Southwest Power Pool

# Facility Study
# For
# Generation Interconnection
# Request
# GEN-2007-004

SPP Tariff Studies

(#GEN-2007-004)

May 2008

## **Summary**

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Xcel Energy performed the following Facility Study to satisfy the Facility Study Agreement executed by the requesting customer and SPP for SPP Generation Interconnection request Gen-2007-004. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

### Impact Re-Study

In the Impact Study for Generation Interconnect Request GEN-2007-004 (dated December 2007), SPP evaluated the Customer request to interconnect its wind farm to the Southwestern Public Service (SPS) transmission system. The interconnection request was studied using seventy-five (75) Gamesa G87 wind turbines at 2.0 MW each for a total output of 150 MW. The study minimum interconnection network upgrade requirements consisted of building a new three-breaker ring, three terminal switching station tapping into the existing 230 kV transmission line between Amoco Switching Station and Yoakum Interchange. However, in the Facility Study SPS is proposing to provide a 230 kV line terminal to interconnect the wind farm facility at the Yoakum Interchange because of its closer proximity to the wind farm facility location as indicated in the request and to eliminate the construction of a new switching station which cannot be completed by the Customer's requested in-service date. SPP has determined that the Yoakum interconnection point electrically similar to the original studied interconnection point so as not to constitute a material modification.

SPP conducted an Impact Re-Study to determine any changes to the stability of the transmission system as a result of changing the Point of Interconnection (POI) to the Yoakum Interchange. The results of the Impact Re-study indicates that the transmission system remains stable for all contingencies simulated. The Customer will be required to maintain unity power factor at Yoakum substation, and will need to determine if additional capacitor banks are required. The entire Impact Re-Study can be found as Attachment 1 following the Facility Study in this document.

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

**Facilities Study For**
**Southwest Power Pool (SPP)**
150 MW Wind-Generated Energy Facility
Terry County, Texas
SPP #GEN-2007-004

April 2, 2008

Xcel Energy Services, Inc.
Transmission Planning

## Executive Summary

Gamesa Energy USA, LLC in January 2007 ("Interconnection Customer") requested the interconnection of a wind energy facility located in Terry County, Texas to the Southwestern Public Service Company (SPS), a New Mexico Corporation and wholly owned subsidiary of Xcel Energy Inc. 230 kV transmission network. The wind energy facility has a net capacity of 150 MW that will interconnect into the existing SPS Yoakum Interchange 230 kV bus located in Yoakum Co., Texas approximately 11 miles North of Denver City, Texas. The Interconnection Customer's expected commercial operation date and back-feed date is December 20, 2009 and October 15, 2009, respectively.

The Southwest Power Pool (SPP) evaluated the request to interconnect the wind farm facility to the SPS transmission system in a System Impact Study (SIS) (GEN-2007-004) completed in December 2007. The interconnection request was studied using seventy-five (75) Gamesa G87 wind turbines at 2.0 MW each for a total output of 150 MW. The study minimum requirements consist of building a new three-breaker ring, three terminal switching station tapping into the existing 230 kV transmission lines between Amoco Switching Station and Yoakum Interchange. However, SPS is instead proposing to provide a 230 kV line terminal to interconnect the wind farm facility at Yoakum Interchange because of its closer proximity to the wind farm facility location as indicated in the request and the in-service date will not be met if a new switching station is built. The Interconnection Customer may also be required to add a capacitor bank on the 34.5 kV side of their collector's 230/34.5 kV bus if it can not meet unity power factor at the point of interconnection.

SPS requires that all construction for this request be in compliance with the latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW, Version 3.0 dated Dec 31, 2006, and is available at (http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_16699_24407-1428-0_0_0-0,00.html). This document describes the requirements for connecting new generation to the Xcel Energy transmission systems including technical, protection, commissioning, operation, and maintenance. SPS will also require that the Interconnection Customer be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Corporation (NERC), Southwest Power Pool (SPP), and the Federal Energy Regulatory Commission (FERC) or their successor organizations.

The Interconnection Customer is responsible for the cost of the Interconnection Facilities, installation of capacitor banks and any Direct Assigned Interconnection Facilities; inclusive of all construction required for the 230 kV transmission line from the Interconnection Customer's substation to the interconnection point at Yoakum Interchange.

It is anticipated that the entire process of constructing the new line terminal at Yoakum Interchange for the acceptance of the wind energy facility output, will require approximately fifteen (15) months to complete from the day an interconnection agreement is signed and after all internal approvals, reviews, permits, engineering and construction unless prior arrangements have been made. It is not required to file a Certificate of Convenience and Necessity (CCN) with the Texas Public Utility Commission in order to construct the new line terminal at Yoakum Interchange. The cost of these upgrades, inclusive of the Interconnection Customer's cost for the interconnection of this wind farm facility, is shown below in Table 1, with the detailed description of the cost shown in Table 3.

**Table 1, Cost Summary[a]**

| | Yoakum Interchange |
|---|---|
| Network Upgrades: | $ **114,375** |
| Interconnection Facilities [b]: | $ **1,125,163** |
| Total: | **$1,219,538** |

[a] The cost estimates are 2008 dollars with an accuracy level of ±20%.
[b] This is a direct assigned cost to the Interconnection Customer.

## General Description of SPS[c] Facilities

1. **Construction a new line terminal at Yoakum Interchange:** See Appendix A, for general vicinity location map.

   1.1. **Location:** SPS will construct a new 230 kV breaker line terminal at Yoakum Interchange Appendix A, Figure A- 2, shows a one-line of the new switching station, while Figure A- 3 shows a plan view of the new 230 kV line terminal added to the Interchange.

   1.2. **Bus Design:** The new 230 kV line terminal will be built to accommodate the output from the wind energy facility. The existing bus design at Yoakum Interchange is a main and transfer bus and has seven (7) existing 230KV breakers. The new 230 kV line terminal proposed is shown in Figure A- 1, Appendix A.

   1.3. **Line Terminals:** The 230kV lines and static wire terminals will be designed to accommodate 2,000 pounds per phase conductor at maximum tension, with a maximum 15-degree pull off from normal.

   1.4. **Control House:** The existing control house will be utilized to house the new metering, protective relaying and control devices, terminal cabinets, and any fiber-optic cable terminations, etc. for the new 230kV line breaker terminal.

   1.5. **Security Fence:** The existing security fence shall be extended if required when the new bay is added for the new line terminal.

   1.6. **Ground Grid**: The existing ground grid shall be extended to accommodate the additional bay required for the additional line terminal per ANSI/IEEE STD 80-1986, with our standard 4/0 copper ground mesh on 40-foot centers with ground rods and 20-foot centers in corners and loop outside of fence.

   1.7. **Site Grading:** Company contractor, per company specifications, will perform any site grading and erosion control to accommodate the new line terminal. Soil compaction shall be not less than 95% of laboratory density as determined by ASTM-D-698.

   1.8. **Station Power:** The existing switching station power, provided from the local distribution system, will be utilized.

   1.9. **Relay and Protection Scheme:** The new 230 kV line terminal primary protection to the interconnection customer 230 kV transmission line will use line current differential relaying over optical fiber installed in the static on the new transmission line. Secondary relaying will use mirrored bit, directional comparison blocking over the optical fiber. An SEL 311L and an SEL 321-1 will be used as primary and secondary relays, respectively. An SEL 279H-2 relay will be installed; however no automatic re-closing scheme will be used. The SEL 279H-2 will be used for line/bus SCADA closing conditions for the 230 kV breaker. Also, a SEL 501-0 will be used for breaker failure.

   The new 230 kV line terminal at Yoakum Interchange to interconnect with the wind farm facility will be added to the existing 230 kV bus differential schemes that provides high speed clearing of 230 kV bus during bus fault conditions.

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[c] All modifications to SPS facilities will be owned, maintained and operated by SPS.

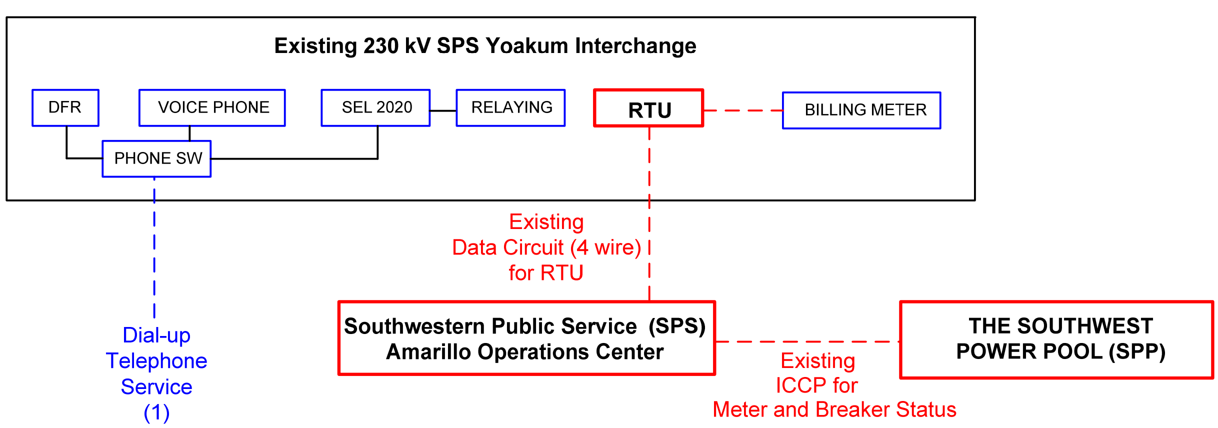
The bus voltage, GCB amps, MW, MVAR, and fault location will be displayed by an SEL DTA-2.

1.10. **Revenue Metering:** On the existing SPS Yoakum Interchange 230 kV line terminal to the Interconnection Customer's substation, an individual billing meter will be installed along with an ION 8400 meter unit, ANSI C12.1 accuracy class 0.2 (3-PT's IEEE C57.13 accuracy class 0.3 and 3 CT's IEEE C57.13 accuracy class 0.15) for full 3 phase 4-wire metering. Also installed for the metering units will be 3-PT's and 3-CT's for full 3-phase 4-wire metering. There will be two meters per line terminal: one will be primary and the other will be back up, each will have full 4 quadrant metering. Pulses out of the primary billing meter will be sent via SCADA to the Transmission Owner's Control Center in Amarillo, Texas.

1.11. **Disturbance Monitoring Device:** Disturbance-monitoring equipment (DFR), capable of recording faults, swings, and long term trending, will be installed to monitor and record conditions in the substation and on the transmission lines. The disturbance equipment shall also be equipped with a GPS time synching clock. This equipment will have communication capability with a dedicated communication circuit. The disturbance equipment will have its own dedicated dial-up communications telephone circuit.

1.12. **Remote Terminal Unit (RTU):** A new RTU will be required at the existing substation to accommodate the new 230 kV line terminal to the wind farm facility for metering and telemetry as required by the latest Xcel Energy Interconnection Guidelines. The direct cost will be charged to the Interconnection Customer.

1.13. **Communications:** The existing RTU communication link will be utilized with communications. An SEL 2020 will be installed for relay communications and other functions as required. ***It is the Interconnection Customer's responsibility to make arrangements with the local phone company to provide a new telephone circuit to the new RTU if required and the disturbance-monitoring device. Prior to any construction, the Interconnection Customer is required to contact the SPS Substation Engineering department for all details.*** A schematic outlining the proposed communications is provided below:




1.14. **Generator Under-frequency Response:** SPP has a coordinated regional under-frequency load shedding and restoration plan. The requirements of that plan are detailed in SPP

Criteria. The load shedding points are 59.3 Hz, 59.0 Hz, and 58.5 Hz. The Interconnection Customer agrees that the wind energy generating units installed at this interconnection will not be tripped for under-frequency conditions before all three steps of load shedding have been utilized, in compliance with SPP criteria. This means that the generation subject to this Interconnection Agreement may not trip for under-frequency conditions on the transmission system until all under-frequency load-shedding relays have operated.

2. **Transmission Work:**

The Interconnection Customer will construct, own, operate, and maintain any customer owned 230 kV transmission line from the Interconnection Customer's 230/34.5 kV substation to the interconnection point at Yoakum Interchange. The interconnection customer is also responsible for the permitting and right of way of their 230 kV transmission line from their substation to the interconnection point at Yoakum Interchange as shown in Appendix A, Figure A- 1. ***The SPS transmission design group prior to any construction by the Interconnection Customer or its contractor on any customer 230 kV transmission lines, or doing work in close proximity to any SPS transmission line, will require an engineering review of the customer's design. It is the Interconnection Customer's responsibility to initiate the design review in a timely manner before construction of any transmission line begins. If the review has not been made or the design at any of the aforementioned locations is deemed inadequate, the crossing(s) and or termination into the new switching station will be delayed until the matters are resolved. SPS will not be held responsible for these delays.***

2.1. **Termination Structure:** The Requester's 230kV line termination structure located outside Yoakum Interchange will require final approval from SPS Transmission Design Group. This is to assure, but is not limited to, the maintaining of proper clearance on the slack span from the termination structure into the interchange. The Requester is required to terminate their 230kV transmission line at Yoakum Interchange. See Figure A- 4, which shows the Point of Interconnection and Change of Ownership.

3. **Right-Of-Way:**

3.1. **Permitting**: Permitting for the construction of the new 230 kV line terminal at Yoakum Interchange is not required from the Public Utility Commission in the State of Texas. The interconnection customer will be responsible for any permitting and right of way of their substation and the 230 kV transmission line from their substation to the interconnection point at Yoakum Interchange.

**4. Construction Power and Distribution Service:** It is the sole responsibility of the Interconnection Customer to make arrangements for both construction and station power, which may be required for the Interconnection Customer's wind farm facility. **Additionally, if the Interconnection Customer's substation(s) and/or construction site(s) are located outside of the SPS service area, SPS cannot provide station power (retail distribution service) and the Interconnection Customer needs to make arrangements for distribution service from the local retail provider.**

5. **Project and Operating Concerns:** Close work between SPS Transmission Design Group, the Interconnection Customer's personnel and local operating groups will be imperative in order to meet any in-service date that has been established.

6. **Fault Current Study:** The available fault current at the interconnection location, without any contribution from the wind farm facilities, is shown in Table 2.

**Table 2, - Available fault current at interconnection location**

| Short Circuit Information at Yoakum Interchange without contribution from Wind Farm Facility[d] | | | | |
|---|---|---|---|---|
| Fault Location | Fault Current (Amps) | | Impedance (Ω) | |
| | Line-to-Ground (L-G) | 3–Phase (3PH) | $Z^+$ | $Z^0$ |
| 230 kV Bus | 11,775 | 12,890 | 0.9593 + j10.2564 | 2.2299 + j13.0848 |

[d] Calculated faults applied at Yoakum Interchange 230 kV bus.

## Estimated Construction Costs

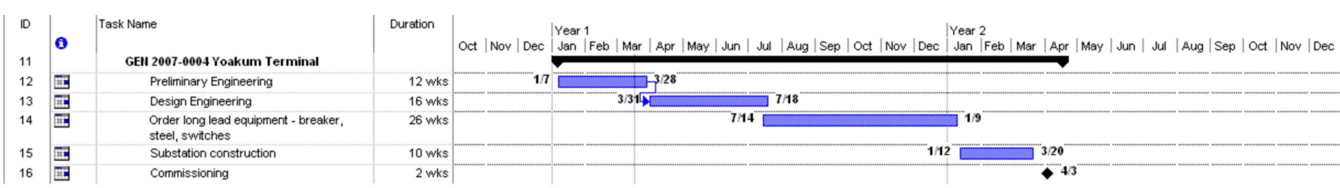
The projects required for the interconnection of this 150 MW Wind Farm facility consist of the projects summarized in the table below.

**Table 3, Required Interconnection Projects**[e]

| Project | Description | Yoakum Intg. |
|---|---|---|
| | **Network Upgrades** | |
| 1 | SPS Transmission Line Work | None |
| 2 | Right of Way-Substation | $ 40,000 |
| 3 | Disturbance Monitoring Device | $ 74,375 |
| | **Subtotal:** | **$ 114,375** |
| | **Interconnection Facilities (at the Interconnection Customer's expense)** | |
| 4 | Communications [f] | *$ See footnote* |
| 5 | Transmission 69kV Joint Crossing Structure[g] | $ 20,000 |
| 6 | 230 kV Breaker Line Terminal | $ 1,000,631 |
| 7 | Remote Terminal Unit (RTU) | $ 19,125 |
| 8 | Revenue metering | $ 74,251 |
| 9 | 230 kV Line arrestors | $ 11,156 |
| | **Subtotal:** | **$ 1,125,163** |
| | **Total Cost:** | **$1,219,538** |

## Engineering and Construction:

An engineering and construction schedule for this project is depicted below and is estimated at approximately fifteen (15) months. The schedule is shown for project duration purposes only and other factors associated with clearances, equipment delays and work schedules could cause additional delays. The schedule below is applicable after all required agreements are signed and internal approvals are granted.




All additional cost for work not identified in this study is the sole responsibility of the Interconnection Customer unless other arrangements are made.

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[e] The cost estimates are 2008 dollars with an accuracy level of ±20%.

[f] It is the Requester's responsibility to provide both the data circuit and both dial-up telephone circuits, see Section 1.13.

[g] It is anticipated that cost will be incurred if customers 230 kV line cross the 69 kV transmission line (Y95) from Tokio sub to SW 7788.

