Southwest Power Pool

Impact Study
For
Generation Interconnection
Request
GEN-2006-043

SPP Tariff Studies

(#GEN-2006-043)

October 2007

Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 300 MW of wind generation within the control area of American Electric Power West (AEPW) in Roger Mills County, Oklahoma. The Customer has proposed an in-service date in two phases - Phase I: August 1, 2008 and Phase II: December 1, 2008. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the AEPW transmission system as well as addressing the need for reactive compensation required by the wind farm because of the use of the GE turbines.

The requirements and cost to interconnect the 300 MW of generation depend upon several prior queued projects. Currently, two prior queued projects are interconnecting to the same point as this request. Several scenarios for the cost of interconnection follow:

1. **Both prior queued projects moving forward and Customer interconnects at 300 MW:**

   The Customer will be responsible for the incremental cost to upgrade the switching station from a four breaker ring bus to an eight breaker breaker-and-a-half configuration. This cost is $4,000,000 (see Table 1). The Customer will also be responsible for the cost to build a 345 kV transmission line from the point of interconnection (POI) to Mooreland in the Western Farmers Electric Company (WFEC) control area. The cost of this scenario is $142,000,000.

2. **Both prior queued project moving forward and Customer interconnects at 126 MW:**

   The Customer will be responsible for the incremental cost to upgrade the switching station from a four breaker ring bus to an eight breaker breaker-and-a-half configuration. This cost is $4,000,000 (see Table 2).

3. **One prior queued project moving forward and Customer interconnects at 300 MW:**

   The prior queued project will be responsible for the cost to build a new three breaker ring bus switching station. The Customer will be responsible for the cost associated with adding a fourth breaker and line termination to the switching station. This cost is $800,000 (see Table 3).

4. **No prior queued projects moving forward and Customer interconnects at 300 MW:**

   The customer will be responsible for the cost of building a three breaker ring bus switching station. The cost is $5,200,000 (see Table 4).

From the new switching station at the POI, the Customer will build a 230 kV line to its 230/34.5 kV collector substation. The customer substation will provide terminations for the wind turbine collection circuits. The cost to provide these facilities is to be determined by the Customer (see Table 5).

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. Seventeen contingencies were simulated in each case. The GE 1.5s 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 60 Mvars of capacitor banks on the 34.5 kV bus. With the addition of the capacitor banks, the reactive capability of the GE turbines allows the wind farm to operate at unity power factor and have reactive reserve for fault recovery.

A preliminary stability analysis done during the feasibility study (Feasibility Study for Generation Interconnection Request, May 2007) showed that with the Customer requested GE wind turbines, the transmission system will be unstable for some of the contingencies studied. For this impact study the following four scenarios were developed:

1. The 300 MW wind generation dispatched at the POI,
2. Same as 1 with the addition of a 200 Mvar SVC in the customer plant,
3. Same as 1 with the addition of a 345 kV line at the POI to Mooreland Substation, and
4. The determination of the maximum generation configuration at the Customer plant without the addition of network upgrades.

The results of these studies are as follows:

1. For scenario 1 the transmission system was found to be unstable for some contingencies. Generation at a prior queued project was tripped off-line due to the additional generation of the Customer plant and unstable oscillation that resulted.
2. For scenario 2 the transmission system was found to be unstable for some contingencies.
3. For scenario 3 the transmission system was found to be stable for all contingencies.
4. For scenario 4 the maximum allowable generation was found to be 126 MW.

Therefore, two options are available to the Customer – (a) 300 MW generation and the construction of a 345 kV line, or (b) 126 MW generation. The Customer will be required to notify SPP at the time of the Facility Study if the customer wishes to proceed with construction of the 345 kV line, or if it wishes to reduce the queue position to 126 MW.

If the Customer changes the manufacturer or type of wind turbine from the GE 1.5 MW, an Impact re-study will be required.

Further Stability study results show that in order for the wind farm to meet FERC Order #661A's Low Voltage Ride Through (LVRT) provisions, the Customer shall purchase the GE turbines with the LVRT II low voltage ride through package available from the manufacturer.

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 300 MW of wind generation within the control area of AEPW in Roger Mills County, Oklahoma. The wind powered generation facility was studied with 200 individual General Electric (GE) 1.5 MW wind turbines. The requested in-service date for the 300 MW facility is August 1, 2008 for Phase I and December 1, 2008 for Phase II. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the AEPW transmission system as well as addressing the need for reactive compensation required by the wind farm because of the use of the GE turbines.

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 Customer supplied drawings that showed the generating facility to be divided into two systems – a West Collector System and an East Collector System. The East Collector System consisted of 106 GE 1.5 MW Wind Turbine Generators (WTG) and the West Collector System consisted of 109 GE 1.5 MW WTG's. The total power if all generators were on line would be 322.5 MW. Since the queue position is only 300 MW, for this impact study the power output was limited to 300 MW by removing 15 wind turbines. Each collector system was limited to 150 MW of generation (100 wind turbines) (see Figure 1). The following wind turbines were not used in the study:

1. East Collector System – E066-E071 (6 wind turbines)
2. West Collector System – W004-W012 (9 wind turbines)

The generating facility was studied with the assumption that it would be using GE 1.5s Wind Turbine Generators. The nameplate rating of each turbine is 1.5 MW (1500 kW) with a machine base of 1667 kVA. The turbine output voltage is 575 V. The GE turbines utilize a doubly fed induction-generator with a wound rotor and slip rings. The generator synchronous speed is 1200 rpm, and a variable frequency power converter tied to the generator rotor allows the generator to operate at speeds ranging from 800 rpm to 1600 rpm. Nominal speed at 1.5 MW power output is 1440 rpm and the maximum allowable non-operating rotational speed is 1680 rpm. The power converter allows the generator to produce power at a power factor of 0.9 lagging to 0.95 leading. The power factor is settable at each WTG or by the Plant SCADA system.

This study was performed using the latest GE Standard Voltage and Frequency Settings with Fault Ride Through modeling stability package available from PTI. These settings are shown in Table 7 and Table 8.

Each wind turbine will feed into a 0.575/34.5 kV GSU rated at 1750 kVA. Impedance for the GSU is 5.75%.

The impedance for each of the 34.5/230 kV transformers is 9.0% on a 100 MVA OA Base with a top rating of 167 MVA.

3.2 <u>Interconnection Facility</u>

The Customer has proposed the point of interconnection to be the AEPW transmission system via a new substation located in northwest Beckham County, Oklahoma on the existing Elk City – Grapevine 230 kV line

The requirements and cost to interconnect the 300 MW of generation depend upon several prior queued projects. Currently, two prior queued projects are interconnecting to the same point as this request. Several scenarios for the cost of interconnection follow:

1. **Both prior queued projects moving forward and Customer 300 MW operation:**

   The Customer will be responsible for the incremental cost to upgrade the switching station from a four breaker ring bus to an eight breaker breaker-and-a-half configuration. This cost is $4,000,000 (see Table 1). The Customer will also be responsible for the cost to build a 345 kV transmission line to Mooreland in the Western Farmers Electric Company (WFEC) control area. The cost of this line is approximately $138,000,000. Figure 2 shows proposed interconnection facility and network reinforcements for this scenario.

2. **Both prior queued project moving forward and Customer 126 MW operation:**

   The Customer will be responsible for the incremental cost to upgrade the switching station from a four breaker ring bus to an eight breaker breaker-and-a-half configuration. This cost is $4,000,000 (see Table 2). Figure 3 shows the proposed interconnection facility for this scenario.

3. **One prior queued project moving forward and Customer 300 MW operation:**

   The prior queued project will be responsible for the cost to build a new three breaker ring bus switching station. The Customer will be responsible for the cost associated with adding a fourth breaker and line termination to the switching station. This cost is $800,000 (see Table 3).

4. **No prior queued projects moving forward and Customer 300 MW operation:**

   The customer will be responsible for the cost of building a three breaker ring bus switching station. The cost is $5,200,000 (see Table 4).

From the new switching station at the POI, the Customer will build a 230 kV line to its 230/34.5 kV collector substation. The customer substation will provide terminations for the wind turbine collection circuits. The costs to provide these facilities are to be determined by the Customer (see Table 5).

Analysis of the reactive compensation requirements of the wind farm at 300 MW indicated the need for a 34.5 kV, 30 Mvar capacitor bank to be located on the secondary side of the East Collector System substation transformer and for a 34.5 kV, 30 Mvar capacitor bank to be located on the secondary side of the West Collector System substation transformer (see Figure 1). These capacitor banks are necessary for reactive compensation for the wind farm (turbine and collector system losses). Because of the reactive capability of the GE turbines, the reactive compensation does not need to be dynamic (SVC).

If the Customer chooses to reduce the output to 126 MW, a total of 15 Mvar of capacitor banks will be required.

Table 1: Required Interconnection Network Upgrade Facilities
(Assuming both prior queued projects stay in the queue and Customer generating 300 MW)

FACILITY	ESTIMATED COST (2007 DOLLARS)
AEPW – Build 230kV, Add 4 breakers to upgrade 4-breaker ring bus to 8-breaker breaker-and-a-half bus switching station. Station to include breakers, switches, control relaying, high speed communications, all structures, and metering and other related equipment.	$4,000,000
AEPW – Build 345 kV switchyard with one (1) 345 kV breaker, one (1) 345/230 kV autotransformer, and one (1) additional 230 kV line terminal at the wind farm.	$10,000,000
WFEC – Build 345 kV switchyard with one (1) 345 kV breaker, one (1) 345/138 kV autotransformer and one additional 138 kV line terminal at Mooreland Substation.	$8,000,000
AEP-SPS-WFEC – Build one hundred twenty (120) miles of 345 kV, 2-795 MCM transmission line.	$120,000,000
Total	**$142,000,000**

Table 2: Required Interconnection Network Upgrade Facilities
(Assuming both prior queued projects stay in the queue and Customer generating 126 MW)

FACILITY	ESTIMATED COST (2007 DOLLARS)
AEPW – Build 230kV, Add 4 breakers to upgrade 4-breaker ring bus to 8-breaker breaker-and-a-half bus switching station. Station to include breakers, switches, control relaying, high speed communications, all structures, and metering and other related equipment.	$4,000,000
Total	**$4,000,000**

Table 3: Required Interconnection Network Upgrade Facilities
(Assuming one prior queued project stays in the queue)

FACILITY	ESTIMATED COST (2007 DOLLARS)
AEPW – Add 230kV line and breaker terminal to the ring bus switching station built initially for request GEN-2006-002 (or GEN-2006-035).	$800,000
Total	**$800,000**

Table 4: Required Interconnection Network Upgrade Facilities
(Assuming both prior queued project withdraws)

FACILITY	ESTIMATED COST (2007 DOLLARS)
AEPW – Build 230kV, 3-breaker ring bus switching station. Station to include breakers, switches, control relaying, high speed communications, all structures, and metering and other related equipment.	$5,200,000
Total	**$5,200,000**

Table 5: Direct Assignment Facilities

FACILITY	ESTIMATED COST (2007 DOLLARS)
Customer – 230/34.5 kV Substation facilities.	*
Customer – 230kV transmission line facilities between Customer facilities and AEPW 230kV switching station.	*
Customer - Right-of-Way for Customer facilities.	*
Customer – 34.5 kV, 60 Mvar capacitor bank(s) in Customer substation.	*
Total	*

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

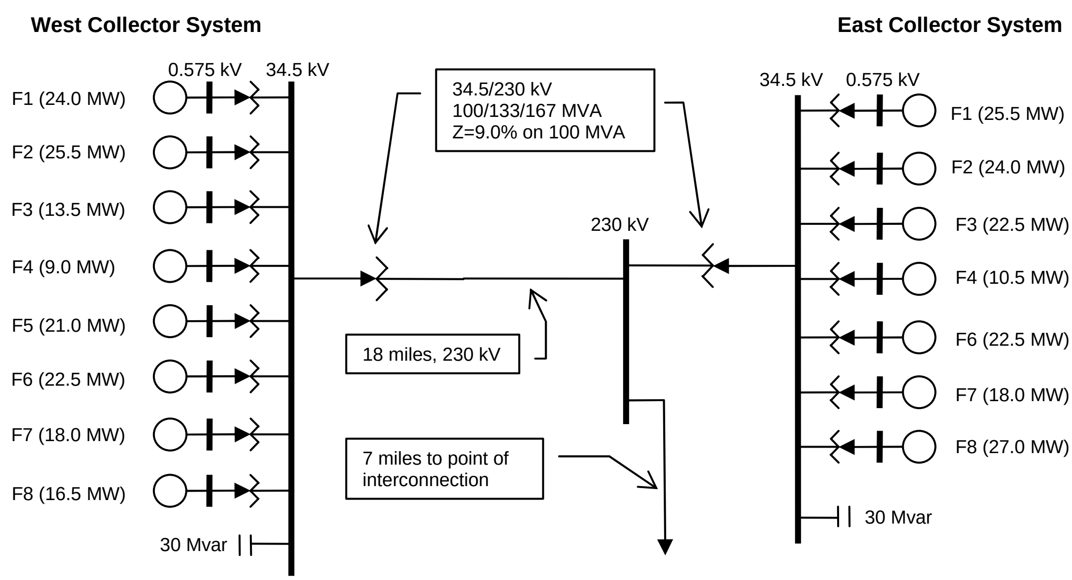


Figure 1: One-Line Drawing of the Customer Generation Facility

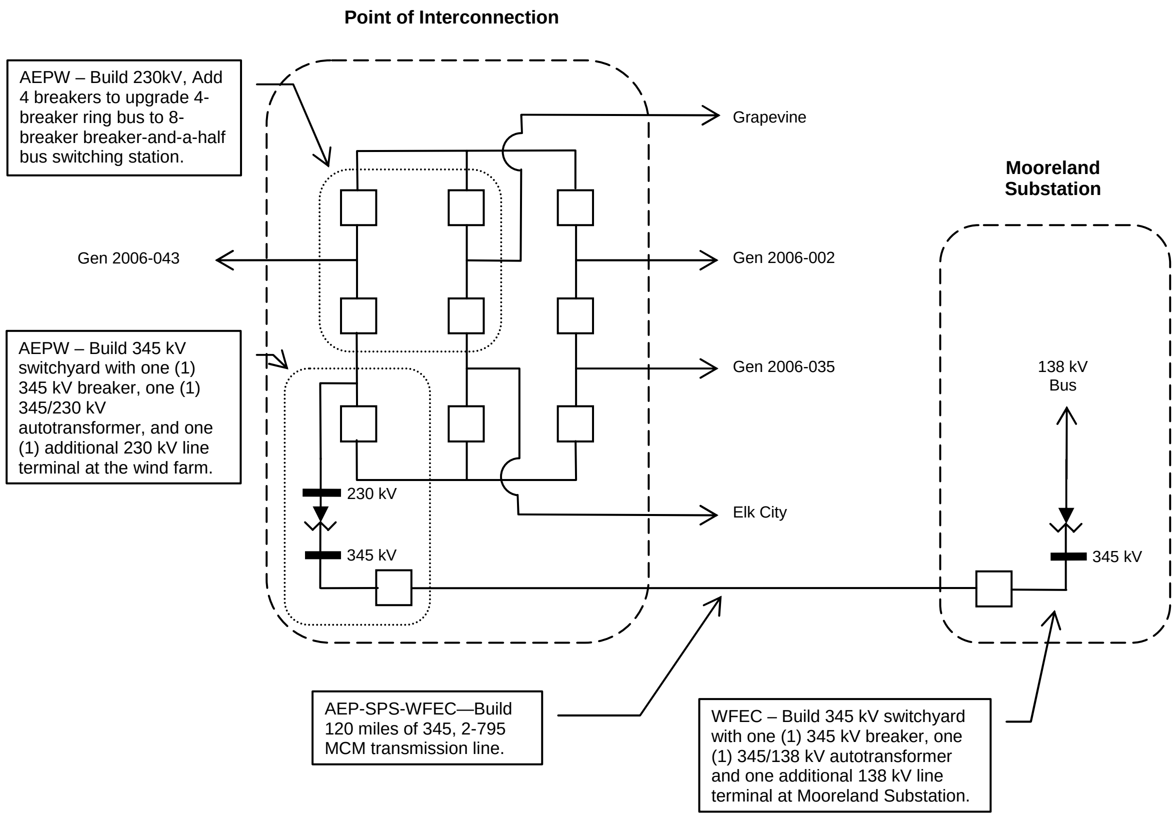


Figure 2: Proposed Interconnection Facility and Network Reinforcements (Customer Generation at 300 MW)

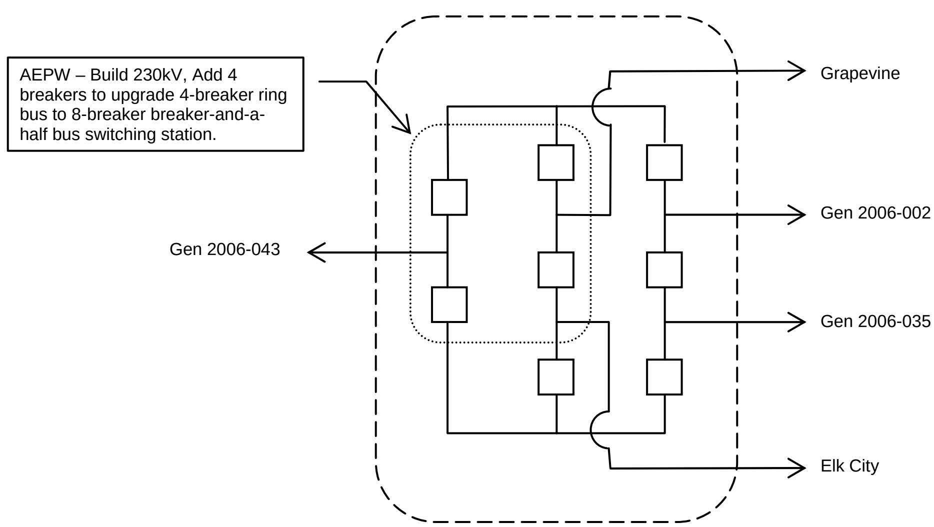


Figure 3: Proposed Interconnection Facility (Customer Generation at 126 MW Maximum)

4.0 Stability Analysis

4.1 Modeling of the Wind Turbines in the Power Flow

In order to simplify the model of the wind farm while capturing the effect of the different impedances of cables (due to change of the conductor size and length), the wind turbines and associated impedances connected to the same 34.5 kV collector lines were aggregated into several equivalent units. The 200 wind turbines were reduced to 107 equivalent units.

4.2 Modeling of the Wind Turbines in Dynamics

The GE 1.5s wind turbine generators utilize a doubly fed induction-generator with a wound rotor and slip rings. The generator synchronous speed is 1200 rpm, and a variable frequency power converter tied to the generator rotor allows the generator to operate at speeds ranging from 800 rpm to 1600 rpm. Nominal speed at 1.5 MW power output is 1440 rpm and the maximum allowable non-operating rotational speed is 1680 rpm. The power converter allows the generator to produce power at a power factor of 0.9 lagging to 0.95 leading. The power factor is settable at each WTG or by the Plant SCADA system.

Power Technologies Inc. (PTI) has produced a GE 1.5s turbine model package for use on their PSS/E simulation software. This package was obtained from PTI and was used exclusively in modeling this wind farm. The GE stability model package used was released by Siemens PTI in July, 2005. The generator data used by the stability model is shown in Table 6.

For the simulations, the wind farm was dispatched to the level specified (100% rated power).

Description	Value
Stator resistance, Ra	0.00706 pu
Stator inductance, La	0.1714 pu
Mutual inductance, Lm	2.904 pu
Rotor resistance	0.005 pu
Rotor inductance	0.1563 pu
Drive train inertia	0.64 sec
Shaft damping	0.73 pu
Shaft stiffness	0.6286 pu
Generator rotor inertia	0.57 sec
Number of generator pole pairs	3
Gear box ratio	72.0

Table 6: GE 1.5 MW Wind Turbine Generator Parameters

4.2.1 Turbine Protection Schemes

The GE 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 the 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 of a specified band for a specified amount of time.

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 AEP switching station) that draw the voltage down at the POI to 0.0 pu.

In order to meet Order #661A, GE provides three different LVRT packages. The voltage settings for the three packages are shown in Table 7. For this study, the wind turbines were determined to need the LVRT II package.

Voltage	Time Limit
1.3000pu +	1.2 cycles (0.02s)
1.1500pu -- 1.299pu	6 cycles (0.1s)
1.1499pu – 1.1000pu	60 cycles (1.0s)
1.0999pu – 0.8501pu	Continuous Operation
0.8500pu -- 0.7501pu	600 cycles (10.0s)
0.7500pu – 0.7001pu	60 cycles (1.0s)
0.7000pu – 0.3001pu	37.5 cycles (0.625s) (LVRTII)
0.3000pu – 0.0000pu	6 cycles (LVRT I)
0.1500pu – 0.0000pu	37.5 cycles (0.625s) (LVRT II)
0.0000pu	60 cycles (1 s) (LVRT III)

Table 7: G.E. Turbine Voltage Protection

The frequency protection scheme for the GE turbines is outlined in Table 8 below:

Frequency	Time Limit
62.5000Hz +	1.2 cycles (0.02s)
62.4999Hz -- 61.500Hz	1800 cycles (30.0s)
61.4999Hz -- 57.5001Hz	Continuous Operation
57.5000Hz – 56.5001Hz	600 cycles (10.0s)
56.5000Hz – 0.0000Hz	1.2 cycles (0.02s)

Table 8: G.E. Turbine Frequency Protection

4.3 <u>Contingencies Simulated</u>

Seventeen (17) contingencies were considered for the transient stability simulations. These contingencies included three phase faults, single phase line faults, and a breaker failure fault at locations defined by SPP. 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 9.

