.5      1.5         0.20        0.1         0.0
                 0.0      3.0         2.0         0.67        1.0
                -2.0      0.1        -0.1         0.0        0.01
                10.0      0.0       211.65      0.00025       4.0
                 4.0     99.0       -99.0                                 / ST1_PID211 18.0 \ EMC_22May08
```

APPENDIX A.B
POLICY STATEMENT/GUIDELINES FOR POWER SYSTEM STABILIZER ON THE ENTERGY SYSTEM

Background:

A Power System Stabilizer (PSS) is an electronic feedback control that is a part of the excitation system control for generating units. The PSS acts to modulate the generator field voltage to damp the Power System oscillation.

Due to restructuring of the utility industry, there has been a significant amount of merchant generation activity on the Entergy system. These generators are typically equipped with modern exciters that have a high gain and a fast response to enhance transient stability. However, these fast response exciters, if used without stabilizers, can lead to oscillatory instability affecting local or regional reliability. This problem is exacerbated particularly in areas where there is a large amount of generation with limited transmission available for exporting power.

Stability studies carried out at Entergy have validated this concern. Furthermore, based on the understanding of operational problems experienced in the WSCC area over the last several years and the opinion of leading experts in the stability area, PSS are an effective and a low cost means of mitigating dynamic stability problems. In particular, PSS cost can be low if it is included in power plant procurement specifications.

Therefore, as a pre-emptive measure, Entergy requires all new generation (including affiliates and qualifying facilities) intending to interconnect to its transmission system to install PSS on their respective units.

The following guidelines shall be followed for PSS installation:

- PSS shall be installed on all new synchronous generators (50 MVA and larger) connecting to the transmission system that were put into service after January 1, 2000.