## Appendix A

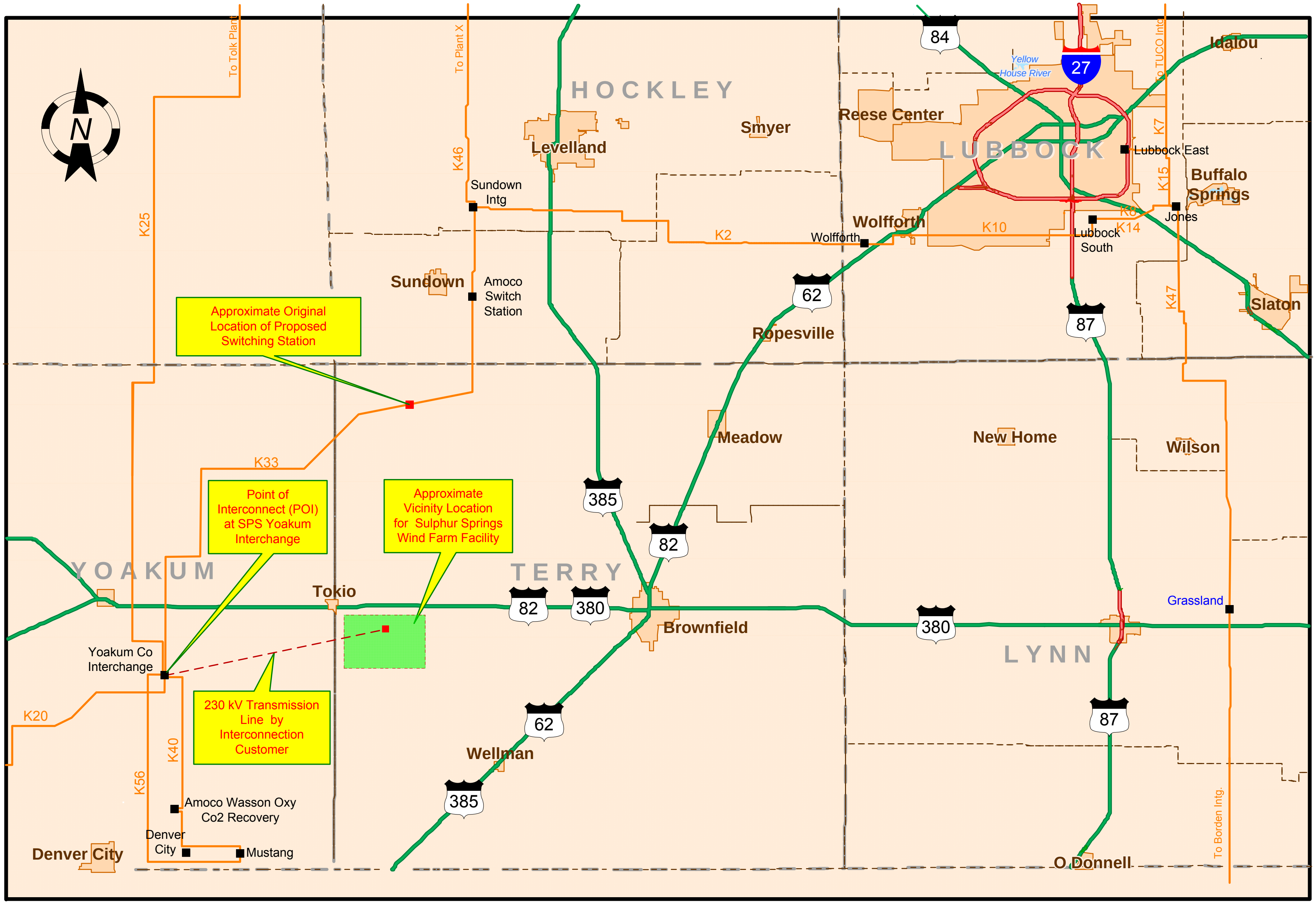



**Figure A- 1 Approximate location of proposed wind farm facility.**

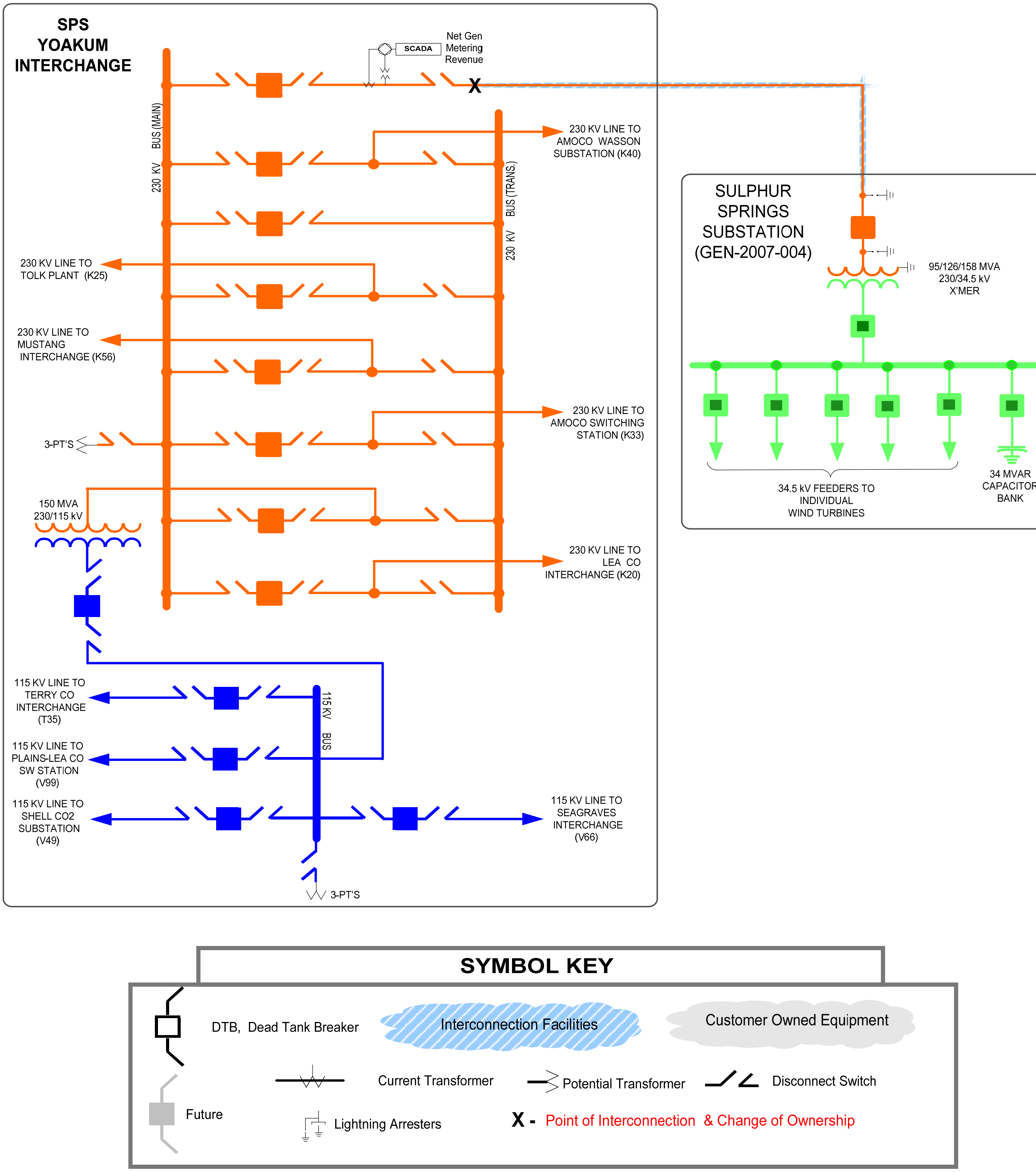



**Figure A- 2 One-line Diagram of New Switching Station**

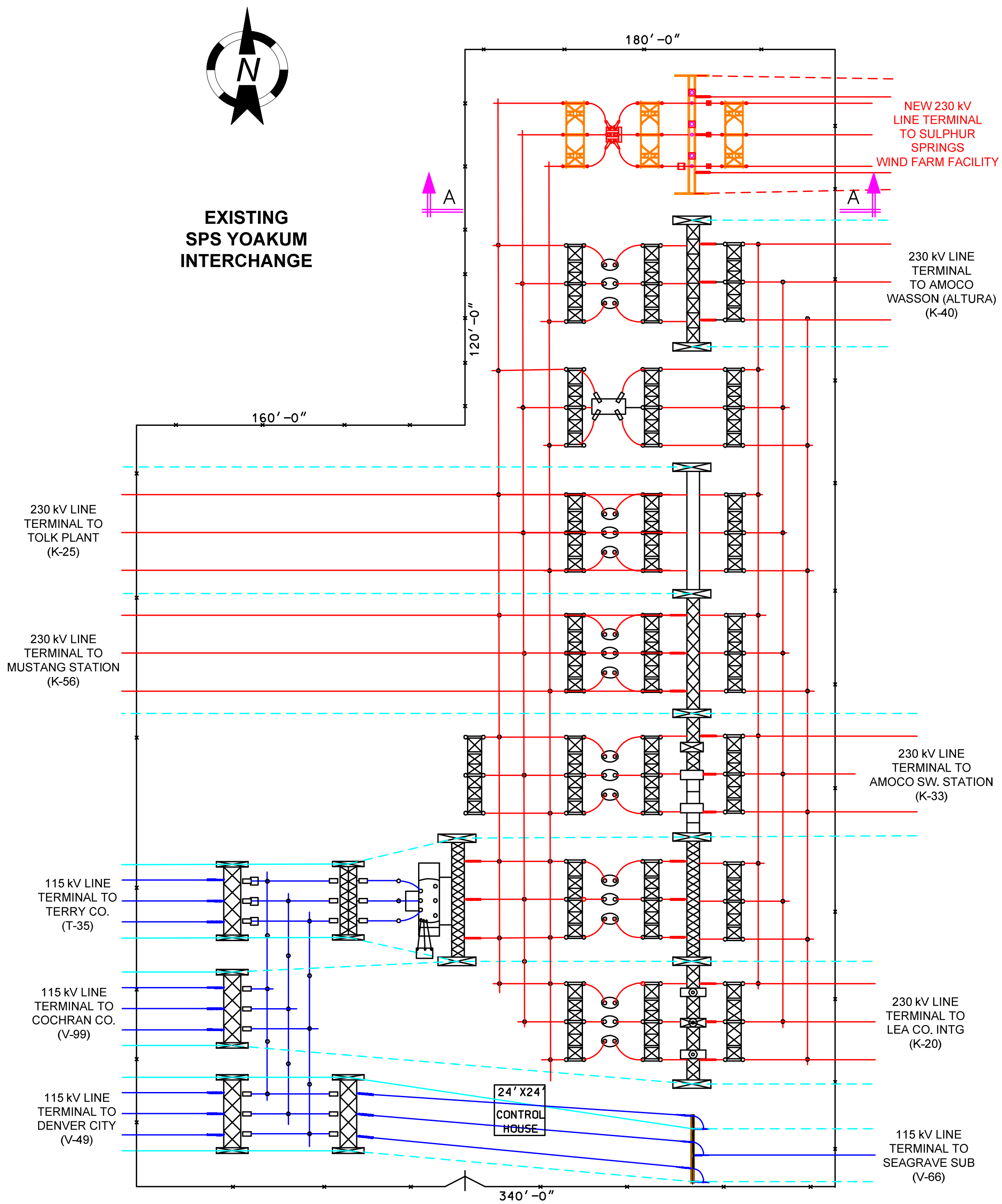



**Figure A- 3 Preliminary General Arrangement Plan View at Yoakum Interchange**

**CUSTOMER SHALL PROVIDE ALL MATERIAL FOR DEAD ENDING PHASES AND STATIC TO 230 kV DEAD END TOWER.**

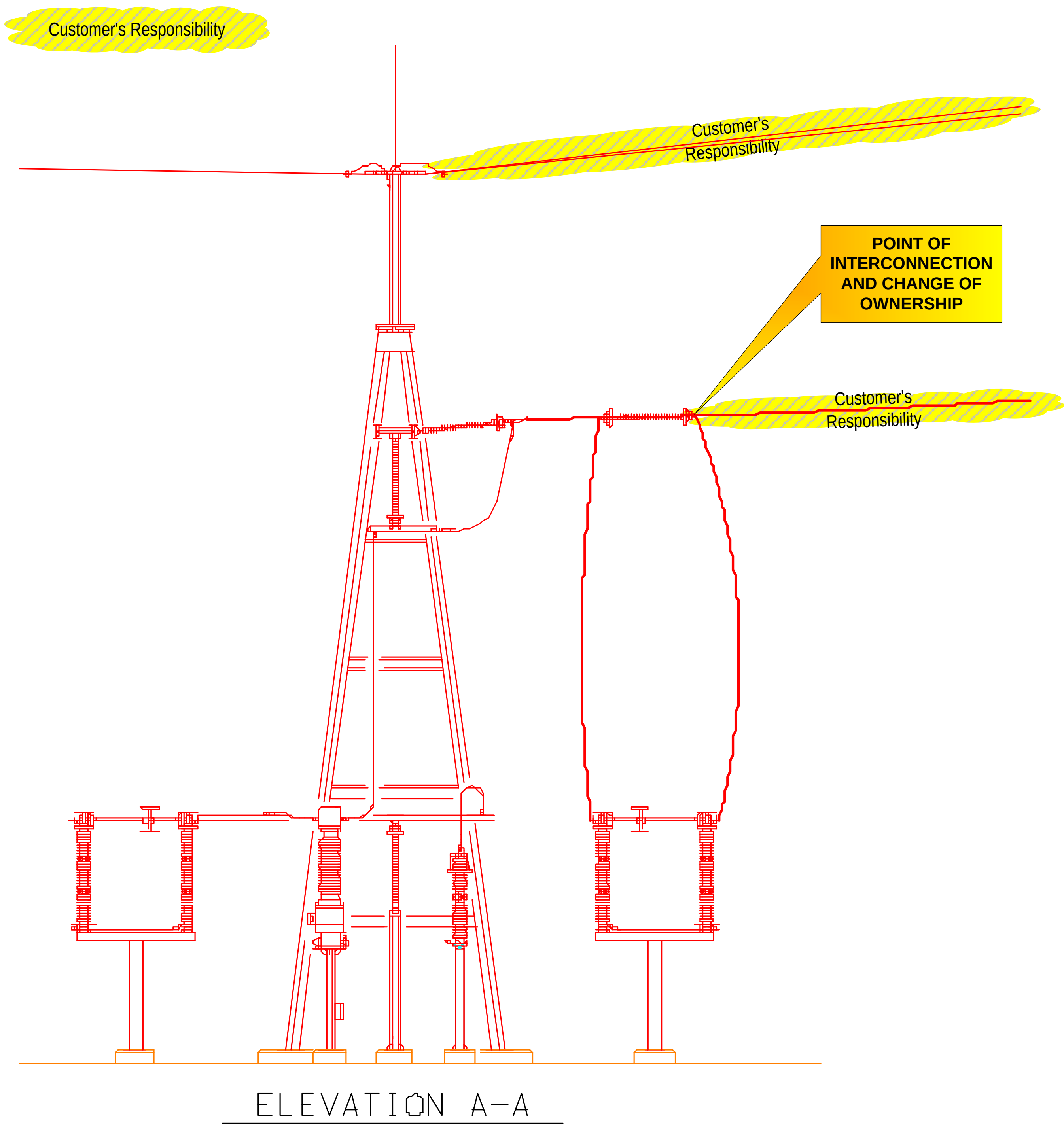



**Figure A- 4 Point of Interconnection & Change of Ownership (Preliminary)**

*– END OF REPORT –*

# *Attachment 1.*
# *Impact Restudy*

# Impact Re-Study
# For
# Generation Interconnection
# Request
# GEN-2007-004

***SPP Tariff Studies***

***(#GEN-2007-004)***

***May 2008***

## Executive Summary

<OMITTED TEXT> (Customer) had 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). SPP completed this Impact Study and published its report in December 2007 (see Impact Study for Generation Interconnection Request Gen-2007-004). The Customer proposed the Point of Interconnection (POI) to be on the Yoakum County Interchange – Amoco Switching Station 230 kV line. This will require building a new 230 kV three-breaker ring-bus substation at the POI.

Excel Energy was contracted to perform the Facility Study. In the Facility Study SPS proposed to provide a 230 kV line terminal at the Yoakum Interchange which now will be POI. This POI is closer to the Customer wind farm, and the SPS proposal will eliminate the need for constructing a new switching station which could not have been built in time for the Customer proposed in-service date of December 20, 2009. SPP has determined that this change in the point of interconnection does not constitute a material change in the interconnection request.

The purpose of this Impact Re-Study is to determine the impact on the transmission system stability as a result in the change of the POI.

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.

The Customer will be required to maintain a unity power factor at the point of interconnection to adhere to LGIA requirements to maintain a steady voltage schedule. The Customer will need to determine if the power factor capabilities of the Gamesa turbines will be able to maintain this required power factor. The study also showed that a dynamic reactive source (SVC or STATCOM) will not be required for FERC Order #661A LVRT requirements.

