Southwest Power Pool

Impact Study For Generation Interconnection Request GEN-2007-004

SPP Tariff Studies

(#GEN-2007-004)

December 2007

Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 150 MW of wind generation within the control area of Southwestern Public Service (SPS). The wind powered generation facility was studied with seventy-five (75) Gamesa G87 2.0 MW wind turbine generators (WTG). The requested in-service date for the 150 MW facility is May 1, 2009. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the SPS transmission system as well as addressing the need for reactive compensation required by the wind farm because of the use of the Gamesa WTGs.

The requirements to interconnect the 150 MW of generation on the Yoakum County Interchange – Amoco Switching Station 230 kV line will consist of building a new 230 kV three-breaker ring-bus substation. The total minimum cost for building the three breaker 230 kV ring bus substation is $3,500,000.

From the new switching station, the Customer will build a 230 kV bus connection to its 230/34.5 kV collector substation which will be adjacent to the 230 kV switching station. The customer substation will provide terminations for the wind turbine collection circuits.

Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were the 2008 winter peak and 2012 summer peak. Each case was modified to include prior queued projects that are listed in the body of the report. Twenty-four (24) contingencies were simulated in each case. The Gamesa G87 wind turbines were modeled using information provided by the manufacturer.

Due to the reactive power losses on the collector system including the substation transformer, the Customer will be required to install in its substation a total of 34 Mvars capacitor bank(s) on the 34.5 kV bus. With the addition of the capacitor bank(s), the reactive capability of the Gamesa G87 turbines allows the wind farm to operate at unity power factor and have reactive reserve for fault recovery. The study also showed that a dynamic reactive source (SVC or STATCOM) will not be required.

Stability study results show that with the Customer requested Gamesa G87 wind turbines, the transmission system remains stable for all simulated contingencies studied. If the Customer changes the manufacturer or type of wind turbines from the Gamesa G87 2.0 MW, an Impact re-study will be required.

The Stability study results also show that the wind farm will meet FERC Order #661A’s Low Voltage Ride Through (LVRT) provisions when using the Gamesa G87 2.0 MW turbines with the factory default under\over voltage and under\over frequency protection schemes.

Nothing in this study should be construed as a guarantee of transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service shall be requested on Southwest Power Pool’s OASIS by the Customer.

1.0 Introduction

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 150 MW of wind powered generation within the control area of Southwestern Public Service (SPS) located in Terry County, Texas. The proposed method and point of interconnection (POI) is a new 230 kV ring-bus switching station to be located on the existing Yoakum County Interchange – Amoco Switching Station 230 kV transmission line owned by SPS. The Customer has proposed an in-service date of May 1, 2009.

2.0 Purpose

The purpose of the Interconnection System Impact Study is to evaluate the impact of the proposed interconnection on the reliability of the Transmission System. The Impact Study considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the Interconnection System Impact Study is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have a pending higher queued Interconnection Request to interconnect to the Transmission System; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions (for example, one or more of the previously queued projects not included in this study signing an interconnection agreement) may require a re-study of this request at the expense of the customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.

3.0 Facilities

3.1 Generating Facility

The generating facility was studied with the assumption that it would be using the Gamesa G87 2.0 MW wind turbines. The nameplate rating of each turbine is 2000 kW with a machine base of 2030 kVA. The turbine output voltage is 690 V. The Gamesa turbines utilize a doubly fed induction-generator. The generator synchronous speed is 1800 rpm, and a variable frequency power converter tied to the generator rotor allows the generator to operate at speeds ranging from 1020 rpm to 2340 rpm. Nominal speed at 2.0 MW power output is 2015 rpm. The power converter allows the generator to produce power at a power factor of 0.95 lagging (producing vars) to 0.9 leading (absorbing vars). The power factor is settable at each WTG or by the Plant SCADA system.

The Customer drawings show that the generating facility consists of five (5) collector circuits each having 15 wind turbines for a total of 75 wind turbines (see Figure 1). The cost of the customer facility is to be determined by the customer (see Table 1).

This study was performed using the latest Gamesa Standard Voltage and Frequency Settings with Fault Ride Through modeling stability package available from Gamesa. These settings are shown in Table 3 and Table 4.

Each wind turbine will feed into a 0.690/34.5 kV GSU rated at 2150 kVA. Impedance for the GSU is 8.8%.

The five collector circuits will feed into one 34.5/230 kV transformer that has an impedance of 9.6% on a 95 MVA OA Base with a top rating of 158 MVA.

3.2 Interconnection Facility

The Customer has proposed the point of interconnection to be the SPS transmission system via a new three-breaker ring-bus substation located in Terry County, Texas on the existing Yoakum County Interchange – Amoco Switching Station 230 kV line (see Figure 2).

From the new switching station (POI), the Customer will build a 230 kV bus connection to its 230/34.5 kV collector substation which is located adjacent to the switching station. The customer substation will provide terminations for the wind turbine collection circuits

Analysis of the reactive compensation requirements of the wind farm at 150 MW indicated the need for a 34.5 kV, 34 Mvar capacitor bank to be located on the secondary side of the Collector System substation transformer. This capacitor bank is necessary for reactive compensation for the wind farm (turbine and collector system losses). Stability analysis revealed that the reactive compensation does not need to be dynamic (SVC or STATCOM).

Table 1: Direct Assignment Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
Customer – (1) 230/34.5 kV Customer substation facilities.	*
Customer – (1) 230 kV transmission line from Customer collector substation to the new SPS three-breaker ring-bus switching station.	*
Customer – 34.5 kV, 34 Mvar capacitor bank(s) to be installed in the Customer 230/34.5 kV collector substation.	*
Customer – Right-of-way for all Customer facilities.	*
Total	*****

Note: * Estimates of cost to be determined by Customer.

Table 2: Required Interconnection Network Upgrade Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
SPS – (1) 230 kV three-breaker ring-bus switching station. Station to include breakers, switches, control relaying, high speed communications, metering and related equipment and all structures.	$3,500,000
Total	**$3,500,000**

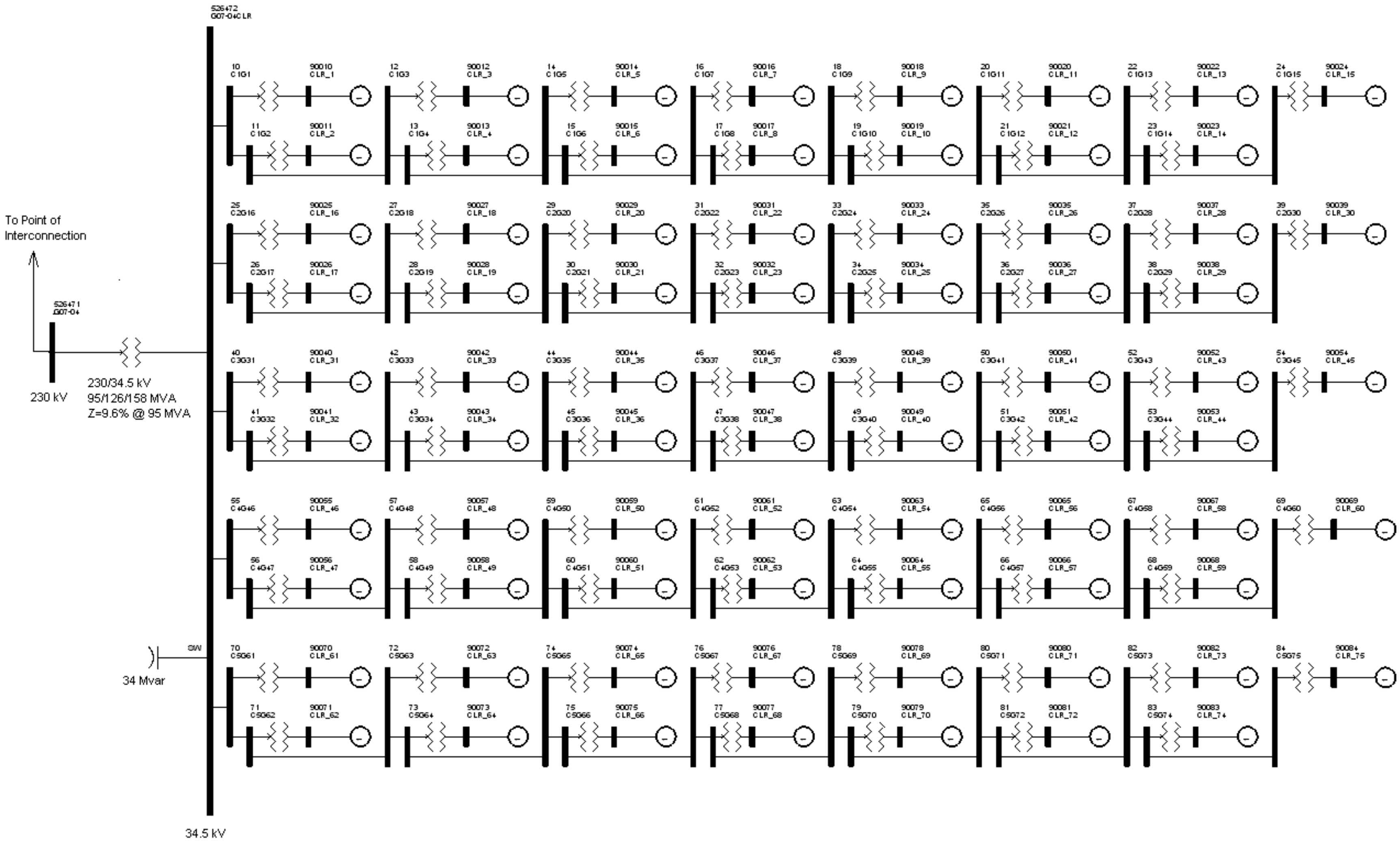


Figure 1: One-Line Drawing of the Customer Generation Facility

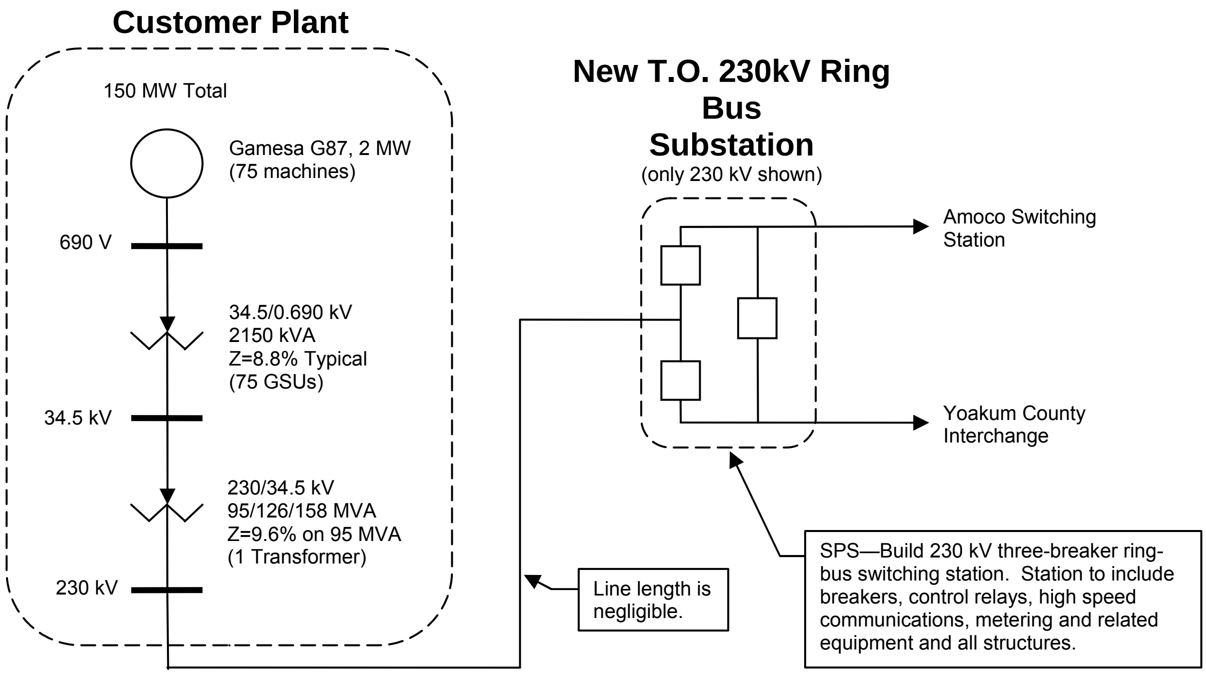


Figure 2: Proposed Interconnection Facility
(Final design to be determined)

4.0 Stability Analysis

4.1 Modeling of the Wind Turbines in the Power Flow

The wind farm was modeled using 75 individual Gamesa G87 wind turbines and the associated GSU's and line impedances. No attempt was made to aggregate wind turbines.

4.2 Modeling of the Wind Turbines in Dynamics

The wind farm was dispatched at its maximum rated power (150 MW). For the simulations in this study, it was assumed the turbines would operate at unity power factor. The factory default protection schemes were used for the turbines.

4.2.1 Turbine Protection Schemes

The Gamesa turbines utilize an undervoltage/overvoltage protection scheme and an underfrequency/overfrequency protection scheme. The various protection schemes are designed to protect the wind turbines in case of system disturbances that can cause damage to the mechanical systems or power electronics on board the turbine. Generally, the protection schemes will disconnect the generator from the electric grid if the sampled frequency or voltage is outside a specified range for a specified time (see Table 3 and Table 4).

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December

31, 2006, wind farms shall stay on line for faults at the POI (in this case, the 230 kV bus at the SPS switching station) that draw the voltage down at the POI to 0.0 pu.

Voltage (Per Unit)	Time Limit (Seconds)
V ≥ 1.10	0.06
0.90 < V < 1.10	None (Continuous operation)
0.75 < V ≤ 0.90	2.55
0.60 < V ≤ 0.75	2.050
0.45 < V ≤ 0.60	1.575
0.30 < V ≤ 0.45	1.10
0.15 < V ≤ 0.30	0.625
V ≤ 0.15	0.04

Table 3: Gamesa Turbine Voltage Protection

Frequency (Hz)	Time Limit (Seconds)
F > 62.0	0.05
57 ≤ F ≤ 62	None (Continuous Operation)
F < 57.0	0.05

Table 4: Gamesa Turbine Frequency Protection

4.3 Contingencies Simulated

Twenty-four (24) contingencies were considered for the transient stability simulations. These contingencies included three phase faults and single phase line faults. Single-phase line faults were simulated by applying a fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

The faults that were defined and simulated are listed in Table 5.