- PSS shall be installed on synchronous generators (50 MVA and larger) installed before January 1, 2000 subject to confirmation by Entergy that these units are good candidates for PSS and installing PSS on these units will enhance stability in the region. The decision to install PSS on a specific unit will be based on the effectiveness of the PSS in controlling oscillations, the suitability of the excitation system, and cost of retrofitting.

- In areas where a dynamic stability problem has not been explicitly identified, all synchronous generators (50 MVA and larger) will still be required to install stabilizers. However, in such cases the tuning will not be required and the stabilizer may remain disconnected until further advised by Entergy.

- Need for testing and tuning of PSS on units requesting transmission service from areas where stability problem has not been explicitly identified will be determined on an as-needed basis as part of transmission service study.

- The plants are responsible for testing and tuning of exciter and stabilizer controls for optimum performance and providing PSS model and data for use with PSS/E stability program.

- PSS equipment shall be tested and calibrated in conjunction with automatic voltage regulation (AVR) testing and calibration at-least every five years in accordance with the NERC Compliance Criteria on Generator Testing. PSS re-calibration must be performed if AVR parameters are modified.

- The PSS equipment to be installed is required to be of the Delta-P-Omega type.

References:

WOTAB Area Stability Study for the Entergy System
WSCC Draft Policy Statement on Power System Stabilizers
PSEC Application Notes: Power System Stabilizer helps need plant stability margins for Simple Cycle and Combined Cycle Power Plants

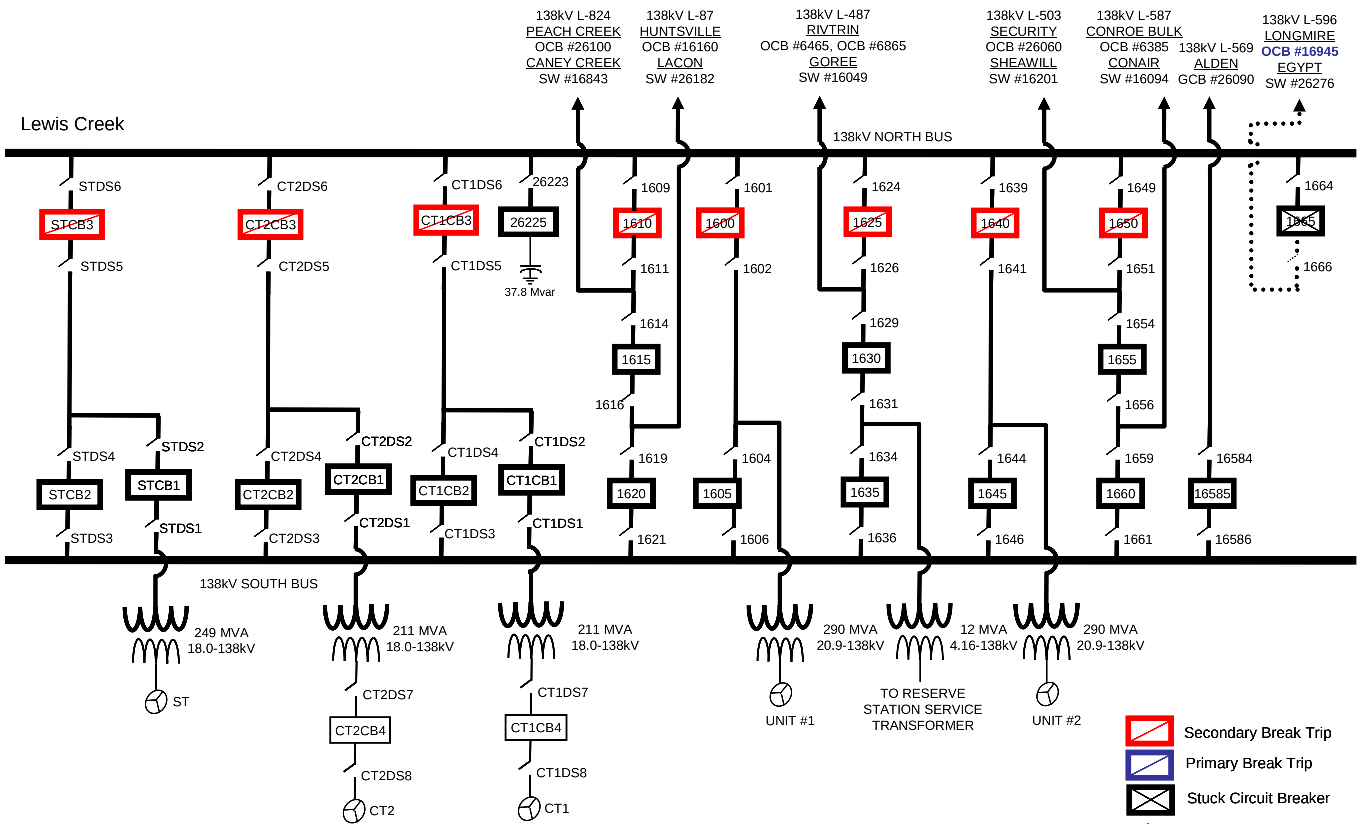
APPENDIX A.C
TRANSIENT STABILITY DATA AND PLOTS

Plots illustrating the results from the simulated cases have been provided. For all cases, machine angle and frequency plots are given for representative generators in the vicinity of major 230kV or 500kV buses in the area near the proposed PID-211 generation.

APPENDIX A.D
SUBSTATION CONFIGURATION FOR THE ADJACENT SUBSTATIONS UNDER STUCK BREAKER FAULT CONDITIONS

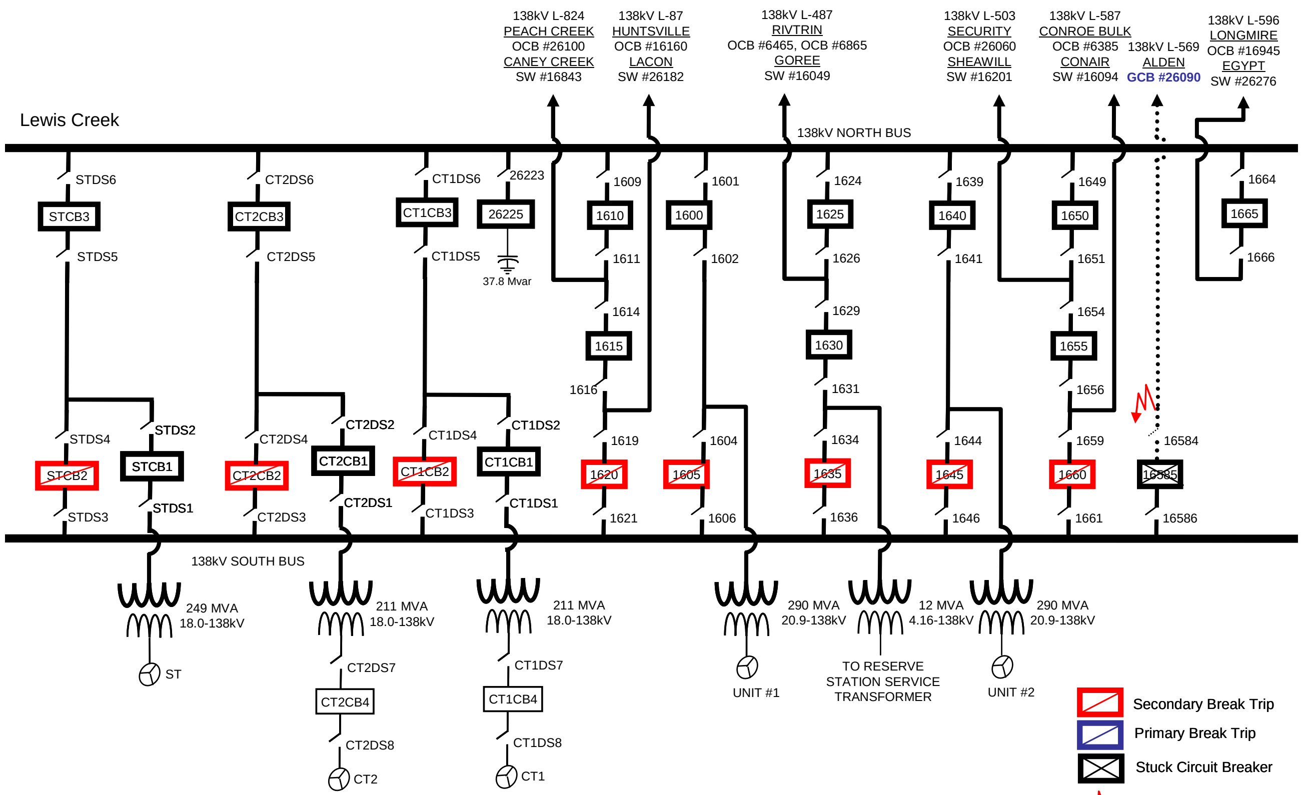