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) had 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). SPP completed this Impact Study and published its report in December 2007 (see Impact Study for Generation Interconnection Request Gen-2007-004). The Customer proposed the Point of Interconnection (POI) to be on the Yoakum County Interchange – Amoco Switching Station 230 kV line. This will require building a new 230 kV three-breaker ring-bus substation at the POI.

Excel Energy was contracted to perform the Facility Study. In the Facility Study SPS proposed to provide a 230 kV line terminal at the Yoakum Interchange which now will be POI. This POI is closer to the Customer wind farm, and the SPS proposal will eliminate the need for constructing a new switching station which could not have been built in time for the Customer proposed in-service date of December 20, 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 0.95 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

For a detailed discussion of the interconnection facilities, see the Facilities Study section of this document.

SPS has proposed to provide a 230 kV line terminal at its Yoakum Interchange. From the Yoakum Interchange, 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 to maintain a unity power factor at the Yoakum substation for all contingencies. The Customer will need to determine if the reactive compensation capabilities of the Gamesa turbines can meet this requirement at the point of interconnection. From the information provided by SPP, it appears a small capacitor bank may be necessary. 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 – Power Factor correction capacitor banks to maintain unity power factor at the POI (if needed) | * |
| 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) |
|---|---|
| **See the Facility Study section for details** | |
| | |
| **Total** | |

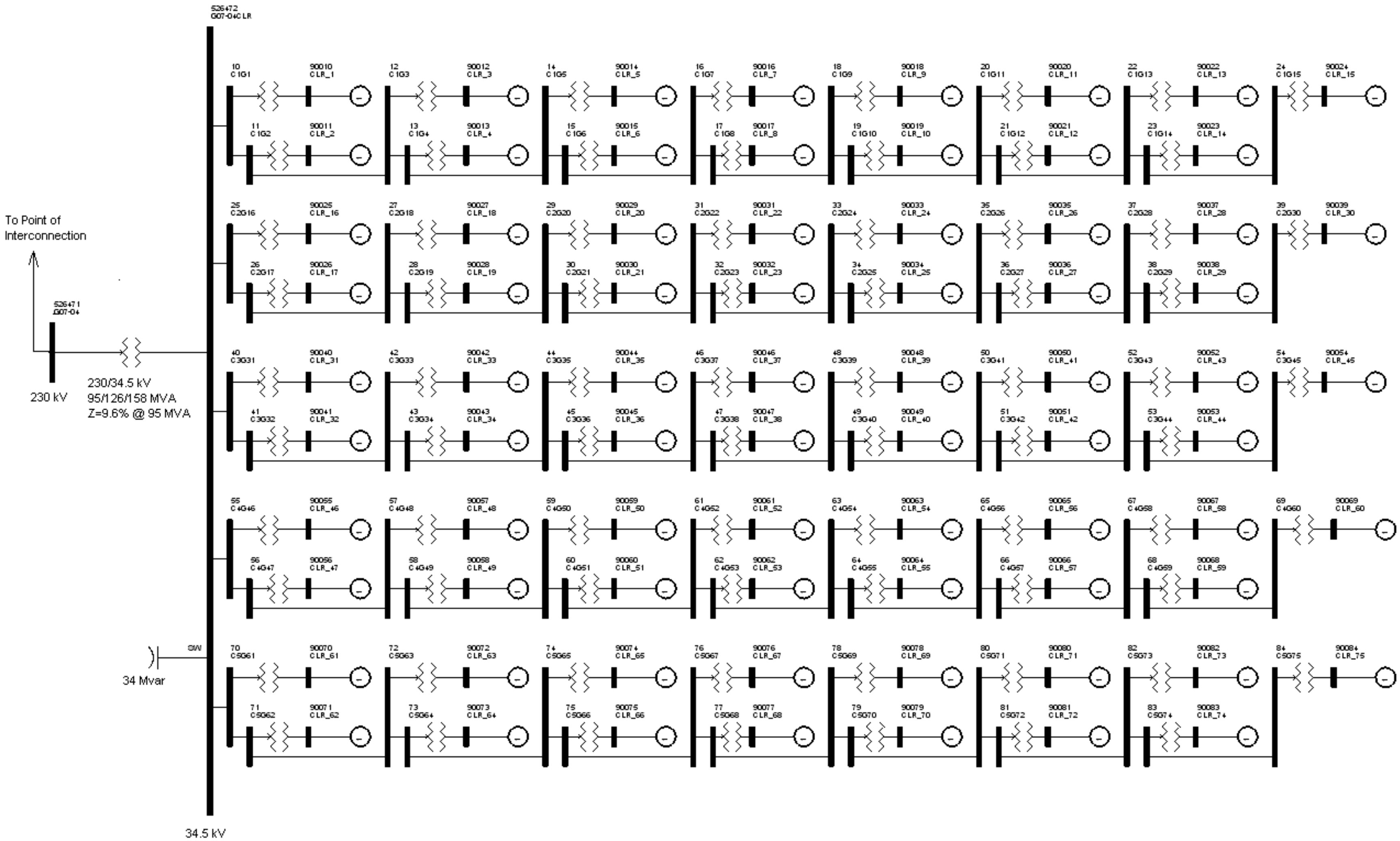



**Figure 1: One-Line Drawing of the Customer Generation Facility**

## 4.0 Power Factor Criteria

Southwest Power Pool' Large Generation Interconnection Agreement requires generation facilities to maintain a voltage schedule. In order to maintain the pre-project voltage schedule at the Yoakum substation, the Customer will be required to maintain a unity power factor at the point of interconnection. The point of measurement will be the interconnection point at Yoakum substation.

The Customer will need to determine if they can meet this power factor with the Gamesa turbines reactive capabilities. If not, additional capacitor banks could be required. From information provided to SPP for this study, it appears a capacitor bank may be necessary.

## 5.0 Stability Analysis

### 5.1 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.

### 5.2 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 a power factor that allows the turbines to operate closely to a 1.02 voltage schedule at the turbine bus. The factory default protection schemes were used for the turbines.

#### 5.2.1 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**

## 5.3 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_1 | 3 phase fault on the Amoco Switch (526460) to 2007-04 (526470) 230 kV line, near Amoco Switch. (526470 was the initially proposed POI located midway between Amoco Switch and Yoakum County.)<br>a. Apply fault at the Amoco Switch (526460) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from the Amoco Switch – 2007-04.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 2 | FLT21PH_1 | Single phase fault and sequence like Cont. No. 1 |
| 3 | FLT33PH_1 | 3 phase fault on the Yoakum County (526935) to 2007-04 (526470) 230 kV line, near Yoakum County. (526470 was the initially proposed POI located midway between Amoco Switch and Yoakum County.)<br>a. Apply fault at the Yoakum County (526935) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – 2007-04.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault. |
| 4 | FLT41PH_1 | 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.<br>a. Apply fault at the Yoakum County (526935) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – Amoco Wasson.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Yoakum County (526935) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – Lea County.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Amoco Switch (526460) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Amoco Switch – Sundown.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Sundown (526435) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Sundown – Plant X.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Sundown (526435) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Sundown – Wolfforth.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Yoakum County (526935) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – Tolk.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Yoakum County (526935) 230 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – Mustang.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Yoakum County (526935) 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Yoakum County – Prentice.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Terry County (526736) 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Terry County – Wolfforth.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Denver City (527136) 115 kV bus.<br>b. Clear fault after 5 cycles by tripping the line from Denver City – Amerada/Hess County.<br>c. Wait 20 cycles, and then re-close the line in (b) back into the fault.<br>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)**

## 5.4 <u>Further Model Preparation</u>

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**

# 6.0 <u>Results</u>

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_1 | STABLE | STABLE |
| FLT21PH_1 | STABLE | STABLE |
| FLT33PH_1 | STABLE | STABLE |
| FLT41PH_1 | 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**

## 7.0 <u>Conclusion</u>

No stability concerns presently exist for the GEN-2007-004 wind farm as a result of changing the POI to the Yoakum Interchange.  The wind farm and the transmission system remain stable for all contingencies studied.

Due to the reactive power losses on the collector system including the substation transformer, the Customer may need to install additional capacitor banks in its substation in order to maintain a unity power factor at the point of interconnection.  The study also showed that a dynamic reactive source (SVC or STATCOM) will not be required.

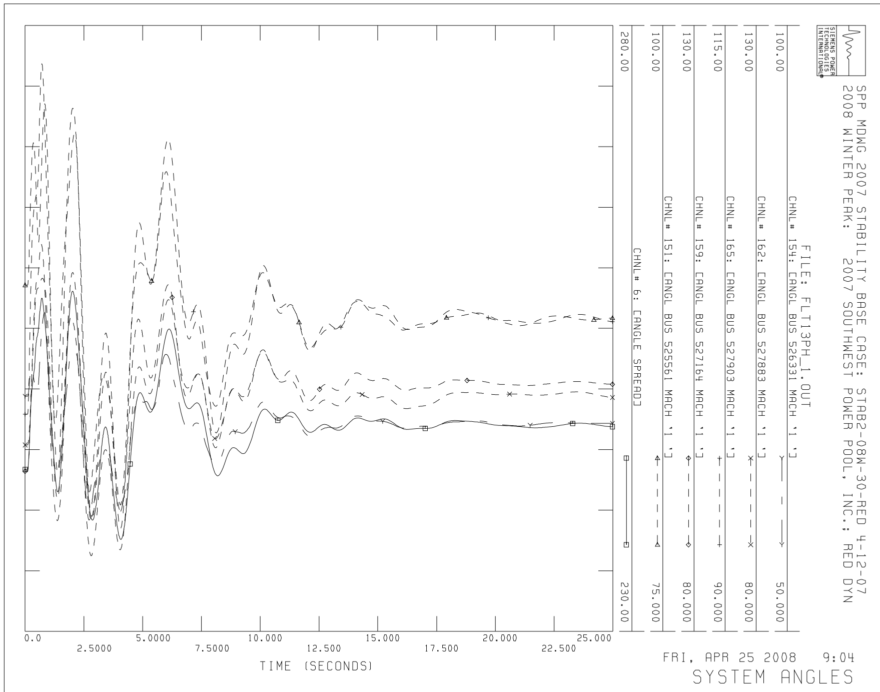
The Stability study results also show that the wind farm will meet FERC Order #661A's Low Voltage Ride Through (LVRT) provisions when using the Gamesa G87 2.0 MW turbines with the factory default under/over voltage and under/over frequency protection schemes.