Table 5: Contingencies Evaluated

Cont. No.	Cont. Name	Description
1	FLT13PH	3 phase fault on the Wind Farm (526470) to Amoco Switch (5526460) 230 kV line, near the Wind Farm. a. Apply fault at the Wind Farm (526470) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from the Wind Farm – Amoco Switch. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT21PH	Single phase fault and sequence like Cont. No. 1
3	FLT33PH	3 phase fault on the Wind Farm (526470) to Yoakum County (526935) 230 kV line, near the Wind Farm. a. Apply fault at the Wind Farm (526470) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from the Wind Farm – Yoakum County. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT41PH	Single phase fault and sequence like Cont. No. 3
5	FLT53PH	3 phase fault on the Yoakum County (526935) – Amoco Wasson (5526784) 230 kV line, near Yoakum County. a. Apply fault at the Yoakum County (526935) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Yoakum County – Amoco Wasson. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT61PH	Single phase fault and sequence like Cont. No. 5
7	FLT73PH	3 phase fault on the Yoakum County (526935) to Lea County (527849) 230 kV line, near Yoakum County. a. Apply fault at the Yoakum County (526935) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Yoakum County – Lea County. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT81PH	Single phase fault and sequence like Cont. No.7
9	FLT93PH	3 phase fault on the Amoco Switch (526460) to Sundown (526435) 230 kV line, near Amoco Switch. a. Apply fault at the Amoco Switch (526460) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Amoco Switch – Sundown. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
10	FLT101PH	Single phase fault and sequence like Cont. No.9
11	FLT113PH	3 phase fault on the Sundown (526435) to Plant X (525481) 230 kV line near Sundown. a. Apply fault at the Sundown (526435) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Sundown – Plant X. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT121PH	Single phase fault and sequence like Cont. No.11
13	FLT133PH	3 phase fault on the Sundown (526435) to Wolfforth (526525) 230 kV line near Sundown. a. Apply fault at the Sundown (526435) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Sundown – Wolfforth. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
14	FLT141PH	Single phase fault and sequence like Cont. No.13
15	FLT153PH	3 phase fault on the Yoakum County (526935) to Tolk (525531) 230 kV line, near Yoakum County. a. Apply fault at the Yoakum County (526935) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Yoakum County – Tolk. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
16	FLT161PH	Single phase fault and sequence like Cont. No.15

Cont. No.	Cont. Name	Description
17	FLT173PH	3 phase fault on the Yoakum County (526935) to Mustang (527149) 230 kV line, near Yoakum County. a. Apply fault at the Yoakum County (526935) 230 kV bus. b. Clear fault after 5 cycles by tripping the line from Yoakum County – Mustang. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
18	FLT181PH	Single phase fault and sequence like Cont. No.17
19	FLT193PH	3 phase fault on the Yoakum County (526935) to Prentice (526792) 115 kV line, near Yoakum County. a. Apply fault at the Yoakum County (526935) 115 kV bus. b. Clear fault after 5 cycles by tripping the line from Yoakum County – Prentice. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
20	FLT201PH	Single phase fault and sequence like Cont. No.19
21	FLT213PH	3 phase fault on the Terry County (526736) to Wolfforth (526524) 115 kV line, near Terry County. a. Apply fault at the Terry County (526736) 115 kV bus. b. Clear fault after 5 cycles by tripping the line from Terry County – Wolfforth. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
22	FLT221PH	Single phase fault and sequence like Cont. No.21
23	FLT233PH	3 phase fault on the Denver City (527136) to Amerada/Hess County (527242) 115 kV line, near Denver City. a. Apply fault at the Denver City (527136) 115 kV bus. b. Clear fault after 5 cycles by tripping the line from Denver City – Amerada/Hess County. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
24	FLT241PH	Single phase fault and sequence like Cont. No.23

Table 5: Contingencies Evaluated (continued)

4.4 Further Model Preparation

The two base cases were modified to include prior queued projects as shown in Table 6. The power generated by the Customer's wind farm and the previously queued projects is dispatched into the SPP footprint. Simulations were carried out on the cases with the added generation for a no-disturbance run of 20 seconds to verify the numerical stability of the model. All cases were confirmed to be stable.

Project	MW
GEN-2001-033	180
GEN-2005-010	232.5
GEN-2006-026	510/605
GEN-2006-048	150
GEN-2007-001	200

Table 6: Prior Queued Projects

5.0 Results

The results of the stability analysis are summarized in Table 7. The results indicate that for all contingencies simulated, the transmission system remains stable for both seasons. Selected stability plots are shown in the appendices. All plots are available on request.

Contingency. Name	2008 Winter Peak	2012 Summer Peak
FLT13PH	STABLE	STABLE
FLT21PH	STABLE	STABLE
FLT33PH	STABLE	STABLE
FLT41PH	STABLE	STABLE
FLT53PH	STABLE	STABLE
FLT61PH	STABLE	STABLE
FLT73PH	STABLE	STABLE
FLT81PH	STABLE	STABLE
FLT93PH	STABLE	STABLE
FLT101PH	STABLE	STABLE
FLT113PH	STABLE	STABLE
FLT121PH	STABLE	STABLE
FLT133PH	STABLE	STABLE
FLT141PH	STABLE	STABLE
FLT153PH	STABLE	STABLE
FLT161PH	STABLE	STABLE
FLT173PH	STABLE	STABLE
FLT181PH	STABLE	STABLE
FLT193PH	STABLE	STABLE
FLT201PH	STABLE	STABLE
FLT213PH	STABLE	STABLE
FLT221PH	STABLE	STABLE
FLT233PH	STABLE	STABLE
FLT241PH	STABLE	STABLE

Table 7: Results of Simulation

6.0 Conclusion

No stability concerns presently exist for the GEN-2007-004 wind farm as proposed and studied using seventy-five (75) Gamesa G87 2.0 MW wind turbines. The wind farm and the transmission system remain stable for all contingencies studied.

The total minimum network upgrade cost for building the 230kV three-breaker ring-bus substation required for interconnection is $3,500,000. These figures do not address the cost of the Customer substation, the Customer 34.5 kV, 34 Mvar capacitor bank(s), or the transmission line between the Customer substation and the proposed SPS switching substation located on the Amoco Switching Station – Yoakum County Interchange 230 kV line.

Due to the reactive power losses on the collector system including the substation transformer, the Customer will be required to install in its substation a total of 34 Mvars capacitor bank(s) on the 34.5 kV bus. With the addition of the capacitor bank(s), the reactive capability of the Gamesa G87 turbines allows the wind farm to operate at unity power factor and have reactive reserve for fault recovery. The study also showed that a dynamic reactive source (SVC or STATCOM) will not be required.

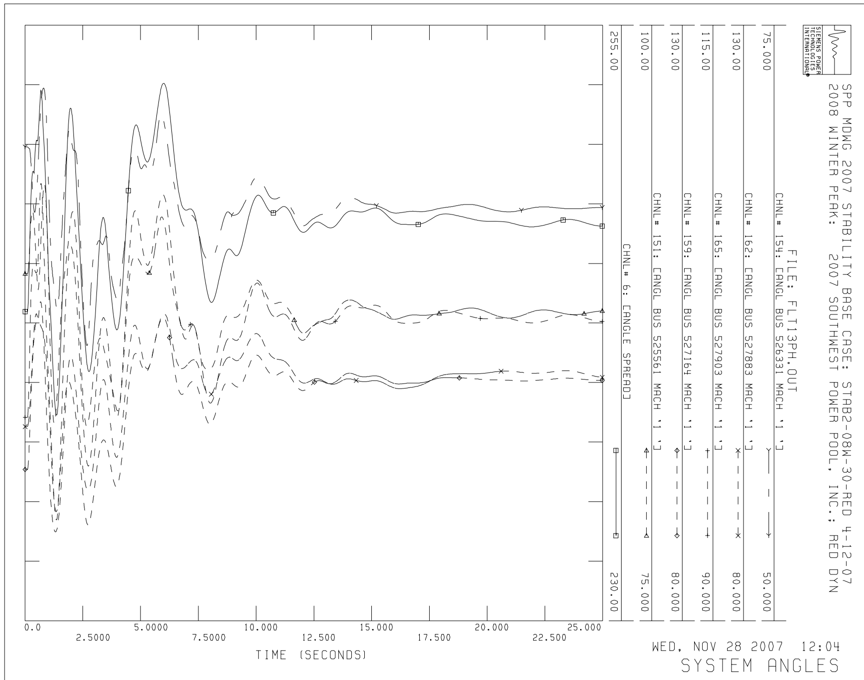
The Stability study results also show that the wind farm will meet FERC Order #661A's Low Voltage Ride Through (LVRT) provisions when using the Gamesa G87 2.0 MW turbines with the factory default under/over voltage and under/over frequency protection schemes.

The costs shown in this document do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS. It should be noted that the models used for simulation do not contain all SPP transmission service.

APPENDIX A.