Table 9: Contingencies Evaluated

Cont. No.	Cont. Name	Description
1	FLT13PH	3 phase fault on the Wind Farm (560012) to Grapevine (523771) 230 kV line, near the Wind Farm. a. Apply fault at the Wind Farm 230 kV bus. b. Clear fault after 5 cycles by tripping the line from the Wind Farm-Grapevine. 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 (560012) to Elk City (511490) 230 kV line, near the Wind Farm. a. Apply fault at the Wind Farm 230 kV bus. b. Clear fault after 5 cycles by tripping the line from the Wind Farm-Elk City. 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 Clinton Jct (511485) – Elk City (511458) 138 kV line, near Clinton Jct. a. Apply fault at the Clinton Jct 138 kV bus. b. Clear fault after 5 cycles by tripping the line from the Elk City – Clinton Jct. 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 G02-05 (560000) – Morewood (521001) 138 kV line, near Morewood. a. Apply fault at the Morewood 138 kV bus. b. Clear fault after 5 cycles by tripping the line from the Elk City – G02-05 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 Hobart Jct (511446) – Elk City (511458) 138 kV line, near Elk City. a. Apply fault at the Elk City 138 kV bus. b. Clear fault after 5 cycles by tripping the line from the Elk City – Clinton AFB (511446) - Hobart Jct 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 Grapevine (523771) – Nichols (524044) 230 kV line near Grapevine. a. Apply fault at the Grapevine bus. b. Clear fault after 5 cycles by tripping the line Grapevine-Nichols 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 Grapevine 230/115 kV autotransformer on the 230 kV bus a. Apply fault at the Grapevine 230 kV bus. b. Clear fault after 5 cycles by tripping the autotransformer c. No recluse
14	FLT141PH	Single phase fault and sequence like Cont. No.13
15	FLT153PH	3 phase fault on the Conway (524079)-Yarnell (524072) –Nichols (524072) 115 kV line near Nichols a. Apply fault at the Nichols bus. b. Clear fault after 5 cycles by tripping the line Conway-Yarnell-Nichols 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	FLT17BF	Breaker failure fault at Elk City 138 kV (511458) a. Apply 1 phase fault at Elk City 138 kV b. After 3.5 cycles, trip line to Hobart (but do not clear fault) c. Run with fault for 11.5 more cycles d. Clear fault e. Open 230 kV line to wind farm

Table 9: Contingencies Evaluated (continued)

4.4 Further Model Preparation

The two base cases contain prior queued projects as shown in Table 10.

The wind farm generation from the study customer and previously queued customers is dispatched into the SPP footprint.

Initial simulations were carried out on both base cases and 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-2001-026	74
GEN-2002-005	114
GEN-2003-004 GEN-2004-023 GEN-2005-003	151
GEN-2003-020	160
GEN-2003-022 GEN-2004-020	147.5
GEN-2004-003	240
GEN-2005-021	85.5
GEN-2006-002*	150
GEN-2006-035*	225

* Gen-2006-002 and Gen-2006-035 have the same POI as Gen-2006-043

Table 10: Prior Queued Projects

4.5 The Scenarios

As mentioned earlier four scenarios were developed for this study, and they are described in this section. Results for these scenarios are found in Section 5.

4.5.1 Scenario 1

In this scenario the full 300 MW of power is dispatched at the POI into the SPP footprint.

4.5.2 Scenario 2

This scenario is the same as Scenario 1 with the addition of an SVC on the primary side of the Customer's 230/34.5 kV transformer located in the East Collector System. SVC sizes up to 200 Mvar were tested.

4.5.3 Scenario 3

This scenario is the same as Scenario 1 with the addition of a 345 kV line at the POI to the Mooreland Substation. See section 3.2 and Table 2 for description.

4.5.4 Scenario 4

This scenario is the same as Scenario 1 with the reduction of generated power. Through several trials it was determined that 126 MW was the maximum power allowed with no network upgrades. The 126 MW was generated by the East Collector System. The power from the West Collector System and from collector F2 of the East Collector System was turned off.

5.0 Results

This section shows the results of the stability analysis for each scenario. Selected stability plots are in the appendices. All plots are available on request.

The wind farm was modeled using the GE LVRT II package. The LVRT II package is required for the wind farm to meet FERC Order #661A Low Voltage Ride Through Requirements. If the Customer changes the wind turbines to be used for this request at any time, an Impact re-study will be required.

5.1 Scenario 1

In this scenario the transmission system was unstable as shown in Table 11. For the contingencies shown in the table, all the generators in GEN-2006-02 tripped offline. Unstable oscillations were observed for the wind turbines. These issues were most likely due to the total amount of proposed generation at the site (675 MW) compared to the strength of the transmission system.

The stability plots for these contingencies are included in Appendix A.

Contingency.	2008 Winter Peak	2012 Summer Peak
FLT13PH	UNSTABLE [1]	UNSTABLE [2]
FLT21PH	UNSTABLE [1]	UNSTABLE [2]
FLT33PH	UNSTABLE [2]	UNSTABLE [2]
FLT41PH	UNSTABLE [2]	UNSTABLE [2]

1. Unstable oscillations of Gen-2006-035 and Gen-2006-043.
2. All Gen-2006-02 generators tripped off-line.

Table 11: Scenario 1 Results

5.2 Scenario 2

In an attempt to make the system stable, a 200 Mvar SVC was modeled at the 230 kV bus. In this scenario the transmission system was unstable as shown in Table 12. For the contingencies shown in the table, almost all the generators in GEN-2006-02 tripped offline. The stability plots for these contingencies are included in Appendix B.

Contingency.	2008 Winter Peak	2012 Summer Peak
FLT13PH	UNSTABLE [1]	UNSTABLE [2]
FLT21PH	UNSTABLE [1]	STABLE
FLT33PH	UNSTABLE [2]	UNSTABLE [2]
FLT41PH	UNSTABLE [2]	UNSTABLE [2]

1. Most Gen-2006-02 generators tripped off-line.
2. All Gen-2006-02 generators tripped off-line.

Table 12: Scenario 2 Results

5.3 Scenario 3

Additional transmission reinforcements were modeled in this scenario. It was found that for the addition of the 345 kV line, the system was stable shown in Table 13. Selected stability plots for these contingencies are included in Appendix C.

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
FLT17BF	STABLE	STABLE

Table 13: Scenario 3 Results

5.4 Scenario 4

An additional scenario was modeled to determine the maximum allowable generation at the site without upgrade. The maximum generation was found to be 126 MW. In this scenario the transmission system was stable as shown in Table 14. Selected stability plots for these contingencies are included in Appendix D.

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
FLT17BF	STABLE	STABLE

Table 14: Scenario 4 Results

6.0 Conclusion

This study has demonstrated that due to the amount of prior queued generation and due to the size of the Customer's project, the Customer project cannot be interconnected at 300 MW without transmission reinforcements if all prior queued projects were placed in service. The cost associated to implement this option is $142,000,000 plus the cost of the Direct Assignment Facilities.

However, if the Customer were to reduce its generation to 126 MW, then the Customer's project can be interconnected without additional transmission reinforcements. The cost to implement this option is $4,000,000 plus the cost of the Direct Assignment Facilities.

In order for the wind farm to meet the LVRT provisions of FERC Order #661A, the Customer will be required to purchase the GE turbines with the LVRT II low voltage ride through package offered by the manufacturer.

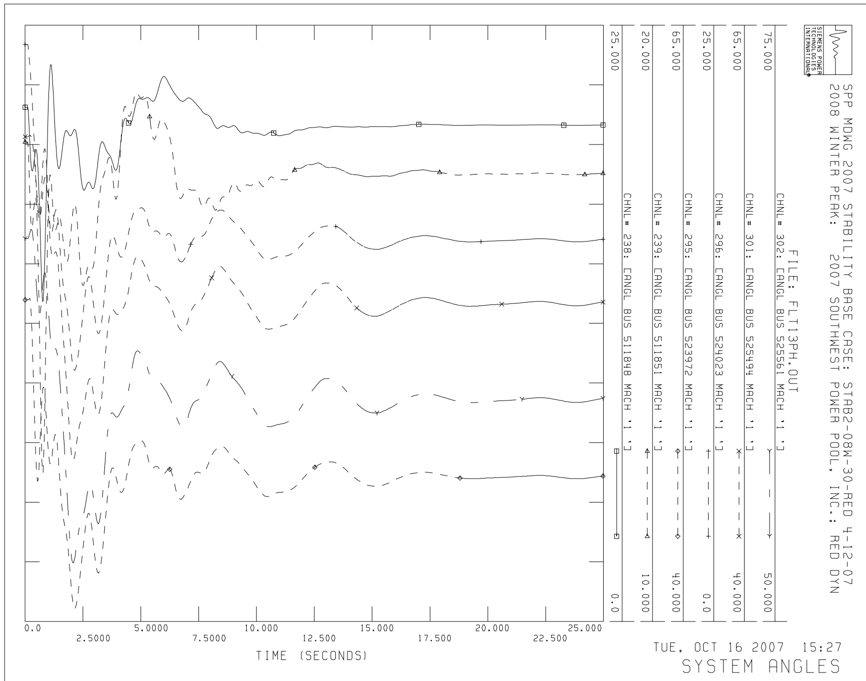
The costs shown in this document do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS. It should be noted that the models used for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

APPENDIX A.

SELECTED STABILITY PLOTS – SCENARIO 1

(Customer's 300 MW generation with no transmission system reinforcement)

All plots available on request.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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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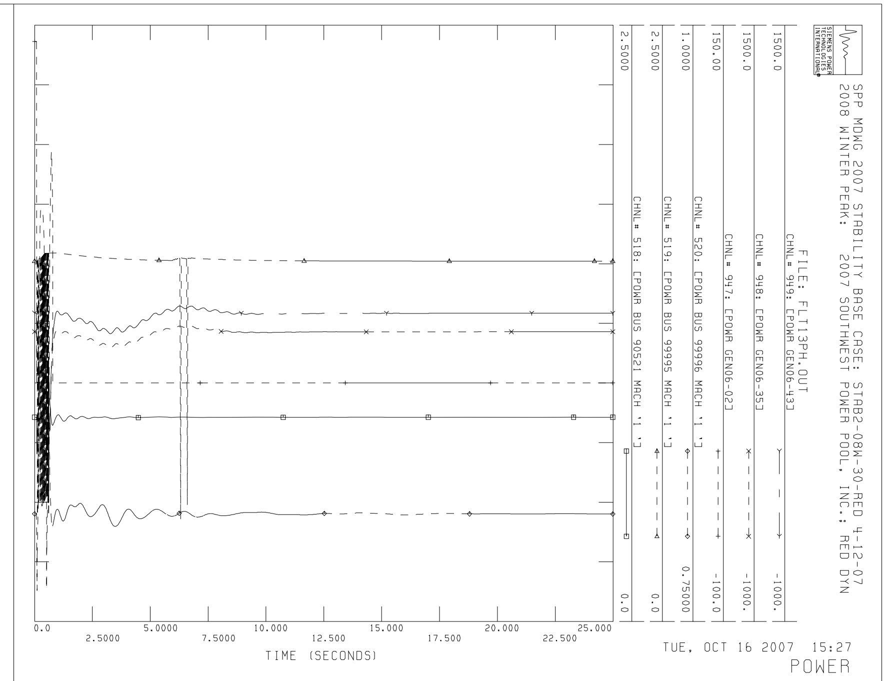
CHNL# 302: [ANGL BUS 525561 MACH '1 ']
CHNL# 301: [ANGL BUS 525494 MACH '1 ']
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
CHNL# 238: [ANGL BUS 511848 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 15:27
SYSTEM ANGLES

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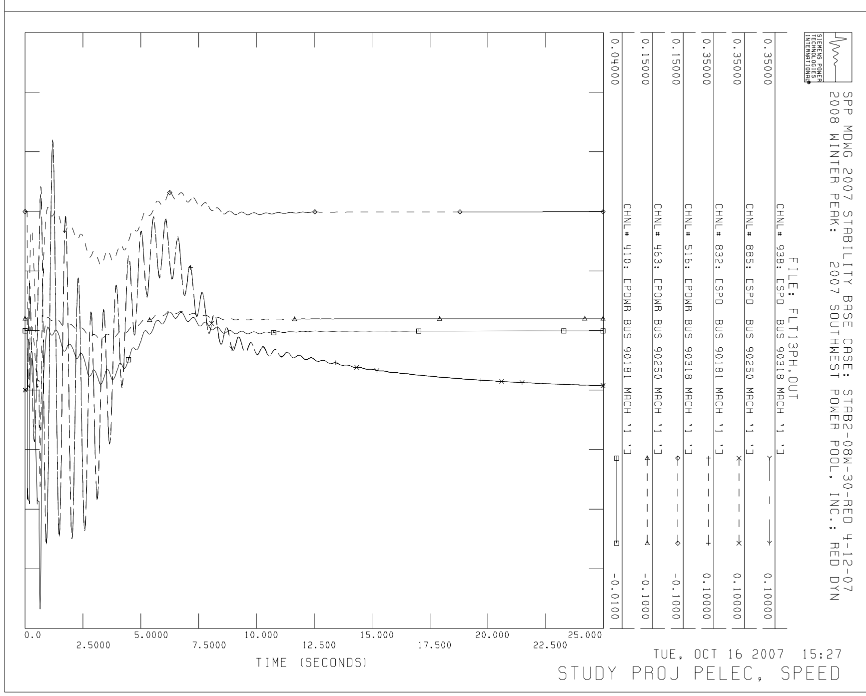
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 949: [POWR GEN06-43]
CHNL# 948: [POWR GEN06-35]
CHNL# 947: [POWR GEN06-02]
CHNL# 520: [POWR BUS 99996 MACH '1 ']
CHNL# 519: [POWR BUS 99995 MACH '1 ']
CHNL# 518: [POWR BUS 90521 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 15:27
POWER