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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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT13PH_1.OUT
CHNL# 154: [ANGL BUS 526331 MACH '1 '] 100.00 50.000
CHNL# 162: [ANGL BUS 527883 MACH '1 '] 130.00 80.000
CHNL# 165: [ANGL BUS 527903 MACH '1 '] 115.00 90.000
CHNL# 159: [ANGL BUS 527164 MACH '1 '] 130.00 80.000
CHNL# 151: [ANGL BUS 525561 MACH '1 '] 100.00 75.000
CHNL# 6: [ANGLE SPREAD] 280.00 230.00
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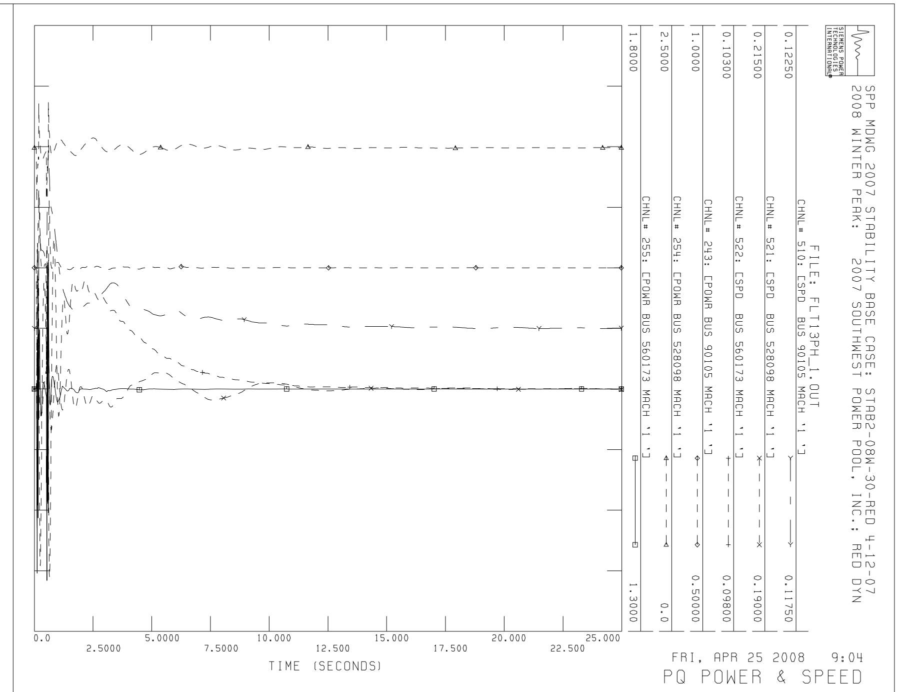
TIME (SECONDS)
FRI, APR 25 2008 9:04
SYSTEM ANGLES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 521: [SPD BUS 528098 MACH '1 '] 0.21500 0.19000
CHNL# 522: [SPD BUS 560173 MACH '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
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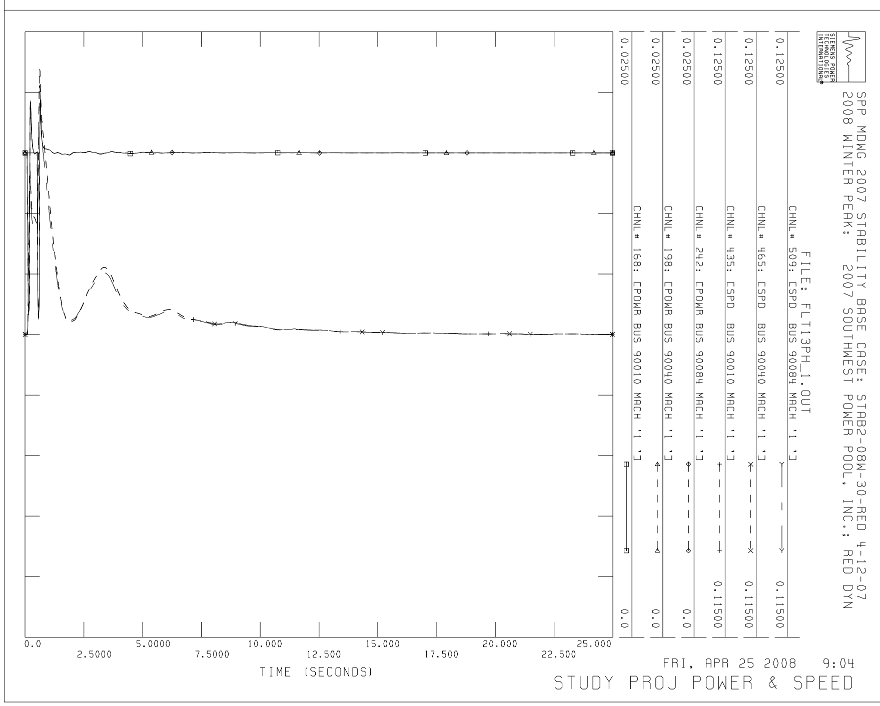
PQ POWER & SPEED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CHNL# 435: [SPD BUS 90010 MACH '1 '] 0.12500 0.11500
CHNL# 242: [POWR BUS 90084 MACH '1 '] 0.02500 0.0
CHNL# 198: [POWR BUS 90040 MACH '1 '] 0.02500 0.0
CHNL# 168: [POWR BUS 90010 MACH '1 '] 0.02500 0.0
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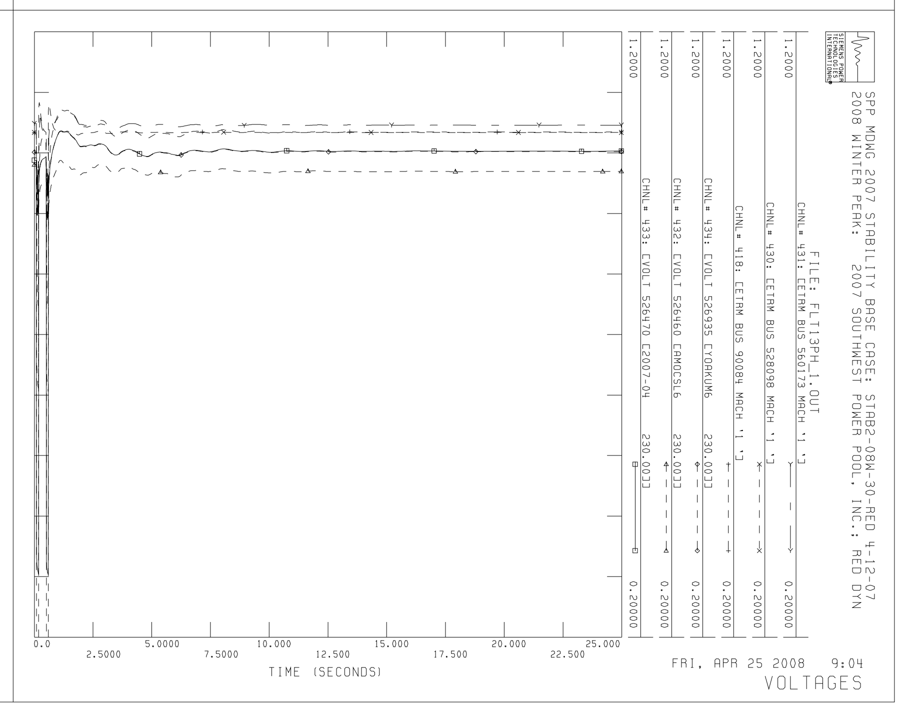
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CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 433: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
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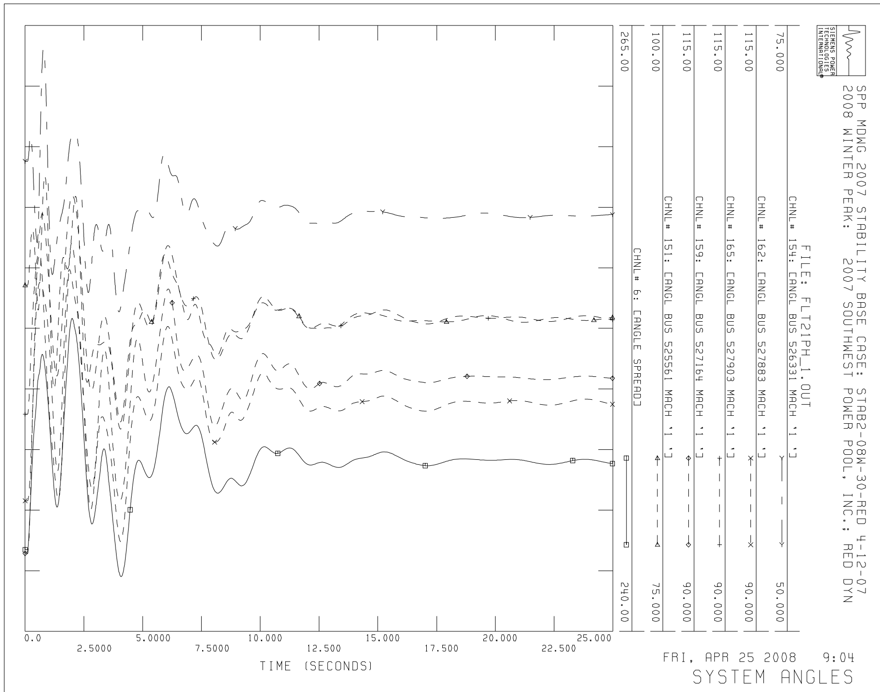
VOLTAGES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CHNL# 162: [ANGL BUS 527883 MACH '1 ']
CHNL# 165: [ANGL BUS 527903 MACH '1 ']
CHNL# 159: [ANGL BUS 527164 MACH '1 ']
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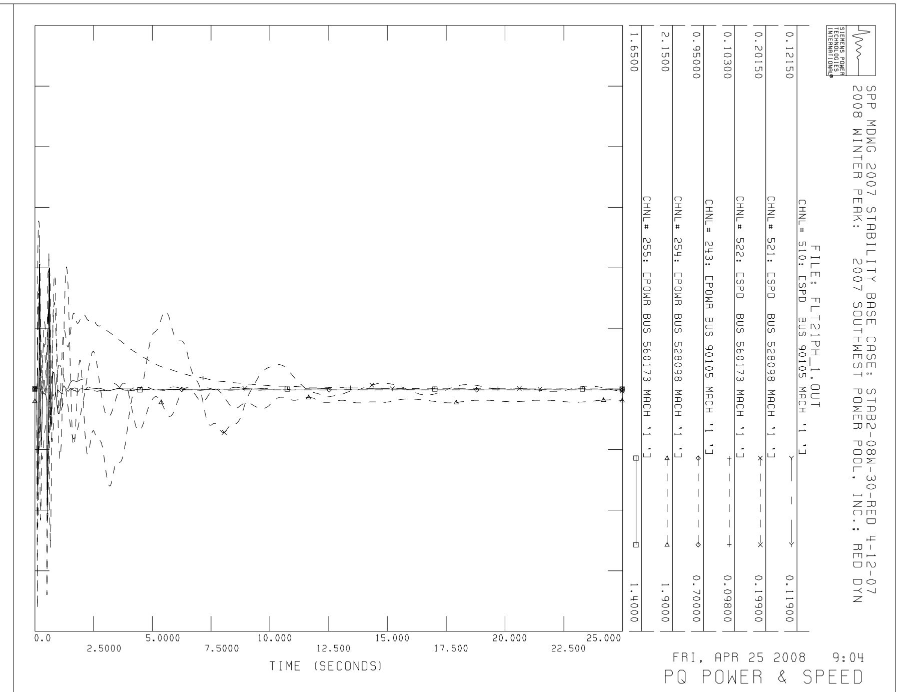
SYSTEM ANGLES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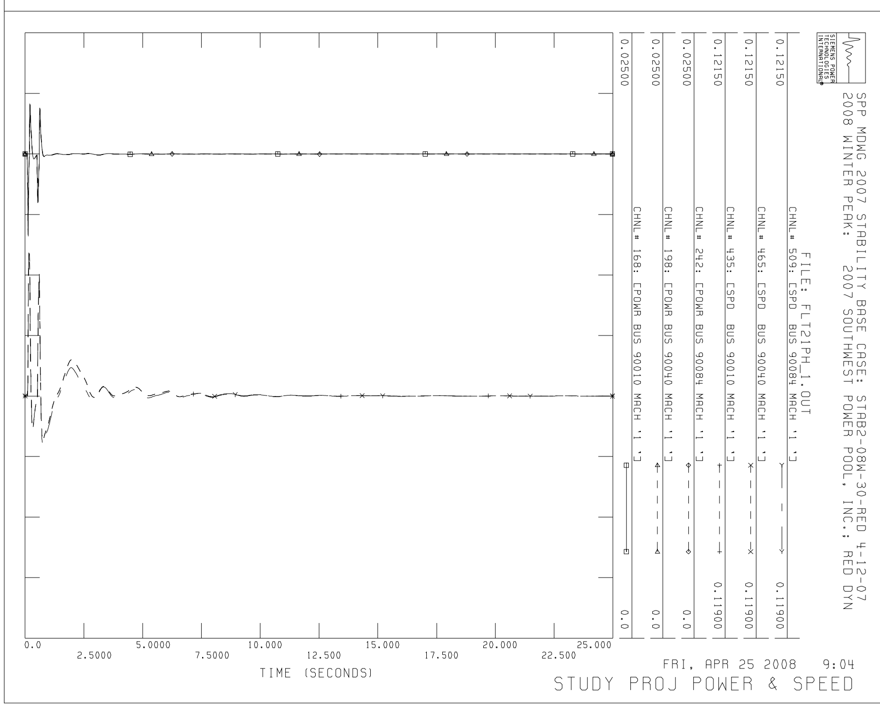
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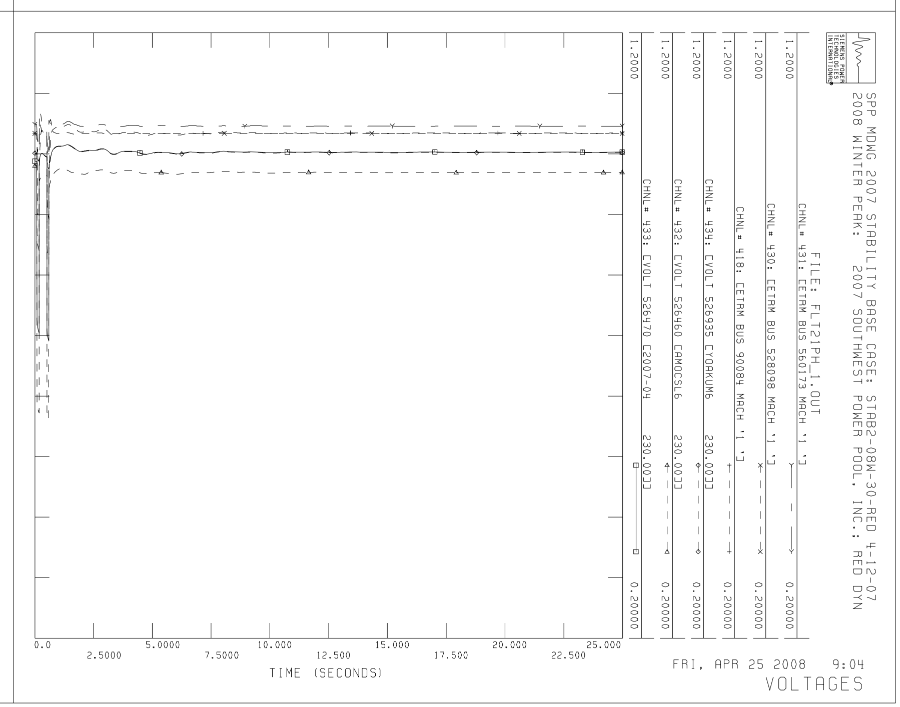