SELECTED STABILITY PLOTS – 2008 Winter Peak

All plots available on request.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CHNL# 162: [ANGL BUS 527883 MACH '1 ']
CHNL# 165: [ANGL BUS 527903 MACH '1 ']
CHNL# 159: [ANGL BUS 527164 MACH '1 ']
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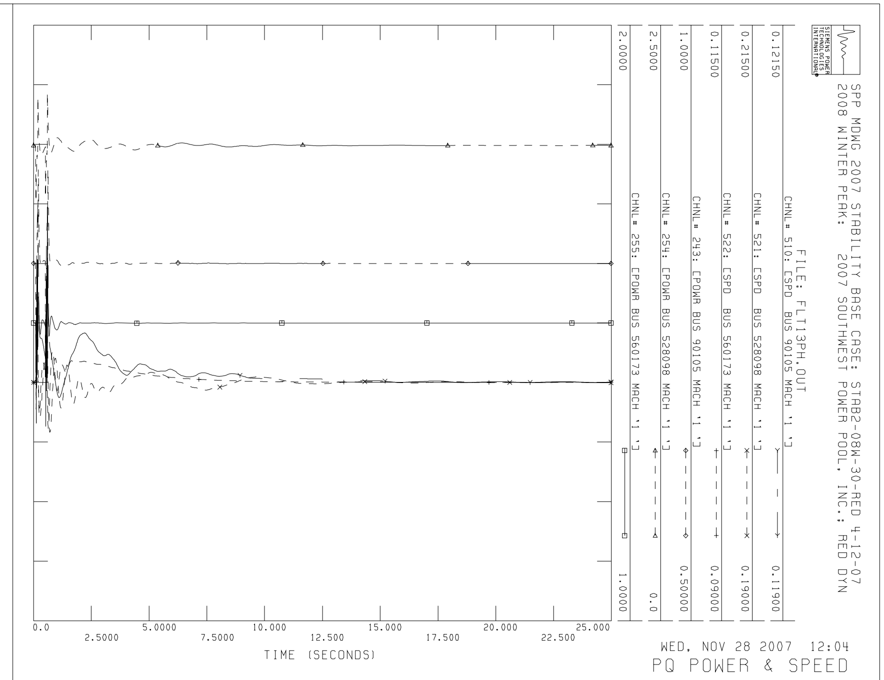
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CHNL# 243: [POWR BUS 90105 MACH '1 ']
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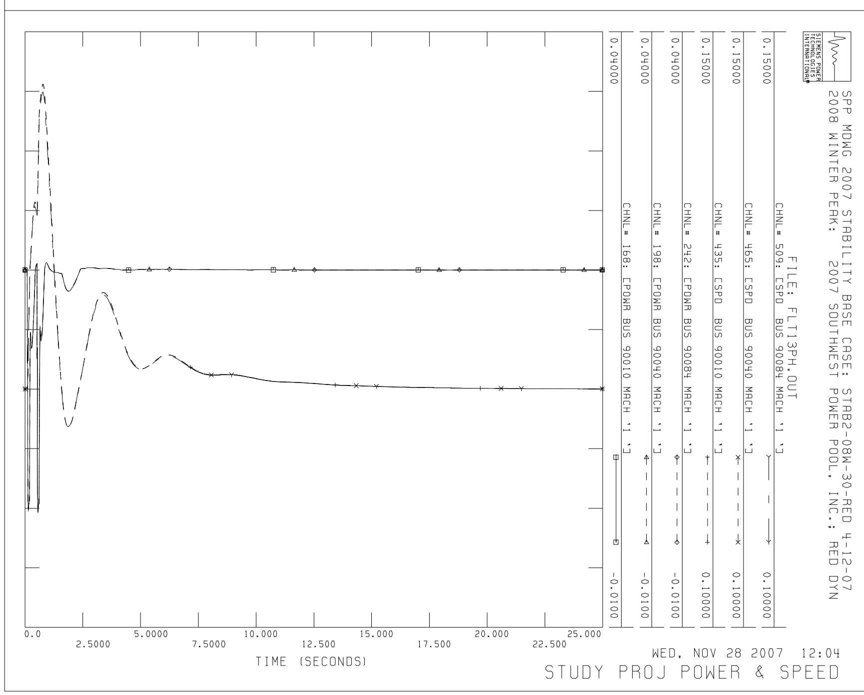
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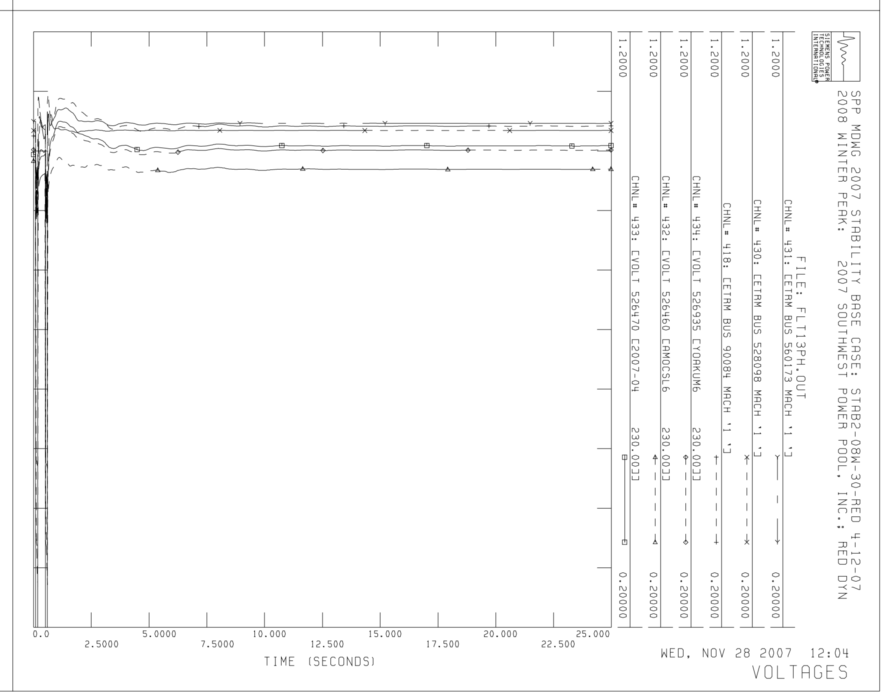
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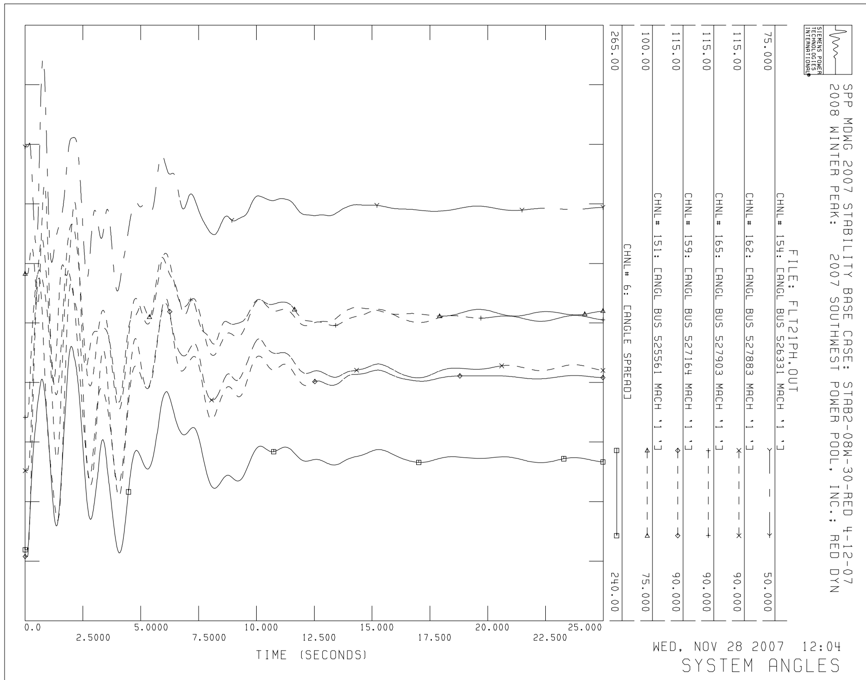
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115.00 90.000
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115.00 90.000
CHNL# 151: CANGL BUS 525561 MACH '1 ']
100.00 75.000
CHNL# 6: CANGLE SPREAD]
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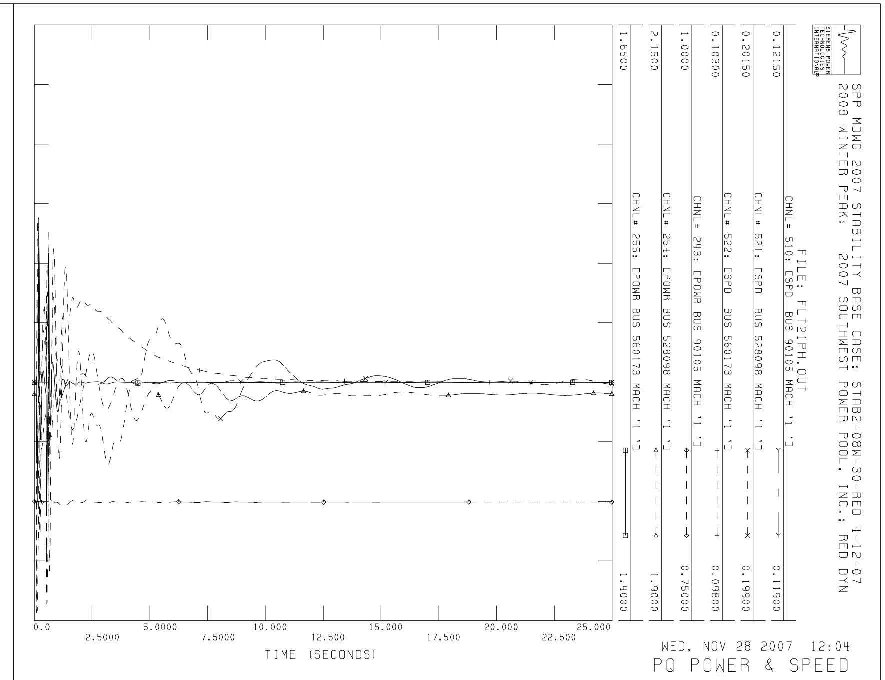
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CHNL# 243: CPOWR BUS 90105 MACH '1 ']
1.0000 0.75000
CHNL# 254: CPOWR BUS 528098 MACH '1 ']
2.1500 1.9000
CHNL# 255: CPOWR BUS 560173 MACH '1 ']
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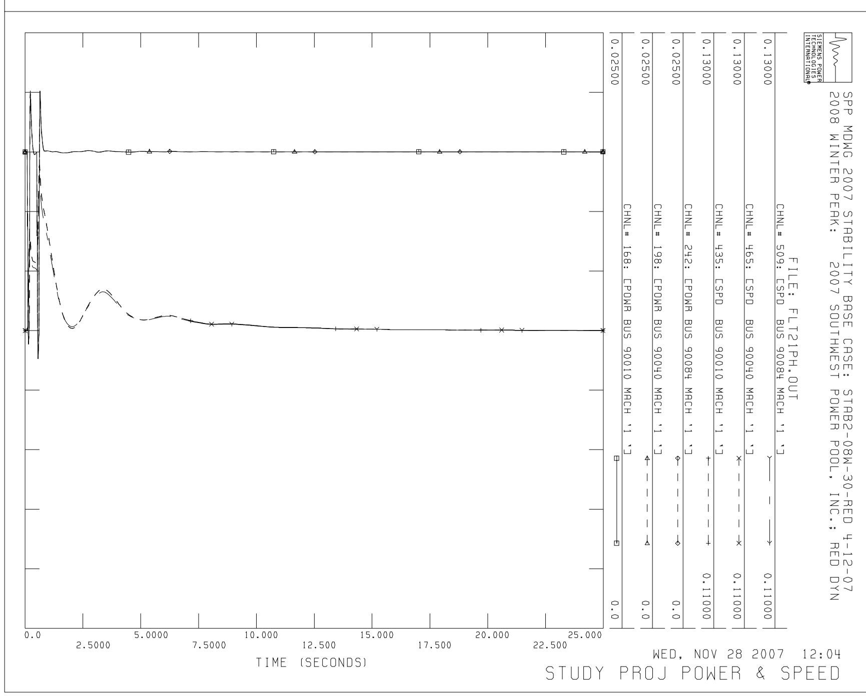
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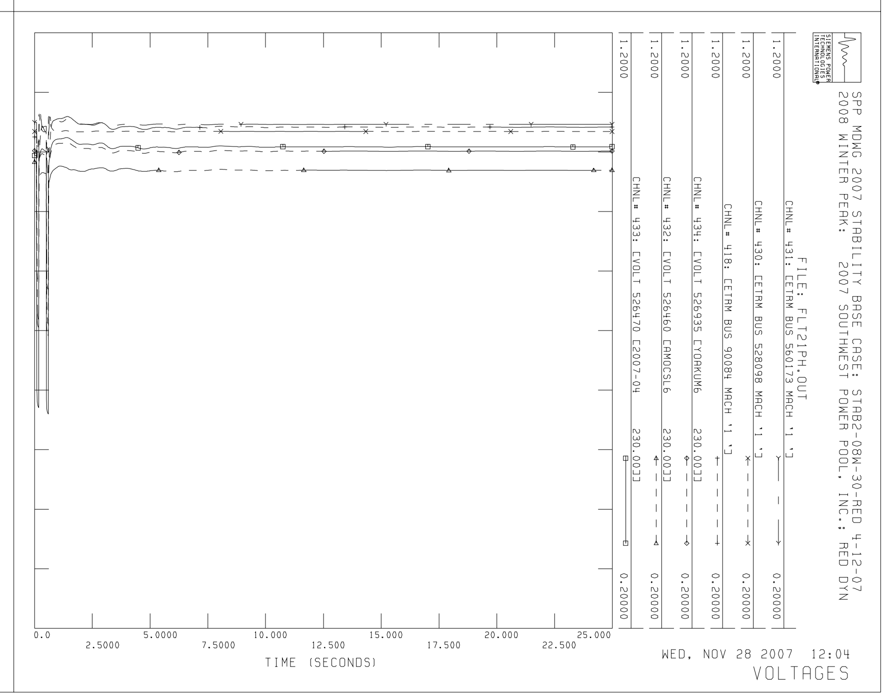
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1.2000 0.20000
CHNL# 432: CVOLT 526460 CAMOCSL6 230.00]
1.2000 0.20000
CHNL# 433: CVOLT 526470 C2007-04 230.00]
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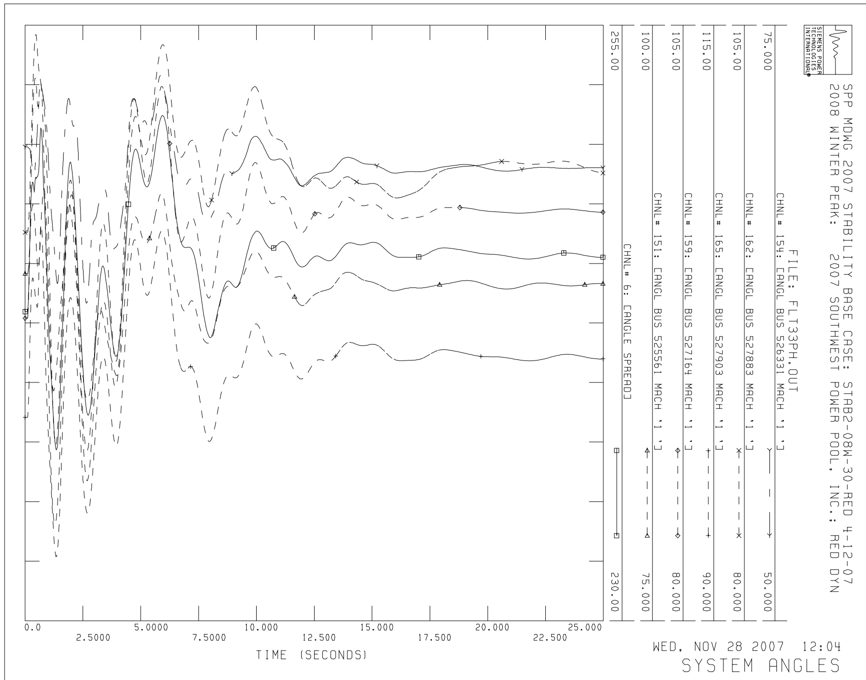
VOLTAGES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 154: [ANGL BUS 526331 MACH '1 '] 75.000 50.000
CHNL# 162: [ANGL BUS 527883 MACH '1 '] 105.00 80.000
CHNL# 165: [ANGL BUS 527903 MACH '1 '] 115.00 90.000
CHNL# 159: [ANGL BUS 527164 MACH '1 '] 105.00 80.000
CHNL# 151: [ANGL BUS 525561 MACH '1 '] 100.00 75.000
CHNL# 6: [ANGLE SPREAD] 255.00 230.00
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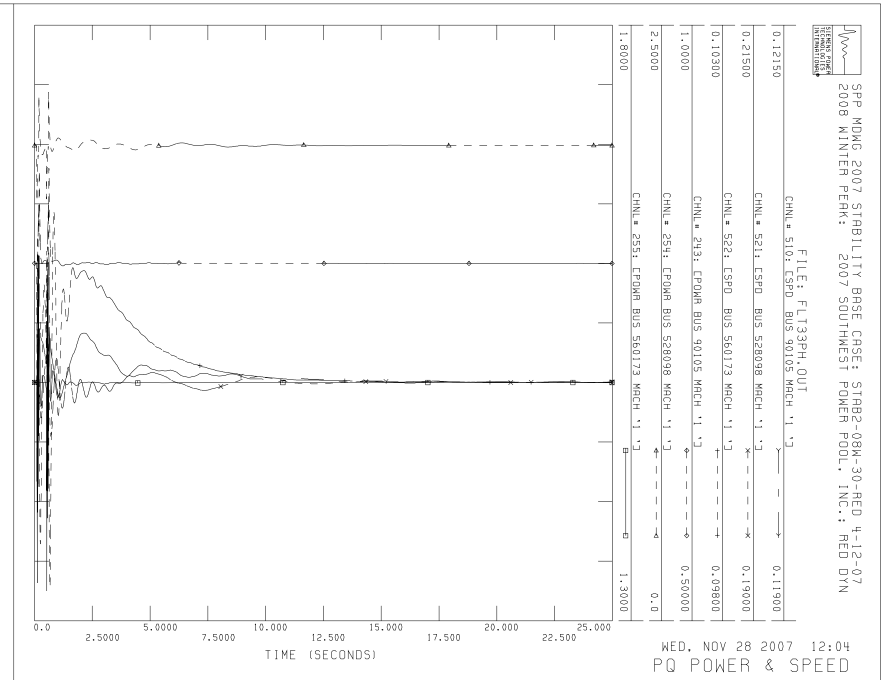
TIME (SECONDS)
WED, NOV 28 2007 12:04
SYSTEM ANGLES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 510: [SPD BUS 90105 MACH '1 '] 0.12150 0.11900
CHNL# 521: [SPD BUS 528098 MACH '1 '] 0.21500 0.19000
CHNL# 522: [SPD BUS 560173 MACH '1 '] 0.10300 0.09800
CHNL# 243: [POWR BUS 90105 MACH '1 '] 1.0000 0.50000
CHNL# 254: [POWR BUS 528098 MACH '1 '] 2.5000 0.0
CHNL# 255: [POWR BUS 560173 MACH '1 '] 1.8000 1.3000
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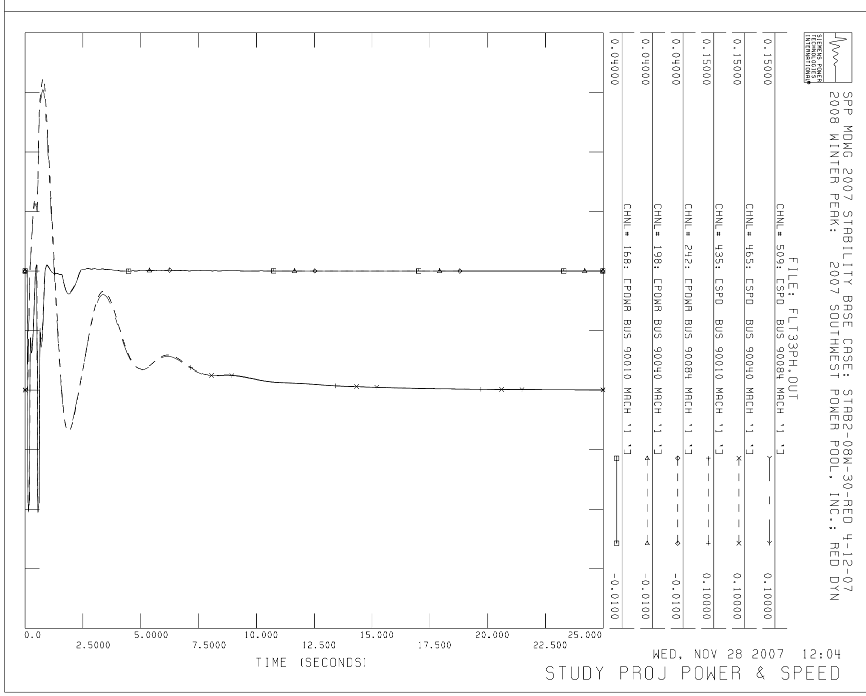
TIME (SECONDS)
WED, NOV 28 2007 12:04
PQ POWER & SPEED


SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
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CHNL# 509: [SPD BUS 90084 MACH '1 '] 0.15000 0.10000
CHNL# 465: [SPD BUS 90040 MACH '1 '] 0.15000 0.10000
CHNL# 435: [SPD BUS 90010 MACH '1 '] 0.15000 0.10000
CHNL# 242: [POWR BUS 90084 MACH '1 '] 0.04000 -0.0100
CHNL# 198: [POWR BUS 90040 MACH '1 '] 0.04000 -0.0100
CHNL# 168: [POWR BUS 90010 MACH '1 '] 0.04000 -0.0100
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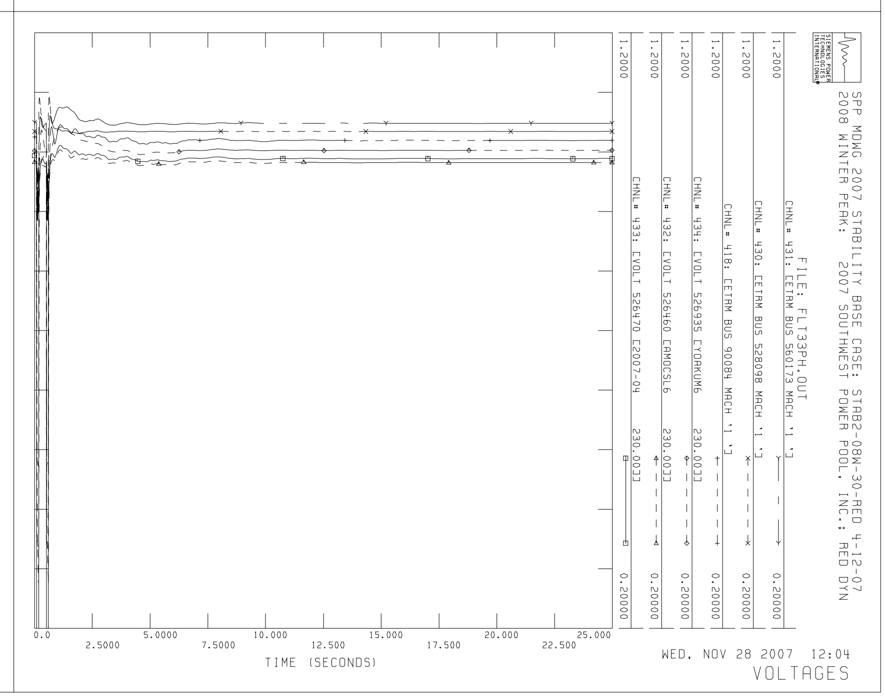
STUDY PROJ POWER & SPEED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CHNL# 434: [VOLT 526935 [YOAKUM6 230.00]] 1.2000 0.20000
CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 433: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
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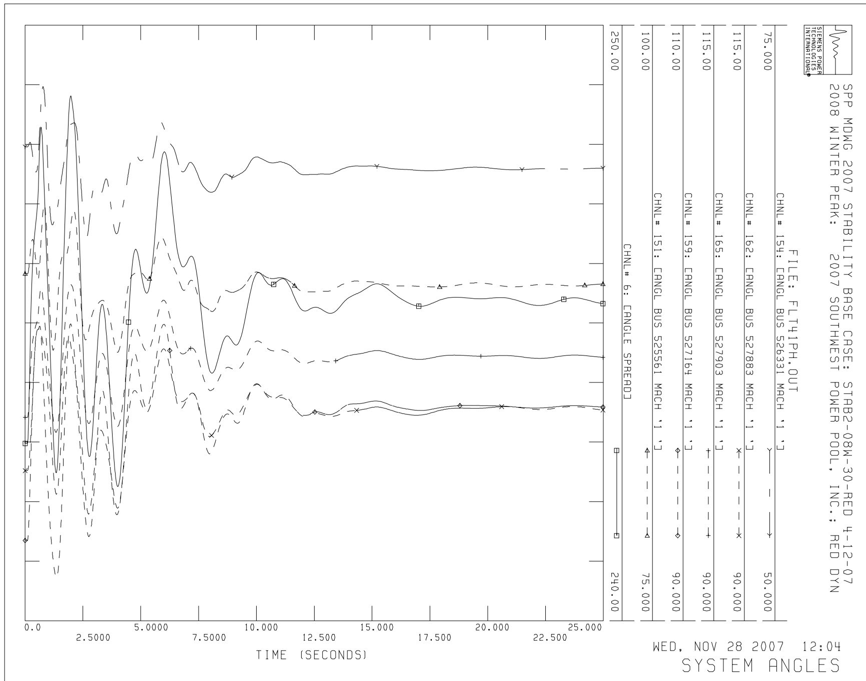
VOLTAGES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FILE: FLT4IPH.OUT
CHNL# 154: [ANGL BUS 526331 MACH '1 '] 75.000 50.000
CHNL# 162: [ANGL BUS 527883 MACH '1 '] 115.00 90.000
CHNL# 165: [ANGL BUS 527903 MACH '1 '] 115.00 90.000
CHNL# 159: [ANGL BUS 527164 MACH '1 '] 110.00 90.000
CHNL# 151: [ANGL BUS 525561 MACH '1 '] 100.00 75.000
CHNL# 6: [ANGLE SPREAD] 250.00 240.00
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TIME (SECONDS)
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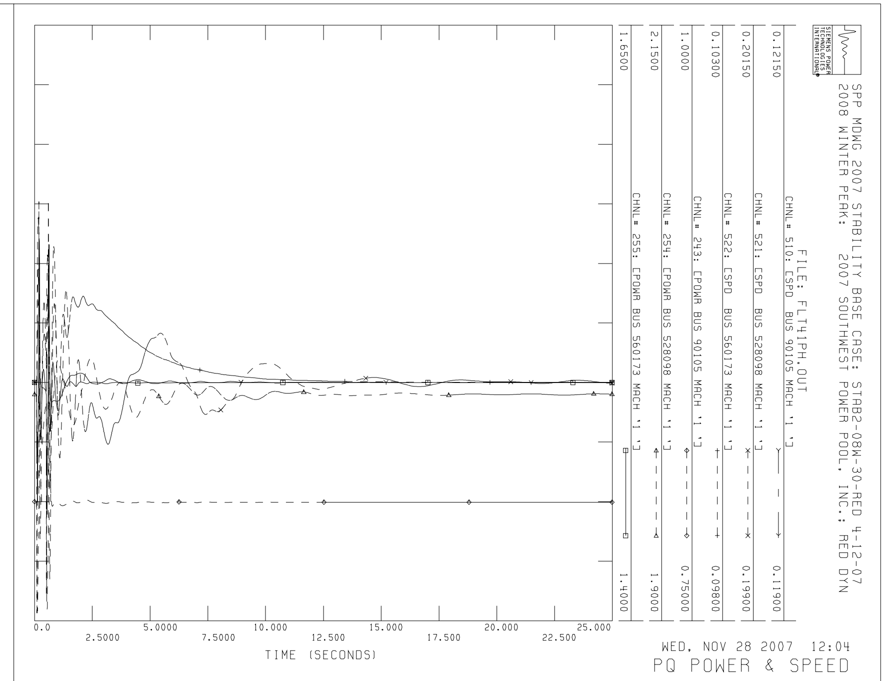
SYSTEM ANGLES

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CHNL# 510: [SPD BUS 90105 MACH '1 '] 0.12150 0.11900
CHNL# 521: [SPD BUS 528098 MACH '1 '] 0.20150 0.19900
CHNL# 522: [SPD BUS 560173 MACH '1 '] 0.10300 0.09800
CHNL# 243: [POWR BUS 90105 MACH '1 '] 1.0000 0.75000
CHNL# 254: [POWR BUS 528098 MACH '1 '] 2.1500 1.9000
CHNL# 255: [POWR BUS 560173 MACH '1 '] 1.6500 1.4000
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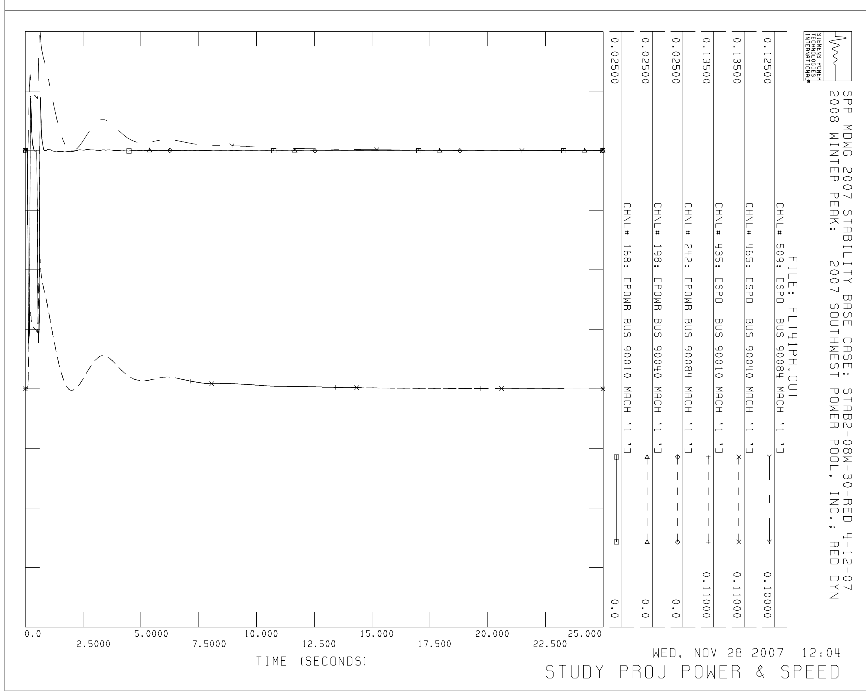
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FILE: FLT4IPH.OUT
CHNL# 509: [SPD BUS 90084 MACH '1 '] 0.12500 0.10000
CHNL# 465: [SPD BUS 90040 MACH '1 '] 0.13500 0.11000
CHNL# 435: [SPD BUS 90010 MACH '1 '] 0.13500 0.11000
CHNL# 242: [POWR BUS 90084 MACH '1 '] 0.02500 0.0
CHNL# 198: [POWR BUS 90040 MACH '1 '] 0.02500 0.0
CHNL# 168: [POWR BUS 90010 MACH '1 '] 0.02500 0.0
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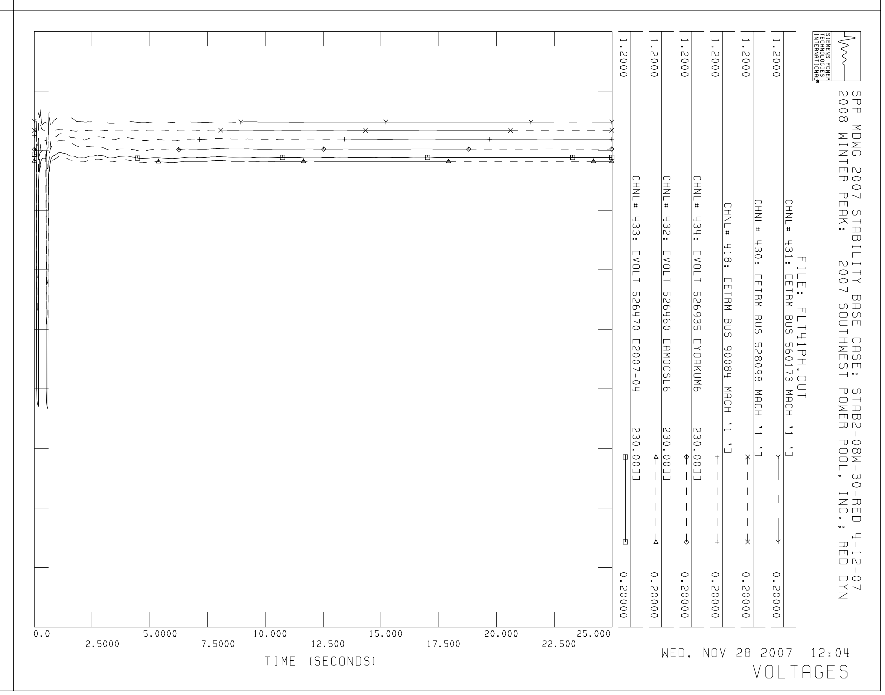
STUDY PROJ POWER & SPEED

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CHNL# 418: [ETRM BUS 90084 MACH '1 '] 1.2000 0.20000
CHNL# 434: [VOLT 526935 [YOAKUM6 230.00]] 1.2000 0.20000
CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 433: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
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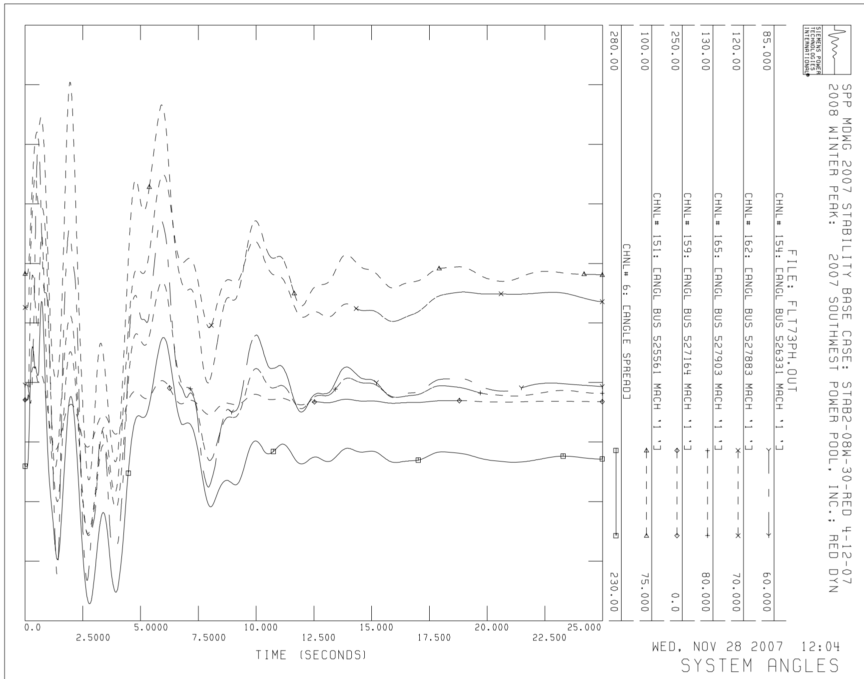
VOLTAGES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FILE: FLT73PH.OUT
CHNL# 154: [ANGL BUS 526331 MACH '1 ']
CHNL# 162: [ANGL BUS 527883 MACH '1 ']
CHNL# 165: [ANGL BUS 527903 MACH '1 ']
CHNL# 159: [ANGL BUS 527164 MACH '1 ']
CHNL# 151: [ANGL BUS 525561 MACH '1 ']
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
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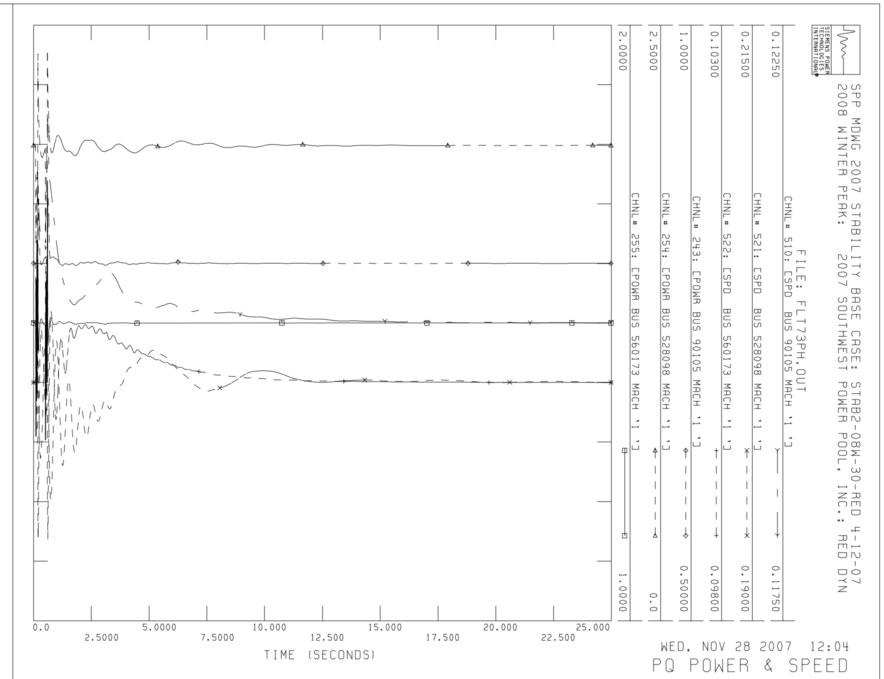
SYSTEM ANGLES

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FILE: FLT73PH.OUT
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CHNL# 521: [SPD BUS 528098 MACH '1 ']
CHNL# 522: [SPD BUS 560173 MACH '1 ']
CHNL# 243: [POWR BUS 90105 MACH '1 ']
CHNL# 254: [POWR BUS 528098 MACH '1 ']
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TIME (SECONDS)
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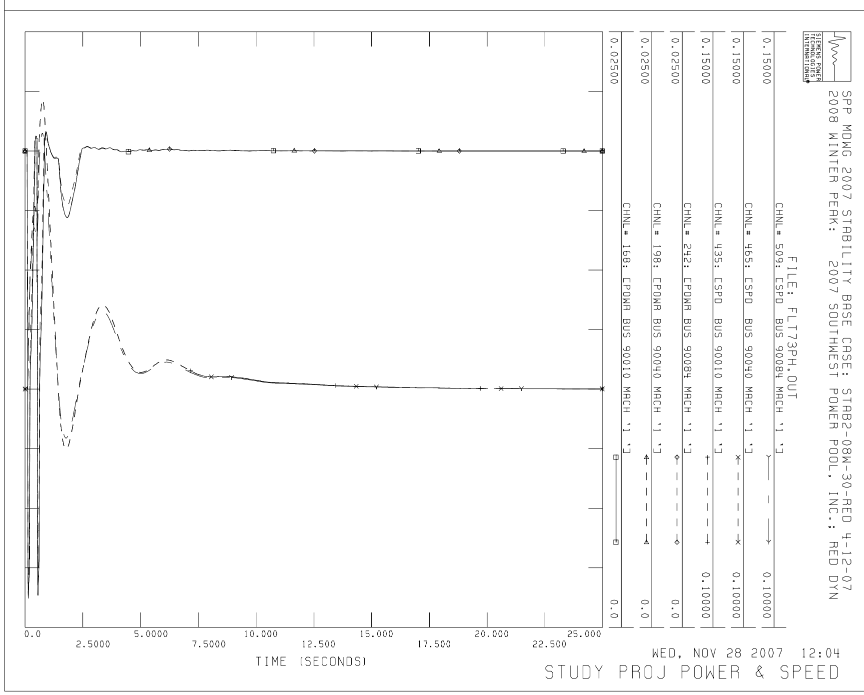
PQ POWER & SPEED