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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 885: [SPD BUS 90250 MACH '1 ']
CHNL# 832: [SPD BUS 90181 MACH '1 ']
CHNL# 516: [POWR BUS 90318 MACH '1 ']
CHNL# 463: [POWR BUS 90250 MACH '1 ']
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TUE, OCT 16 2007 15:27
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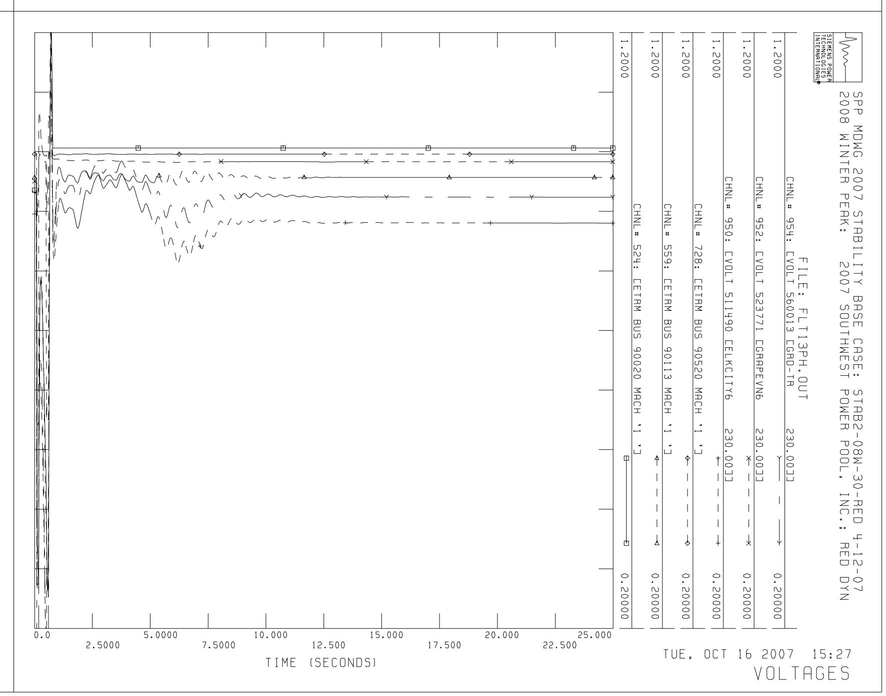
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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 954: [VOLT 56013 [GRD-TA 230.00]]
CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
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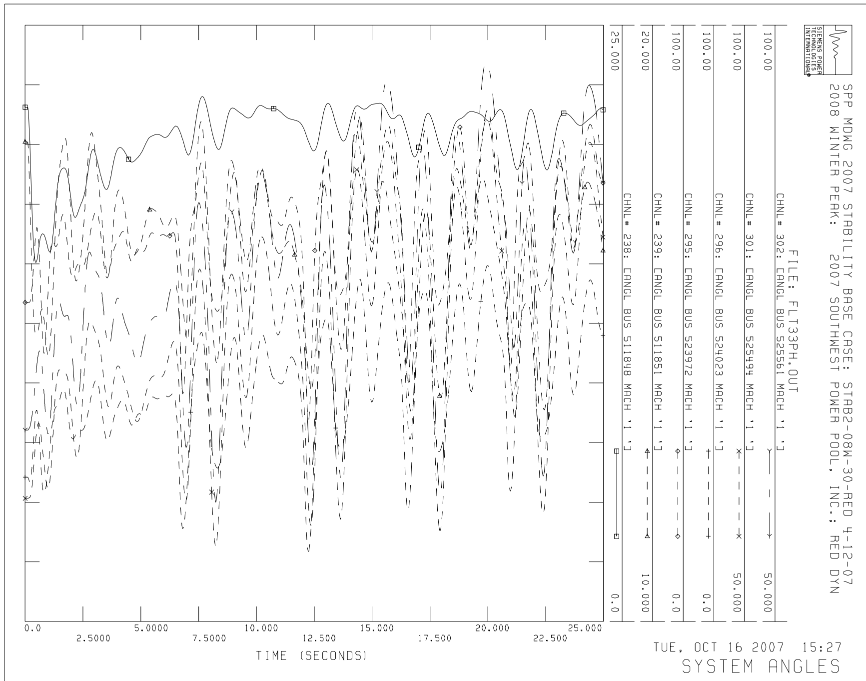
VOLTAGES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FILE: FLT33PH.OUT
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CHNL# 301: [ANGL BUS 525494 MACH '1 ']
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
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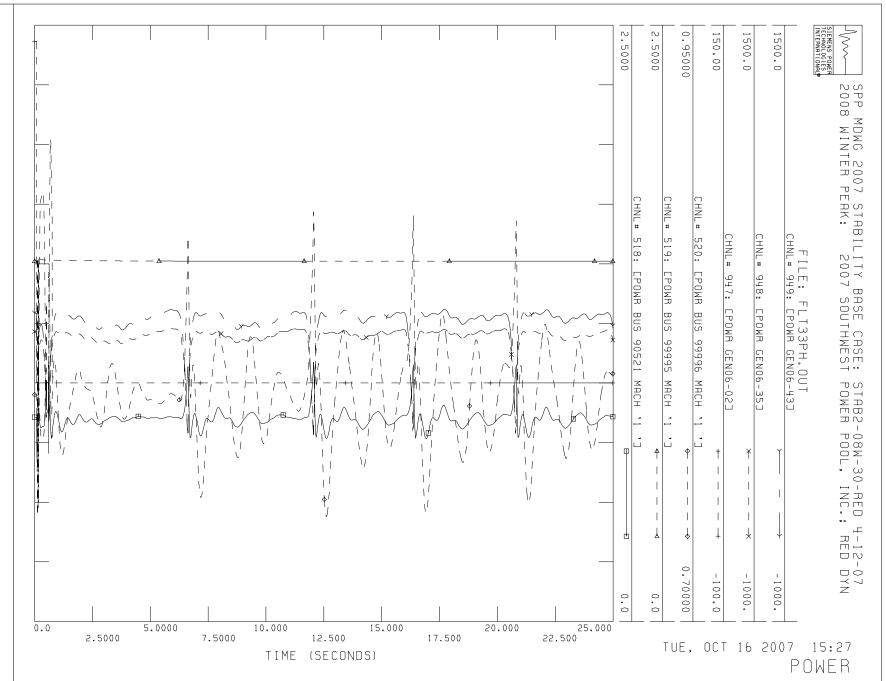
TUE, OCT 16 2007 15:27
SYSTEM ANGLES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FILE: FLT33PH.OUT
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CHNL# 948: [POWR GEN06-35]
CHNL# 947: [POWR GEN06-02]
CHNL# 520: [POWR BUS 99996 MACH '1 ']
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TIME (SECONDS)
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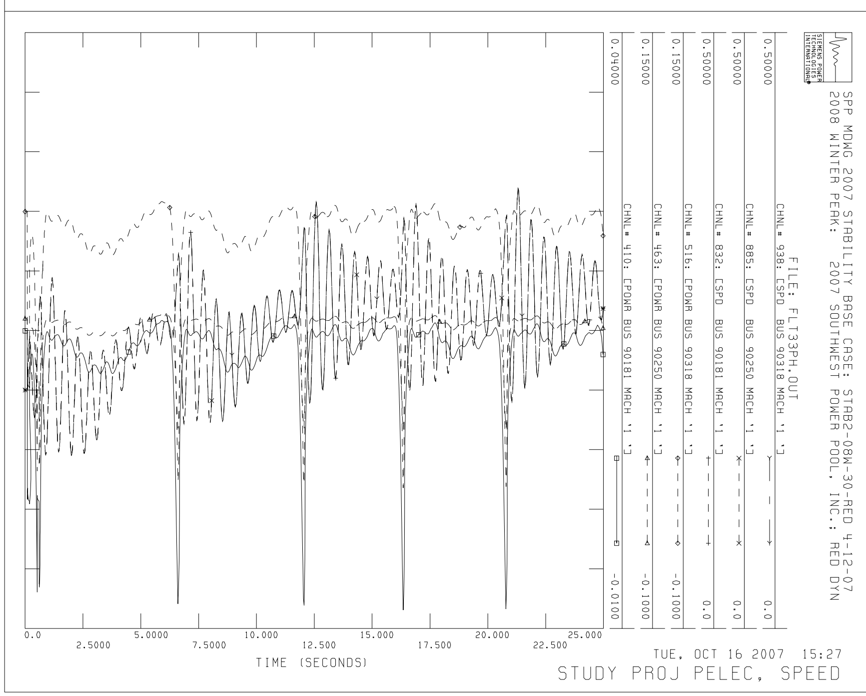
POWER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CHNL# 885: [SPD BUS 90250 MACH '1 ']
CHNL# 832: [SPD BUS 90181 MACH '1 ']
CHNL# 516: [POWR BUS 90318 MACH '1 ']
CHNL# 463: [POWR BUS 90250 MACH '1 ']
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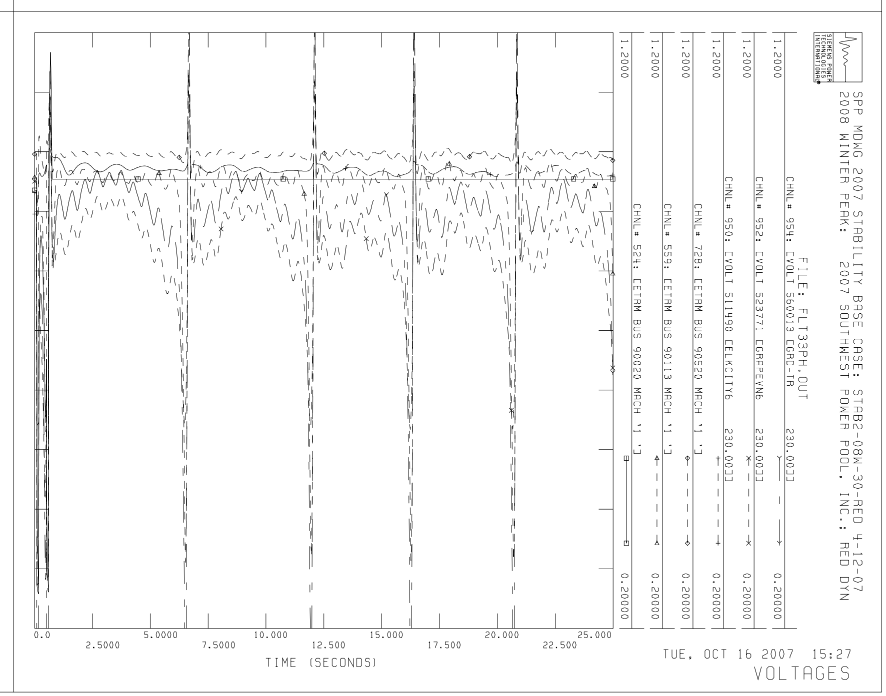
STUDY PROJ PELEC, SPEED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CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
CHNL# 559: [ETRM BUS 90113 MACH '1 ']
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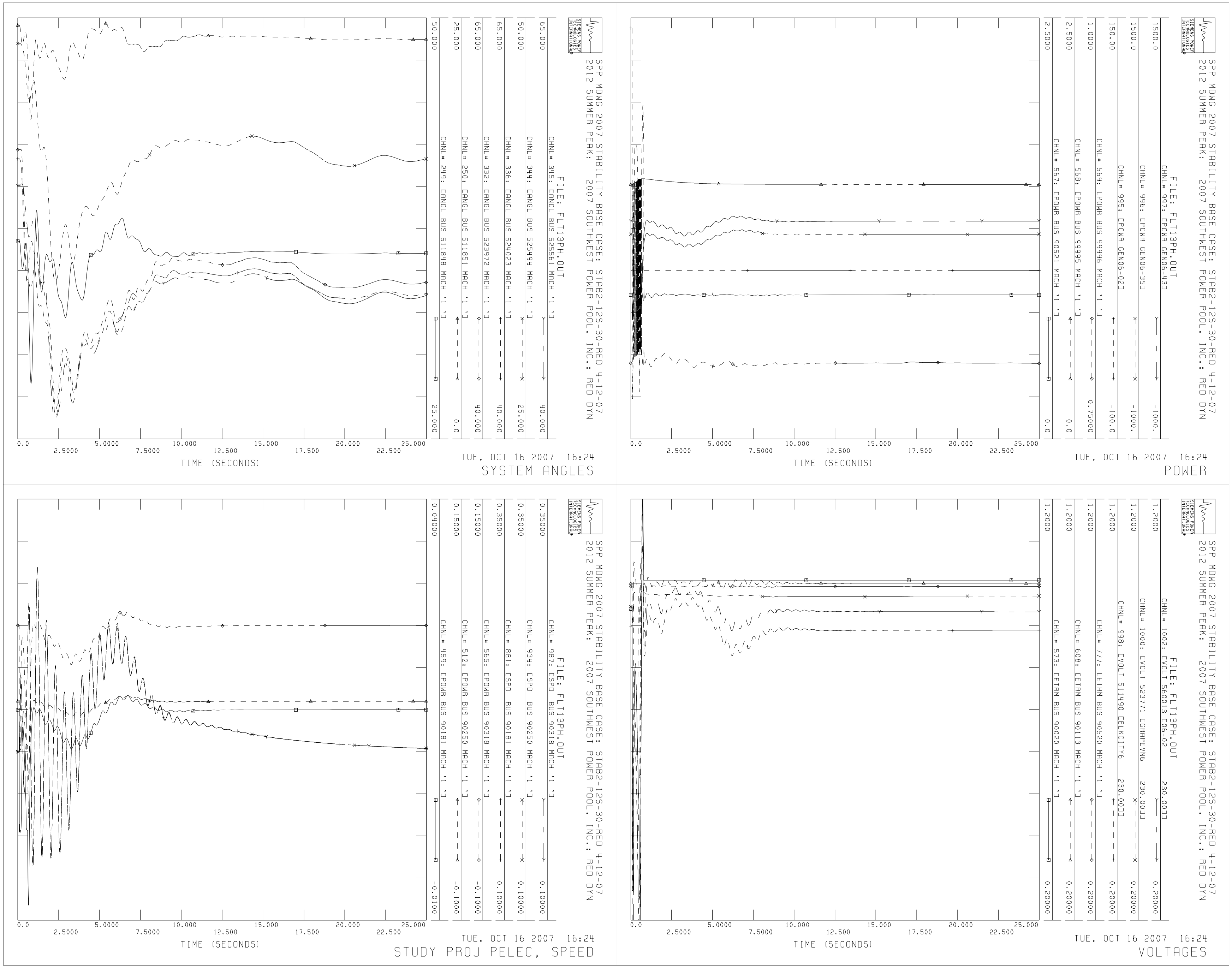
VOLTAGES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CHNL# 336: [ANGL BUS 524023 MACH '1 '] 65.000 40.000
CHNL# 332: [ANGL BUS 523972 MACH '1 '] 65.000 40.000
CHNL# 250: [ANGL BUS 511851 MACH '1 '] 25.000 0.0
CHNL# 249: [ANGL BUS 511848 MACH '1 '] 50.000 25.000
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TUE, OCT 16 2007 16:24
SYSTEM ANGLES
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CHNL# 567: [POWR BUS 90521 MACH '1 '] 2.5000 0.0
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TIME (SECONDS)
TUE, OCT 16 2007 16:24
POWER
SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 565: [POWR BUS 90318 MACH '1 '] 0.15000 -0.1000
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CHNL# 459: [POWR BUS 90181 MACH '1 '] 0.04000 -0.0100
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STUDY PROJ PELEC, SPEED
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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 1000: [VOLT 523771 CGRAPEVN6 230.00] 1.2000 0.20000
CHNL# 998: [VOLT 511490 CELKCITY6 230.00] 1.2000 0.20000
CHNL# 777: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 608: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
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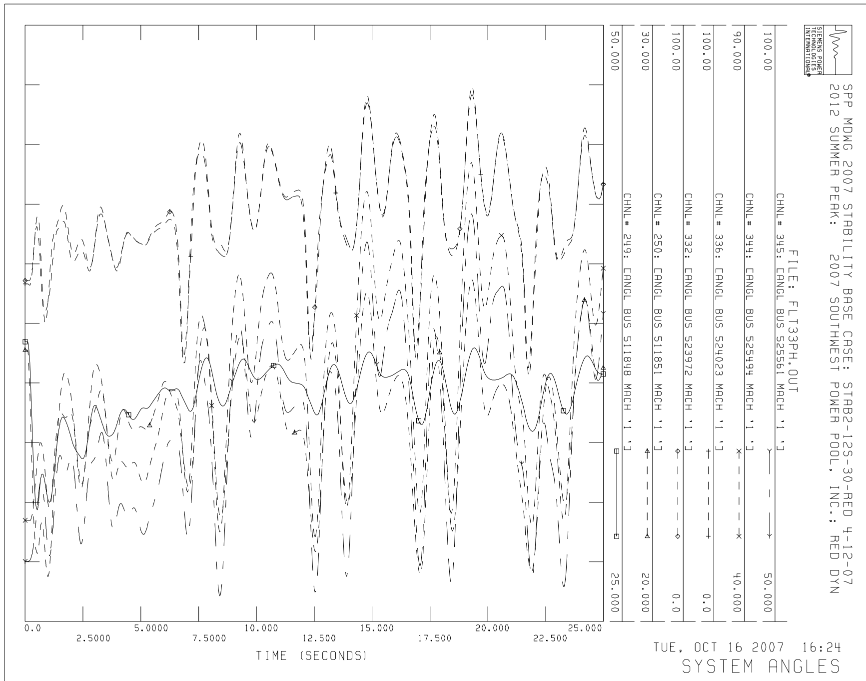
VOLTAGES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CHNL# 332: [ANGL BUS 523972 MACH '1 '] 100.00 0.0
CHNL# 250: [ANGL BUS 511851 MACH '1 '] 30.000 20.000
CHNL# 249: [ANGL BUS 511898 MACH '1 '] 50.000 25.000
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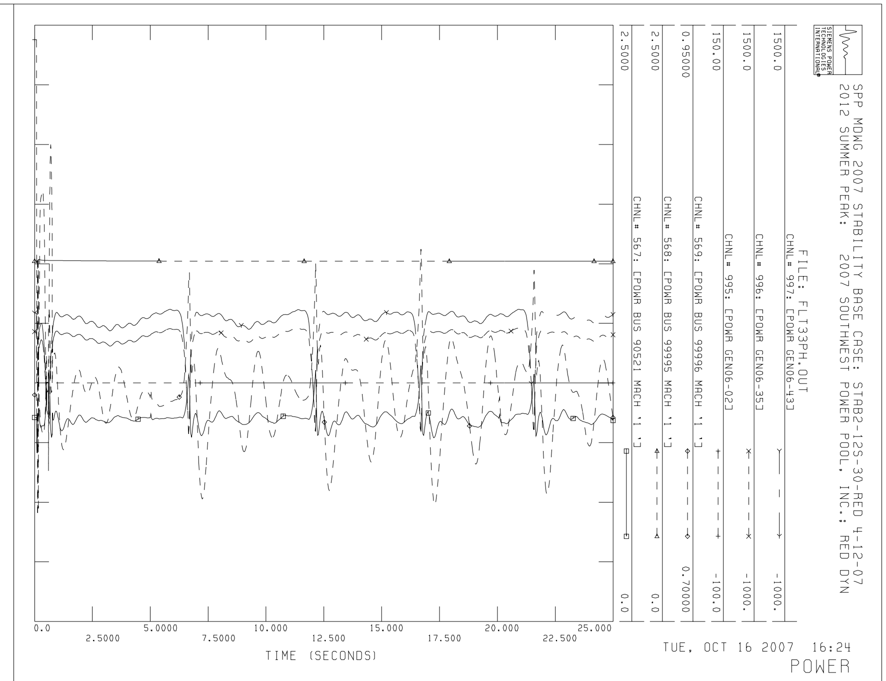
SYSTEM ANGLES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CHNL# 996: [POWR GEN06-35] 1500.0 -1000.
CHNL# 995: [POWR GEN06-02] 150.00 -100.0
CHNL# 569: [POWR BUS 99996 MACH '1 '] 0.95000 0.70000
CHNL# 568: [POWR BUS 99995 MACH '1 '] 2.5000 0.0
CHNL# 567: [POWR BUS 90521 MACH '1 '] 2.5000 0.0
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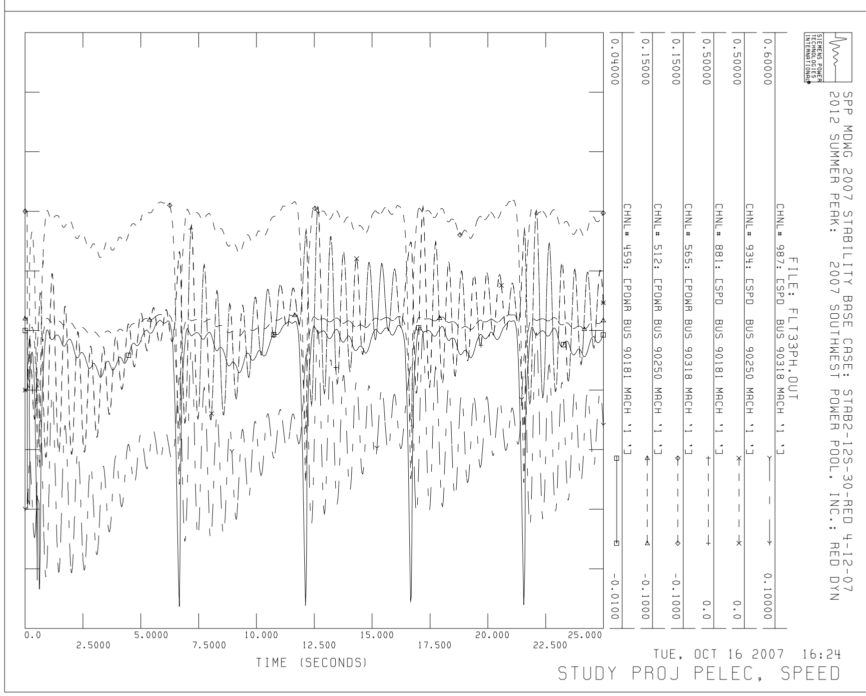
TIME (SECONDS)
TUE, OCT 16 2007 16:24
POWER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CHNL# 934: [SPD BUS 90250 MACH '1 '] 0.50000 0.0
CHNL# 881: [SPD BUS 90181 MACH '1 '] 0.50000 0.0
CHNL# 565: [POWR BUS 90318 MACH '1 '] 0.15000 -0.1000
CHNL# 512: [POWR BUS 90250 MACH '1 '] 0.15000 -0.1000
CHNL# 459: [POWR BUS 90181 MACH '1 '] 0.04000 -0.0100
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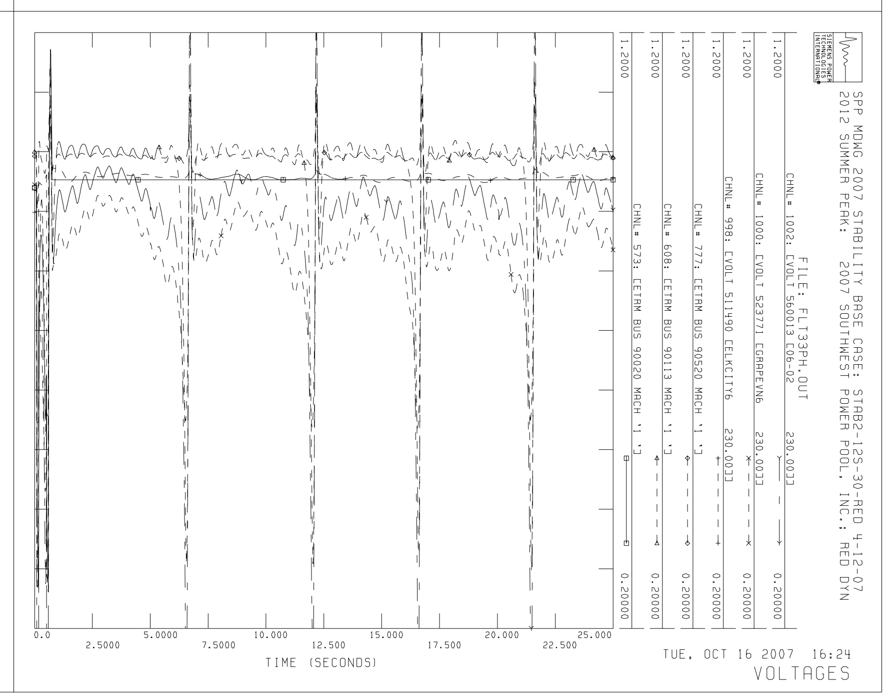
TIME (SECONDS)
TUE, OCT 16 2007 16:24
STUDY PROJ PELEC, SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 1002: [VOLT 560013 G06-02 230.00] 1.2000 0.20000
CHNL# 1000: [VOLT 523771 GRAPEVN6 230.00] 1.2000 0.20000
CHNL# 998: [VOLT 511490 ELKCITY6 230.00] 1.2000 0.20000
CHNL# 777: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 608: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
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TIME (SECONDS)
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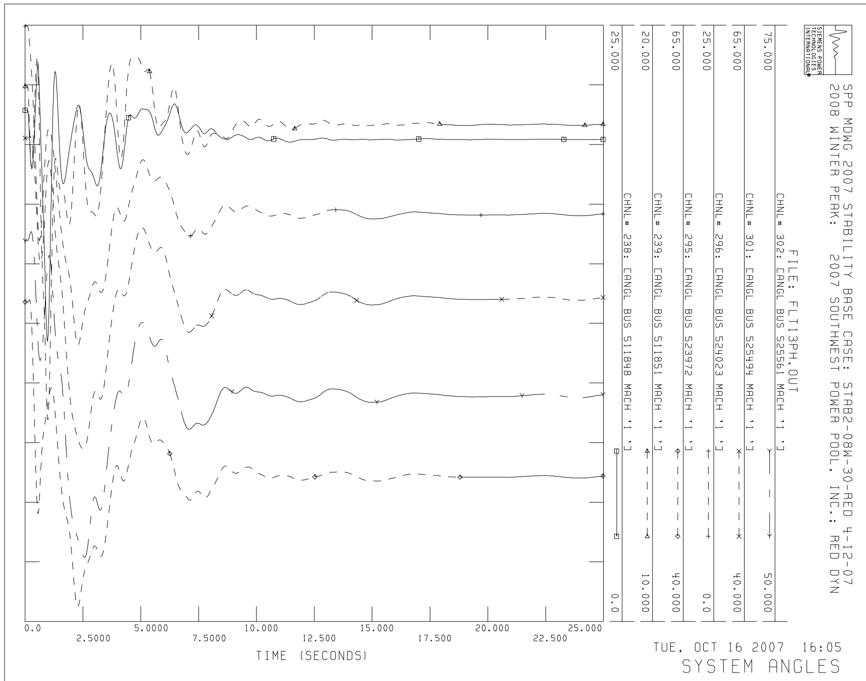
VOLTAGES

APPENDIX B.