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CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]]
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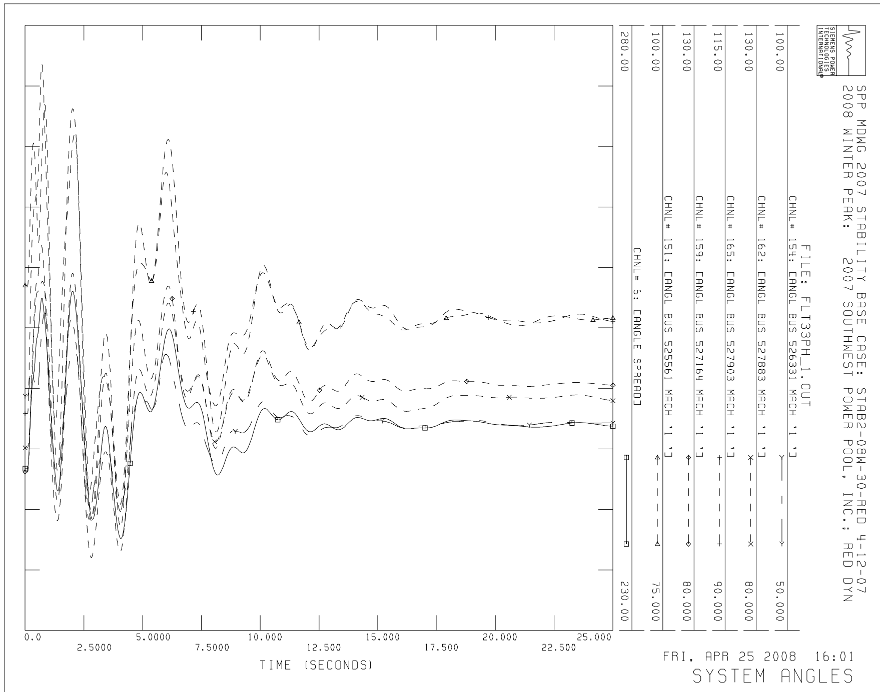
VOLTAGES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CHNL# 159: CANGL BUS 527164 MACH '1 ' 130.00 80.000
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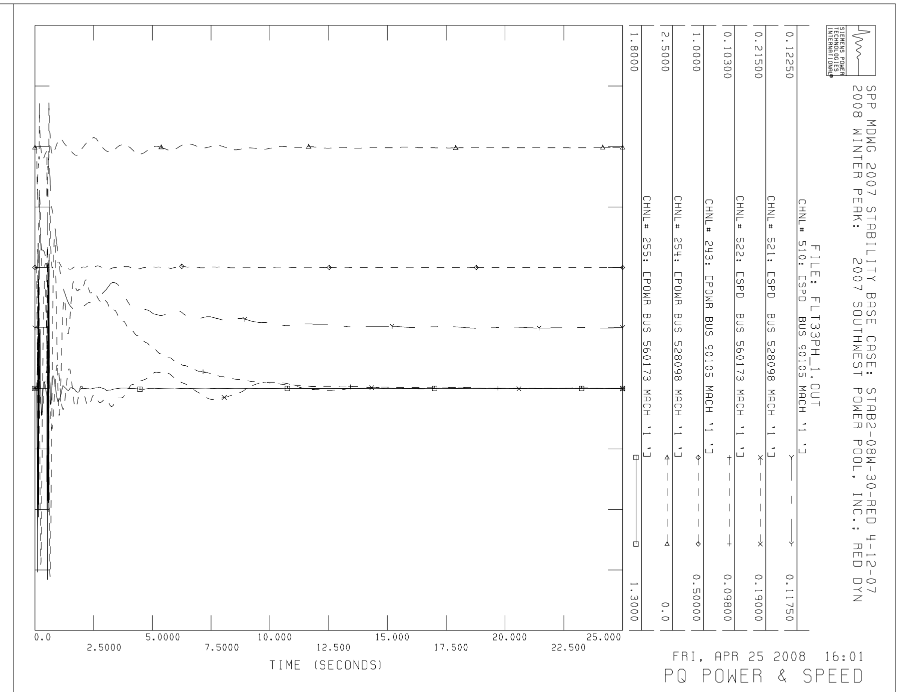
SYSTEM ANGLES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CHNL# 243: CPOWR BUS 90105 MACH '1 ' 1.0000 0.50000
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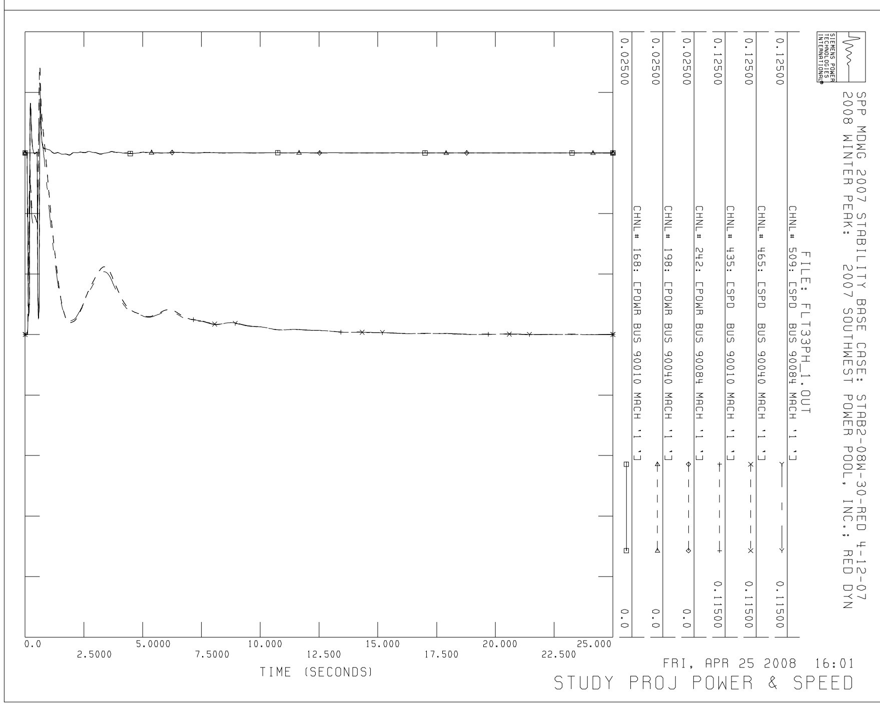
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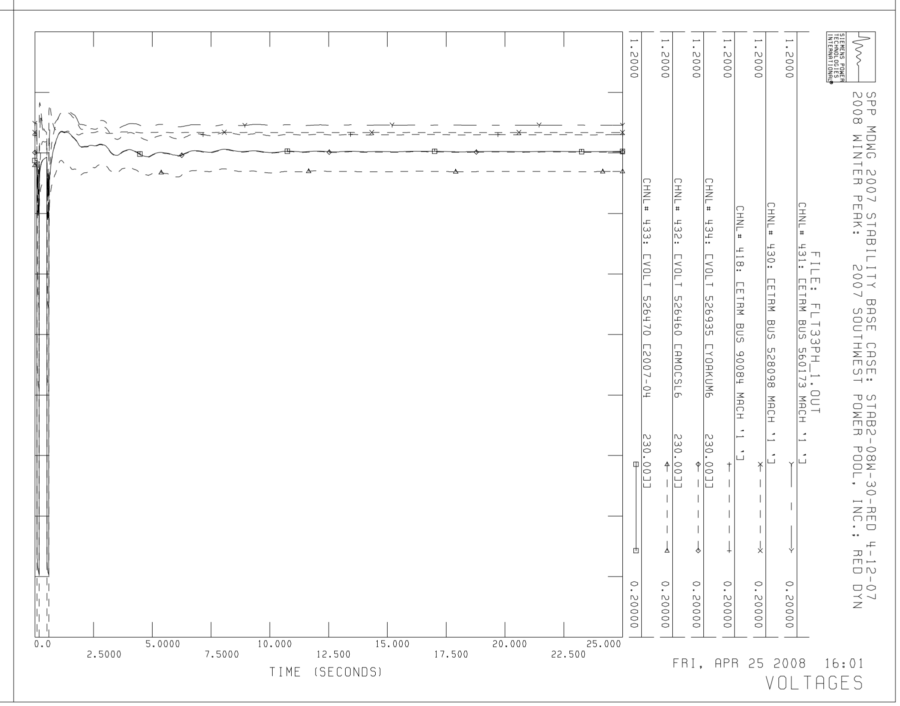
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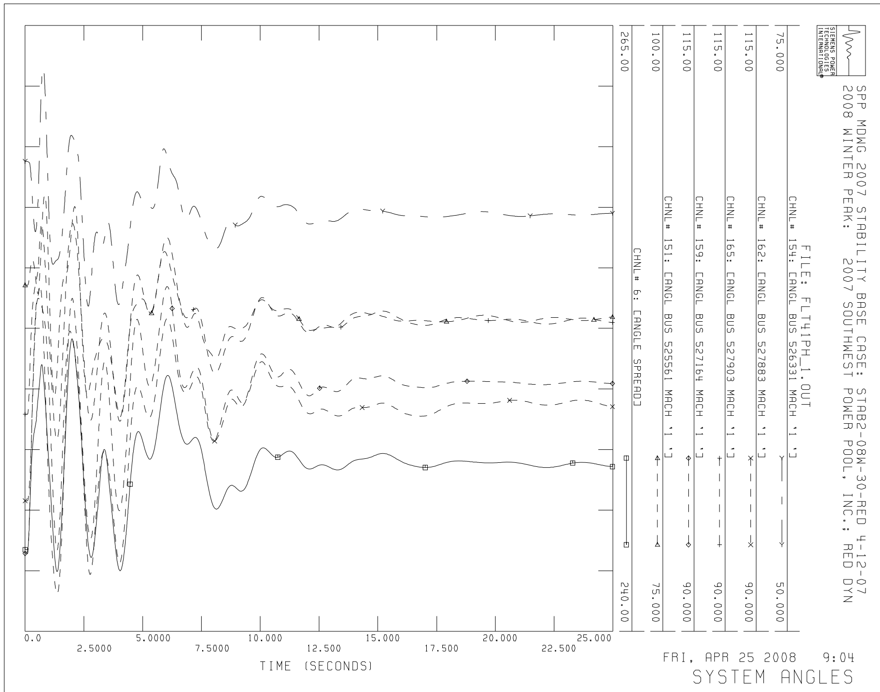
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CHNL# 165: CANGL BUS 527903 MACH '1 ' 115.00 90.000
CHNL# 159: CANGL BUS 527164 MACH '1 ' 115.00 90.000
CHNL# 151: CANGL BUS 525561 MACH '1 ' 100.00 75.000
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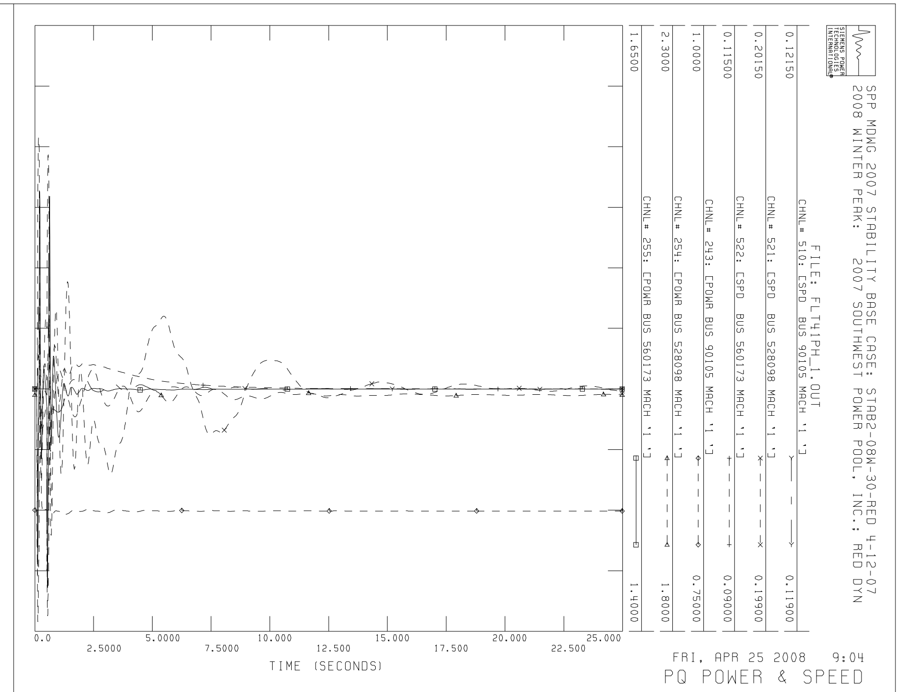
SYSTEM ANGLES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CHNL# 243: CPOWR BUS 90105 MACH '1 ' 1.0000 0.75000
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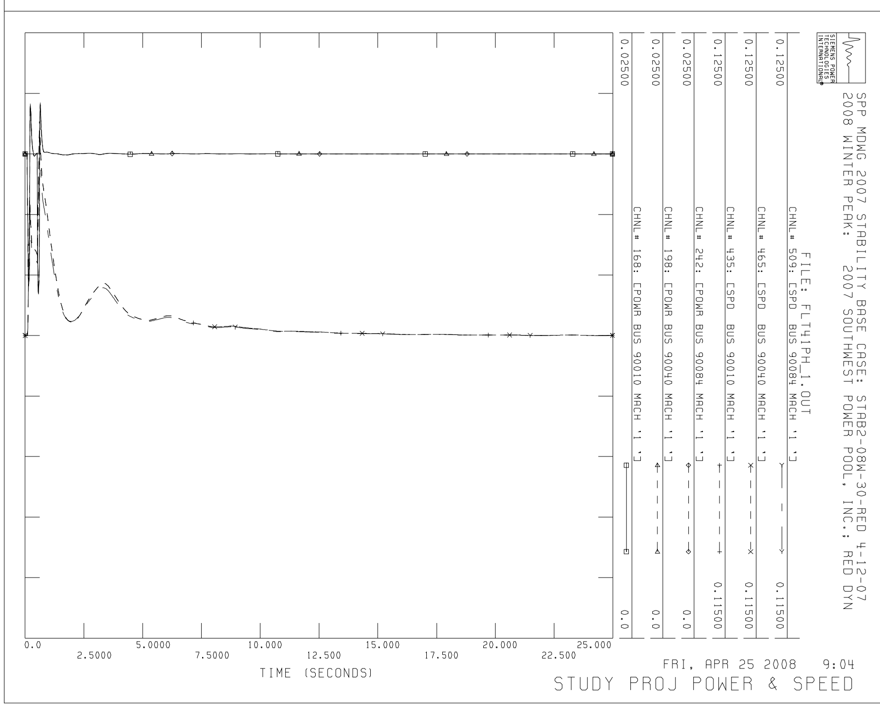
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CHNL# 465: CSPD BUS 90040 MACH '1 ' 0.12500 0.11500
CHNL# 435: CSPD BUS 90010 MACH '1 ' 0.12500 0.11500
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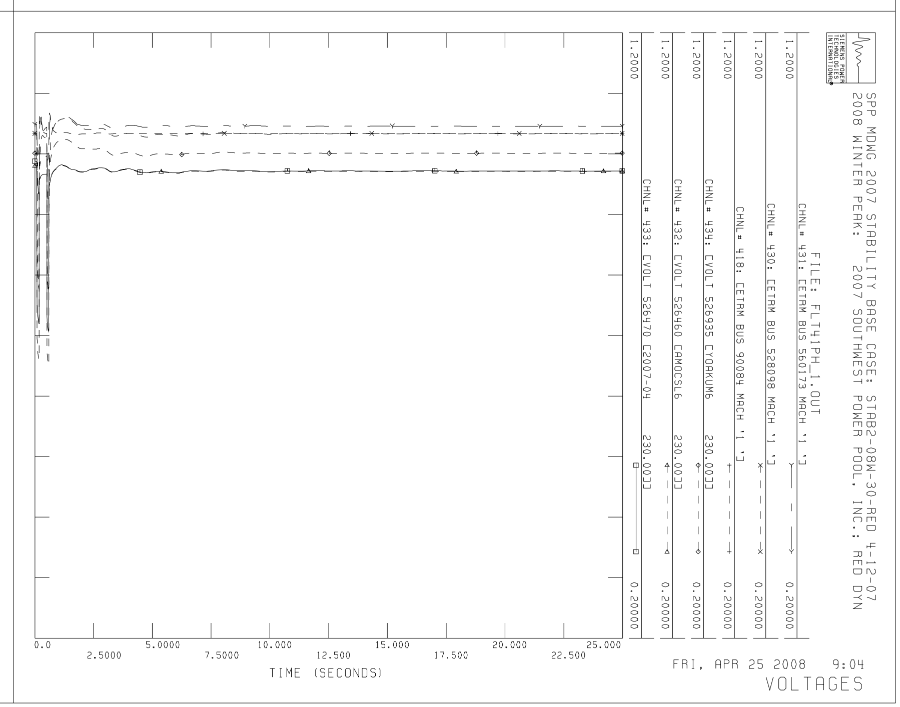
STUDY PROJ POWER & SPEED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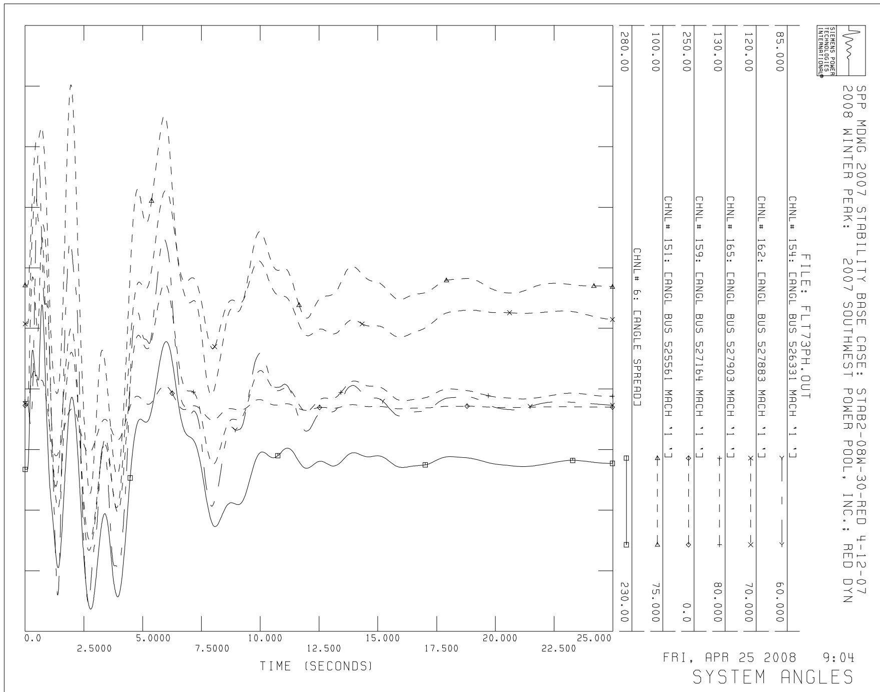
FRI, APR 25 2008 9:04
VOLTAGES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 159: [ANGL BUS 527164 MACH '1 '] 250.00 0.0
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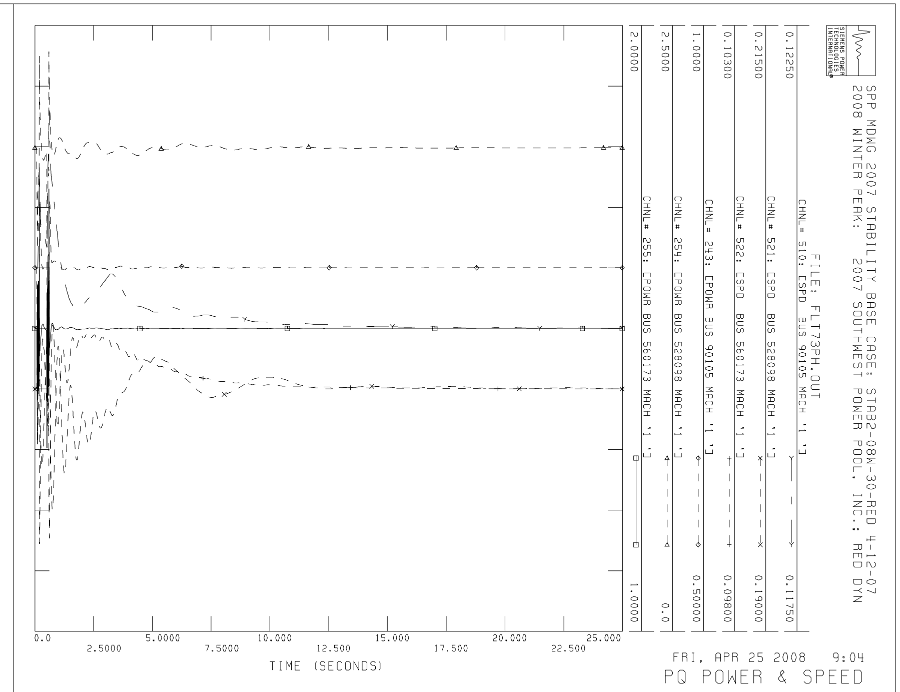
SYSTEM ANGLES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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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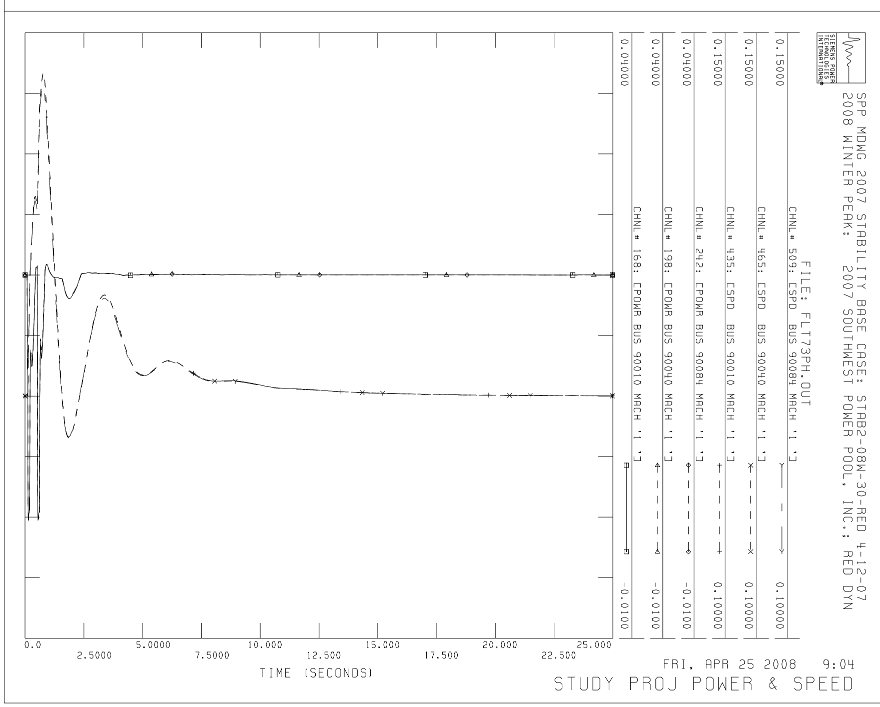