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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 465: [SPD BUS 90040 MACH '1 ']
CHNL# 435: [SPD BUS 90010 MACH '1 ']
CHNL# 242: [POWR BUS 90084 MACH '1 ']
CHNL# 198: [POWR BUS 90040 MACH '1 ']
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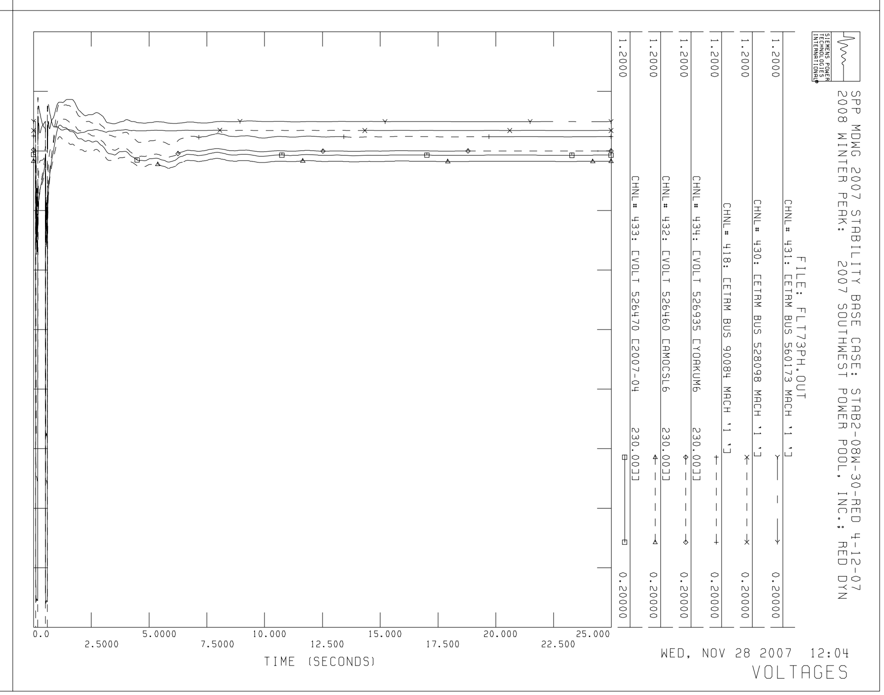
TIME (SECONDS)
WED, NOV 28 2007 12:04
STUDY PROJ POWER & SPEED

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FILE: FLT73PH.OUT
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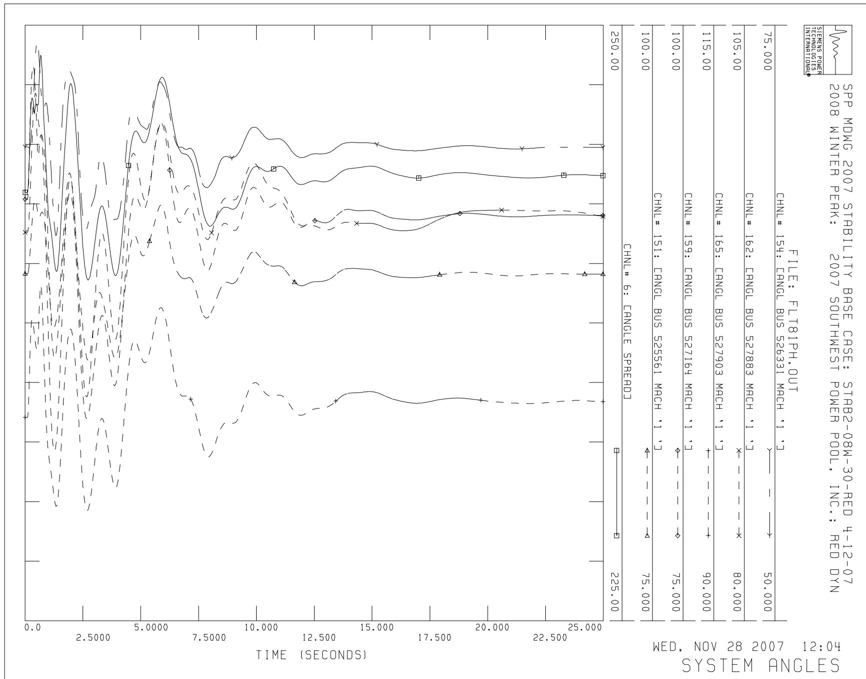
CHNL# 430: [ETRM BUS 528098 MACH '1 ']
CHNL# 418: [ETRM BUS 90084 MACH '1 ']
CHNL# 434: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]]
CHNL# 433: [VOLT 526470 [2007-04 230.00]]
TIME (SECONDS)
WED, NOV 28 2007 12:04
VOLTAGES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CHNL# 162: [ANGL BUS 527883 MACH '1 ']
CHNL# 165: [ANGL BUS 527903 MACH '1 ']
CHNL# 159: [ANGL BUS 527164 MACH '1 ']
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CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
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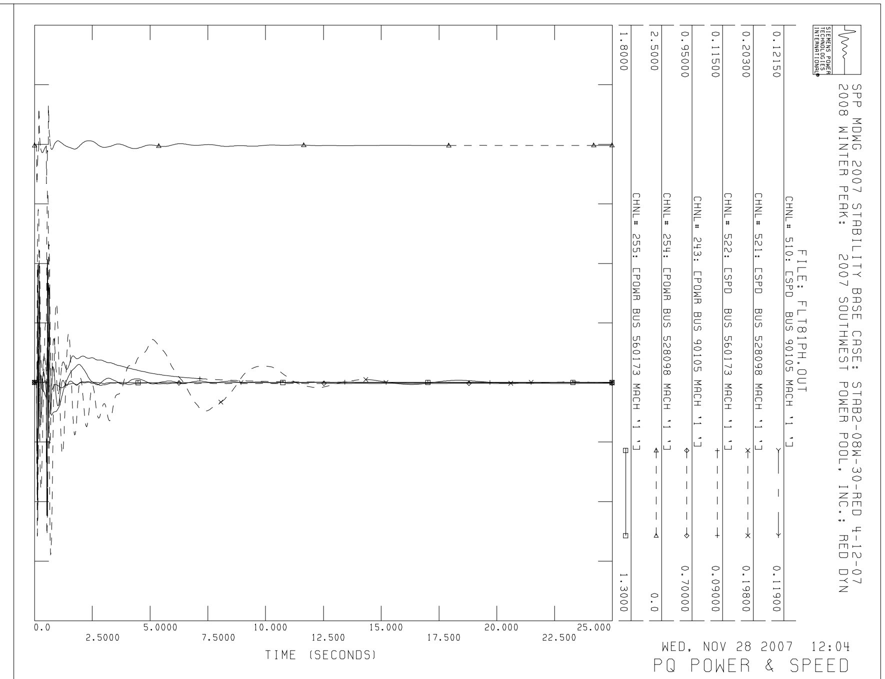
SYSTEM ANGLES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 521: [SPD BUS 528098 MACH '1 ']
CHNL# 522: [SPD BUS 560173 MACH '1 ']
CHNL# 243: [POWR BUS 90105 MACH '1 ']
CHNL# 254: [POWR BUS 528098 MACH '1 ']
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TIME (SECONDS)
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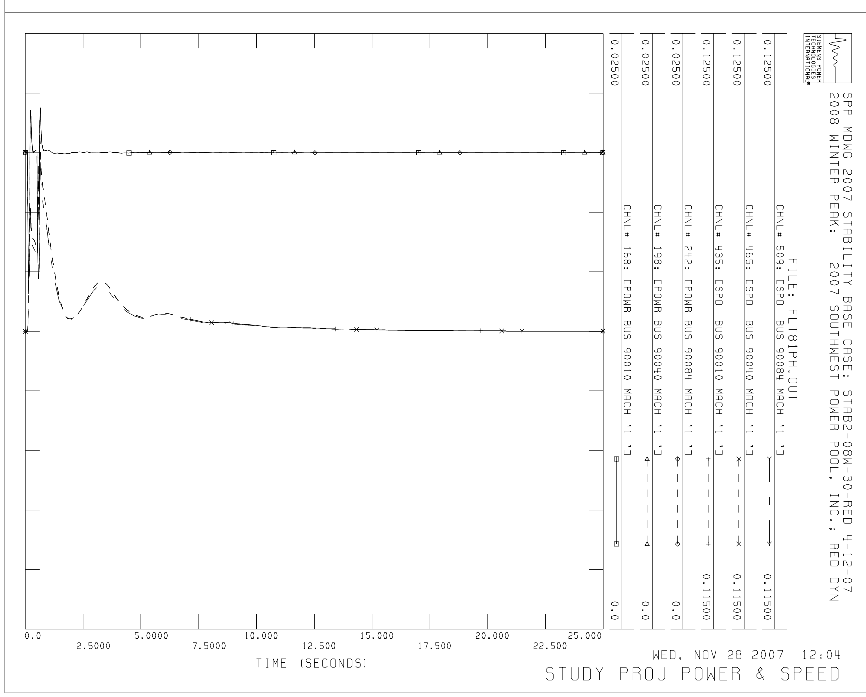
PQ POWER & SPEED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FILE: FLT81PH.OUT
CHNL# 509: [SPD BUS 90084 MACH '1 ']
CHNL# 465: [SPD BUS 90040 MACH '1 ']
CHNL# 435: [SPD BUS 90010 MACH '1 ']
CHNL# 242: [POWR BUS 90084 MACH '1 ']
CHNL# 198: [POWR BUS 90040 MACH '1 ']
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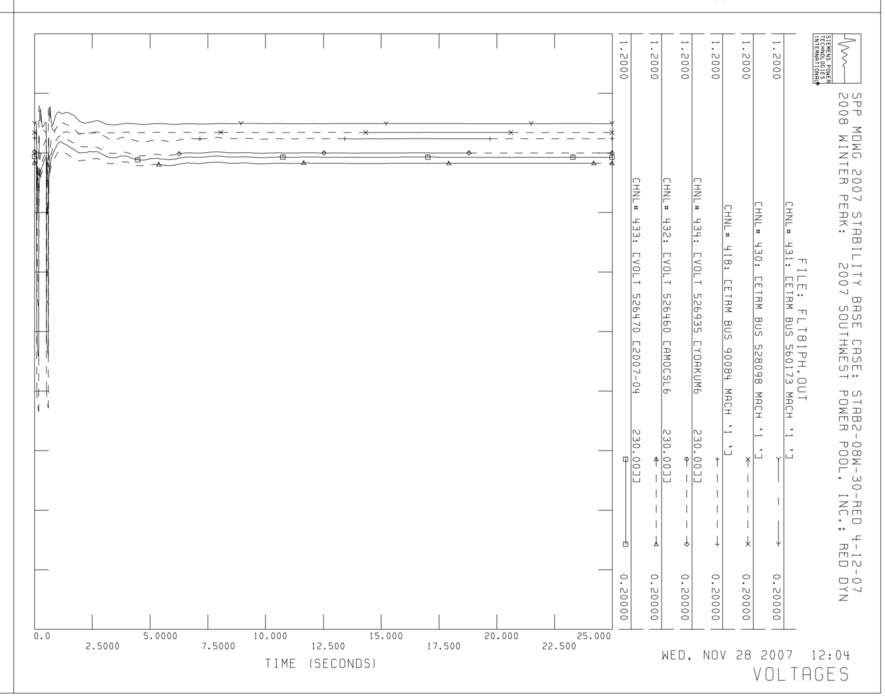
TIME (SECONDS)
WED, NOV 28 2007 12:04
STUDY PROJ POWER & SPEED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CHNL# 431: [ETRM BUS 560173 MACH '1 ']
CHNL# 430: [ETRM BUS 528098 MACH '1 ']
CHNL# 418: [ETRM BUS 90084 MACH '1 ']
CHNL# 434: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]]
CHNL# 433: [VOLT 526470 [2007-04 230.00]]
TIME (SECONDS)
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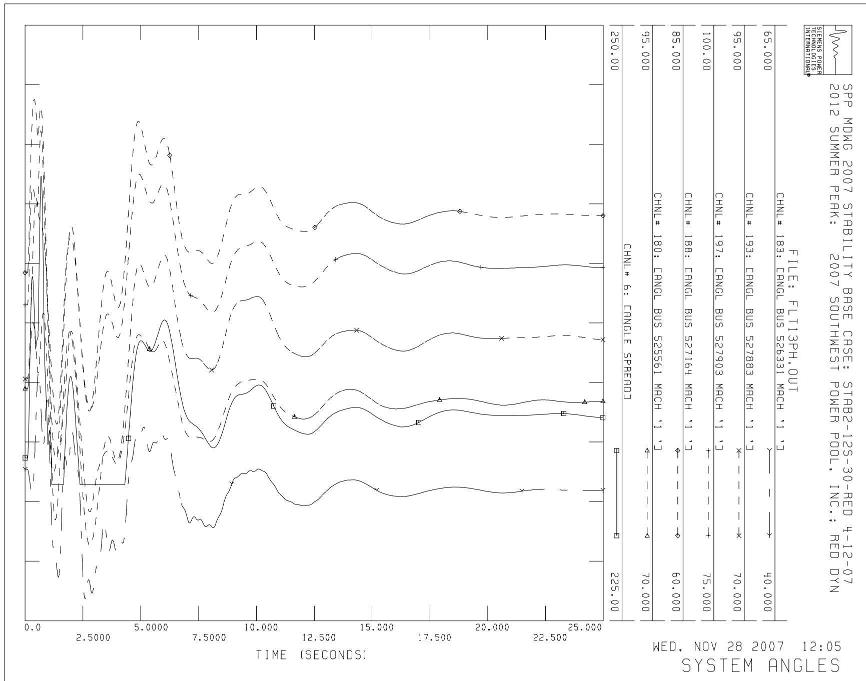
VOLTAGES

APPENDIX B.