SELECTED STABILITY PLOTS – SCENARIO 2

(Customer's 300 MW generation with addition of SVC)

All plots available on request.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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 301: [ANGL BUS 525494 MACH '1 '] 65.000 40.000
CHNL# 296: [ANGL BUS 524023 MACH '1 '] 25.000 0.0
CHNL# 295: [ANGL BUS 523972 MACH '1 '] 65.000 40.000
CHNL# 239: [ANGL BUS 511851 MACH '1 '] 20.000 10.000
CHNL# 238: [ANGL BUS 511848 MACH '1 '] 25.000 0.0
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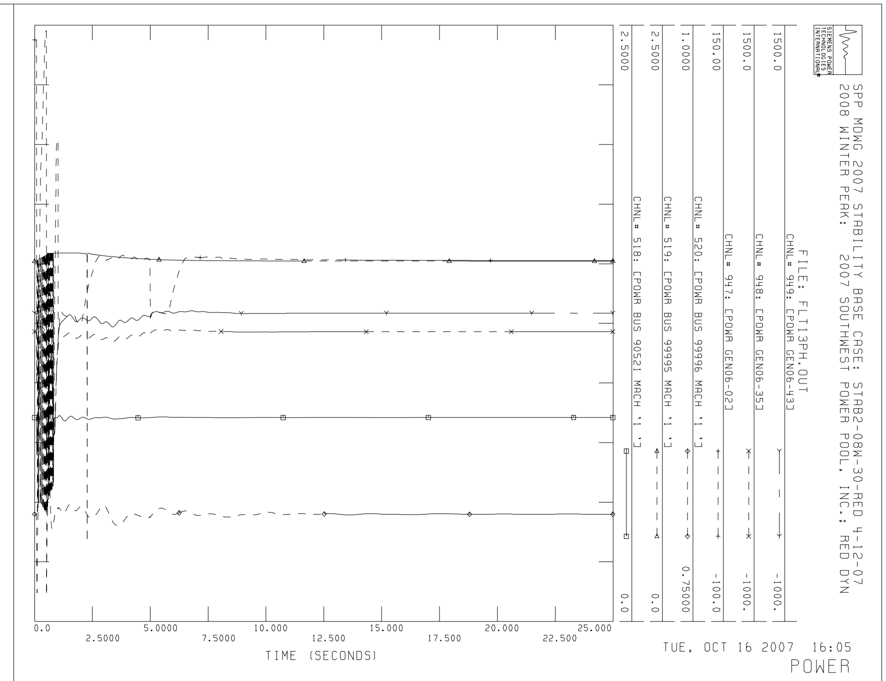
SYSTEM ANGLES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 949: [POWR GEN06-43] 1500.0 -1000.
CHNL# 948: [POWR GEN06-35] 1500.0 -1000.
CHNL# 947: [POWR GEN06-02] 150.00 -100.0
CHNL# 520: [POWR BUS 99996 MACH '1 '] 1.0000 0.75000
CHNL# 519: [POWR BUS 99995 MACH '1 '] 2.5000 0.0
CHNL# 518: [POWR BUS 90521 MACH '1 '] 2.5000 0.0
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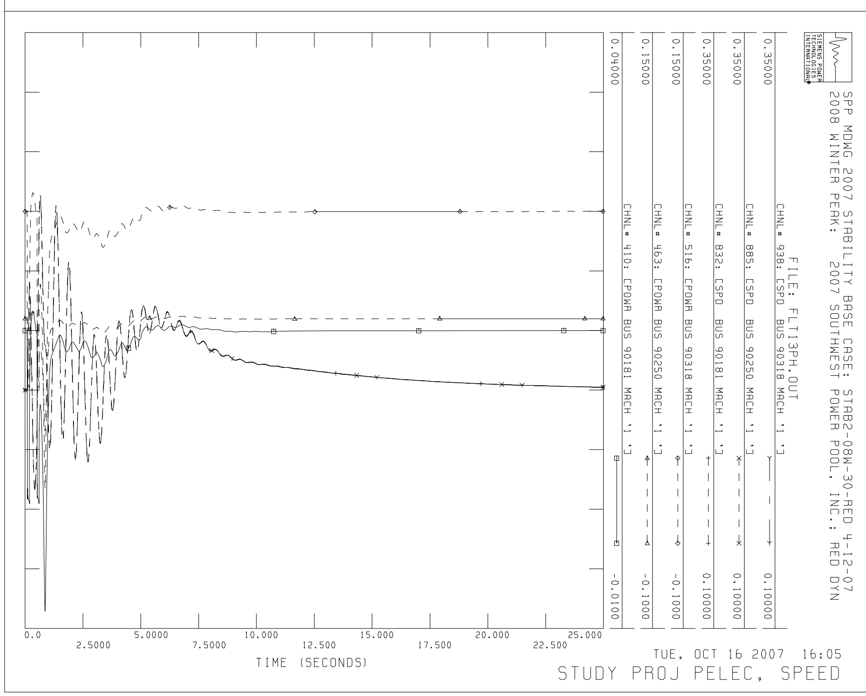
TIME (SECONDS)
TUE, OCT 16 2007 16:05
POWER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FILE: FLT13PH.OUT
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CHNL# 885: [SPD BUS 90250 MACH '1 '] 0.35000 0.10000
CHNL# 832: [SPD BUS 90181 MACH '1 '] 0.35000 0.10000
CHNL# 516: [POWR BUS 90318 MACH '1 '] 0.15000 -0.1000
CHNL# 463: [POWR BUS 90250 MACH '1 '] 0.15000 -0.1000
CHNL# 410: [POWR BUS 90181 MACH '1 '] 0.04000 -0.0100
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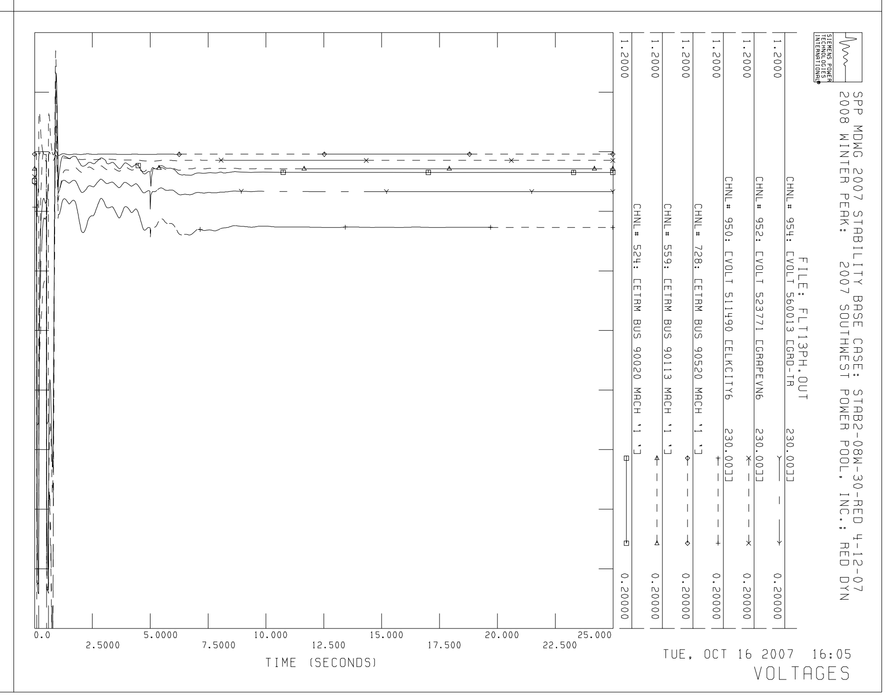
TIME (SECONDS)
TUE, OCT 16 2007 16:05
STUDY PROJ PELEC, SPEED


SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 954: [VOLT 560013 [GRD-TA 230.00]] 1.2000 0.20000
CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]] 1.2000 0.20000
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]] 1.2000 0.20000
CHNL# 728: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 559: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
CHNL# 524: [ETRM BUS 90020 MACH '1 '] 1.2000 0.20000
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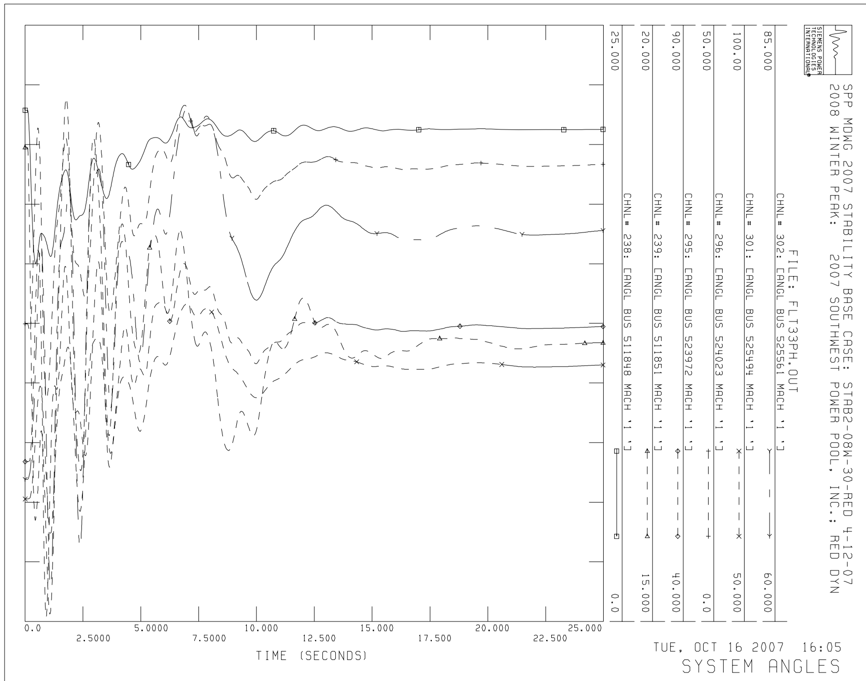
TIME (SECONDS)
TUE, OCT 16 2007 16:05
VOLTAGES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CHNL# 302: [ANGL BUS 525561 MACH '1 ']
85.000
60.000
CHNL# 301: [ANGL BUS 525494 MACH '1 ']
100.00
50.000
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
50.000
0.0
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
90.000
40.000
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
20.000
15.000
CHNL# 238: [ANGL BUS 511848 MACH '1 ']
25.000
0.0
0.0
2.5000
5.0000
7.5000
10.000
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17.500
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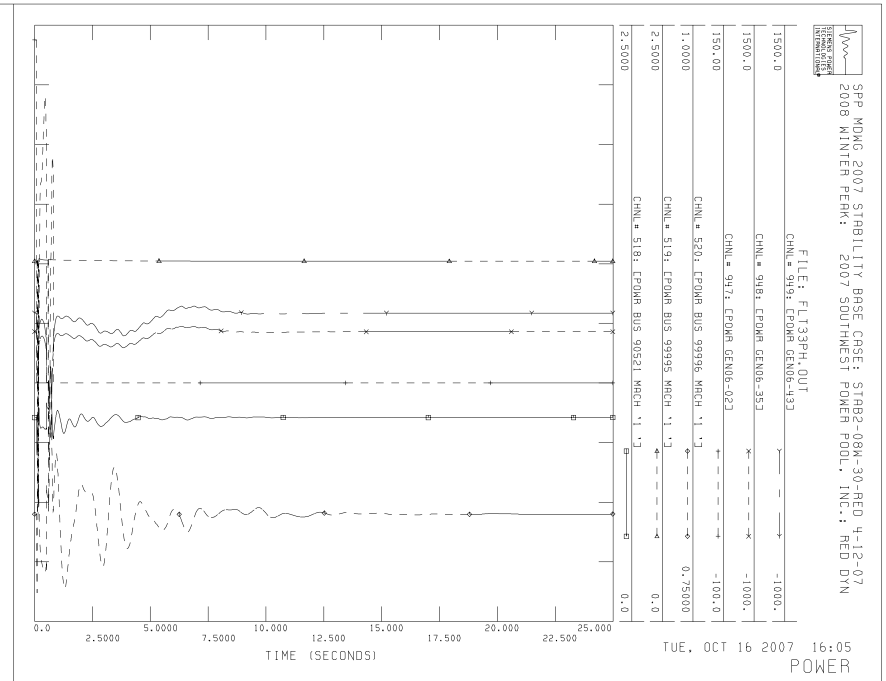
SYSTEM ANGLES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FILE: FLT33PH.OUT
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1500.0
-1000.
CHNL# 948: [POWR GEN06-35]
1500.0
-1000.
CHNL# 947: [POWR GEN06-02]
150.00
-100.0
CHNL# 520: [POWR BUS 99996 MACH '1 ']
1.0000
0.75000
CHNL# 519: [POWR BUS 99995 MACH '1 ']
2.5000
0.0
CHNL# 518: [POWR BUS 90521 MACH '1 ']
2.5000
0.0
0.0
2.5000
5.0000
7.5000
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15.000
17.500
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22.500
25.000
TIME (SECONDS)
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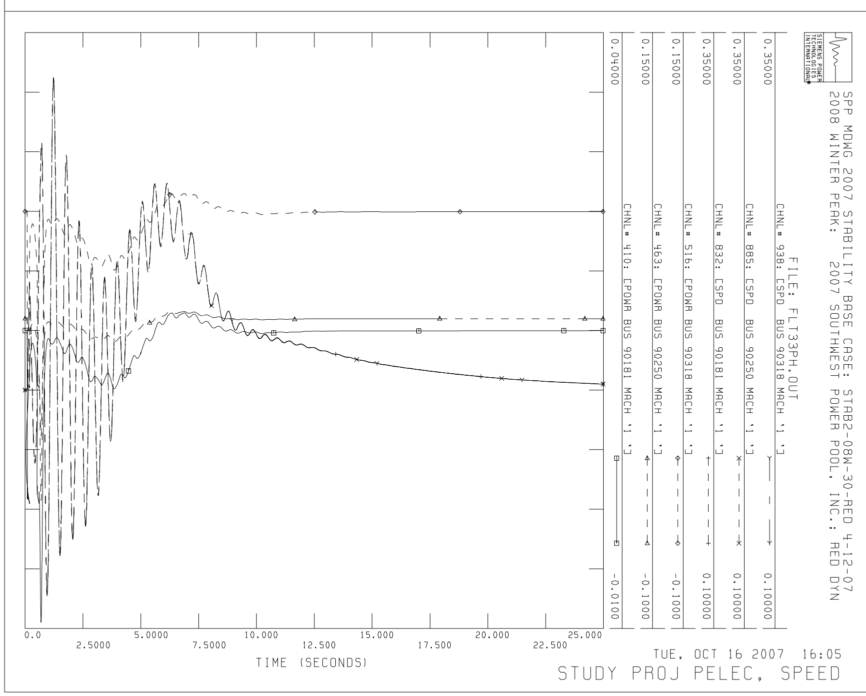
POWER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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 938: [SPD BUS 90318 MACH '1 ']
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0.10000
CHNL# 885: [SPD BUS 90250 MACH '1 ']
0.35000
0.10000
CHNL# 832: [SPD BUS 90181 MACH '1 ']
0.35000
0.10000
CHNL# 516: [POWR BUS 90318 MACH '1 ']
0.15000
-0.1000
CHNL# 463: [POWR BUS 90250 MACH '1 ']
0.15000
-0.1000
CHNL# 410: [POWR BUS 90181 MACH '1 ']
0.04000
-0.0100
0.0
2.5000
5.0000
7.5000
10.000
12.500
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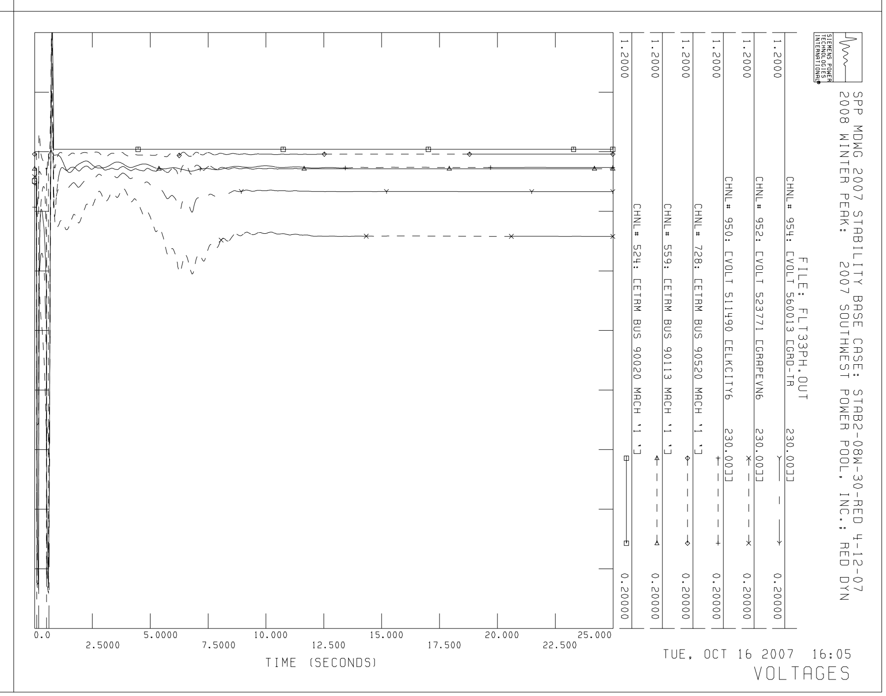
25.000
TIME (SECONDS)
TUE, OCT 16 2007 16:05
STUDY PROJ PELEC, SPEED