PQ POWER & SPEED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2008 WINTER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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CHNL# 242: [POWR BUS 90084 MACH '1 '] 0.04000 -0.0100
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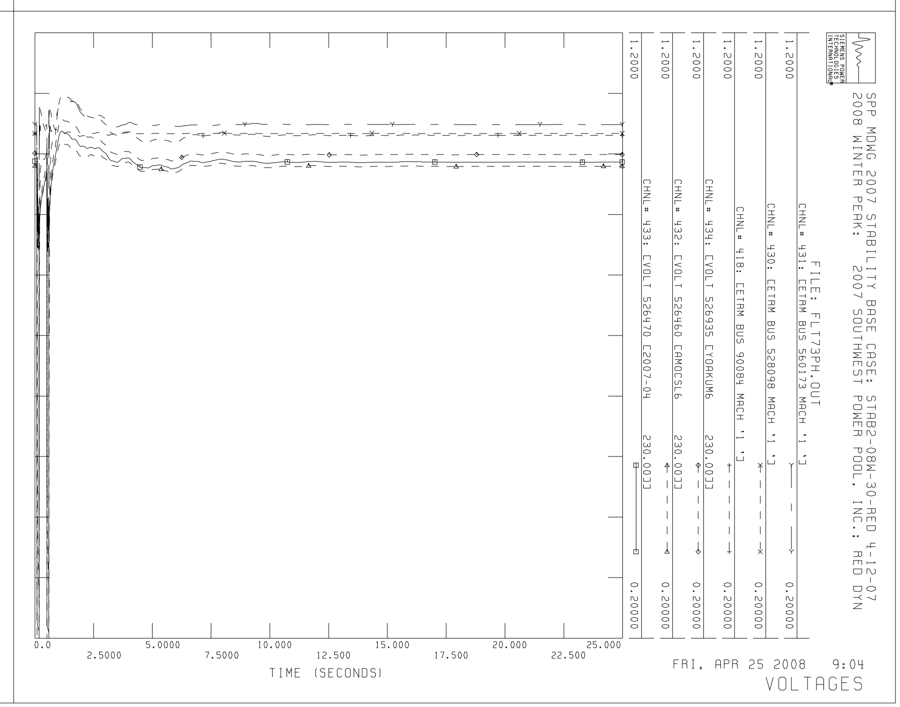
STUDY PROJ POWER & SPEED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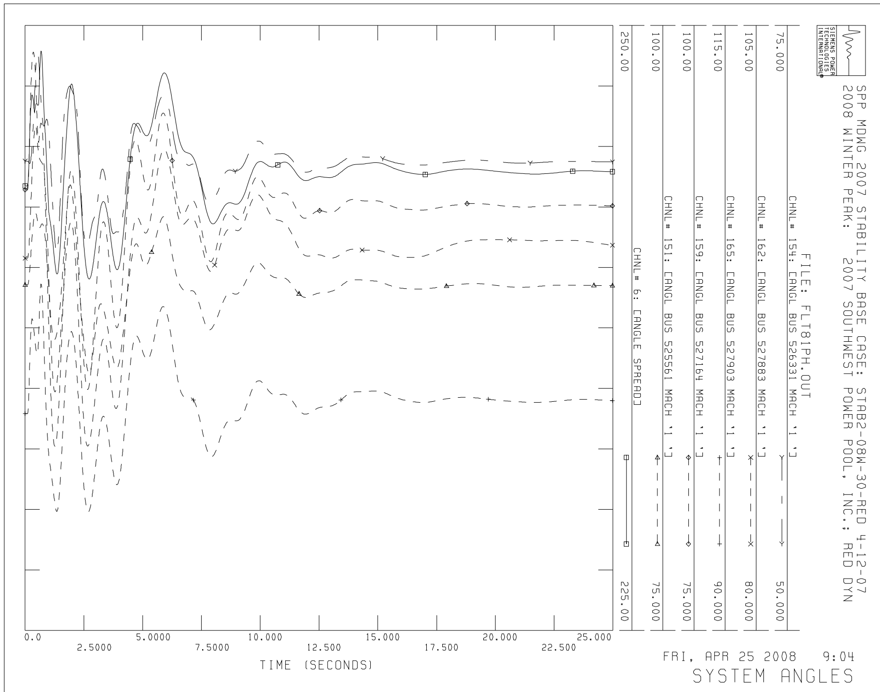
VOLTAGES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CHNL# 165: [ANGL BUS 527903 MACH '1 '] 115.00 90.000
CHNL# 159: [ANGL BUS 527164 MACH '1 '] 100.00 75.000
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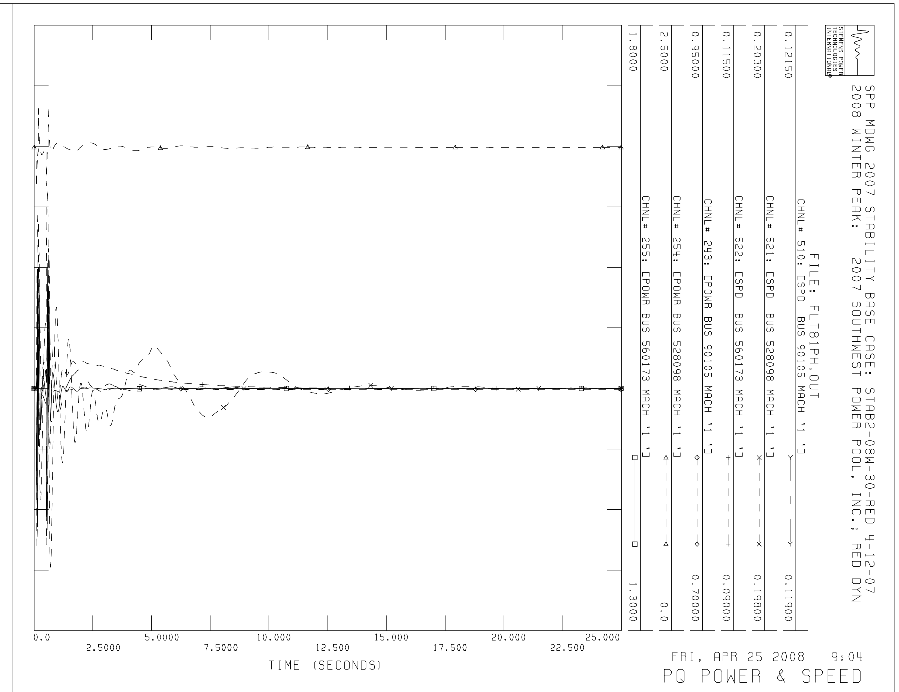
TIME (SECONDS)
FRI, APR 25 2008 9:04
SYSTEM ANGLES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CHNL# 521: [SPD BUS 528098 MACH '1 '] 0.20300 0.19800
CHNL# 522: [SPD BUS 560173 MACH '1 '] 0.11500 0.09000
CHNL# 243: [POWR BUS 90105 MACH '1 '] 0.95000 0.70000
CHNL# 254: [POWR BUS 528098 MACH '1 '] 2.5000 0.0
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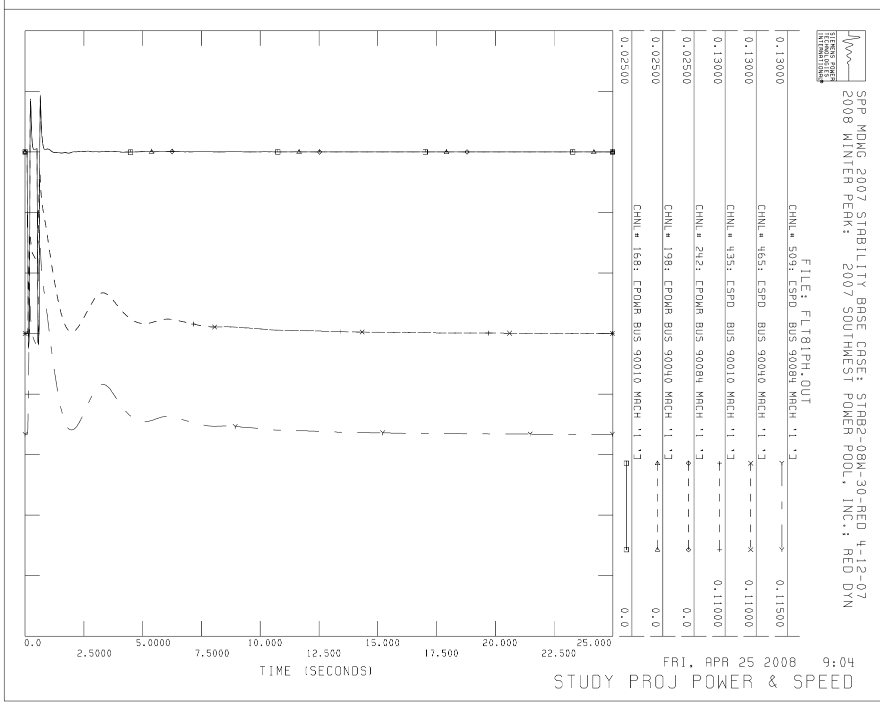
FRI, APR 25 2008 9:04
PQ POWER & SPEED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CHNL# 465: [SPD BUS 90040 MACH '1 '] 0.13000 0.11000
CHNL# 435: [SPD BUS 90010 MACH '1 '] 0.13000 0.11000
CHNL# 242: [POWR BUS 90084 MACH '1 '] 0.02500 0.0
CHNL# 198: [POWR BUS 90040 MACH '1 '] 0.02500 0.0
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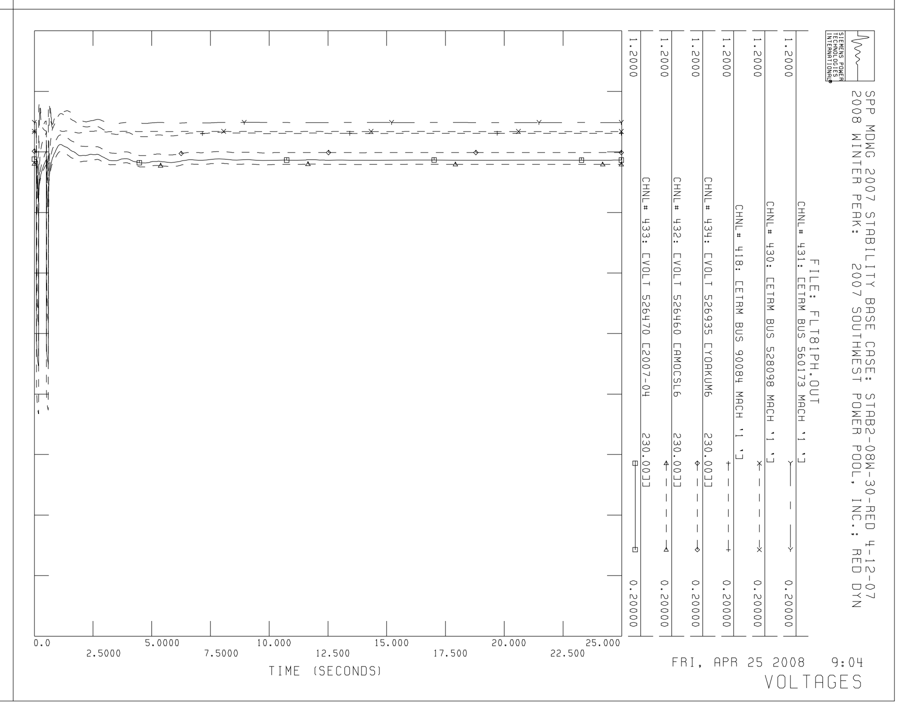
FRI, APR 25 2008 9:04
STUDY PROJ POWER & SPEED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CHNL# 430: [ETRM BUS 528098 MACH '1 '] 1.2000 0.20000
CHNL# 418: [ETRM BUS 90084 MACH '1 '] 1.2000 0.20000
CHNL# 434: [VOLT 526935 [YOAKUM6 230.00]] 1.2000 0.20000
CHNL# 432: [VOLT 526460 [AMOCSL6 230.00]] 1.2000 0.20000
CHNL# 433: [VOLT 526470 [2007-04 230.00]] 1.2000 0.20000
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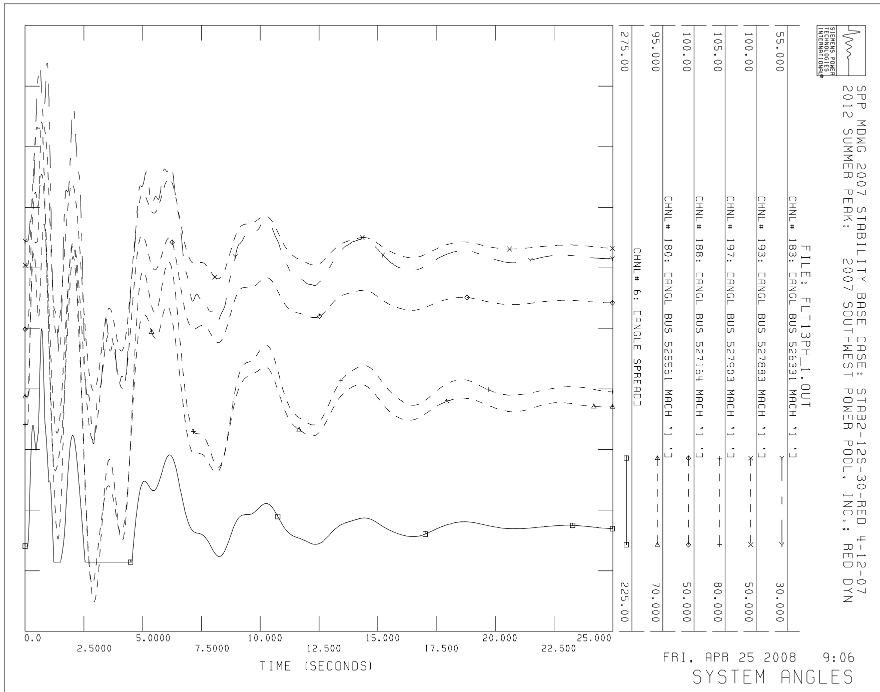
VOLTAGES