Fault-1A: Fault on the Lewis Creek – Longmire 138 kV

Stuck Circuit Breaker (CB) 1665 at Lewis Creek 138 kV with 138 kV North Bus CB's Last to Open

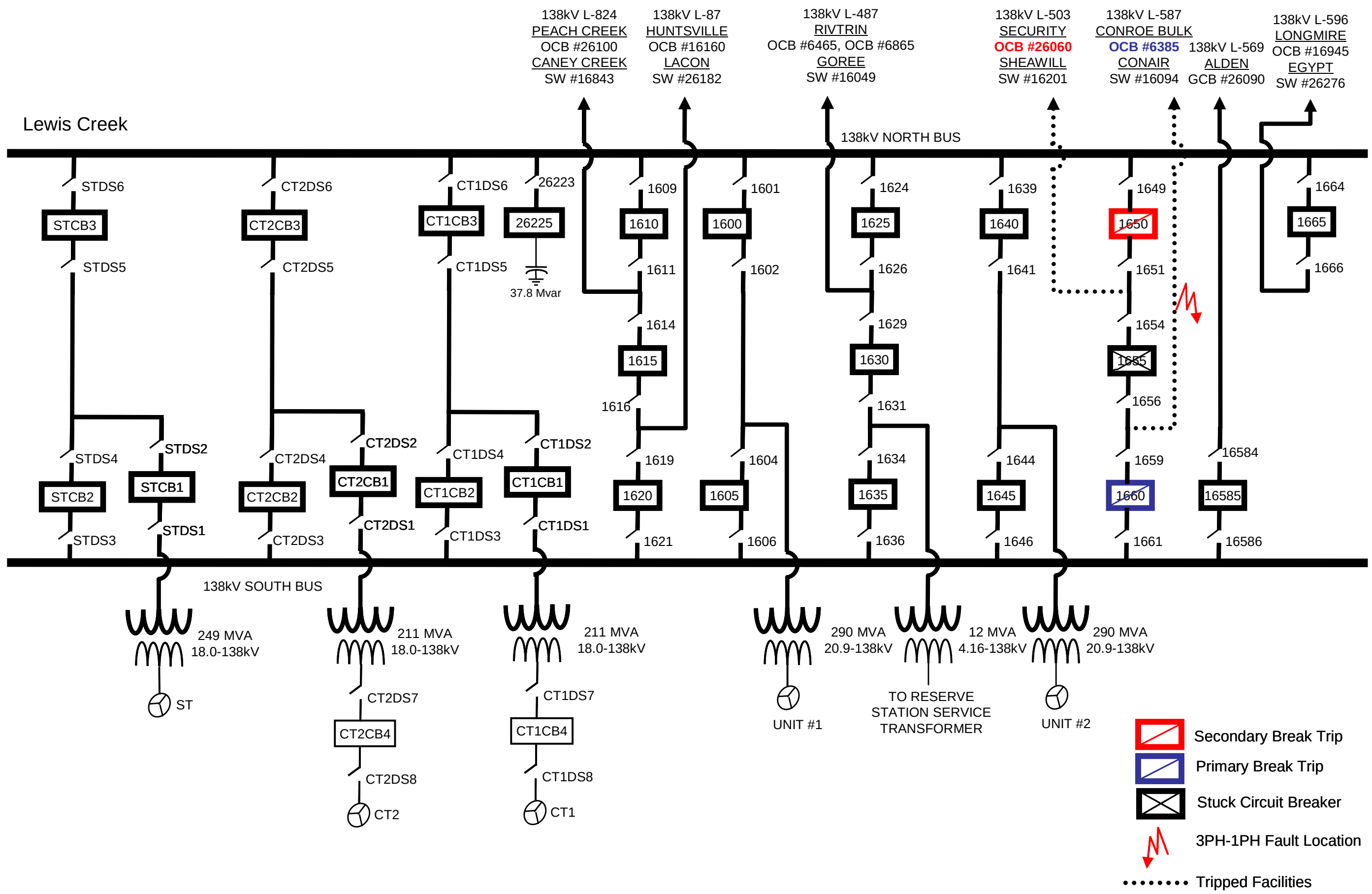


Fault-2A: Fault on the Lewis Creek – Alden 138 kV

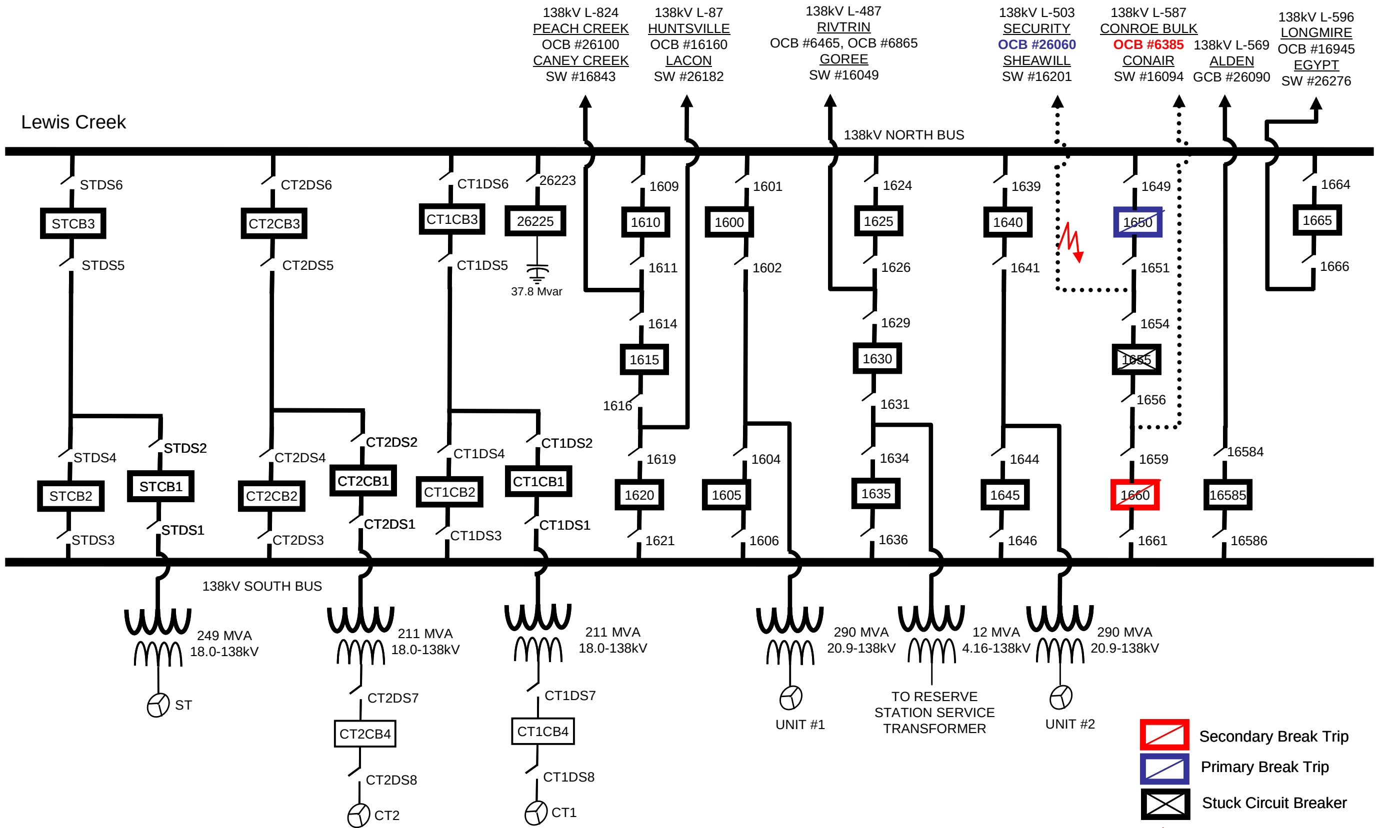
Stuck Circuit Breaker (CB) 16585 at Lewis Creek 138 kV with 138 kV South Bus CB's Last to Open



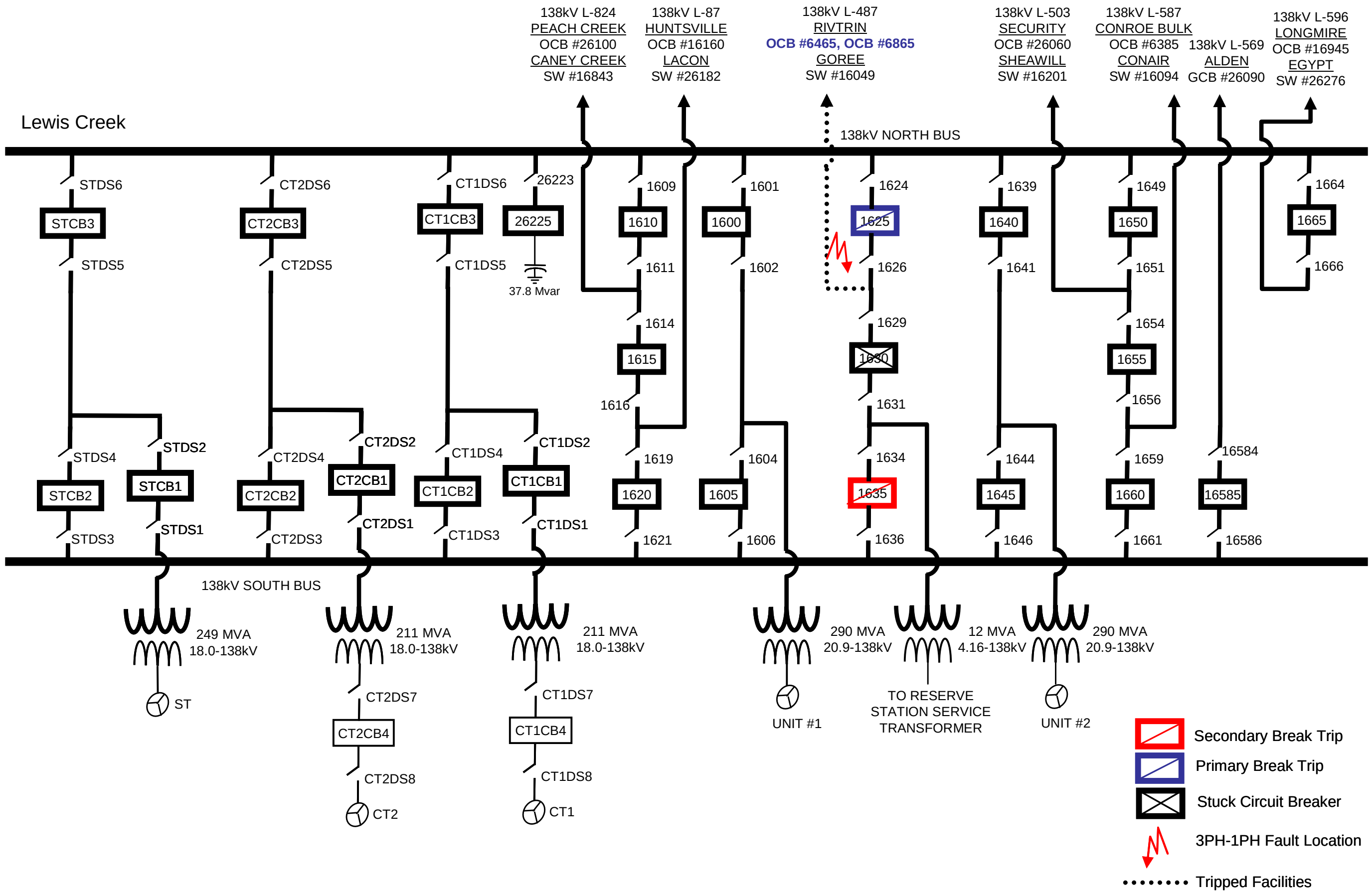
Fault-3A: Fault on the Lewis Creek – Conroe Bulk 138 kV
Stuck Circuit Breaker (CB) 1655 at Lewis Creek 138 kV with CB 1650 and Security CB 26060 Last to Open



Fault-4A: Fault on the Lewis Creek – Security 138 kV
Stuck Circuit Breaker (CB) 1655 at Lewis Creek 138 kV with CB 1660 and Conroe Bulk CB 6385 Last to Open

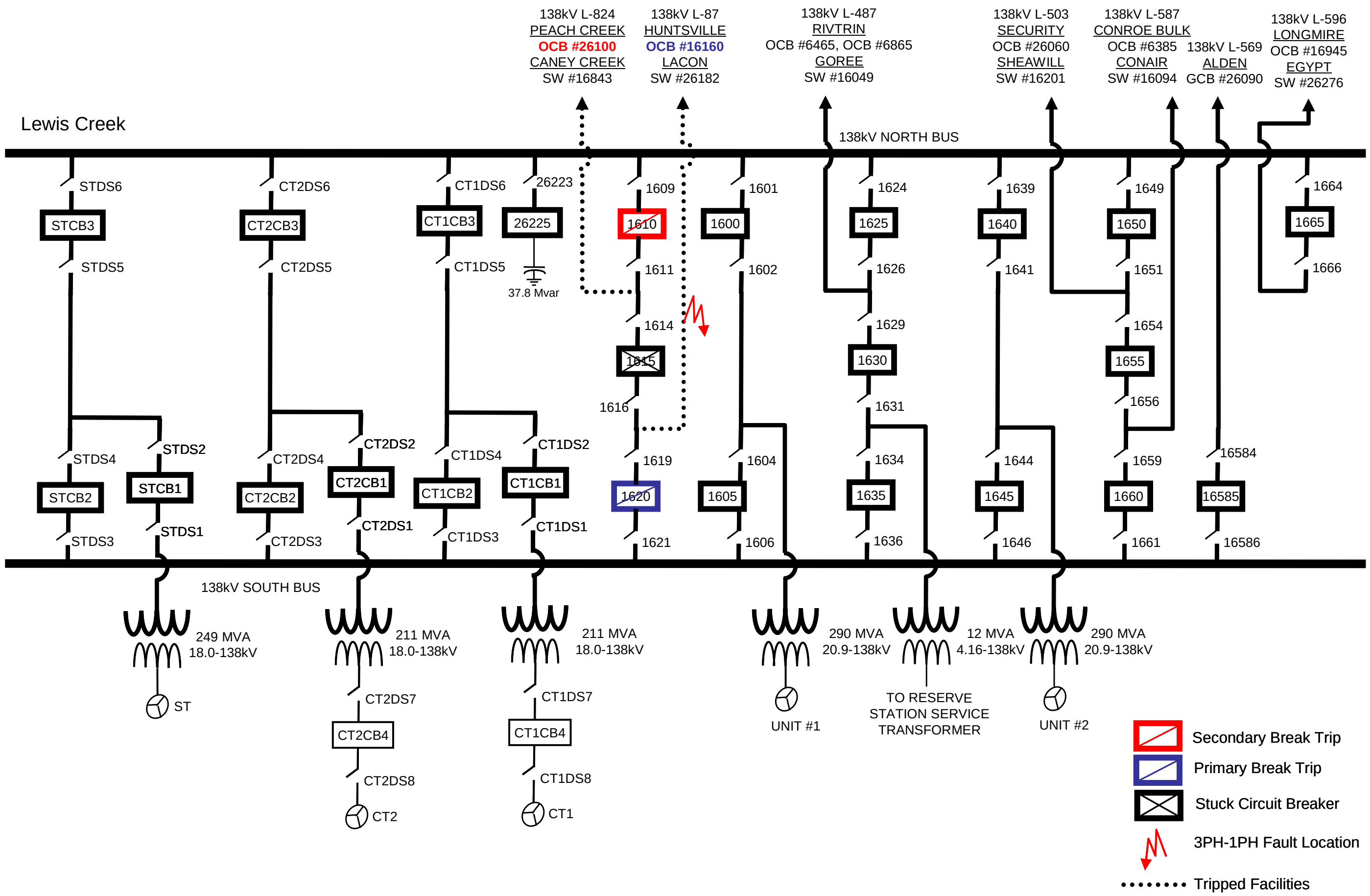


Fault-5A: Fault on the Lewis Creek – Rivtrin 138 kV
Stuck Circuit Breaker (CB) 1630 at Lewis Creek 138 kV with CB 1635 Last to Open



Fault-6A: Fault on the Lewis Creek – Huntsville 138 kV

Stuck Circuit Breaker (CB) 1615 at Lewis Creek 138 kV with CB 1610 and Peach Creek CB 26100 Last to Open



Section – B

Network Resource Interconnection Service

TABLE OF CONTENTS FOR NRIS (SECTION – B)

Introduction:

A Network Resource Interconnection Services (NRIS) study was requested by Entergy Services EMO (EMO) to serve 570 MW of Entergy network load. The expected in service date for this NRIS generator is 1/1/2011. The tests were performed with only confirmed transmission reservations and existing network generators and with transmission service requests in study mode.

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

D. Models

The models used for this analysis are the 2011 and 2015 summer peak cases developed in September 2007 and revised on 3/4/2008.

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 and 2015. These requests are:

OASIS#	PSE	POR	POD	Sink	MW	Service	Begin	End
1464028	East Texas Electric Coop.	EES	EES	ETEC	168	Yearly Network - Designated Resources	1/1/2010	1/1/2040

- Approved transmission reliability upgrades for 2007 - 2010 were included in the base case. These upgrades can be found at Entergy's OASIS web page, http://oasis.e-terrasolutions.com/documents/EES/Disclaimer.html under approved future projects.