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# 954: [VOLT 560013 [GRD-TA   230.00]]
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0.20000
CHNL# 952: [VOLT 523771 [GRAPEVN6   230.00]]
1.2000
0.20000
CHNL# 950: [VOLT 511490 [ELKCITY6   230.00]]
1.2000
0.20000
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
1.2000
0.20000
CHNL# 559: [ETRM BUS 90113 MACH '1 ']
1.2000
0.20000
CHNL# 524: [ETRM BUS 90020 MACH '1 ']
1.2000
0.20000
0.0
2.5000
5.0000
7.5000
10.000
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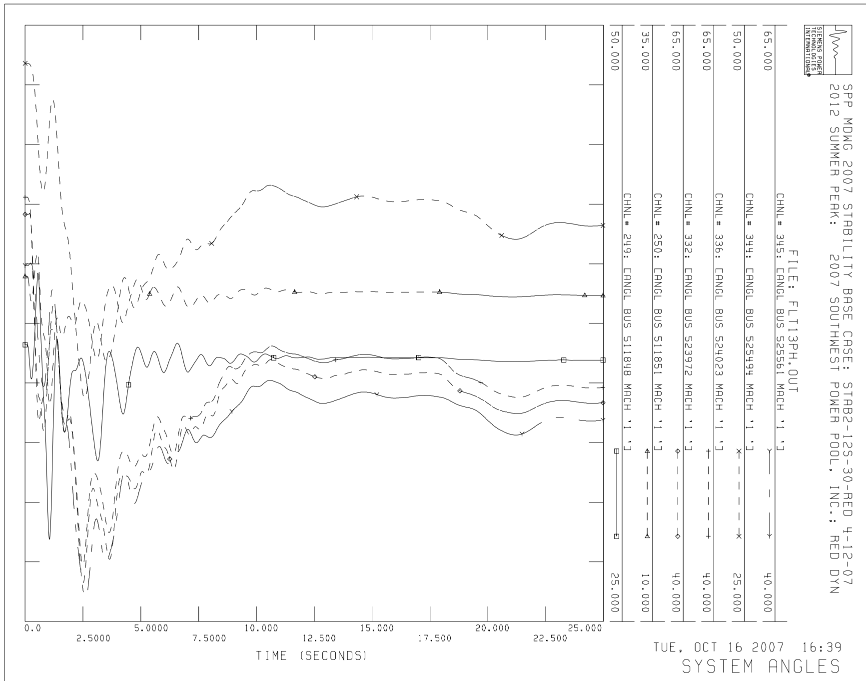
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 345: [ANGL BUS 525561 MACH '1 '] 65.000 40.000
CHNL# 344: [ANGL BUS 525494 MACH '1 '] 50.000 25.000
CHNL# 336: [ANGL BUS 524023 MACH '1 '] 65.000 40.000
CHNL# 332: [ANGL BUS 523972 MACH '1 '] 65.000 40.000
CHNL# 250: [ANGL BUS 511851 MACH '1 '] 35.000 10.000
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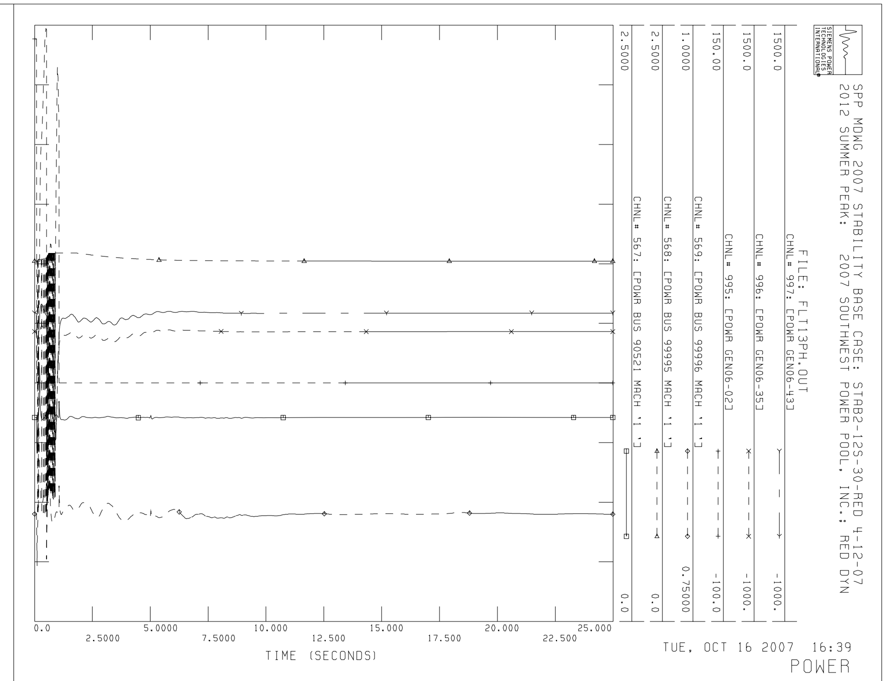
TUE, OCT 16 2007 16:39
SYSTEM ANGLES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 996: [POWR GEN06-35] 1500.0 -1000.
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CHNL# 569: [POWR BUS 99996 MACH '1 '] 1.0000 0.75000
CHNL# 568: [POWR BUS 99995 MACH '1 '] 2.5000 0.0
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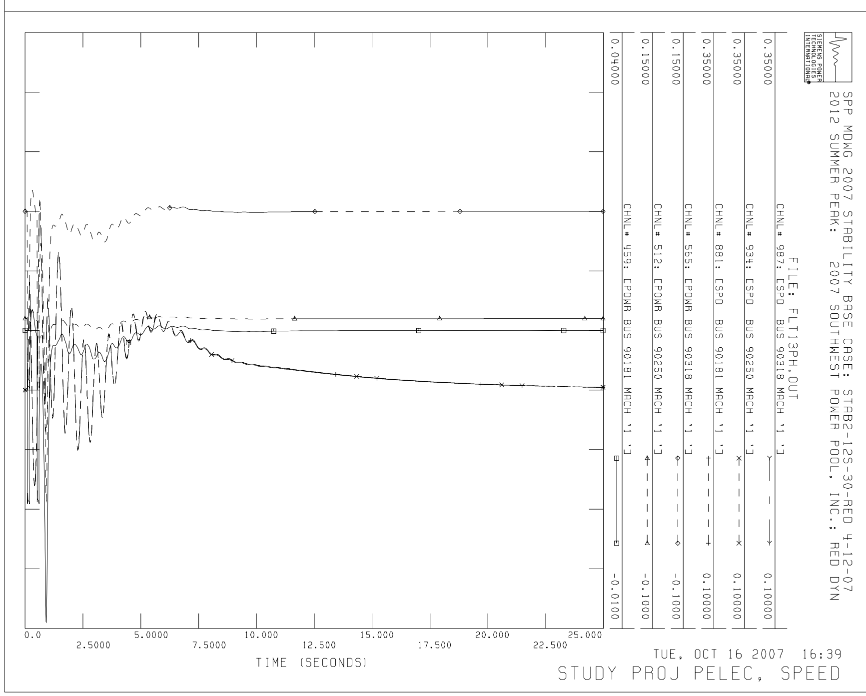
POWER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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 934: [SPD BUS 90250 MACH '1 '] 0.35000 0.10000
CHNL# 881: [SPD BUS 90181 MACH '1 '] 0.35000 0.10000
CHNL# 565: [POWR BUS 90318 MACH '1 '] 0.15000 -0.1000
CHNL# 512: [POWR BUS 90250 MACH '1 '] 0.15000 -0.1000
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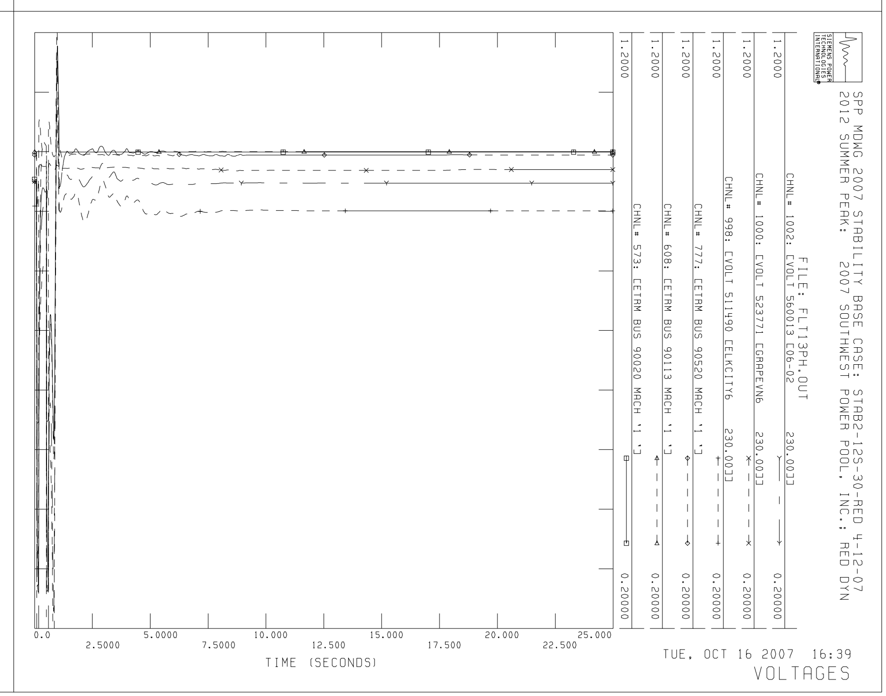
TUE, OCT 16 2007 16:39
STUDY PROJ PELEC, SPEED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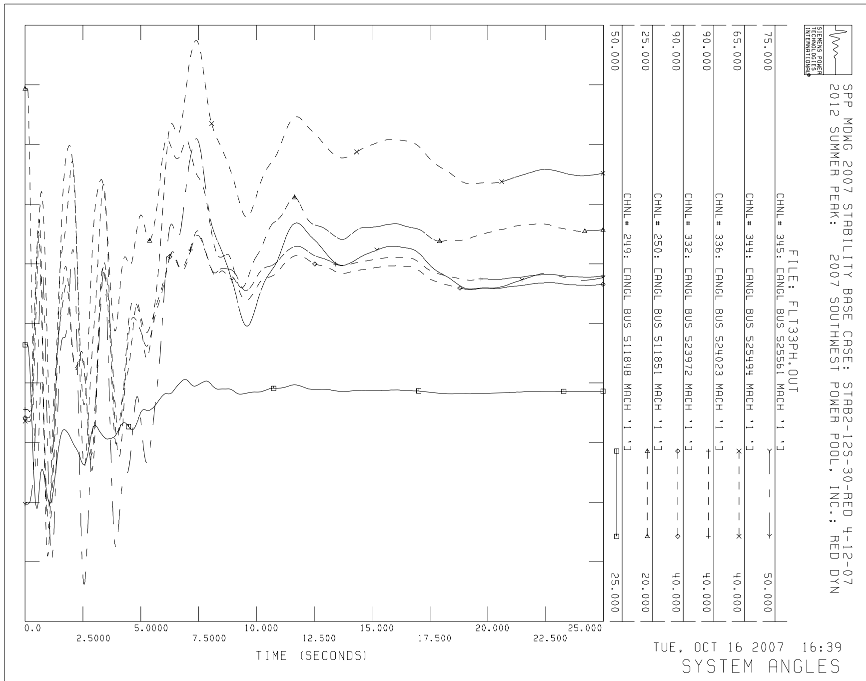
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 1002: [VOLT 560013 G06-02 230.00] 1.2000 0.20000
CHNL# 1000: [VOLT 523771 GRAPEVN6 230.00] 1.2000 0.20000
CHNL# 998: [VOLT 511490 ELKCITY6 230.00] 1.2000 0.20000
CHNL# 777: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 608: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
CHNL# 573: [ETRM BUS 90020 MACH '1 '] 1.2000 0.20000
TIME (SECONDS)
TUE, OCT 16 2007 16:39
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 345: [ANGL BUS 525561 MACH '1 '] 75.000 50.000
CHNL# 344: [ANGL BUS 525494 MACH '1 '] 65.000 40.000
CHNL# 336: [ANGL BUS 524023 MACH '1 '] 90.000 40.000
CHNL# 332: [ANGL BUS 523972 MACH '1 '] 90.000 40.000
CHNL# 250: [ANGL BUS 511851 MACH '1 '] 25.000 20.000
CHNL# 249: [ANGL BUS 511848 MACH '1 '] 50.000 25.000
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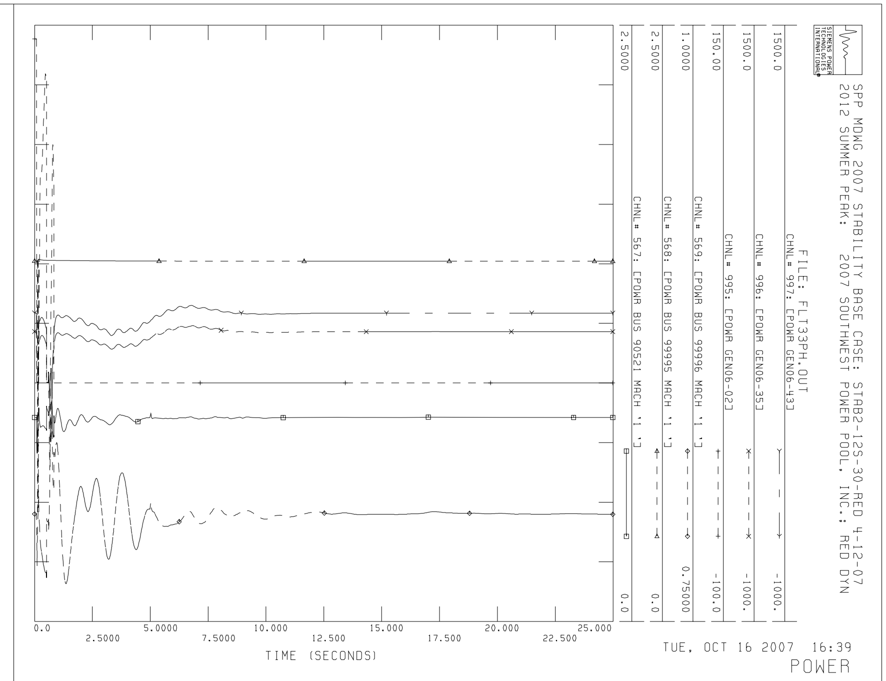
TIME (SECONDS)
TUE, OCT 16 2007 16:39
SYSTEM ANGLES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 997: [POWR GEN06-43] 1500.0 -1000.
CHNL# 996: [POWR GEN06-35] 1500.0 -1000.
CHNL# 995: [POWR GEN06-02] 150.00 -100.0
CHNL# 569: [POWR BUS 99996 MACH '1 '] 1.0000 0.75000
CHNL# 568: [POWR BUS 99995 MACH '1 '] 2.5000 0.0
CHNL# 567: [POWR BUS 90521 MACH '1 '] 2.5000 0.0
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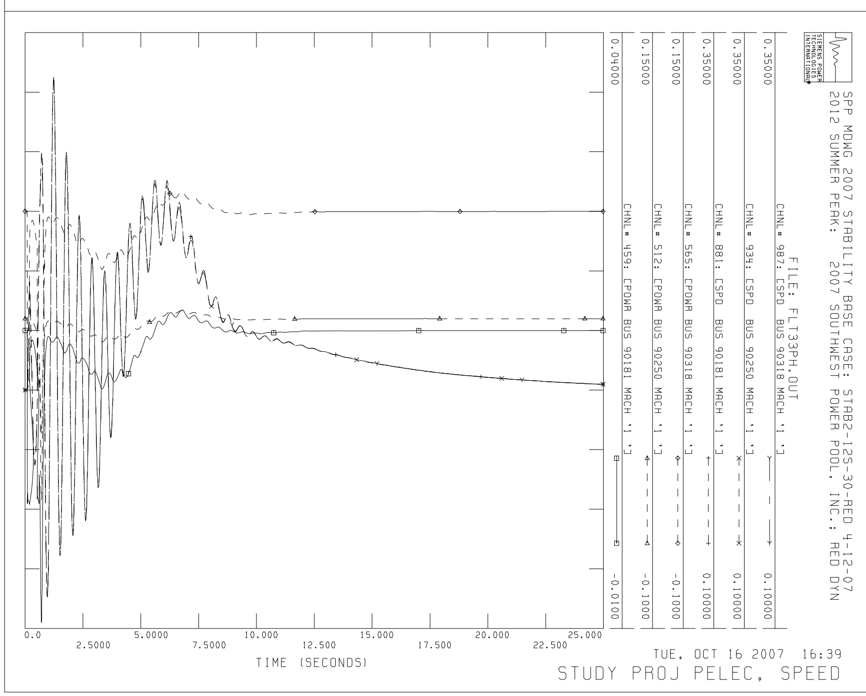
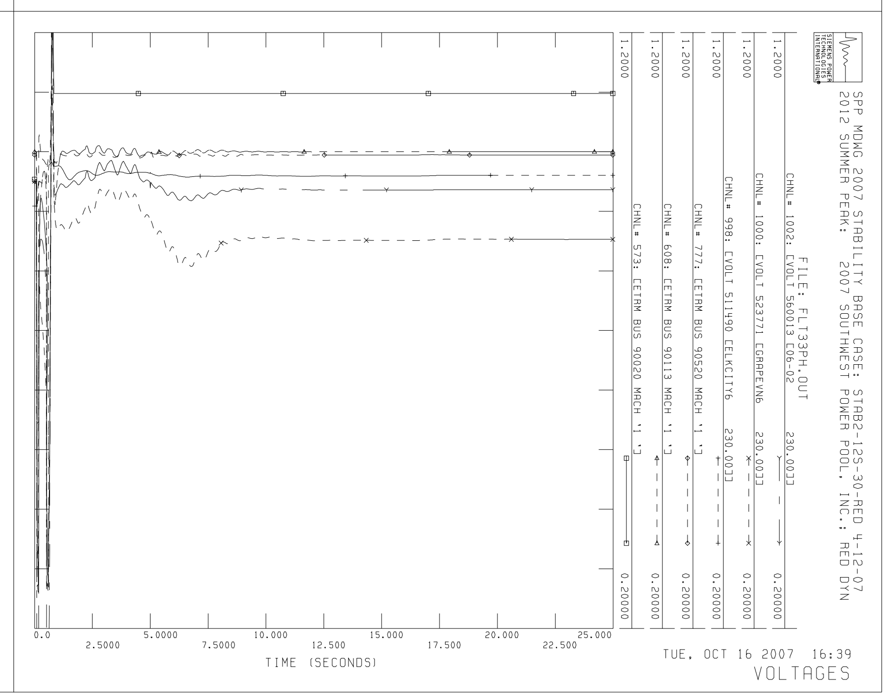
TIME (SECONDS)
TUE, OCT 16 2007 16:39
POWER


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# 987: [SPD BUS 90318 MACH '1 '] 0.35000 0.10000
CHNL# 934: [SPD BUS 90250 MACH '1 '] 0.35000 0.10000
CHNL# 881: [SPD BUS 90181 MACH '1 '] 0.35000 0.10000
CHNL# 565: [POWR BUS 90318 MACH '1 '] 0.15000 -0.1000
CHNL# 512: [POWR BUS 90250 MACH '1 '] 0.15000 -0.1000
CHNL# 459: [POWR BUS 90181 MACH '1 '] 0.04000 -0.0100
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
TIME (SECONDS)
TUE, OCT 16 2007 16:39
STUDY PROJ PELEC, SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 1002: [VOLT 560013 [G06-02 230.00]] 1.2000 0.20000
CHNL# 1000: [VOLT 523771 [GRAPEVN6 230.00]] 1.2000 0.20000
CHNL# 998: [VOLT 511490 [ELKCITY6 230.00]] 1.2000 0.20000
CHNL# 777: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 608: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
CHNL# 573: [ETRM BUS 90020 MACH '1 '] 1.2000 0.20000
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
TIME (SECONDS)
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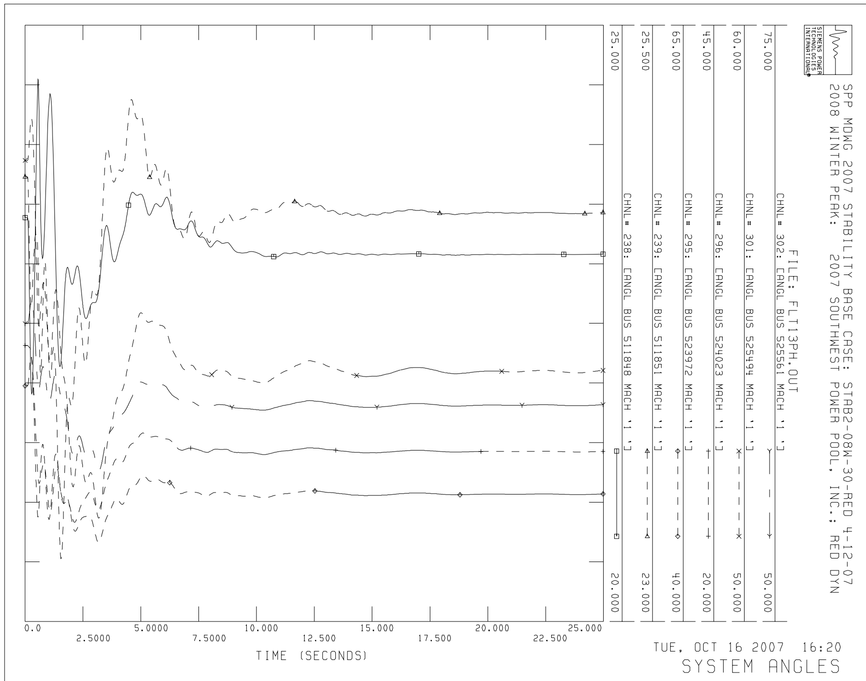
VOLTAGES

APPENDIX C.

SELECTED STABILITY PLOTS – SCENARIO 3

(Customer's 300 MW generation with addition of 345 kV line)

All plots available on request.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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 302: [ANGL BUS 525561 MACH '1 ']
CHNL# 301: [ANGL BUS 525494 MACH '1 ']
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
CHNL# 238: [ANGL BUS 511848 MACH '1 ']
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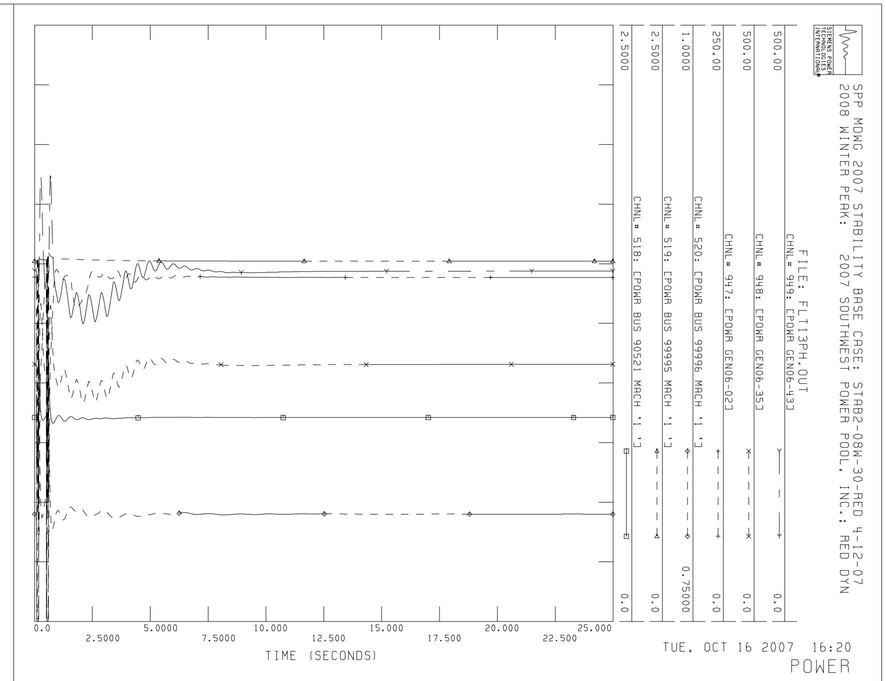
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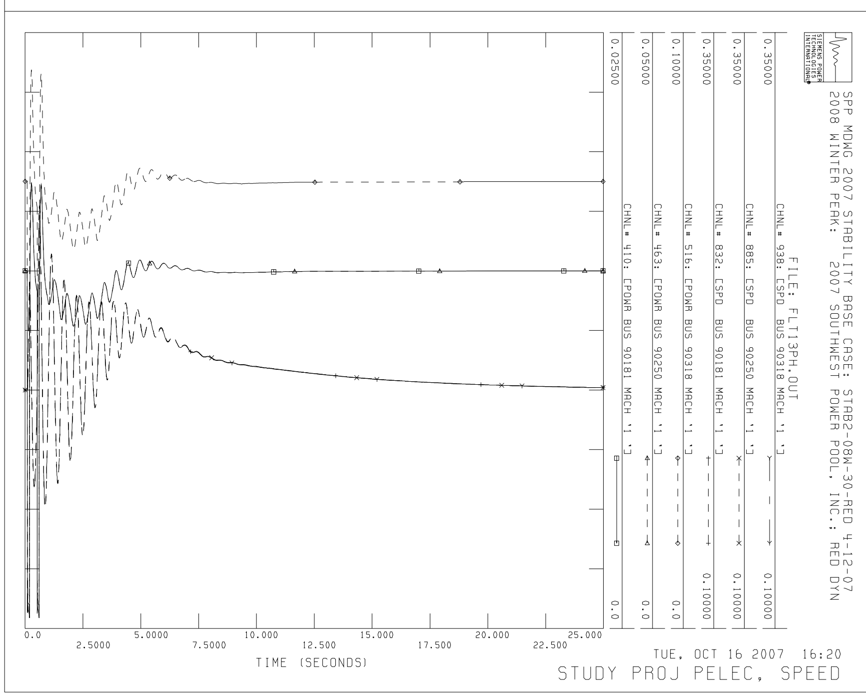
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 949: [POWR GEN06-43]
CHNL# 948: [POWR GEN06-35]
CHNL# 947: [POWR GEN06-02]
CHNL# 520: [POWR BUS 99996 MACH '1 ']
CHNL# 519: [POWR BUS 99995 MACH '1 ']
CHNL# 518: [POWR BUS 90521 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:20
POWER