## APPENDIX B.

### SELECTED STABILITY PLOTS – 2012 Summer Peak

All plots available on request.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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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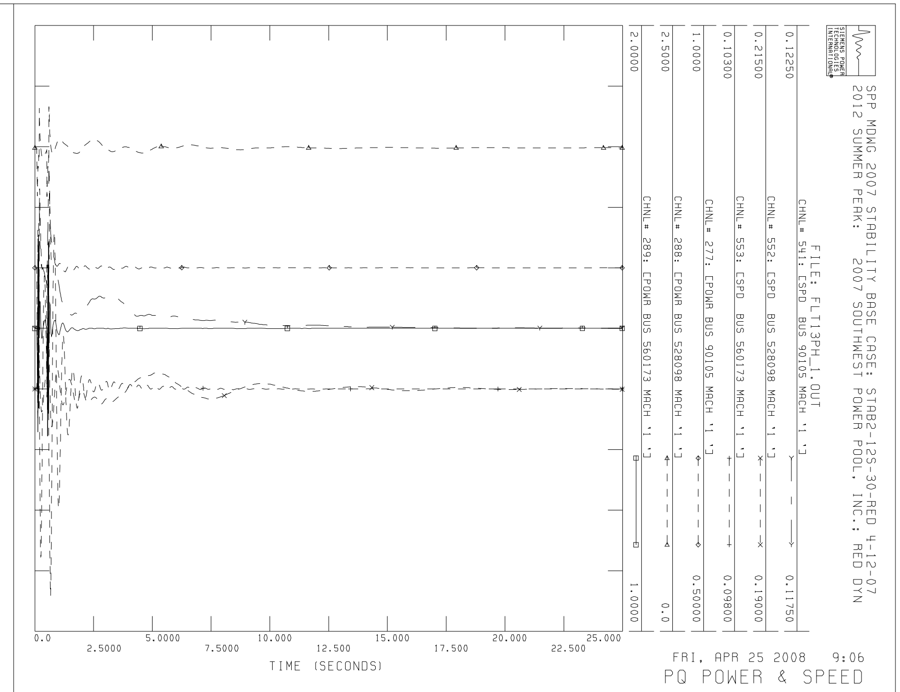
CHNL# 6: [ANGLE SPREAD]
TIME (SECONDS)
FRI, APR 25 2008 9:06
SYSTEM ANGLES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CHNL# 277: [POWR BUS 90105 MACH '1 ']
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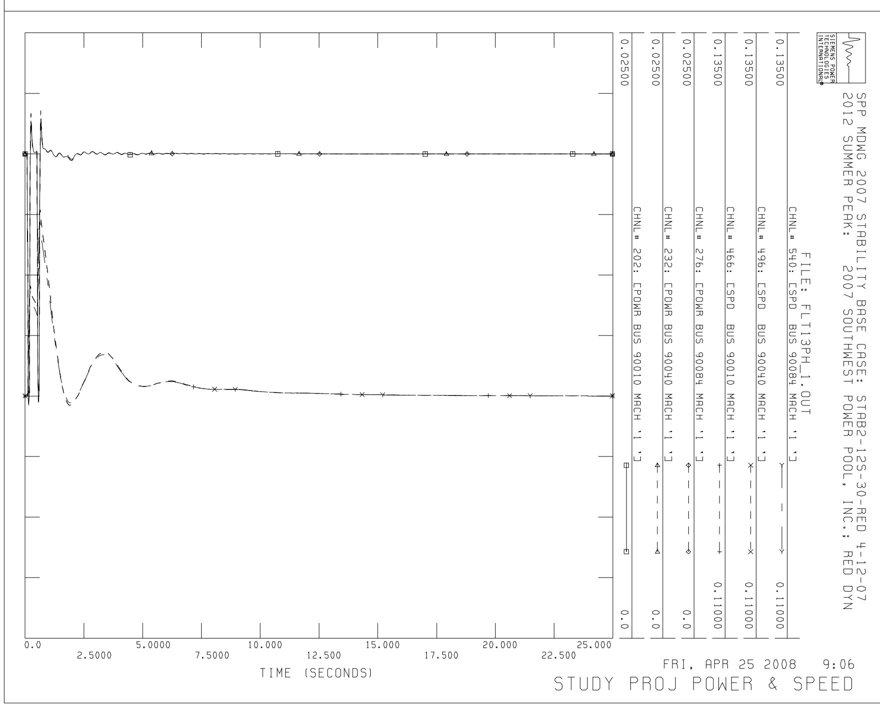
PQ POWER & SPEED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CHNL# 276: [POWR BUS 90084 MACH '1 ']
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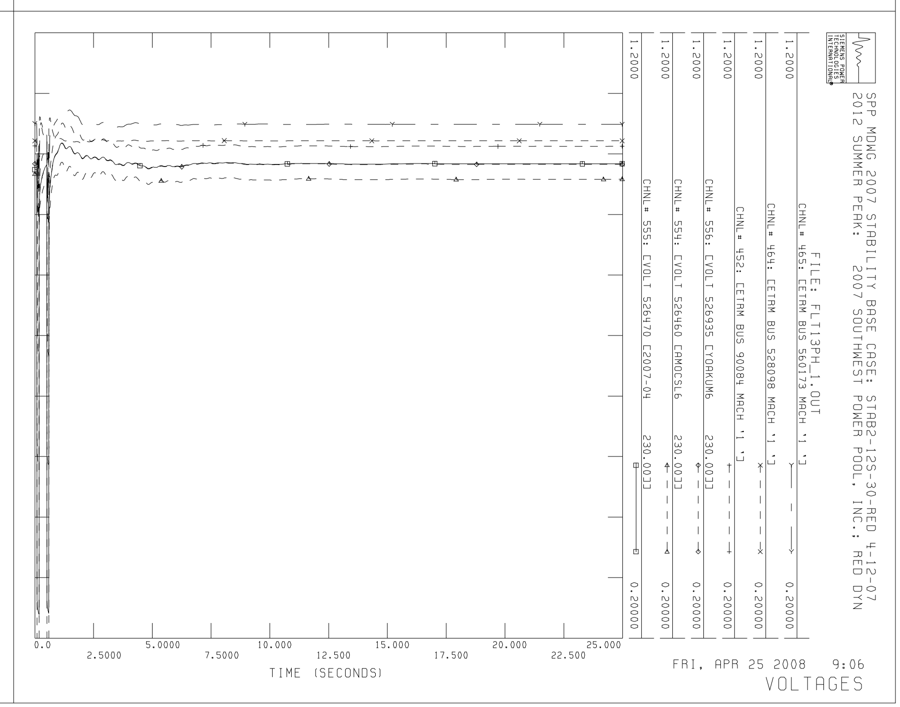
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CHNL# 464: [ETRM BUS 528098 MACH '1 ']
CHNL# 452: [ETRM BUS 90084 MACH '1 ']
CHNL# 556: [VOLT 526935 [YOAKUM6 230.00]]
CHNL# 554: [VOLT 526460 [AMOCSL6 230.00]]
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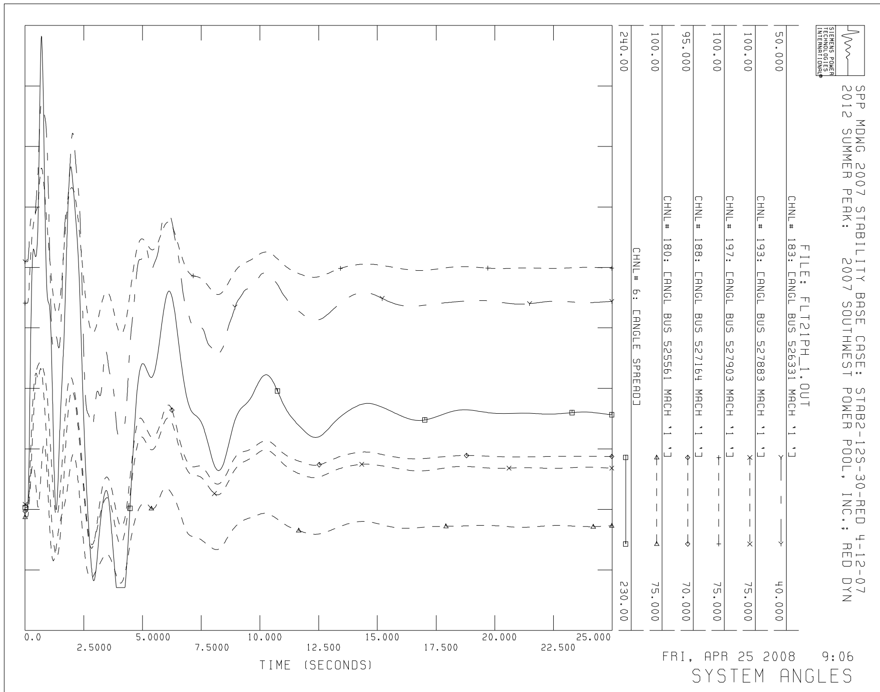
VOLTAGES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CHNL# 197: CANGL BUS 527903 MACH '1 '] 100.00 75.000
CHNL# 188: CANGL BUS 527164 MACH '1 '] 95.000 70.000
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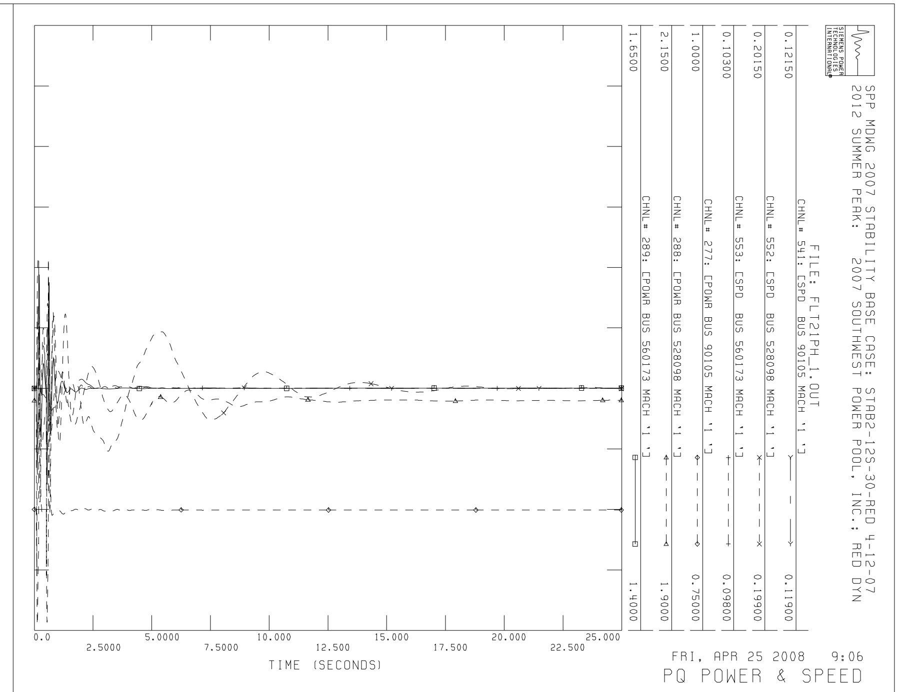
SYSTEM ANGLES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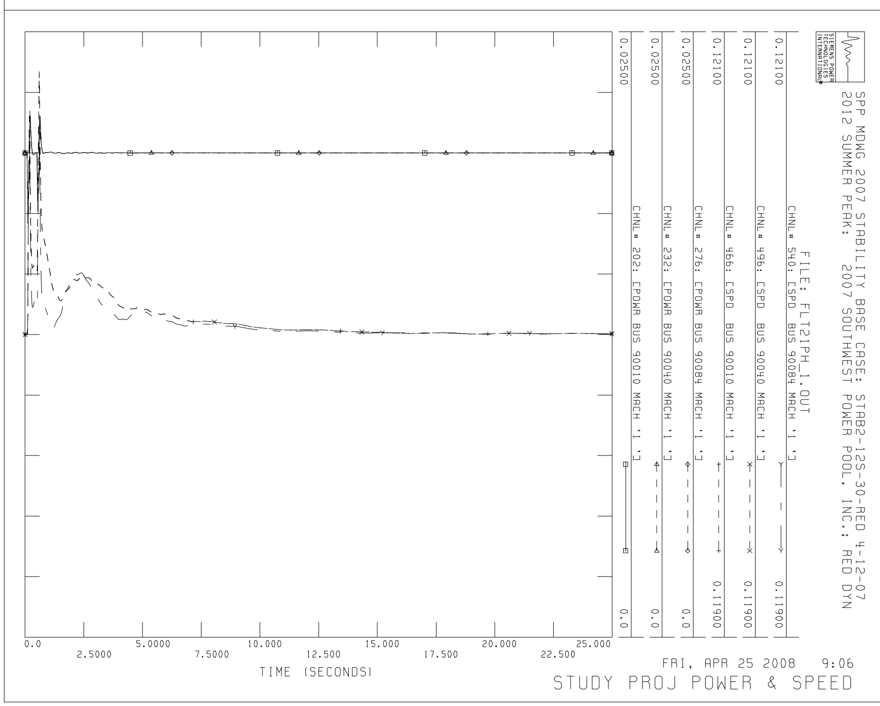
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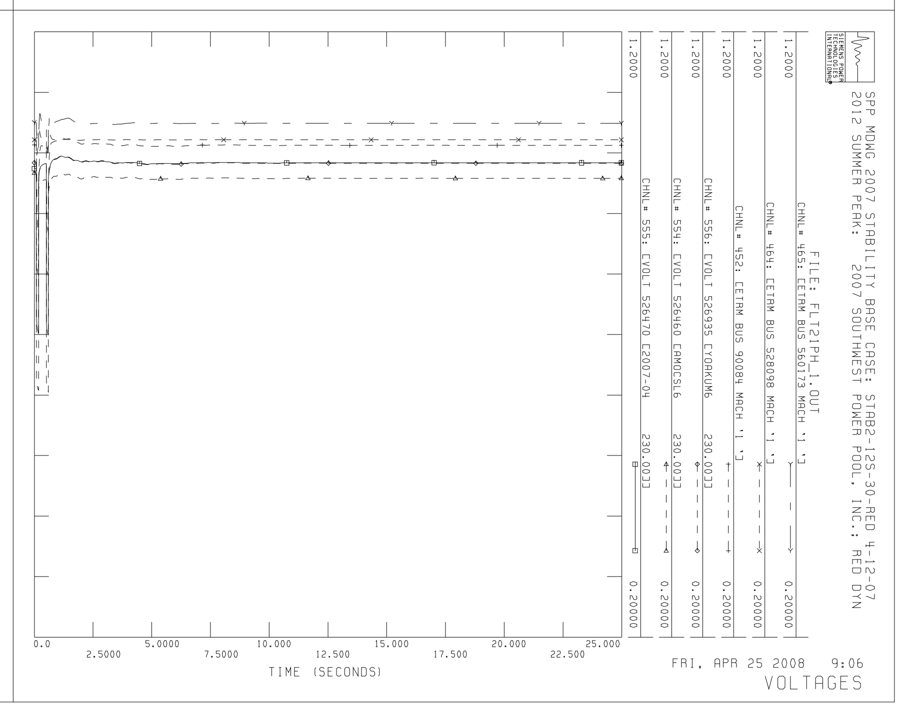
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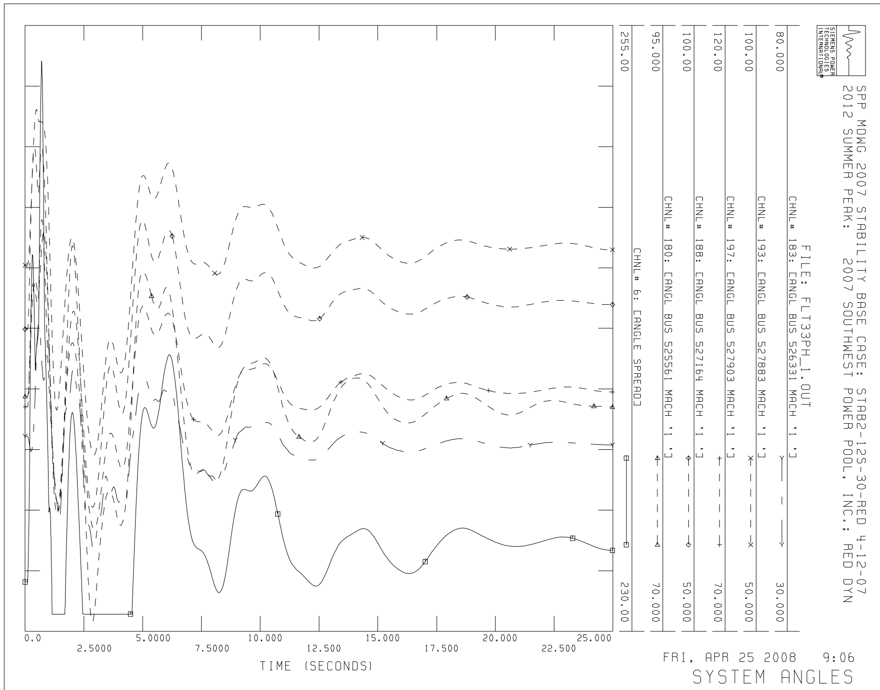
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CHNL# 197: [ANGL BUS 527903 MACH '1 '] 120.00 70.000
CHNL# 188: [ANGL BUS 527164 MACH '1 '] 100.00 50.000