SELECTED STABILITY PLOTS – 2012 Summer Peak

All plots available on request.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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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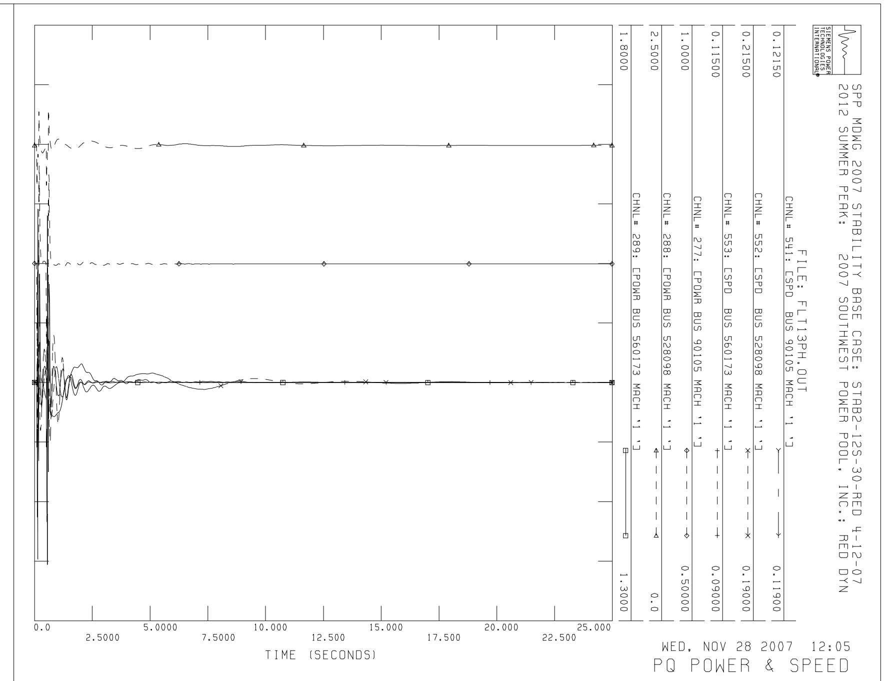
CHNL# 193: [ANGL BUS 527883 MACH '1 ']
CHNL# 197: [ANGL BUS 527903 MACH '1 ']
CHNL# 188: [ANGL BUS 527164 MACH '1 ']
CHNL# 180: [ANGL BUS 525561 MACH '1 ']
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 541: [SPD BUS 90105 MACH '1 ']
CHNL# 552: [SPD BUS 528098 MACH '1 ']
CHNL# 553: [SPD BUS 560173 MACH '1 ']
CHNL# 277: [POWR BUS 90105 MACH '1 ']
CHNL# 288: [POWR BUS 528098 MACH '1 ']
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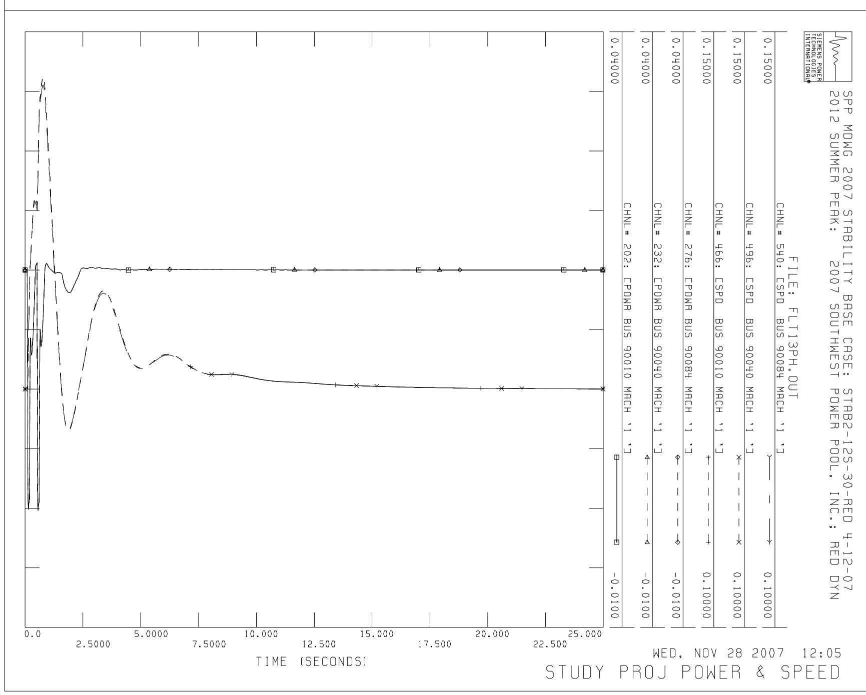
PQ POWER & SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
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CHNL# 496: [SPD BUS 90040 MACH '1 ']
CHNL# 466: [SPD BUS 90010 MACH '1 ']
CHNL# 276: [POWR BUS 90084 MACH '1 ']
CHNL# 232: [POWR BUS 90040 MACH '1 ']
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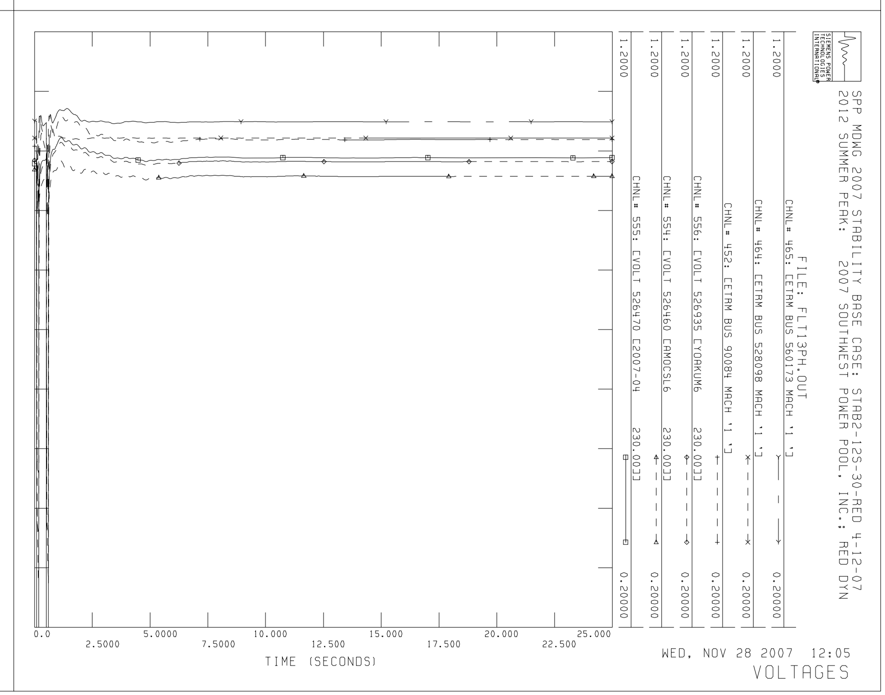
STUDY PROJ POWER & SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 464: [ETRM BUS 528098 MACH '1 ']
CHNL# 452: [ETRM BUS 90084 MACH '1 ']
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]]
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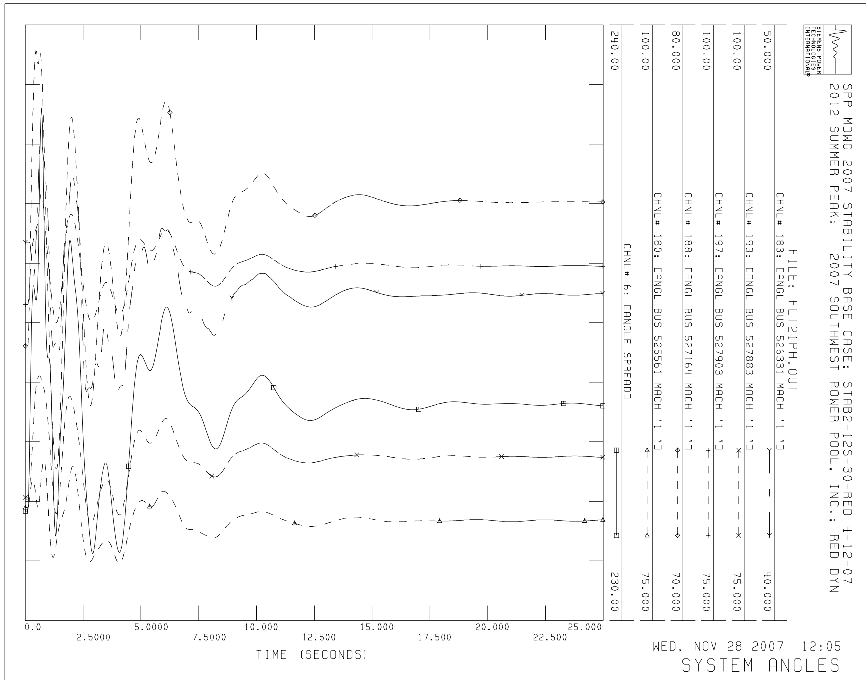
WED, NOV 28 2007 12:05
VOLTAGES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CHNL# 193: [ANGL BUS 527883 MACH '1 ']
CHNL# 197: [ANGL BUS 527903 MACH '1 ']
CHNL# 188: [ANGL BUS 527164 MACH '1 ']
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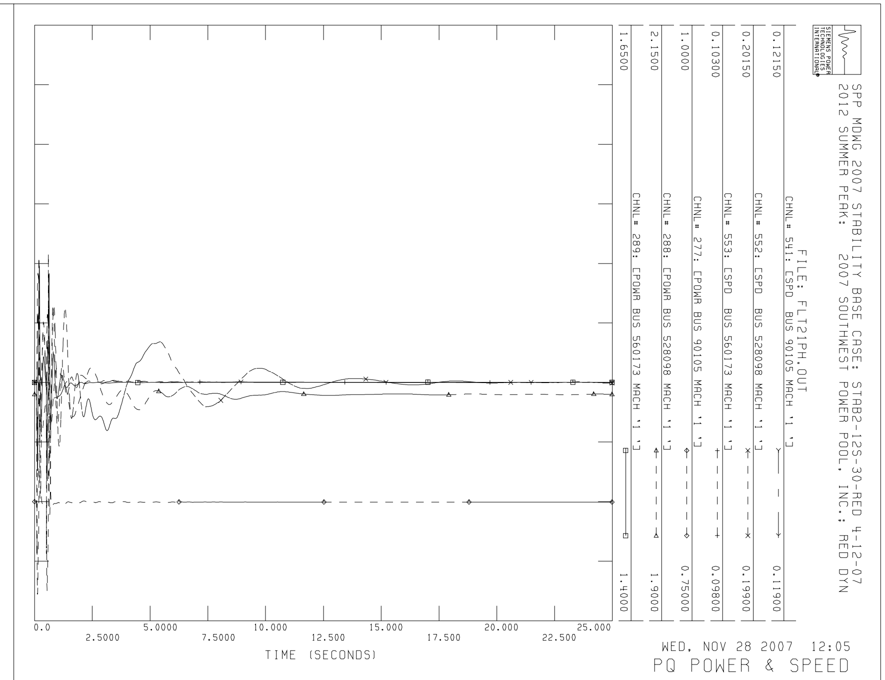
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES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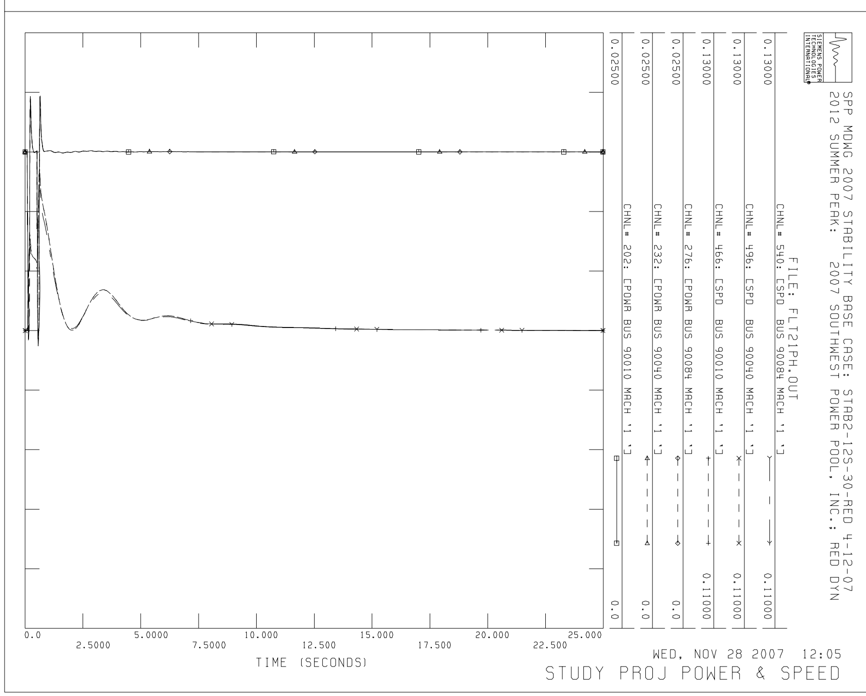
CHNL# 553: [SPD BUS 560173 MACH '1 ']
CHNL# 277: [POWR BUS 90105 MACH '1 ']
CHNL# 288: [POWR BUS 528098 MACH '1 ']
CHNL# 289: [POWR BUS 560173 MACH '1 ']
TIME (SECONDS)
WED, NOV 28 2007 12:05
PQ POWER & SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 466: [SPD BUS 90010 MACH '1 ']
CHNL# 276: [POWR BUS 90084 MACH '1 ']
CHNL# 232: [POWR BUS 90040 MACH '1 ']
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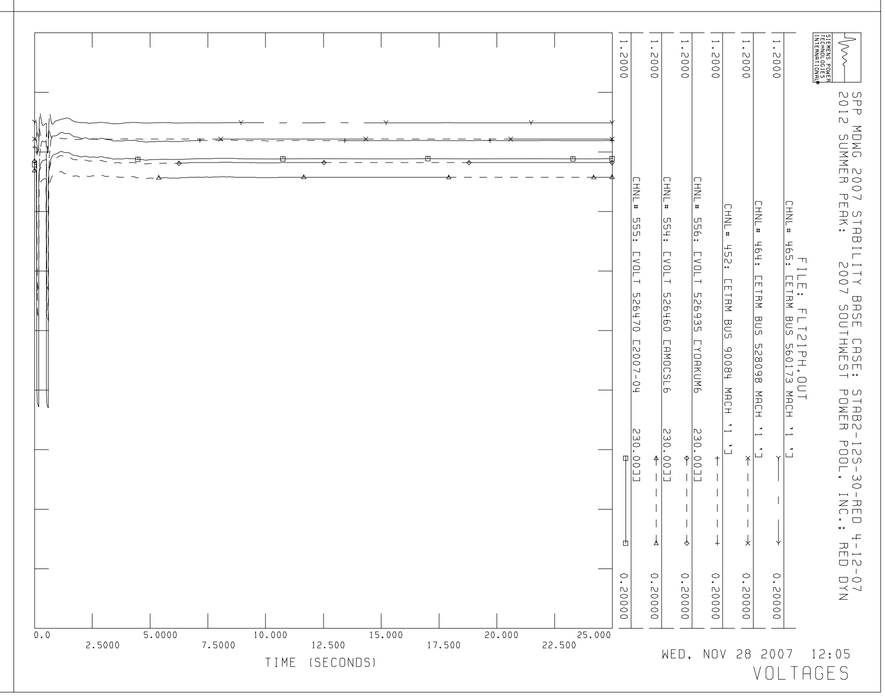
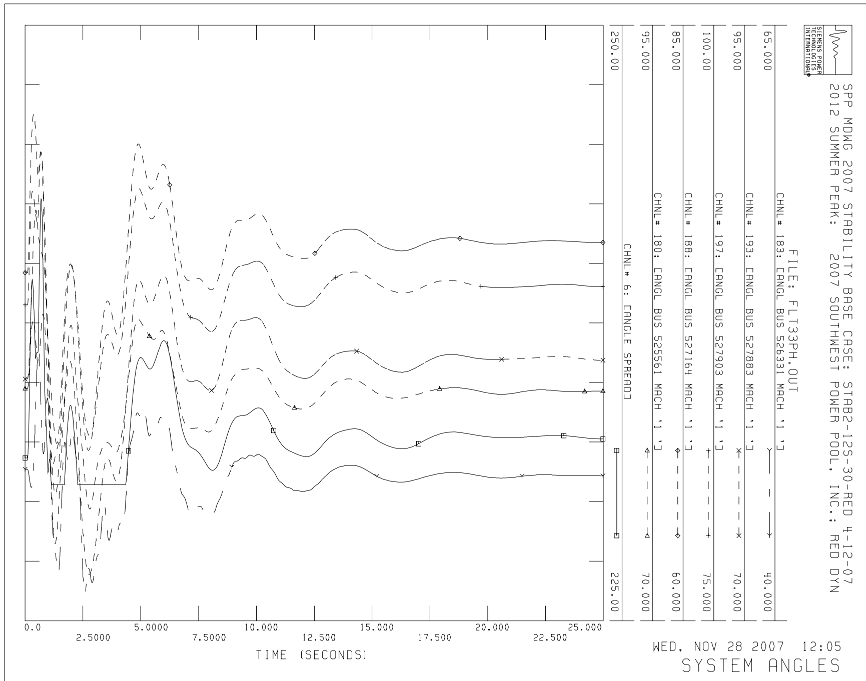
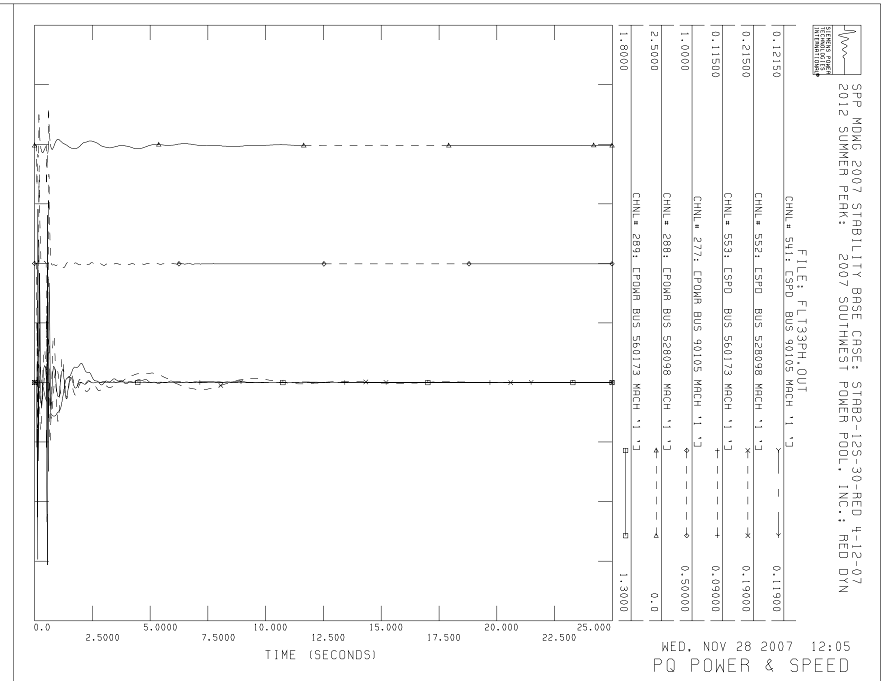
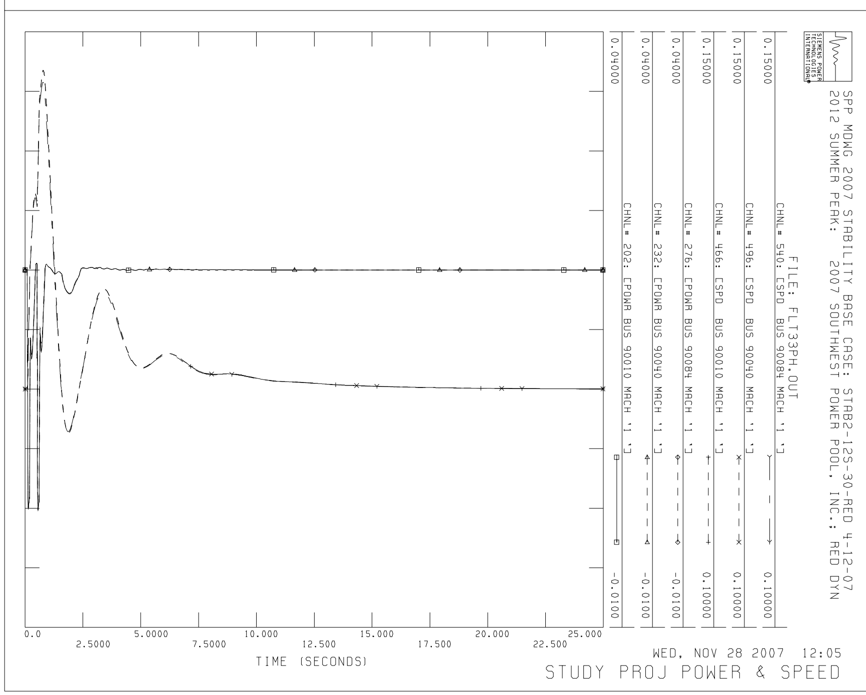
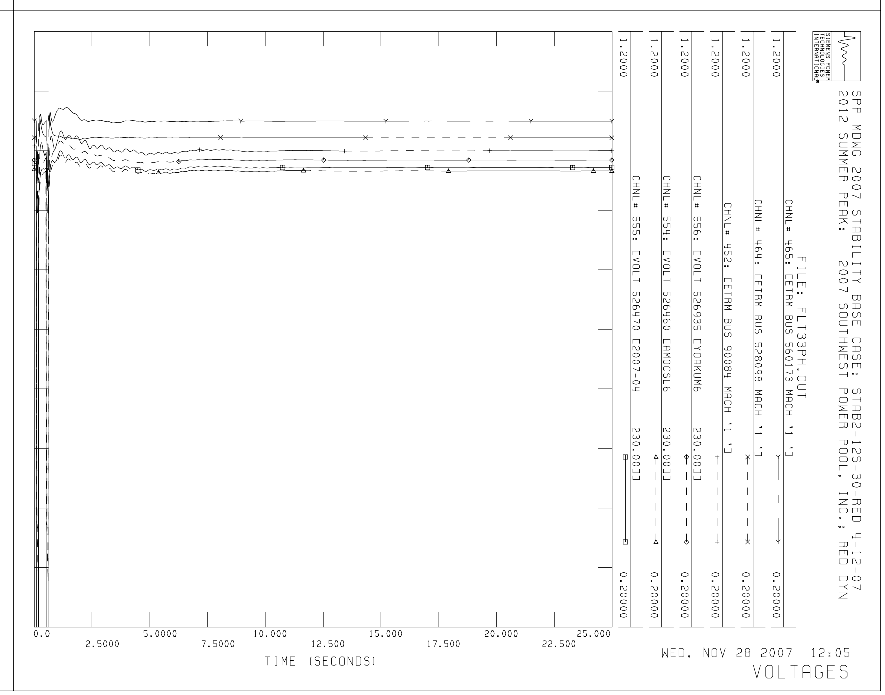
TIME (SECONDS)
WED, NOV 28 2007 12:05
STUDY PROJ POWER & SPEED