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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 938: [SPD BUS 90318 MACH '1 ']
CHNL# 885: [SPD BUS 90250 MACH '1 ']
CHNL# 832: [SPD BUS 90181 MACH '1 ']
CHNL# 516: [POWR BUS 90318 MACH '1 ']
CHNL# 463: [POWR BUS 90250 MACH '1 ']
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TIME (SECONDS)
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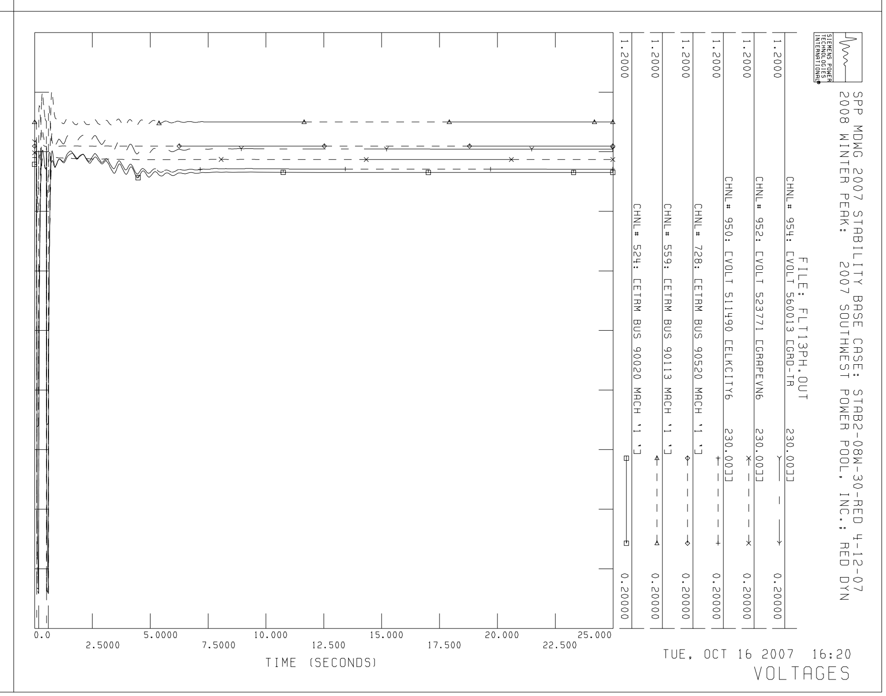
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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 954: [VOLT 56013 [GRD-TR 230.00]]
CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
CHNL# 559: [ETRM BUS 90113 MACH '1 ']
CHNL# 524: [ETRM BUS 90020 MACH '1 ']
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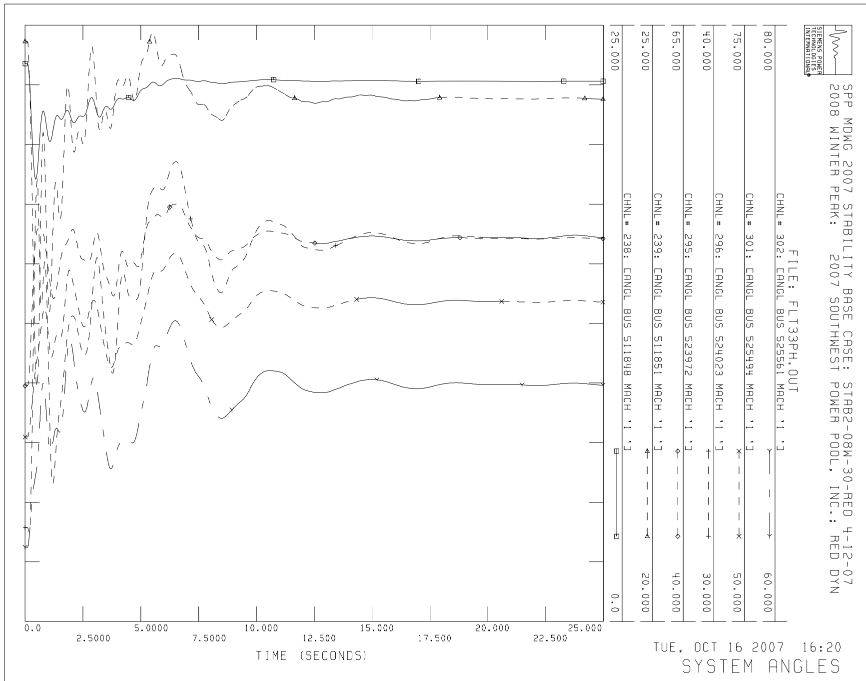
VOLTAGES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CHNL# 301: [ANGL BUS 525494 MACH '1 ']
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
CHNL# 238: [ANGL BUS 511848 MACH '1 ']
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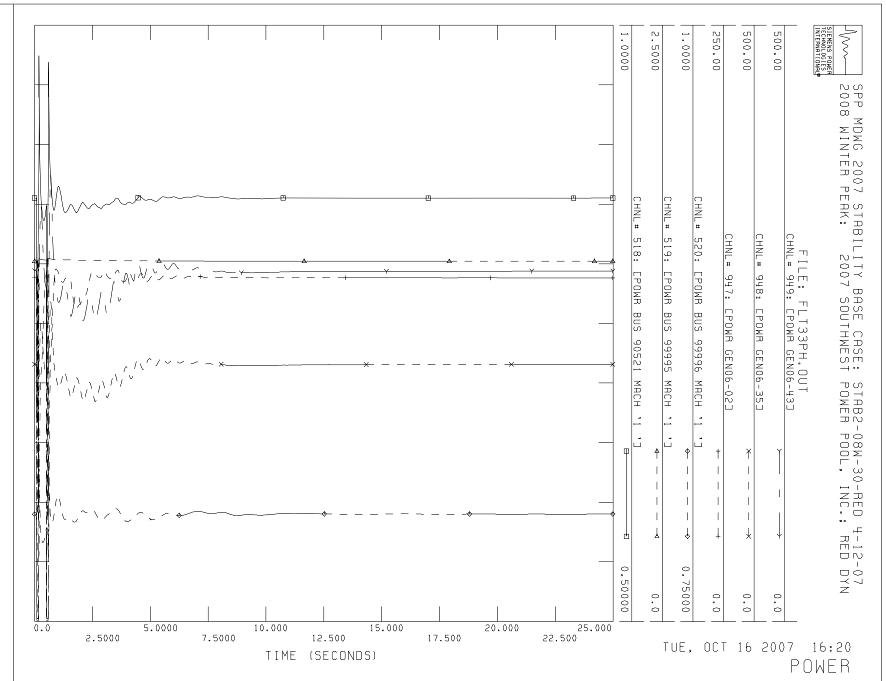
SYSTEM ANGLES

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CHNL# 948: [POWR GEN06-35]
CHNL# 947: [POWR GEN06-02]
CHNL# 520: [POWR BUS 99996 MACH '1 ']
CHNL# 519: [POWR BUS 99995 MACH '1 ']
CHNL# 518: [POWR BUS 90521 MACH '1 ']
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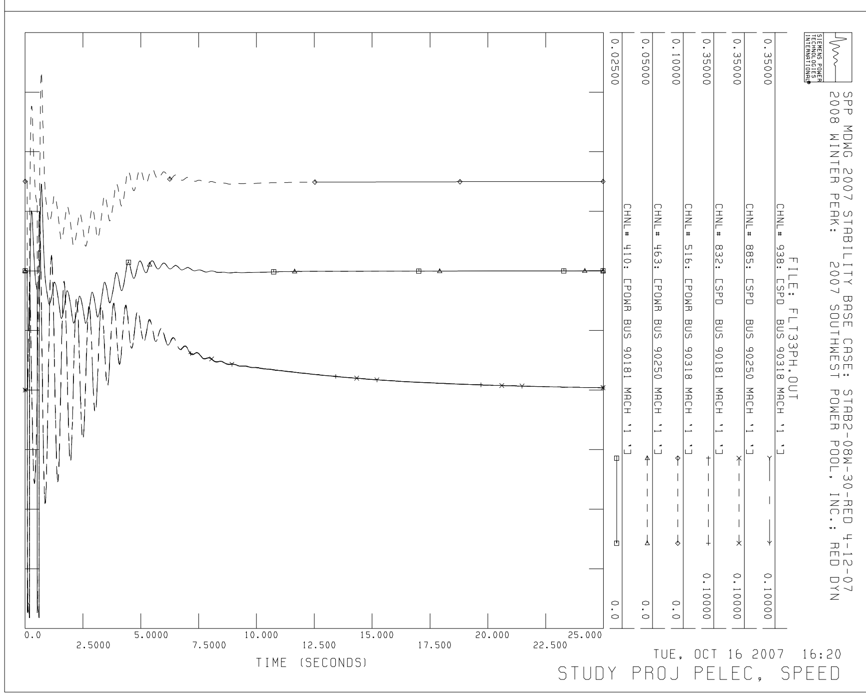
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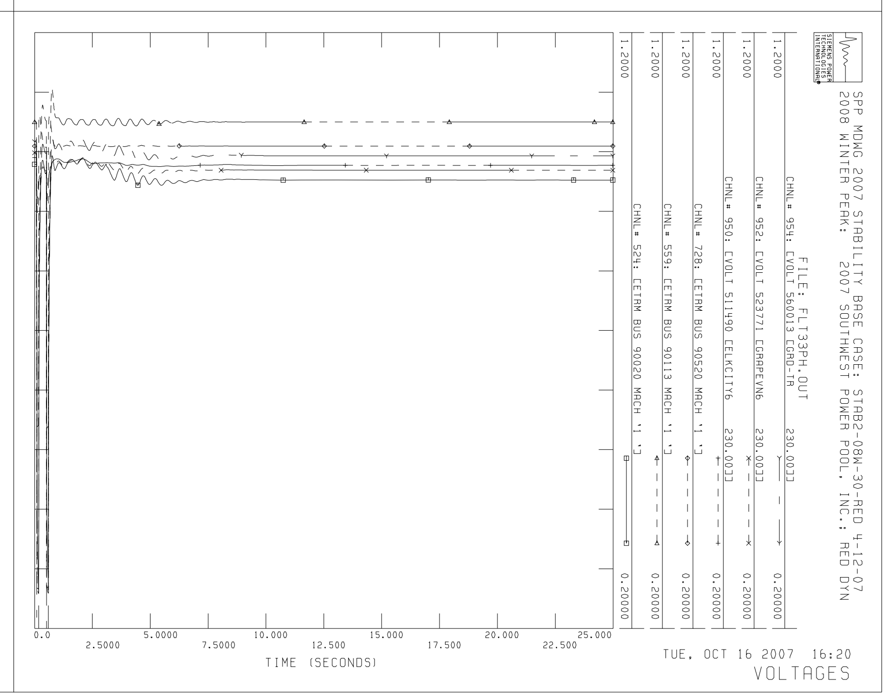
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CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
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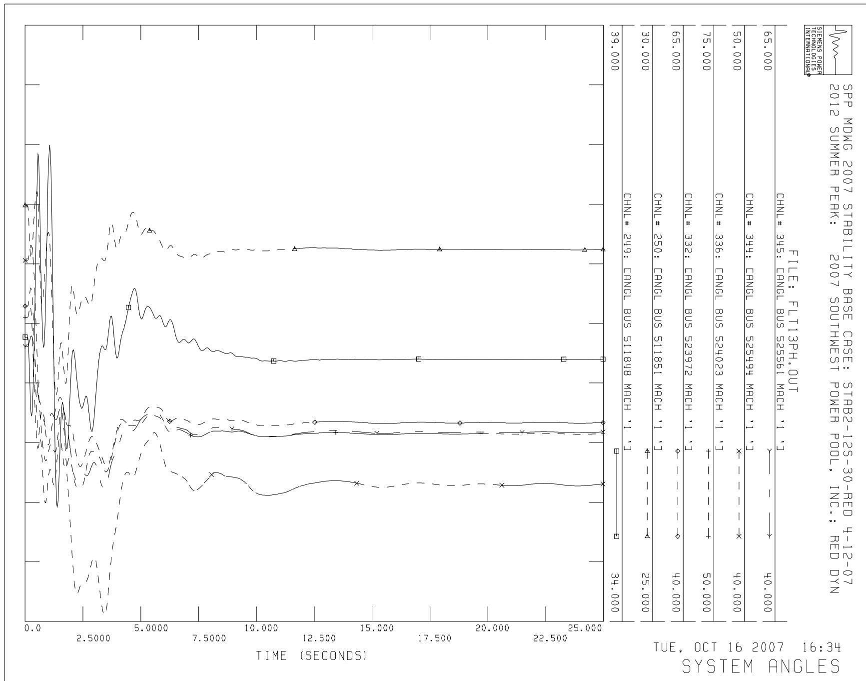
VOLTAGES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 344: [ANGL BUS 525494 MACH '1 ']
CHNL# 336: [ANGL BUS 524023 MACH '1 ']
CHNL# 332: [ANGL BUS 523972 MACH '1 ']
CHNL# 250: [ANGL BUS 511851 MACH '1 ']
CHNL# 249: [ANGL BUS 511848 MACH '1 ']
65.000 40.000
50.000 40.000
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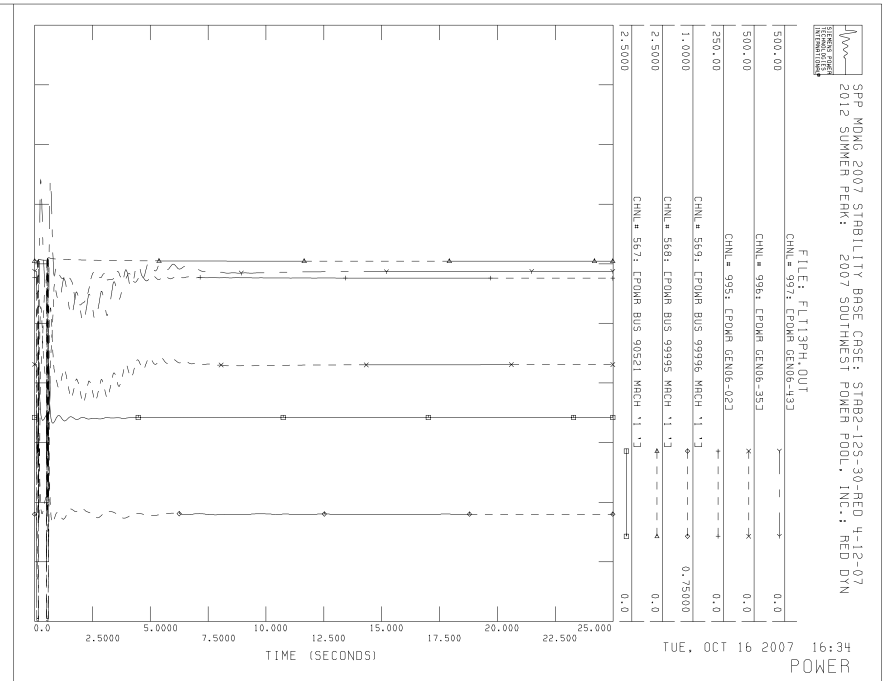
SYSTEM ANGLES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
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CHNL# 996: [POWR GEN06-35]
CHNL# 995: [POWR GEN06-02]
CHNL# 569: [POWR BUS 99996 MACH '1 ']
CHNL# 568: [POWR BUS 99995 MACH '1 ']
CHNL# 567: [POWR BUS 90521 MACH '1 ']
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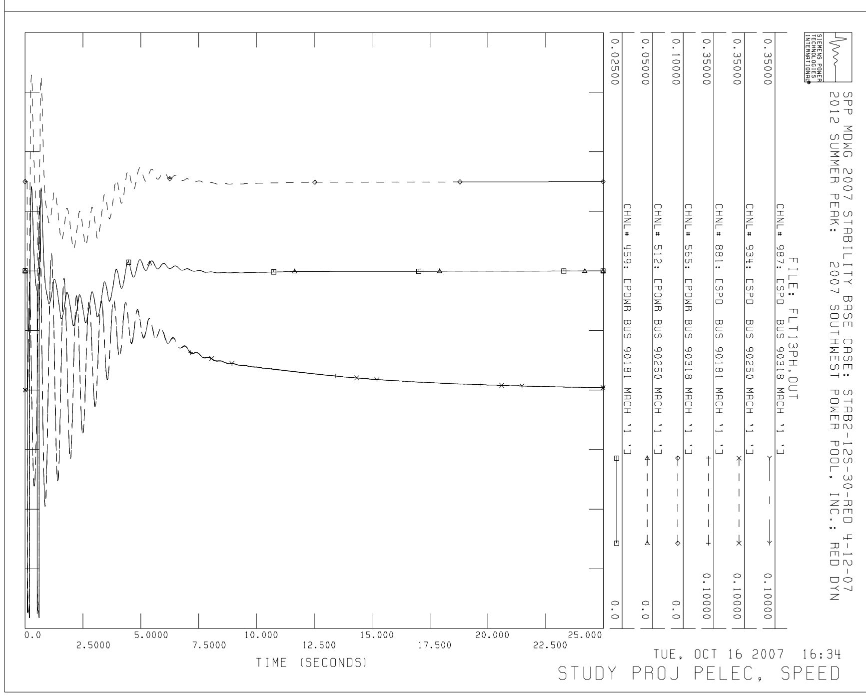
POWER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FILE: FLT13PH.OUT
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CHNL# 934: [SPD BUS 90250 MACH '1 ']
CHNL# 881: [SPD BUS 90181 MACH '1 ']
CHNL# 565: [POWR BUS 90318 MACH '1 ']
CHNL# 512: [POWR BUS 90250 MACH '1 ']
CHNL# 459: [POWR BUS 90181 MACH '1 ']
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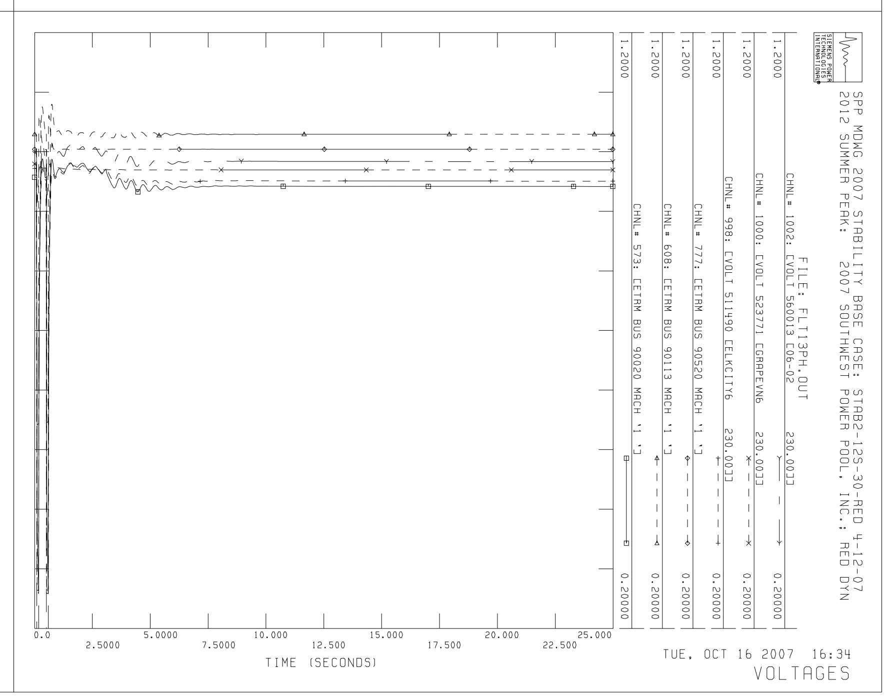
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CHNL# 1002: [VOLT 560013 [G06-02 230.00]]
CHNL# 1000: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 998: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 777: [ETRM BUS 90520 MACH '1 ']
CHNL# 608: [ETRM BUS 90113 MACH '1 ']
CHNL# 573: [ETRM BUS 90020 MACH '1 ']
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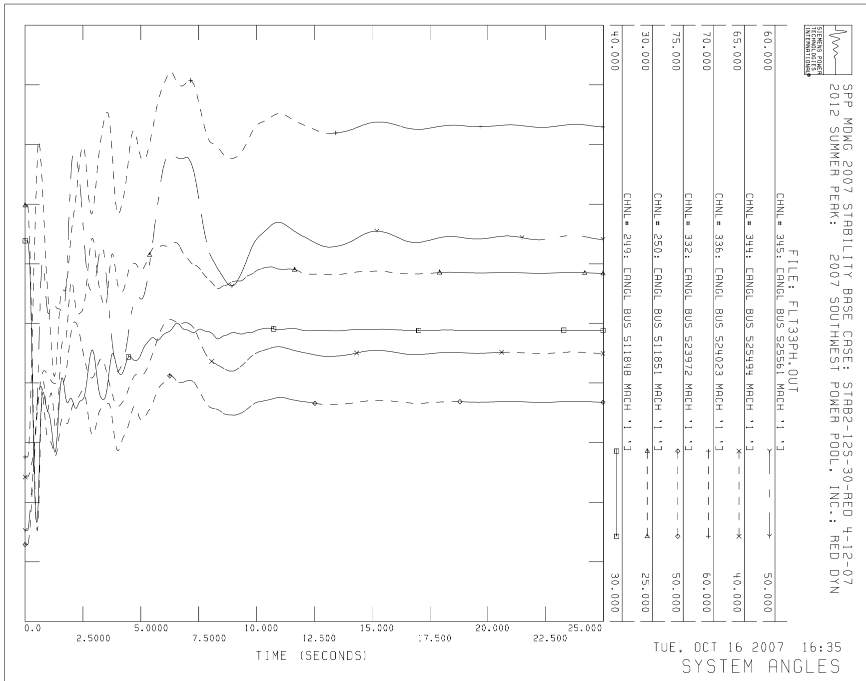
VOLTAGES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CHNL# 345: [ANGL BUS 525561 MACH '1 ']
CHNL# 344: [ANGL BUS 525494 MACH '1 ']
CHNL# 336: [ANGL BUS 524023 MACH '1 ']
CHNL# 332: [ANGL BUS 523972 MACH '1 ']
CHNL# 250: [ANGL BUS 511851 MACH '1 ']
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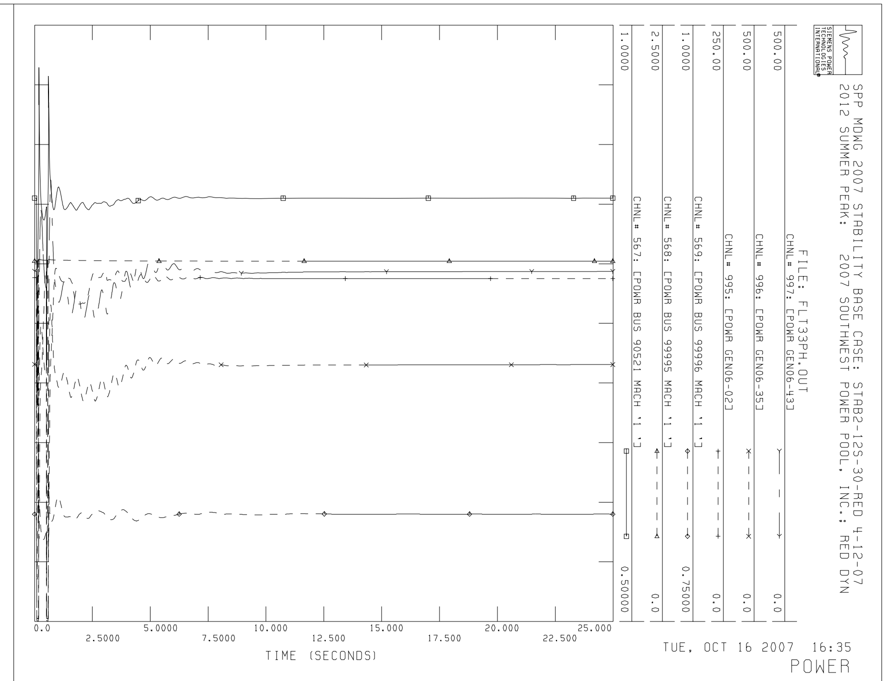
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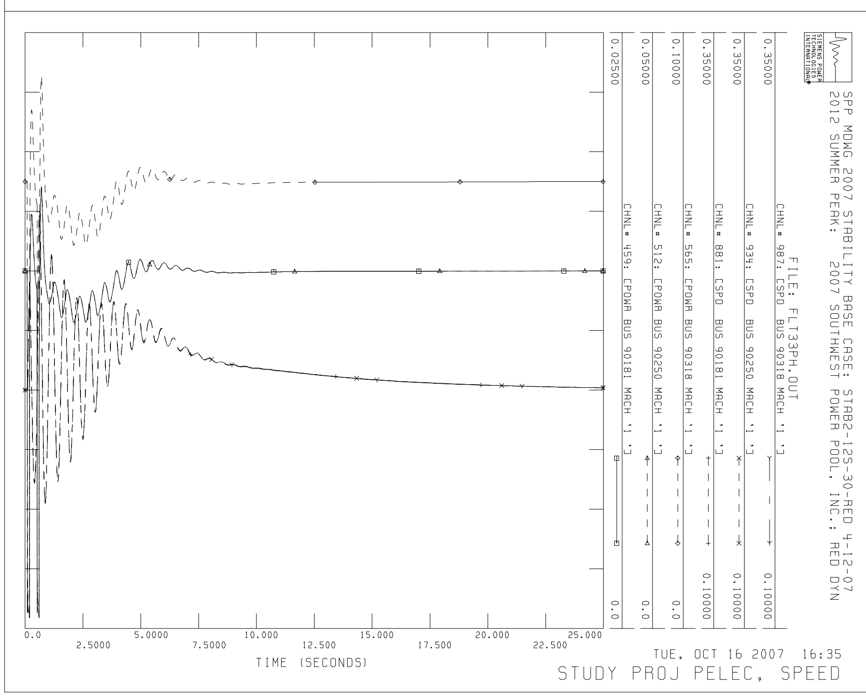
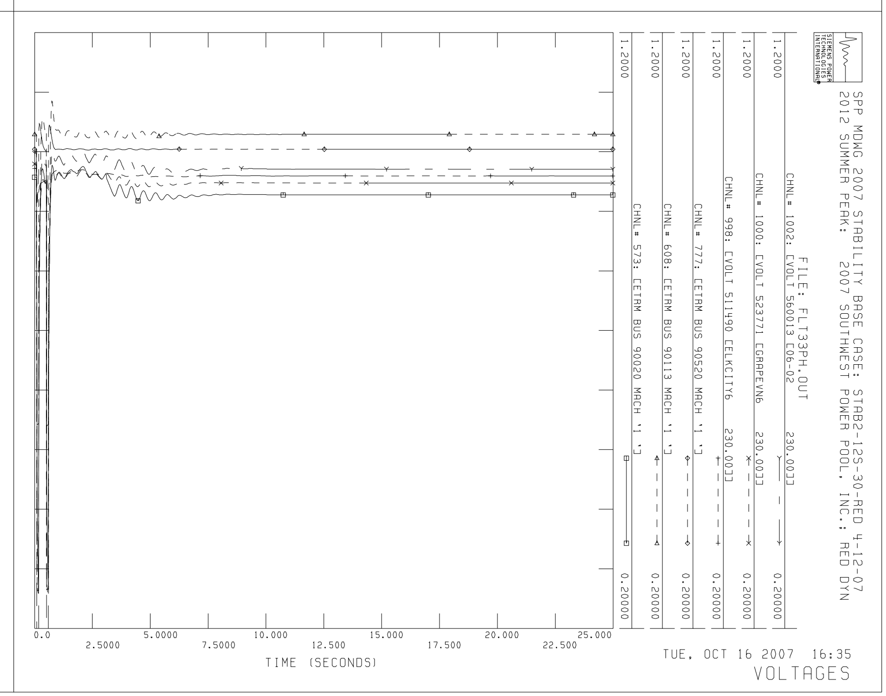
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 997: [POWR GEN06-43]
CHNL# 996: [POWR GEN06-35]
CHNL# 995: [POWR GEN06-02]
CHNL# 569: [POWR BUS 99996 MACH '1 ']
CHNL# 568: [POWR BUS 99995 MACH '1 ']
CHNL# 567: [POWR BUS 90521 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:35
POWER