- Increased the output of Big Cajun 2 units to reflect there NITS and firm point to point transfers from that unit. To do this, the output of Bayou Cove and Ouachita were reduced to 0MW.

Another model was created to include all prior NRIS interconnection generators. The NRIS interconnection generators are:

PID	Substation	MW	In Service Date
207	Grand Gulf	1594	1/1/2015
208	Fancy Point	1594	1/1/2015

The following is a list of prior transmission service studies that were included in the priors case for this analysis:

OASIS #		PSE	MW	Begin	End
1460876		Aquila Networks - MPS	75	3/1/2009	3/1/2029
1460878		Aquila Networks - MPS	75	3/1/2009	3/1/2029
1460879		Aquila Networks - MPS	75	3/1/2009	3/1/2029
1460881		Aquila Networks - MPS	75	3/1/2009	3/1/2029
1460900		Louisiana Energy & Power Authority	116	1/1/2009	1/1/2030
1468113		Municipal Energy Agency of Miss	20	6/1/2011	6/1/2041

OASIS #		PSE	MW	Begin	End
1468285		MidAmerican Energy, Inc.	103	9/1/2007	9/1/2008
1468286		MidAmerican Energy, Inc.	103	9/1/2007	9/1/2008
1468288		MidAmerican Energy, Inc.	103	1/1/2008	1/1/2009
1468289		MidAmerican Energy, Inc.	103	1/1/2008	1/1/2009
1470484		City of West Memphis	20	1/1/2011	1/1/2041
1477636		Westar Energy Gen & Mtkg	27	6/1/2010	6/1/2040
1477639		Westar Energy Gen & Mtkg	27	6/1/2010	6/1/2011
1478781		Entergy Services, Inc. (EMO)	804	1/1/2008	1/1/2058
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
1495910		Southwestern Electric Cooperative, Inc.	78	5/1/2010	5/1/2013

Transfer analysis was performed from Lewis Creek to loads in zone 100 – 199 and 500 – 998 using MUST.

B. 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.

C. Generation used for the transfer

The Lewis Creek 138kV bus was used as the source for the "from generation" test for deliverability.

Results

I. 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.

Table III-1 Summary of Results of DFAX Test

Study Case	Study Case with Priors
Conair - Lewis Creek SES 138kV	Conair - Lewis Creek SES 138kV
Goree - Lewis Creek SES 138kV	Goree - Lewis Creek SES 138kV
Alden - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV
Goree - Rivtrin 138kV	Goree - Rivtrin 138kV
	Lewis Creek – Sheawill 138kV
	Lewis Creek - Egypt

Table III-2 2011 DFAX Study Case Results without priors:

Limiting Element	Contingency Element	ATC
Conair - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV	425
Goree - Lewis Creek SES 138kV	Lacon - Lewis Creek SES 138kV	450
Goree - Lewis Creek SES 138kV	Lacon - 8LNG 138kV	487
Goree - Lewis Creek SES 138kV	LNG - Temco 138kV	508
Alden - Lewis Creek SES 138kV	Conair - Lewis Creek SES 138kV	525
Goree - Lewis Creek SES 138kV	Georgia - Temco 138kV	528
Goree - Lewis Creek SES 138kV	Georgia - Huntsville 138kV	549
Goree - Rivtrin 138kV	Lacon - Lewis Creek SES 138kV	559

Upgrading Goree – Lewis Creek 138kV line to 313MVA (1272 Bittern) 22.11 miles

Limiting Element	Contingency Element	ATC
None	None	570

Table III-3 2015 DFAX Study Case Results without Priors:

Limiting Element	Contingency Element	ATC
Conair - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV	341
Alden - Lewis Creek SES 138kV	Conair - Lewis Creek SES 138kV	392
Lewis Creek SES - Sheawill 138kV	Cleveland - Jacinto 138kV	509
Goree - Lewis Creek SES 138kV	Lacon - Lewis Creek SES 138kV	543

Alden - Lewis Creek SES 138kV	Conair - Line 523 Tap 587 138 kV	571
Lewis Creek SES – Egypt 138kV	Grimes – Frontier 345kV	617

Option 1: Build 230kV substation at Lewis Creek and Conroe Bulk, Add 230kV line from Lewis Creek – Conroe Bulk. Close a normally open switch at JeffCon, a substation between Conair and Conroe Bulk, which ties JeffCon to the Lewis Creek – Sheawill – FT.Worth Pipe – Crystal 138kV line. This will require relay work for the new three terminal line.