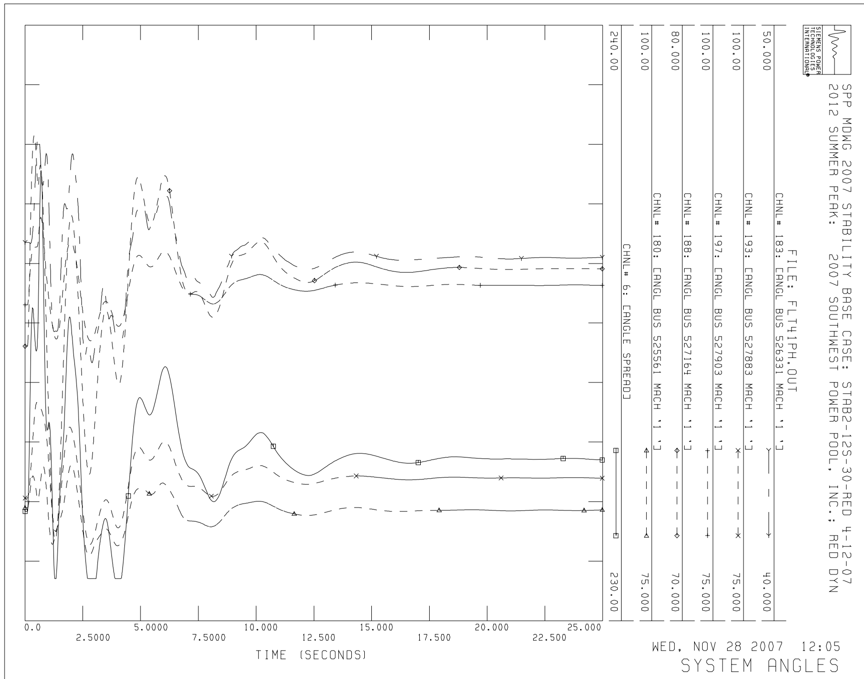

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT21PH.OUT
CHNL# 465: [ETRM BUS 560173 MACH '1 ']
CHNL# 464: [ETRM BUS 528098 MACH '1 ']
CHNL# 452: [ETRM BUS 90084 MACH '1 ']
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]]
CHNL# 555: [VOLT 526470 [2007-04 230.00]]
TIME (SECONDS)
WED, NOV 28 2007 12:05
VOLTAGES

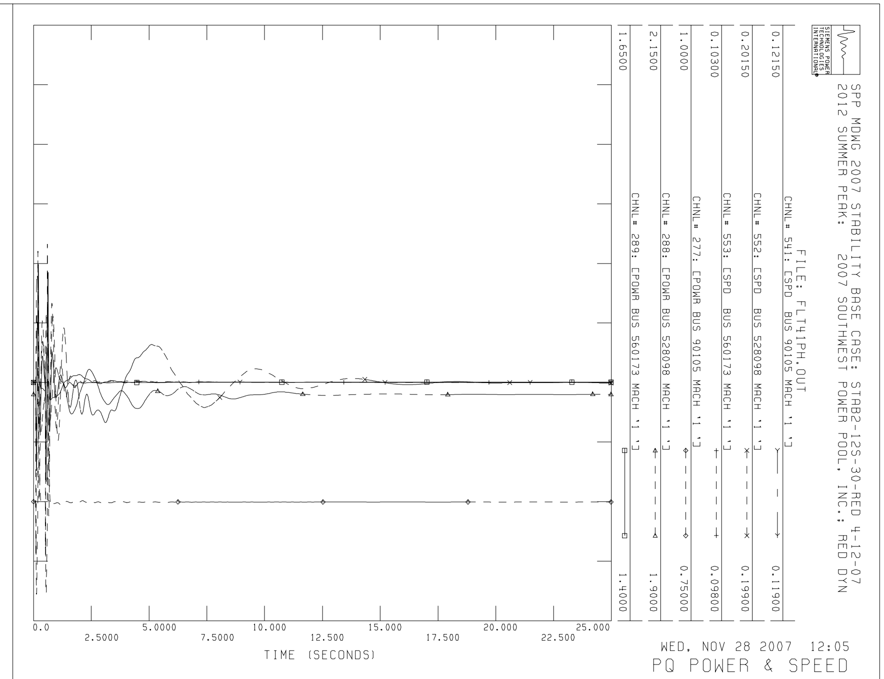

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 183: [ANGL BUS 526331 MACH '1 '] 65.000 40.000
CHNL# 193: [ANGL BUS 527883 MACH '1 '] 95.000 70.000
CHNL# 197: [ANGL BUS 527903 MACH '1 '] 100.00 75.000
CHNL# 188: [ANGL BUS 527164 MACH '1 '] 85.000 60.000
CHNL# 180: [ANGL BUS 525561 MACH '1 '] 95.000 70.000
CHNL# 6: [ANGLE SPREAD] 250.00 225.00
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES

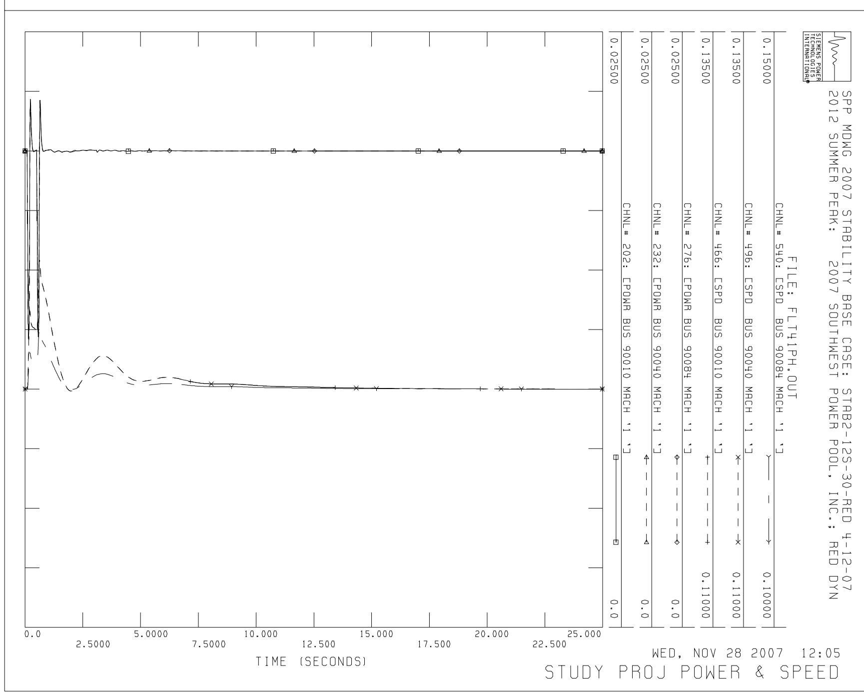

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 541: [SPD BUS 90105 MACH '1 '] 0.12150 0.11900
CHNL# 552: [SPD BUS 528098 MACH '1 '] 0.21500 0.19000
CHNL# 553: [SPD BUS 560173 MACH '1 '] 0.11500 0.09000
CHNL# 277: [POWR BUS 90105 MACH '1 '] 1.0000 0.50000
CHNL# 288: [POWR BUS 528098 MACH '1 '] 2.5000 0.0
CHNL# 289: [POWR BUS 560173 MACH '1 '] 1.8000 1.3000
TIME (SECONDS)
WED, NOV 28 2007 12:05
PQ POWER & SPEED

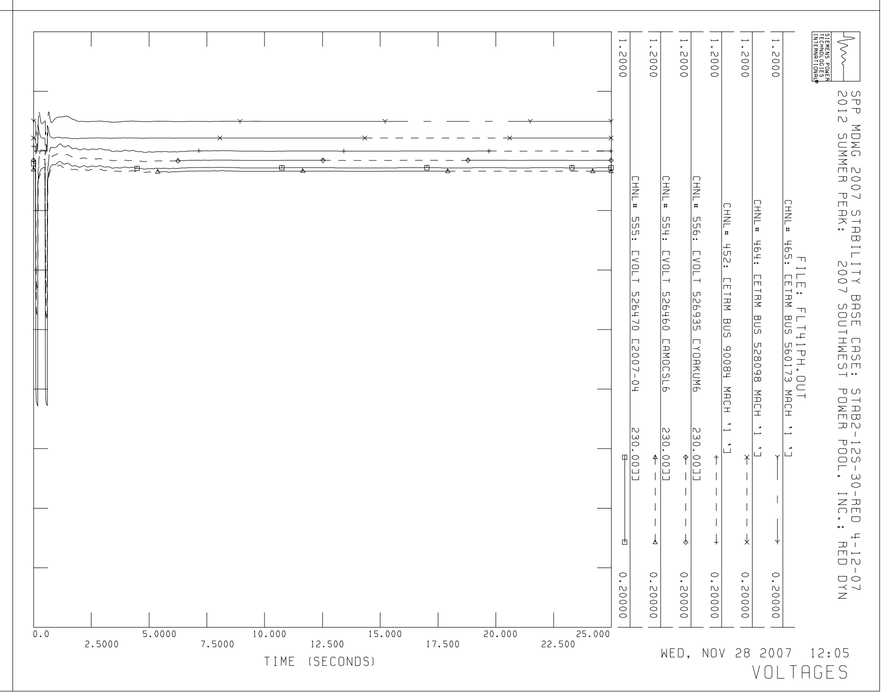

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 540: [SPD BUS 90084 MACH '1 '] 0.15000 0.10000
CHNL# 496: [SPD BUS 90040 MACH '1 '] 0.15000 0.10000
CHNL# 466: [SPD BUS 90010 MACH '1 '] 0.15000 0.10000
CHNL# 276: [POWR BUS 90084 MACH '1 '] 0.04000 -0.0100
CHNL# 232: [POWR BUS 90040 MACH '1 '] 0.04000 -0.0100
CHNL# 202: [POWR BUS 90010 MACH '1 '] 0.04000 -0.0100
TIME (SECONDS)
WED, NOV 28 2007 12:05
STUDY PROJ POWER & SPEED

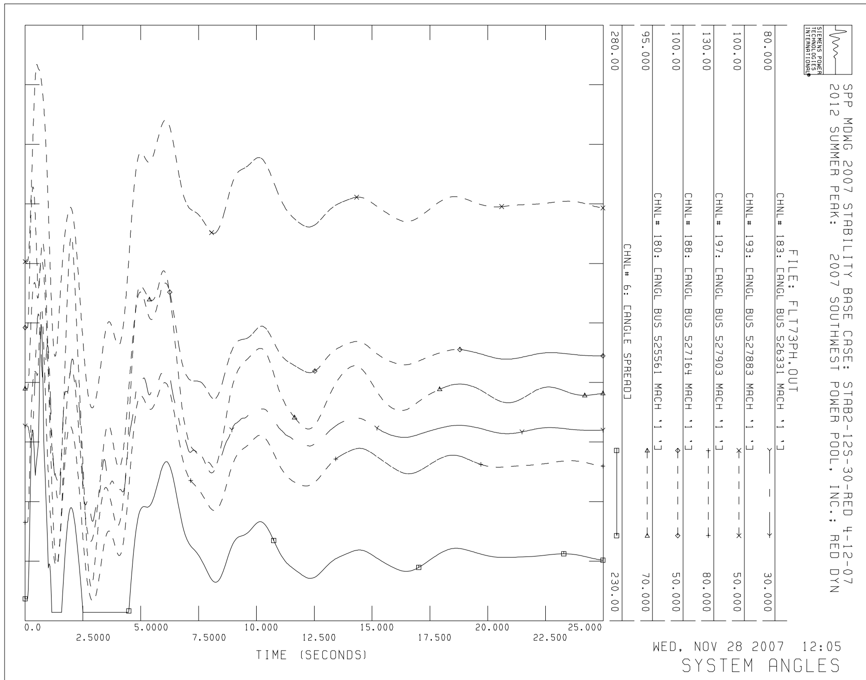

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 465: [ETRM BUS 560173 MACH '1 '] 1.2000 0.20000
CHNL# 464: [ETRM BUS 528098 MACH '1 '] 1.2000 0.20000
CHNL# 452: [ETRM BUS 90084 MACH '1 '] 1.2000 0.20000
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]] 1.2000 0.20000
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 555: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
TIME (SECONDS)
WED, NOV 28 2007 12:05
VOLTAGES