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# 987: [SPD BUS 90318 MACH '1 ']
CHNL# 934: [SPD BUS 90250 MACH '1 ']
CHNL# 881: [SPD BUS 90181 MACH '1 ']
CHNL# 565: [POWR BUS 90318 MACH '1 ']
CHNL# 512: [POWR BUS 90250 MACH '1 ']
CHNL# 459: [POWR BUS 90181 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:35
STUDY PROJ PELEC, SPEED


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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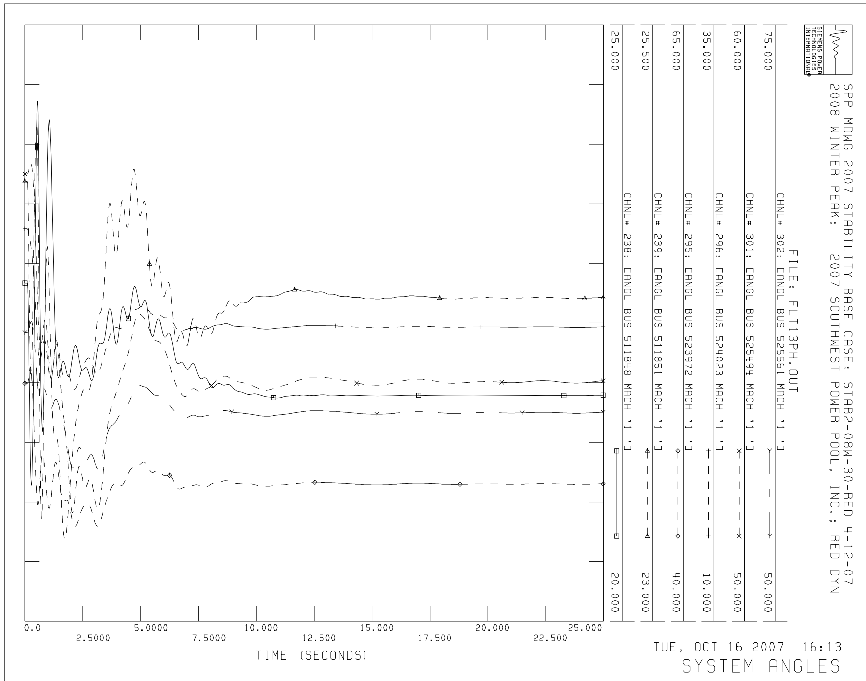
CHNL# 1002: [VOLT 560013 [G06-02 230.00]]
CHNL# 1000: [VOLT 523771 [GRAPEVN6 230.00]]
CHNL# 998: [VOLT 511490 [ELKCITY6 230.00]]
CHNL# 777: [ETRM BUS 90520 MACH '1 ']
CHNL# 608: [ETRM BUS 90113 MACH '1 ']
CHNL# 573: [ETRM BUS 90020 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:35
VOLTAGES

APPENDIX D.

SELECTED STABILITY PLOTS – SCENARIO 4

(Customer's maximum generation set at 126 MW with no transmission system reinforcement)

All plots available on request.


SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 302: [ANGL BUS 525561 MACH '1 ']
75.000 50.000
CHNL# 301: [ANGL BUS 525494 MACH '1 ']
60.000 50.000
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
35.000 10.000
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
65.000 40.000
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
25.500 23.000
CHNL# 238: [ANGL BUS 511898 MACH '1 ']
25.000 20.000
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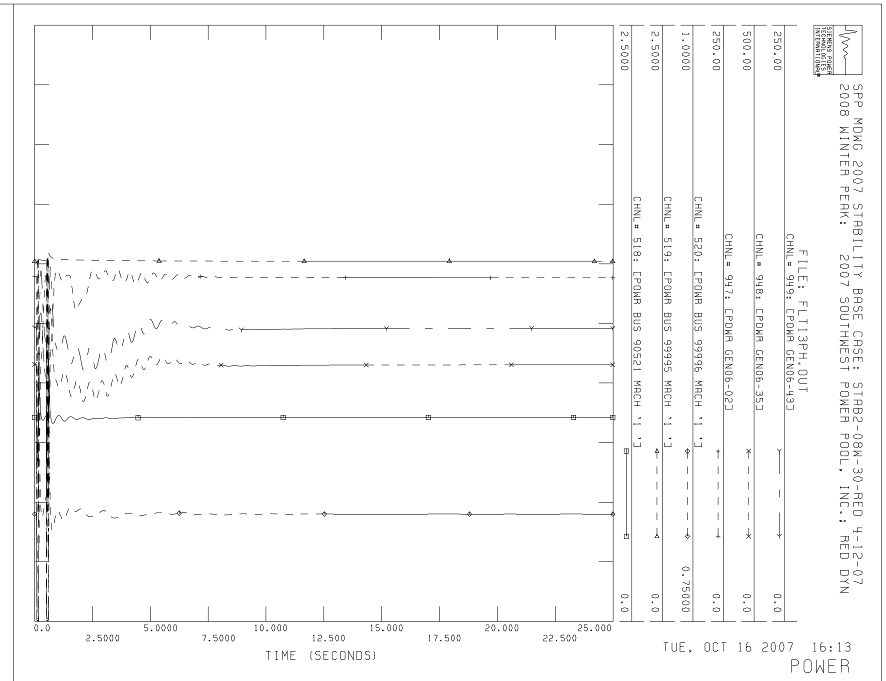
TUE, OCT 16 2007 16:13
SYSTEM ANGLES

SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 949: [POWR GEN06-43]
250.00 0.0
CHNL# 948: [POWR GEN06-35]
500.00 0.0
CHNL# 947: [POWR GEN06-02]
250.00 0.0
CHNL# 520: [POWR BUS 99996 MACH '1 ']
1.0000 0.75000
CHNL# 519: [POWR BUS 99995 MACH '1 ']
2.5000 0.0
CHNL# 518: [POWR BUS 90521 MACH '1 ']
2.5000 0.0
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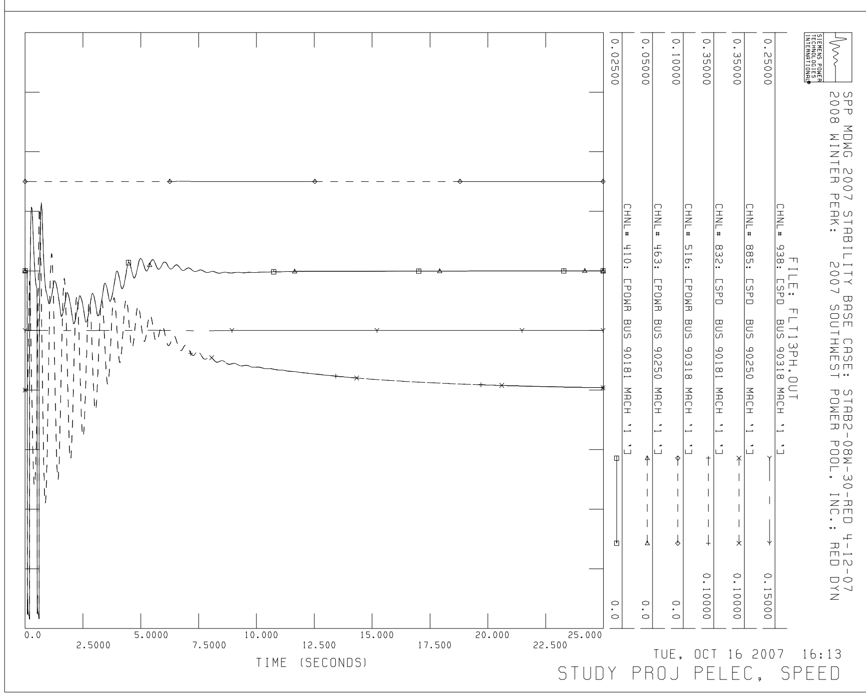
TIME (SECONDS)
TUE, OCT 16 2007 16:13
POWER

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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 938: [SPD BUS 90318 MACH '1 ']
0.25000 0.15000
CHNL# 885: [SPD BUS 90250 MACH '1 ']
0.35000 0.10000
CHNL# 832: [SPD BUS 90181 MACH '1 ']
0.35000 0.10000
CHNL# 516: [POWR BUS 90318 MACH '1 ']
0.10000 0.0
CHNL# 463: [POWR BUS 90250 MACH '1 ']
0.05000 0.0
CHNL# 410: [POWR BUS 90181 MACH '1 ']
0.02500 0.0
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
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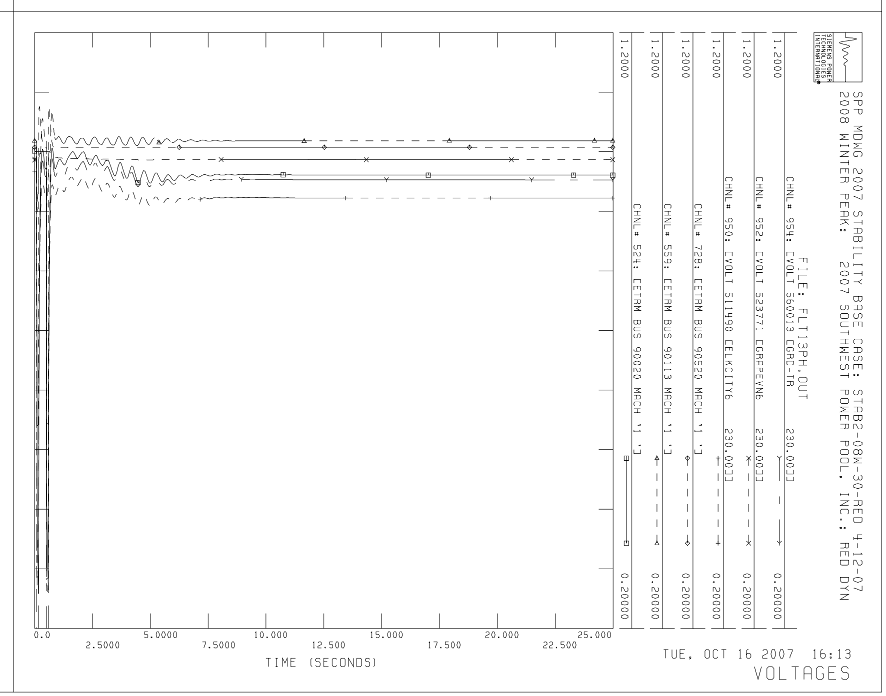
TUE, OCT 16 2007 16:13
STUDY PROJ PELEC, SPEED