Limiting Element	Contingency Element	ATC
None	None	570

Option 2: Upgrade the following 138kV lines:

Lewis Creek – Goree – Rivtrin 313MVA (1272 Bittern) 35 miles
Lewis Creek – Alden 138kV to 625MVA (1272 Bittern DB) 16.3 miles
Lewis Creek – Conair 138kV to 625MVA (1272 Bittern DB) 11.2 miles
Lewis Creek – Sheawill 138kV to 423MVA (666 Flamingo DB) 5.1 miles
Sheawill – FT Worth Pipe 138kV to 423 MVA (666 Flamingo DB) 9.8 miles
Lewis Creek – Egypt 138kV to 423 MVA (666 Flamingo DB) 3.8 miles, shows up as a limiting element during AC contingency analysis.

Limiting Element	Contingency Element	ATC
None	None	570

Table III-4 2015 DFAX Study Case with Priors Results:

Limiting Element	Contingency Element	ATC
Conair - Lewis Creek SES 138kV	Alden - Lewis Creek SES 138kV	342
Alden - Lewis Creek SES 138kV	Conair - Lewis Creek SES 138kV	394
Lewis Creek SES - Sheawill 138kV	Cleveland - Jacinto 138kV	473
Goree - Lewis Creek SES 138kV	Lacon - Lewis Creek SES 138kV	540
Lewis Creek SES – Egypt 138kV	Grimes – Frontier 345kV	577

To alleviate the constrained identified in Tables III-2 & 3 a second iteration of DFAX test was performed with the following upgrades included in the model and results are listed in Table III-5 & 6:
Option 1: Build 230kV substation at Lewis Creek and Conroe Bulk. Add 230kV line from Lewis Creek – Conroe Bulk. Close a normally open switch at JeffCon, a substation between Conair and Conroe Bulk, which ties JeffCon to the Lewis Creek – Sheawill – FT.Worth Pipe – Crystal 138kV line. This will require relay work for the new three terminal line.

Table III-5 2015 DFAX Study Case with Option 1 upgrades Results with Priors:

Limiting Element	Contingency Element	ATC
None	None	570

Option 2: Upgrade the following 138kV lines:

Lewis Creek – Goree – Rivtrin 313MVA (1272 Bittern) 35 miles
Lewis Creek – Alden 138kV to 625MVA (1272 Bittern DB) 16.3 miles
Lewis Creek – Conair 138kV to 625MVA (1272 Bittern DB) 11.2 miles
Lewis Creek – Sheawill 138kV to 423MVA (666 Flamingo DB) 5.1 miles
Sheawill – FT Worth Pipe 138kV to 423 MVA (666 Flamingo DB) 9.8 miles
Lewis Creek – Egypt 138kV to 423 MVA (666 Flamingo DB) 3.8 miles, shows up as a limiting element during AC contingency analysis.

Table III-6 2015 DFAX Study Case with Option 2 upgrades Results with Priors:

Limiting Element	Contingency Element	ATC
None	None	570

II. 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

Option 1

Limiting Element	Planning Estimate for Upgrade
Conair – Lewis Creek SES 138kV	Build 230kV substation at Lewis Creek and Conroe Bulk. Add 230kV line from Lewis Creek – Conroe Bulk. Estimated Cost: $34,600,000
Alden – Lewis Creek SES 138kV	
Lewis Creek SES – Egypt 138kV	
Goree – Lewis Creek 138 kV	
Lewis – Creek – Sheawill 138kV	Close a normally open switch at JeffCon, a substation between Conair and Conroe Bulk, which ties JeffCon to the Lewis Creek – Sheawill – FT.Worth Pipe – Crystal 138kV line. This will require relay work for the new three terminal line. Estimated Cost $5,000,000

Option 2

Limiting Element	Planning Estimate for Upgrade
Lewis Creek – Goree – Rivtrin 138kV	Lewis Creek – Goree – Rivtrin 313MVA (1272 Bittern) 35 miles $43,750,000
Lewis Creek – Alden 138kV	Lewis Creek – Alden 138kV to 625MVA (1272 Bittern DB) 16.3 miles $20,375,000
Lewis Creek - Conair 138kV	Lewis Creek – Conair 138kV to 625MVA (1272 Bittern DB) 11.2 miles $14,000,000
Lewis Creek – Sheawill 138kV	Lewis Creek – Sheawill 138kV to 423MVA (666 Flamingo DB) 5.1 miles $6,375,000
Sheawill – Ft Worth Pipe 138kV	Sheawill – FT Worth Pipe 138kV to 423 MVA (666 Flamingo DB) 9.8 miles $12,250,000
Lewis Creek – Egypt 138kV	Lewis Creek – Egypt 138kV to 423 MVA (666 Flamingo DB) 3.8 miles $4,750,000

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

APPENDIX B.A - Deliverability Test for NRIS

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.