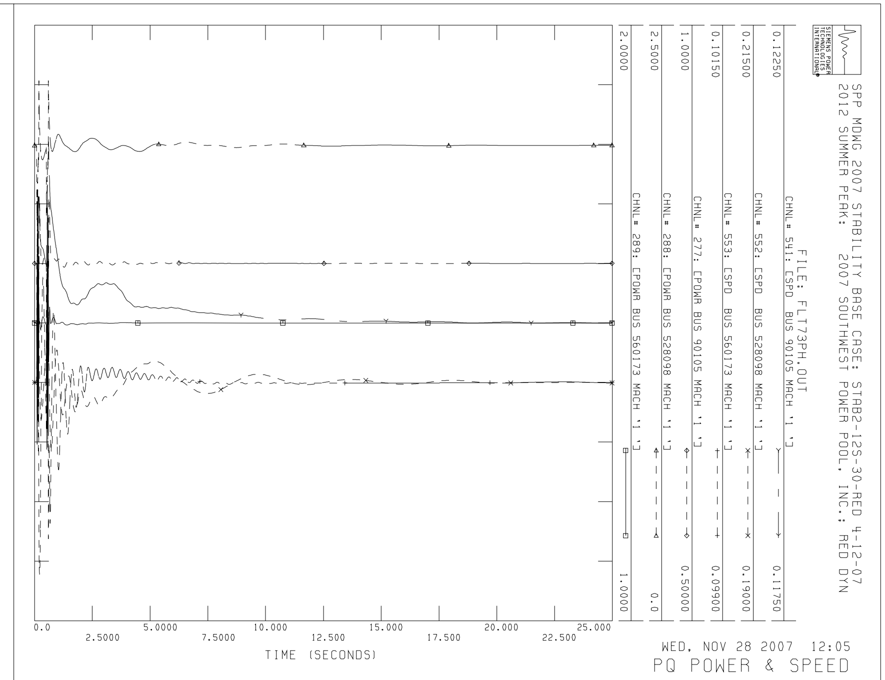

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT4IPH.OUT
CHNL# 183: [ANGL BUS 526331 MACH '1 '] 50.000 40.000
CHNL# 193: [ANGL BUS 527883 MACH '1 '] 100.00 75.000
CHNL# 197: [ANGL BUS 527903 MACH '1 '] 100.00 75.000
CHNL# 188: [ANGL BUS 527164 MACH '1 '] 80.000 70.000
CHNL# 180: [ANGL BUS 525561 MACH '1 '] 100.00 75.000
CHNL# 6: [ANGLE SPREAD] 240.00 230.00
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES

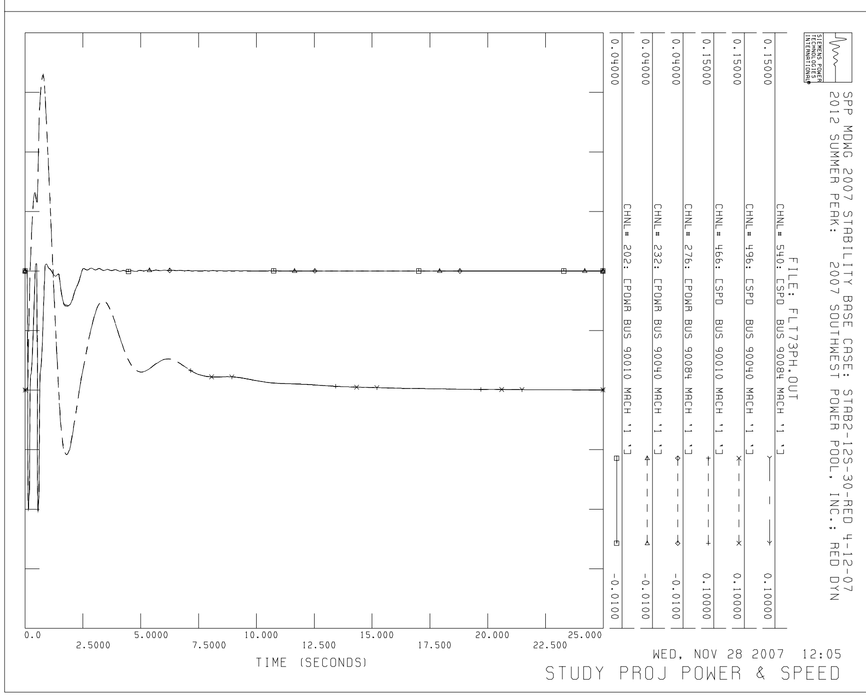

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT4IPH.OUT
CHNL# 541: [SPD BUS 90105 MACH '1 '] 0.12150 0.11900
CHNL# 552: [SPD BUS 528098 MACH '1 '] 0.20150 0.19900
CHNL# 553: [SPD BUS 560173 MACH '1 '] 0.10300 0.09800
CHNL# 277: [POWR BUS 90105 MACH '1 '] 1.0000 0.75000
CHNL# 288: [POWR BUS 528098 MACH '1 '] 2.1500 1.9000
CHNL# 289: [POWR BUS 560173 MACH '1 '] 1.6500 1.4000
TIME (SECONDS)
WED, NOV 28 2007 12:05
PQ POWER & SPEED

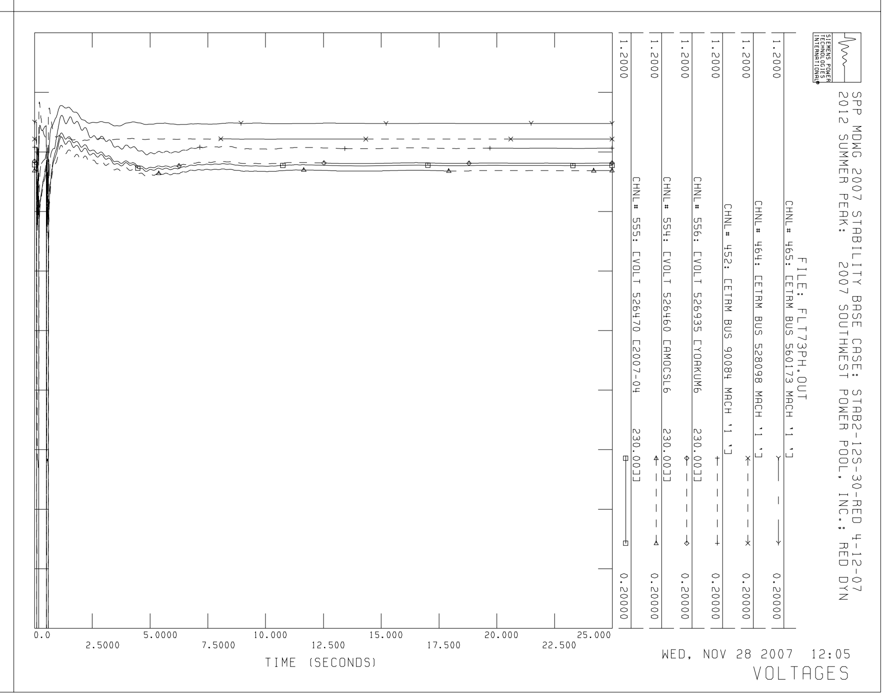

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT4IPH.OUT
CHNL# 540: [SPD BUS 90084 MACH '1 '] 0.15000 0.10000
CHNL# 496: [SPD BUS 90040 MACH '1 '] 0.13500 0.11000
CHNL# 466: [SPD BUS 90010 MACH '1 '] 0.13500 0.11000
CHNL# 276: [POWR BUS 90084 MACH '1 '] 0.02500 0.0
CHNL# 232: [POWR BUS 90040 MACH '1 '] 0.02500 0.0
CHNL# 202: [POWR BUS 90010 MACH '1 '] 0.02500 0.0
TIME (SECONDS)
WED, NOV 28 2007 12:05
STUDY PROJ POWER & SPEED

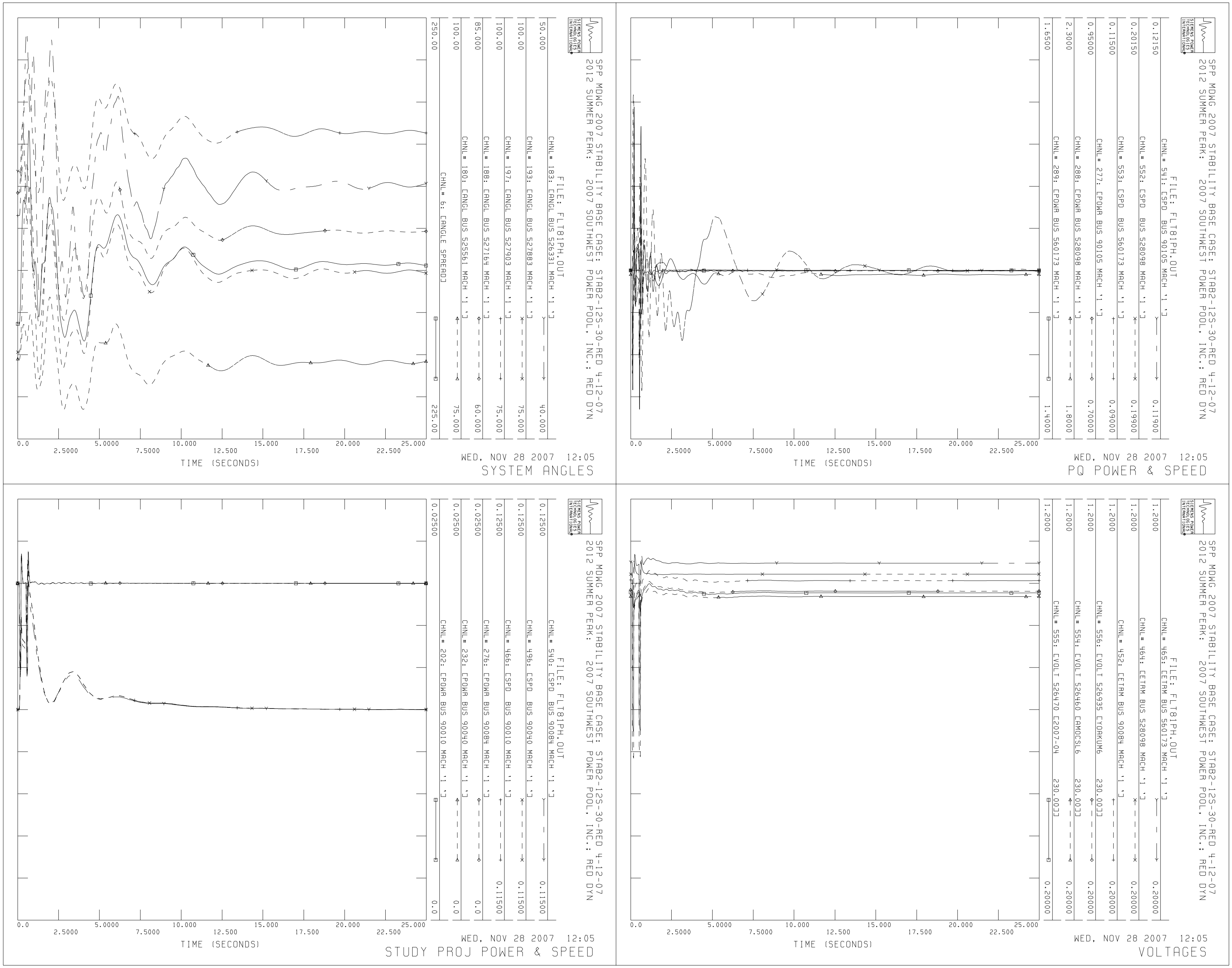

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT4IPH.OUT
CHNL# 465: [ETRM BUS 560173 MACH '1 '] 1.2000 0.20000
CHNL# 464: [ETRM BUS 528098 MACH '1 '] 1.2000 0.20000
CHNL# 452: [ETRM BUS 90084 MACH '1 '] 1.2000 0.20000
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]] 1.2000 0.20000
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 555: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
TIME (SECONDS)
WED, NOV 28 2007 12:05
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT73PH.OUT
CHNL# 183: [ANGL BUS 526331 MACH '1 ']
CHNL# 193: [ANGL BUS 527883 MACH '1 ']
CHNL# 197: [ANGL BUS 527903 MACH '1 ']
CHNL# 188: [ANGL BUS 527164 MACH '1 ']
CHNL# 180: [ANGL BUS 525561 MACH '1 ']
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT73PH.OUT
CHNL# 541: [SPD BUS 90105 MACH '1 ']
CHNL# 552: [SPD BUS 528098 MACH '1 ']
CHNL# 553: [SPD BUS 560173 MACH '1 ']
CHNL# 277: [POWR BUS 90105 MACH '1 ']
CHNL# 288: [POWR BUS 528098 MACH '1 ']
CHNL# 289: [POWR BUS 560173 MACH '1 ']
TIME (SECONDS)
WED, NOV 28 2007 12:05
PQ POWER & SPEED


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT73PH.OUT
CHNL# 540: [SPD BUS 90084 MACH '1 ']
CHNL# 496: [SPD BUS 90040 MACH '1 ']
CHNL# 466: [SPD BUS 90010 MACH '1 ']
CHNL# 276: [POWR BUS 90084 MACH '1 ']
CHNL# 232: [POWR BUS 90040 MACH '1 ']
CHNL# 202: [POWR BUS 90010 MACH '1 ']
TIME (SECONDS)
WED, NOV 28 2007 12:05
STUDY PROJ POWER & SPEED


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT73PH.OUT
CHNL# 465: [ETRM BUS 560173 MACH '1 ']
CHNL# 464: [ETRM BUS 528098 MACH '1 ']
CHNL# 452: [ETRM BUS 90084 MACH '1 ']
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]]
CHNL# 555: [VOLT 526470 [2007-04 230.00]]
TIME (SECONDS)
WED, NOV 28 2007 12:05
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT81PH.OUT
CHNL# 183: [ANGL BUS 526331 MACH '1 ']
CHNL# 193: [ANGL BUS 527883 MACH '1 ']
CHNL# 197: [ANGL BUS 527903 MACH '1 ']
CHNL# 188: [ANGL BUS 527164 MACH '1 ']
CHNL# 180: [ANGL BUS 525561 MACH '1 ']
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
WED, NOV 28 2007 12:05
SYSTEM ANGLES
CHNL# 541: [SPD BUS 90105 MACH '1 ']
CHNL# 552: [SPD BUS 528098 MACH '1 ']
CHNL# 553: [SPD BUS 560173 MACH '1 ']
CHNL# 277: [POWR BUS 90105 MACH '1 ']
CHNL# 288: [POWR BUS 528098 MACH '1 ']
CHNL# 289: [POWR BUS 560173 MACH '1 ']
PQ POWER & SPEED
CHNL# 540: [SPD BUS 90084 MACH '1 ']
CHNL# 496: [SPD BUS 90040 MACH '1 ']
CHNL# 466: [SPD BUS 90010 MACH '1 ']
CHNL# 276: [POWR BUS 90084 MACH '1 ']
CHNL# 232: [POWR BUS 90040 MACH '1 ']
CHNL# 202: [POWR BUS 90010 MACH '1 ']
STUDY PROJ POWER & SPEED
CHNL# 465: [ETRM BUS 560173 MACH '1 ']
CHNL# 464: [ETRM BUS 528098 MACH '1 ']
CHNL# 452: [ETRM BUS 90084 MACH '1 ']
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]]
CHNL# 555: [VOLT 526470 [2007-04 230.00]]
VOLTAGES