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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 954: [VOLT 56013 [GRD-IR 230.00]]
1.2000 0.20000
CHNL# 952: [VOLT 523771 [GRAPEVN6 230.00]]
1.2000 0.20000
CHNL# 950: [VOLT 511490 [ELKCITY6 230.00]]
1.2000 0.20000
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
1.2000 0.20000
CHNL# 559: [ETRM BUS 90113 MACH '1 ']
1.2000 0.20000
CHNL# 524: [ETRM BUS 90020 MACH '1 ']
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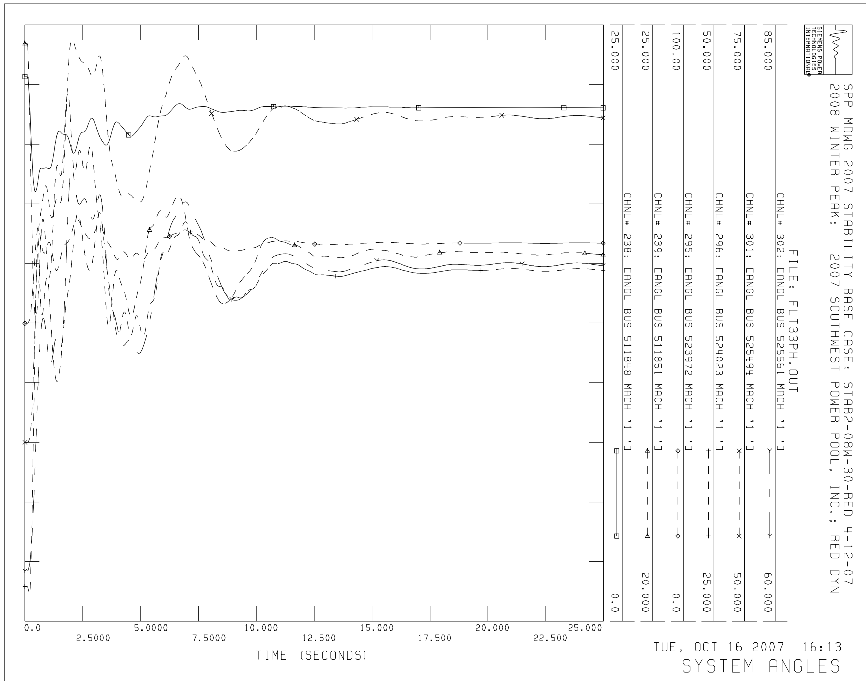
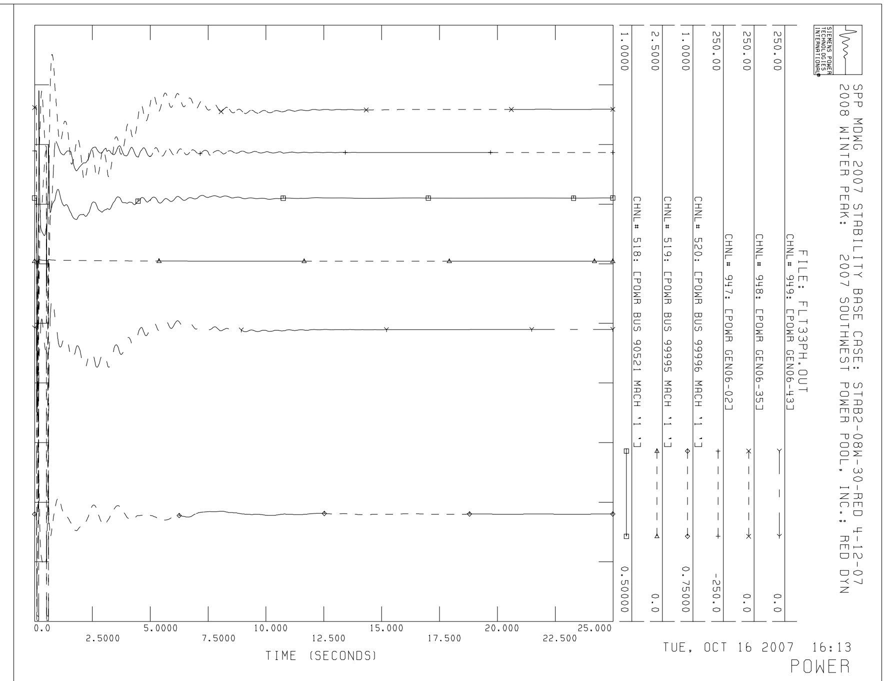
TIME (SECONDS)
TUE, OCT 16 2007 16:13
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 302: [ANGL BUS 525561 MACH '1 ']
CHNL# 301: [ANGL BUS 525494 MACH '1 ']
CHNL# 296: [ANGL BUS 524023 MACH '1 ']
CHNL# 295: [ANGL BUS 523972 MACH '1 ']
CHNL# 239: [ANGL BUS 511851 MACH '1 ']
CHNL# 238: [ANGL BUS 511848 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:13
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
FILE: FLT33PH.OUT
CHNL# 949: [POWR GEN06-43]
CHNL# 948: [POWR GEN06-35]
CHNL# 947: [POWR GEN06-02]
CHNL# 520: [POWR BUS 99996 MACH '1 ']
CHNL# 519: [POWR BUS 99995 MACH '1 ']
CHNL# 518: [POWR BUS 90521 MACH '1 ']
TIME (SECONDS)
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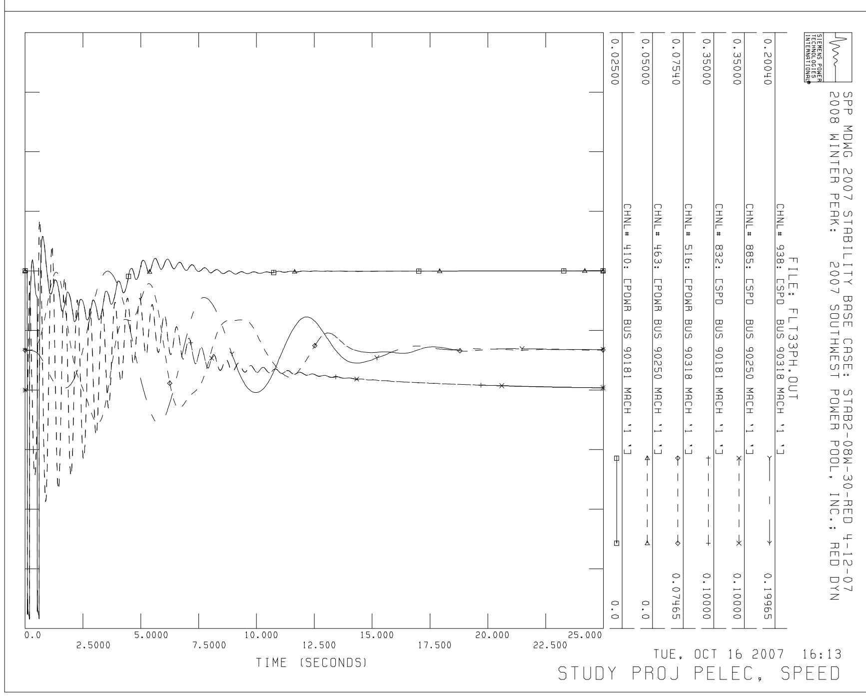
POWER

SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 938: [SPD BUS 90318 MACH '1 ']
CHNL# 885: [SPD BUS 90250 MACH '1 ']
CHNL# 832: [SPD BUS 90181 MACH '1 ']
CHNL# 516: [POWR BUS 90318 MACH '1 ']
CHNL# 463: [POWR BUS 90250 MACH '1 ']
CHNL# 410: [POWR BUS 90181 MACH '1 ']
TIME (SECONDS)
TUE, OCT 16 2007 16:13
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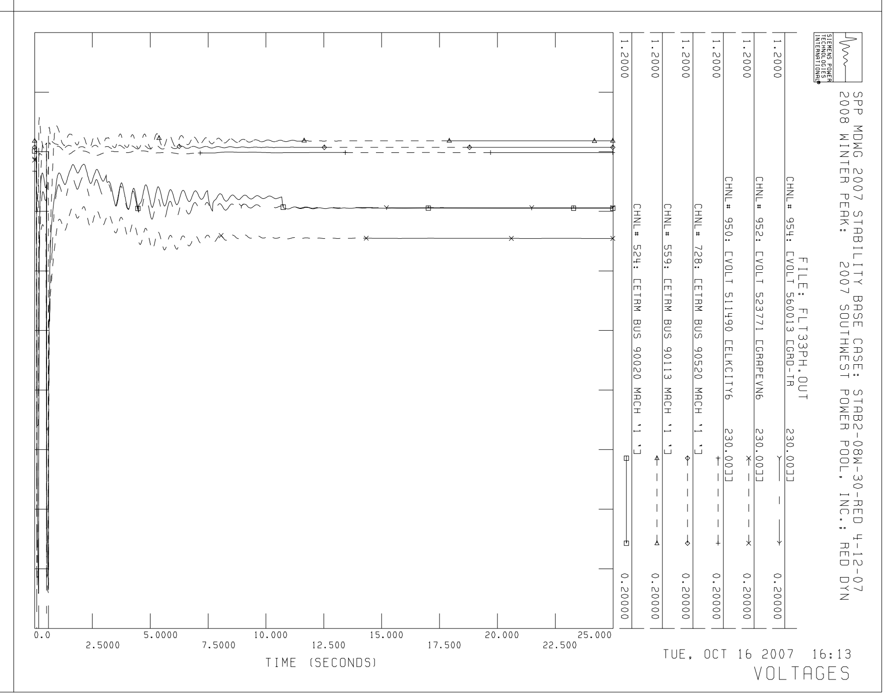
SPP MDWG 2007 STABILITY BASE CASE: STAB2-08W-30-RED 4-12-07
2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
CHNL# 954: [VOLT 560013 CGRD-TR 230.00]
CHNL# 952: [VOLT 523771 CGRAPEVN6 230.00]
CHNL# 950: [VOLT 511490 CELKCITY6 230.00]
CHNL# 728: [ETRM BUS 90520 MACH '1 ']
CHNL# 559: [ETRM BUS 90113 MACH '1 ']
CHNL# 524: [ETRM BUS 90020 MACH '1 ']
TIME (SECONDS)
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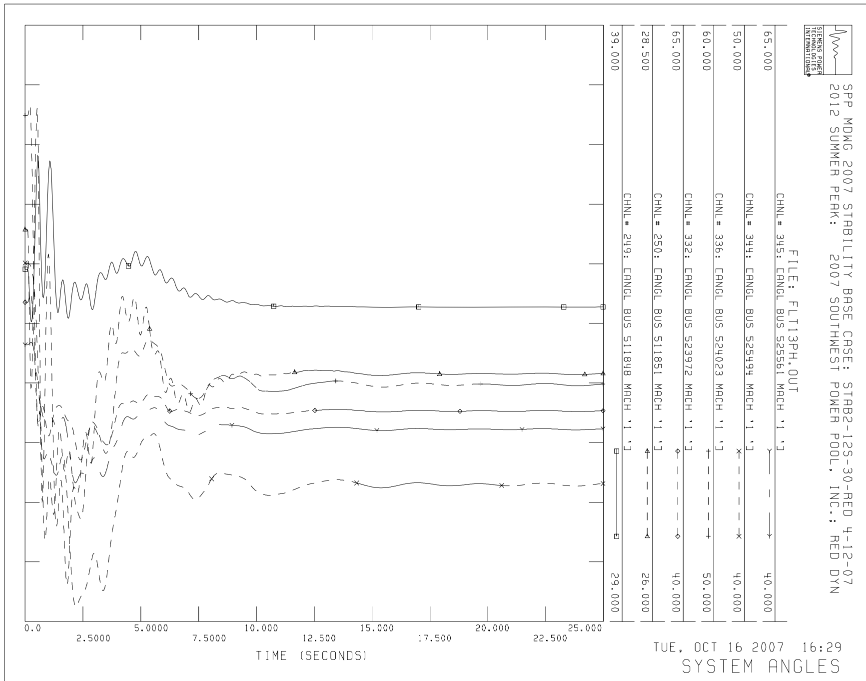
VOLTAGES


SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 345: [ANGL BUS 525561 MACH '1 '] 65.000 40.000
CHNL# 344: [ANGL BUS 525494 MACH '1 '] 50.000 40.000
CHNL# 336: [ANGL BUS 524023 MACH '1 '] 60.000 50.000
CHNL# 332: [ANGL BUS 523972 MACH '1 '] 65.000 40.000
CHNL# 250: [ANGL BUS 511851 MACH '1 '] 28.500 26.000
CHNL# 249: [ANGL BUS 511898 MACH '1 '] 39.000 29.000
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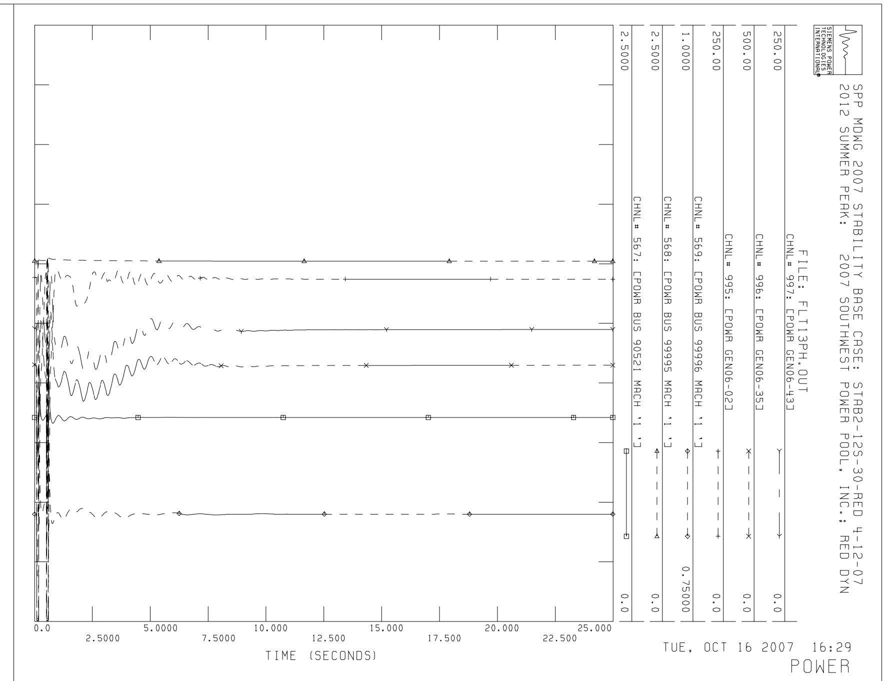
TUE, OCT 16 2007 16:29
SYSTEM ANGLES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 997: [POWR GEN06-43] 250.00 0.0
CHNL# 996: [POWR GEN06-35] 500.00 0.0
CHNL# 995: [POWR GEN06-02] 250.00 0.0
CHNL# 569: [POWR BUS 99996 MACH '1 '] 1.0000 0.75000
CHNL# 568: [POWR BUS 99995 MACH '1 '] 2.5000 0.0
CHNL# 567: [POWR BUS 90521 MACH '1 '] 2.5000 0.0
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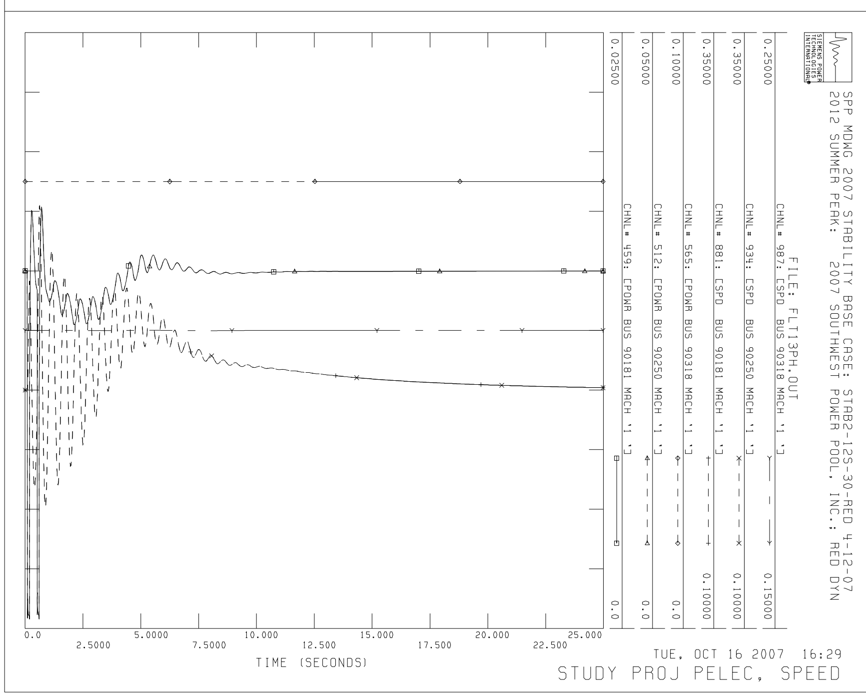
TIME (SECONDS)
TUE, OCT 16 2007 16:29
POWER


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# 987: [SPD BUS 90318 MACH '1 '] 0.25000 0.15000
CHNL# 934: [SPD BUS 90250 MACH '1 '] 0.35000 0.10000
CHNL# 881: [SPD BUS 90181 MACH '1 '] 0.35000 0.10000
CHNL# 565: [POWR BUS 90318 MACH '1 '] 0.10000 0.0
CHNL# 512: [POWR BUS 90250 MACH '1 '] 0.05000 0.0
CHNL# 459: [POWR BUS 90181 MACH '1 '] 0.02500 0.0
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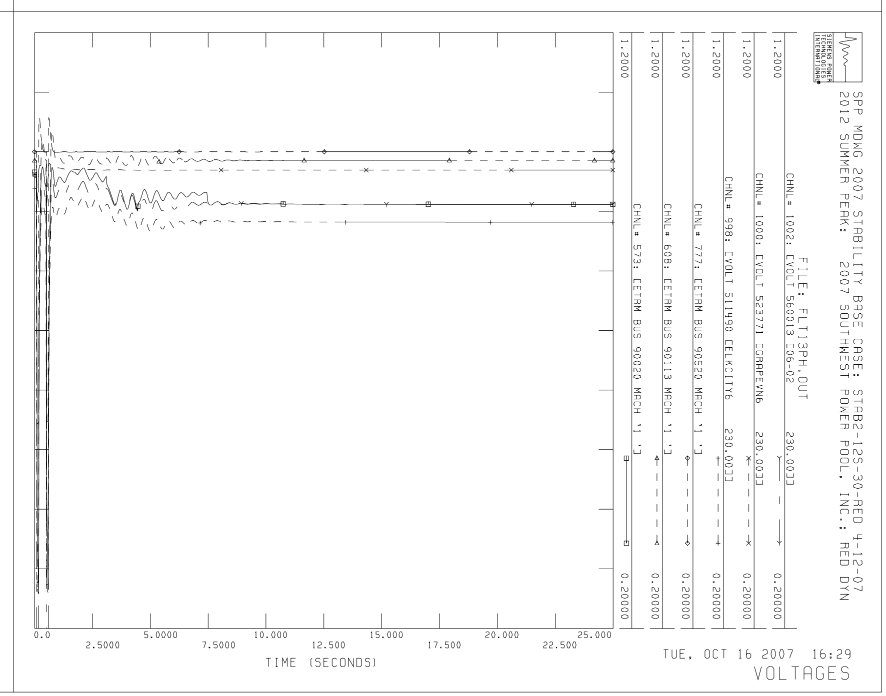
TUE, OCT 16 2007 16:29
STUDY PROJ PELEC, SPEED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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH.OUT
CHNL# 1002: [VOLT 560013 C06-02 230.00] 1.2000 0.20000
CHNL# 1000: [VOLT 523771 CGRAPEVN6 230.00] 1.2000 0.20000
CHNL# 998: [VOLT 511490 CELKCITY6 230.00] 1.2000 0.20000
CHNL# 777: [ETRM BUS 90520 MACH '1 '] 1.2000 0.20000
CHNL# 608: [ETRM BUS 90113 MACH '1 '] 1.2000 0.20000
CHNL# 573: [ETRM BUS 90020 MACH '1 '] 1.2000 0.20000
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TIME (SECONDS)
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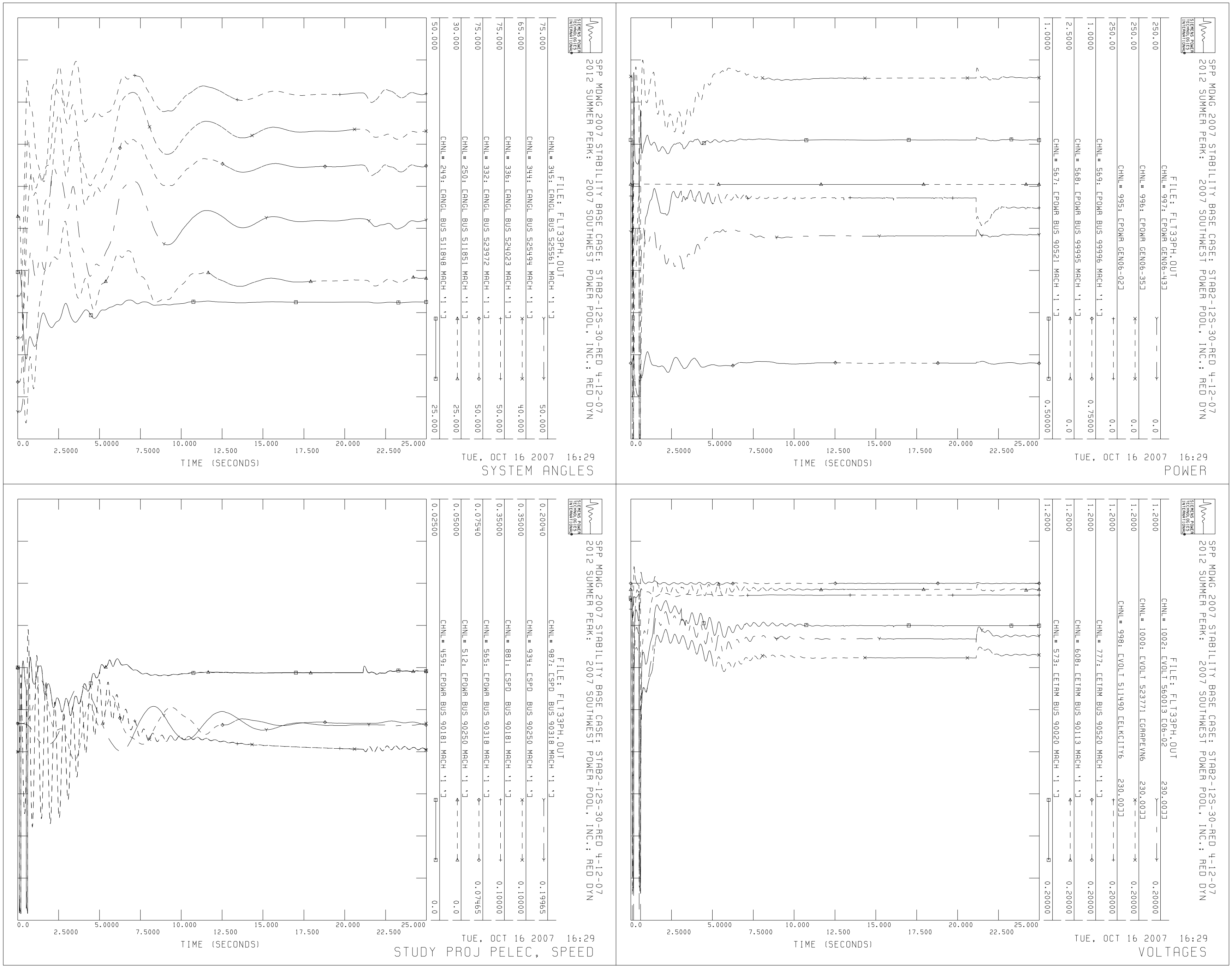
VOLTAGES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT33PH.OUT
TIME (SECONDS)
TUE, OCT 16 2007 16:29
SYSTEM ANGLES
POWER
STUDY PROJ PELEC, SPEED
VOLTAGES