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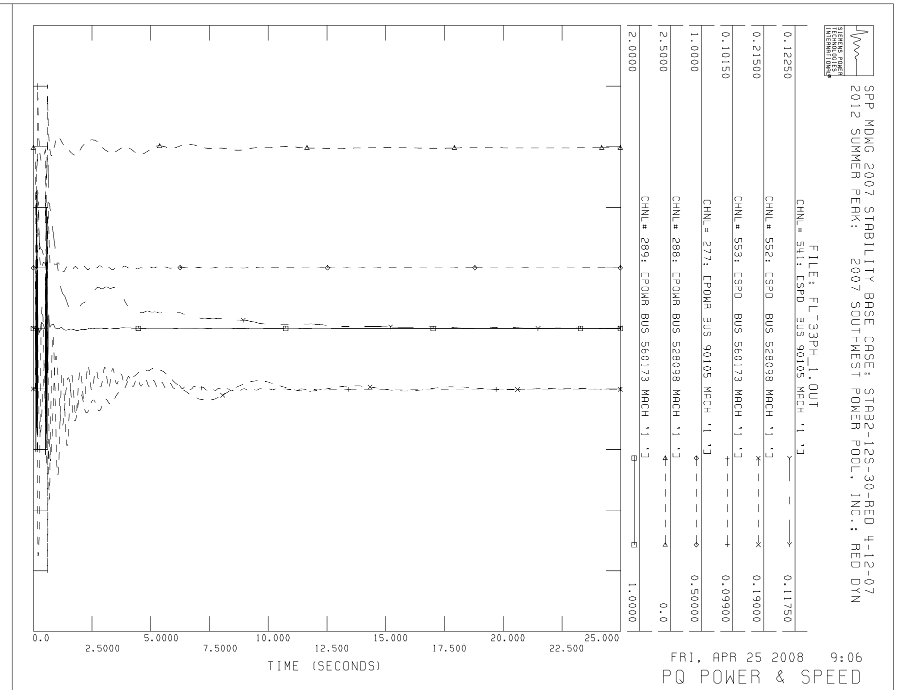
SYSTEM ANGLES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2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
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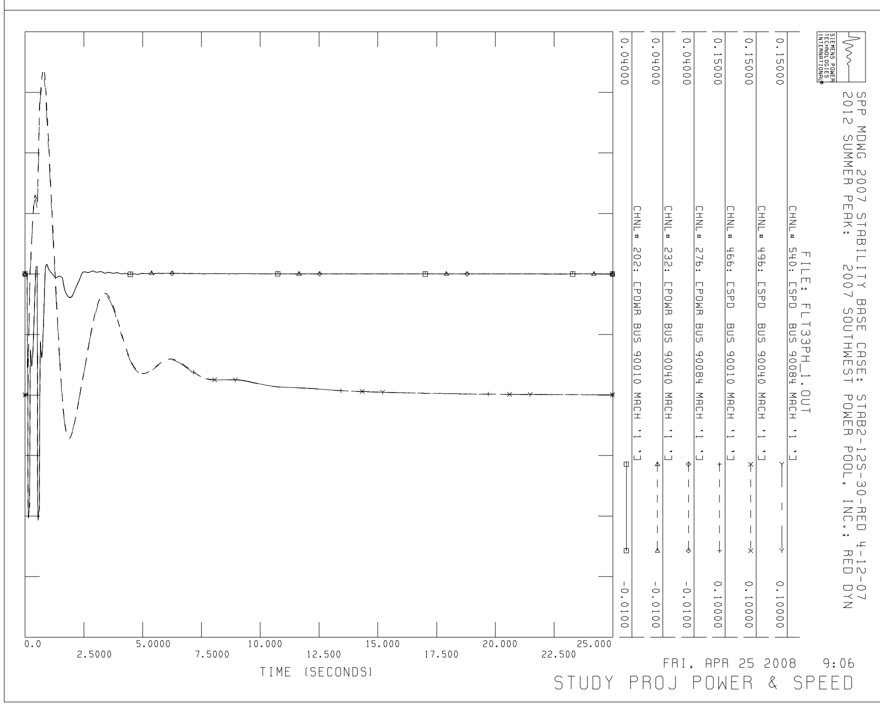
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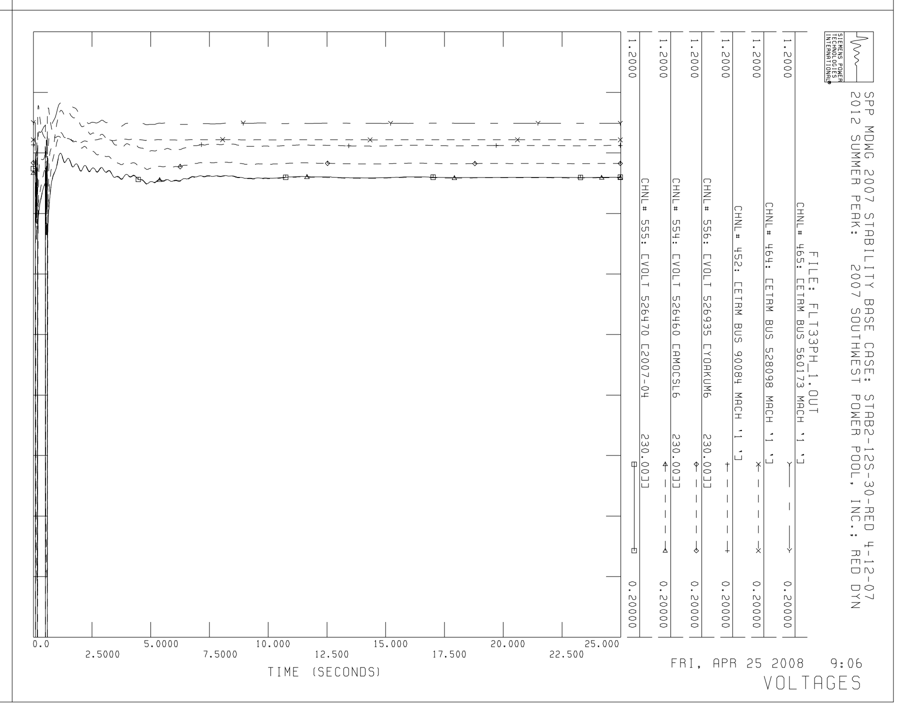
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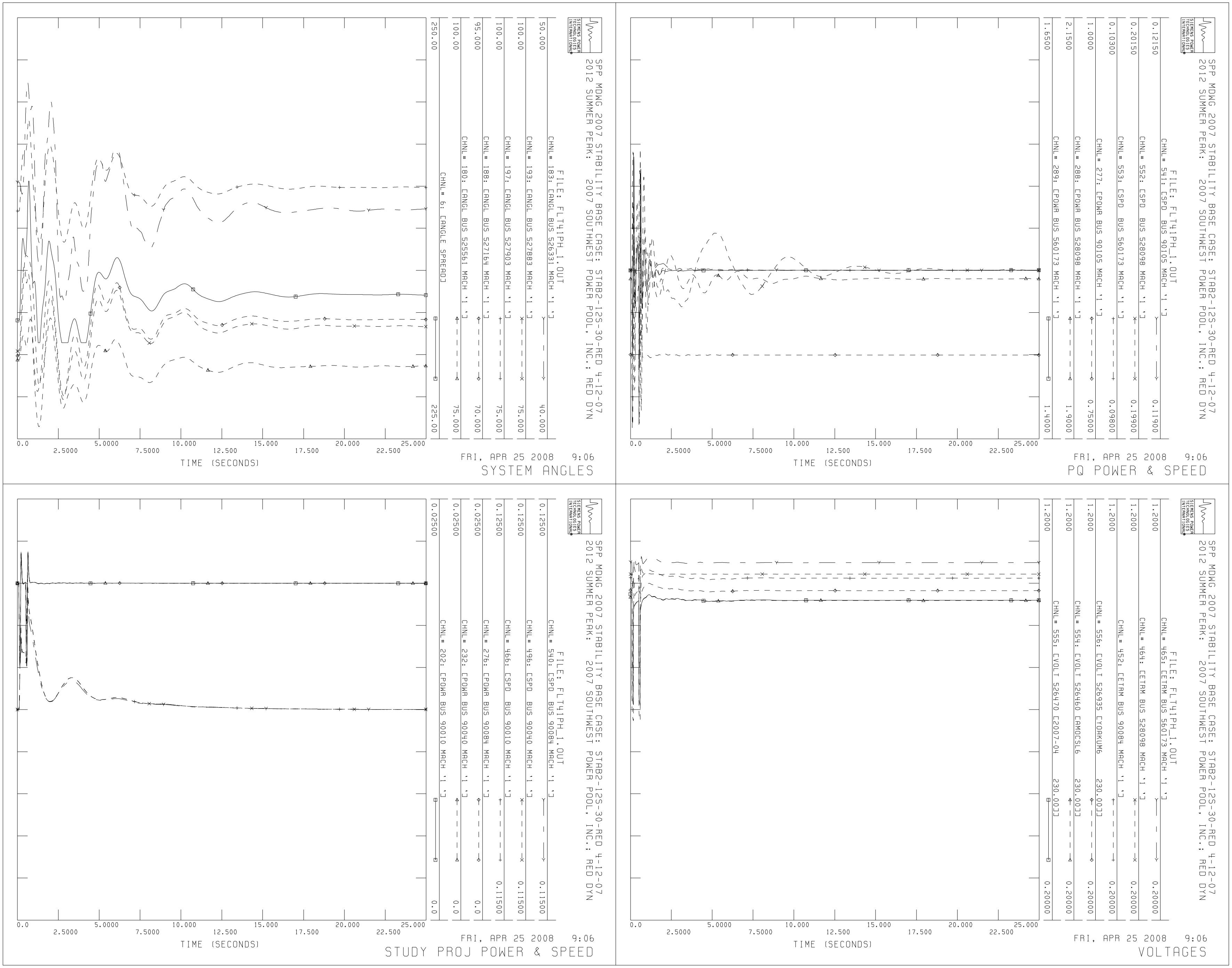
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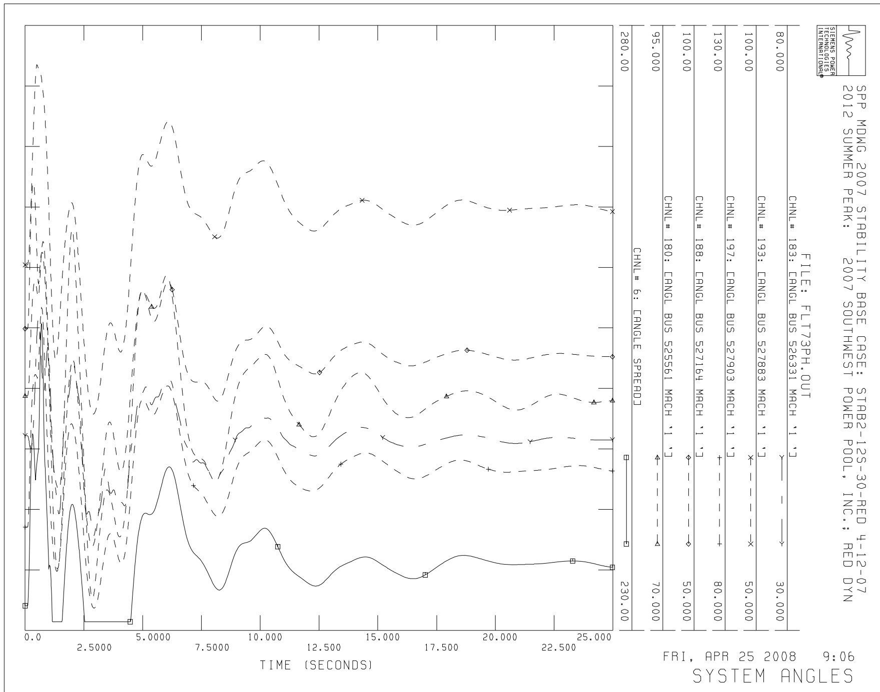
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CHNL# 193: [ANGL BUS 527883 MACH '1 '] 100.00 50.000
CHNL# 197: [ANGL BUS 527903 MACH '1 '] 130.00 80.000
CHNL# 188: [ANGL BUS 527164 MACH '1 '] 100.00 50.000
CHNL# 180: [ANGL BUS 525561 MACH '1 '] 95.000 70.000
CHNL# 6: [ANGLE SPREAD] 280.00 230.00
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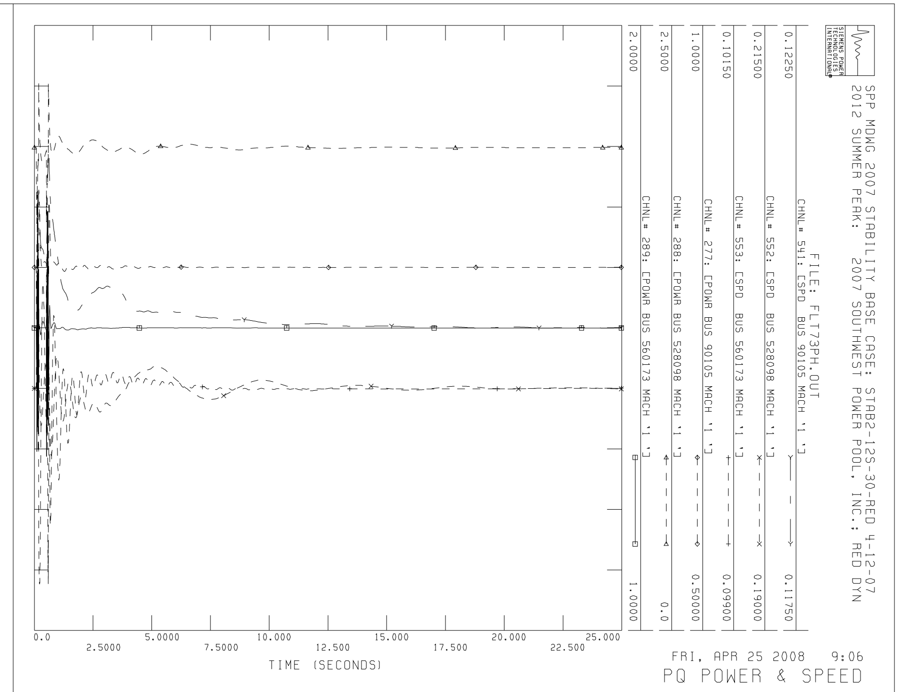
SYSTEM ANGLES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FILE: FLT73PH.OUT
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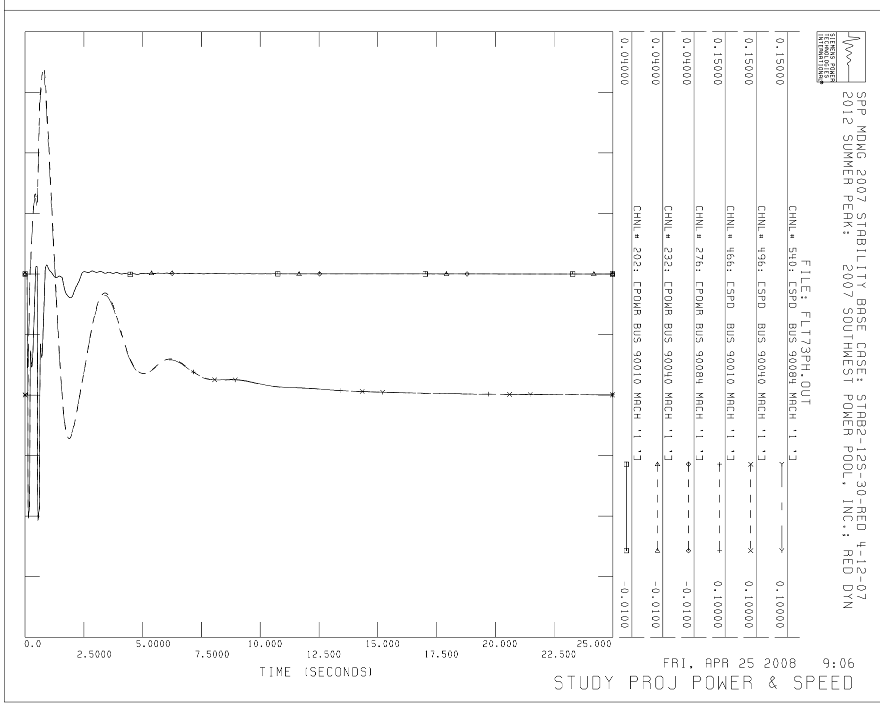
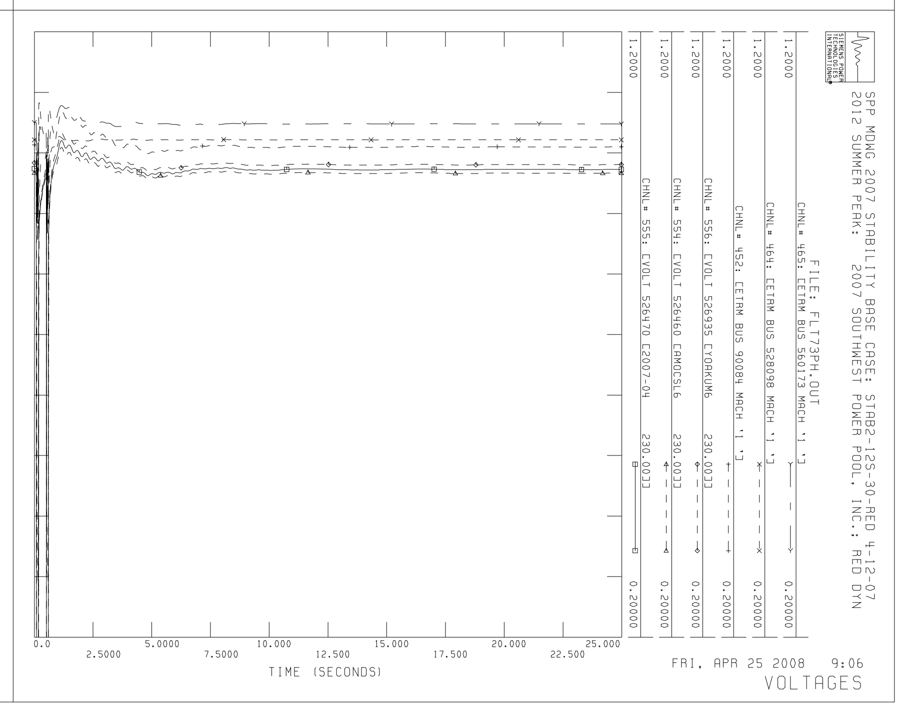
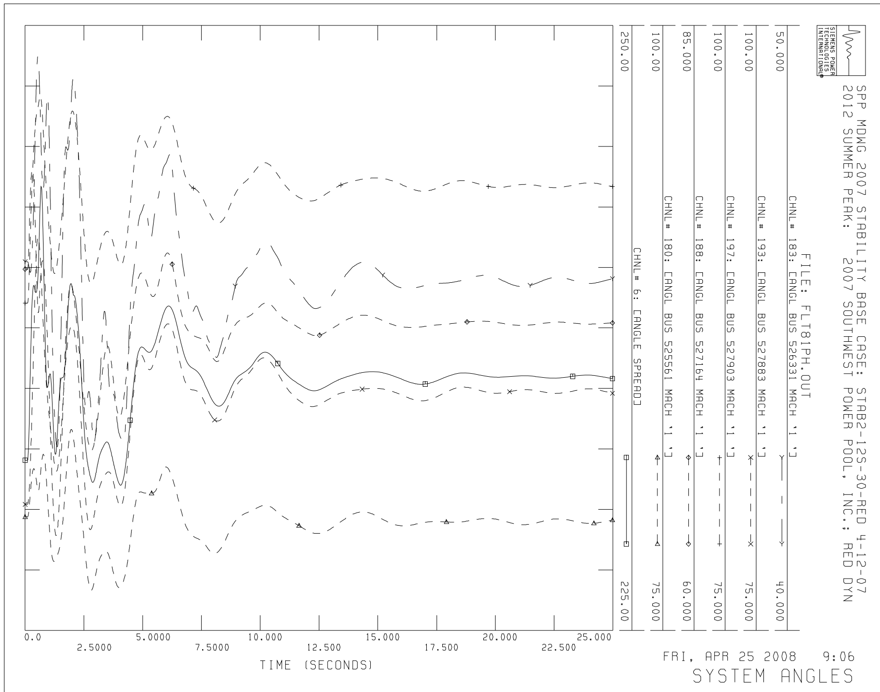
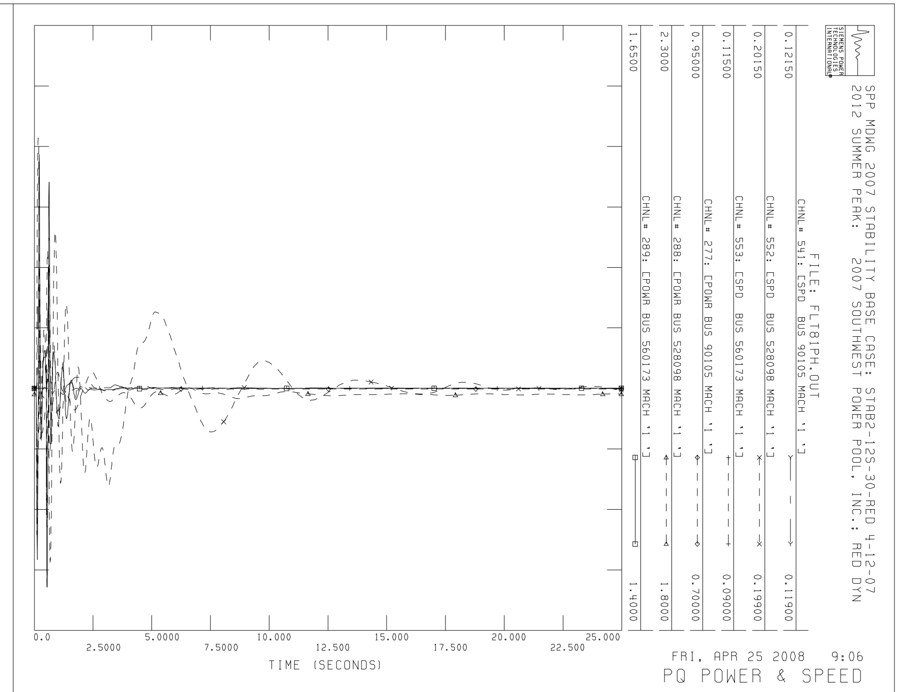
CHNL# 552: [SPD BUS 528098 MACH '1 '] 0.21500 0.19000
CHNL# 553: [SPD BUS 560173 MACH '1 '] 0.10150 0.09900
CHNL# 277: [POWR BUS 90105 MACH '1 '] 1.0000 0.50000
CHNL# 288: [POWR BUS 528098 MACH '1 '] 2.5000 0.0
CHNL# 289: [POWR BUS 560173 MACH '1 '] 2.0000 1.0000
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
TIME (SECONDS)
FRI, APR 25 2008 9:06
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 '] 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
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
TIME (SECONDS)
FRI, APR 25 2008 9:06
STUDY PROJ POWER & SPEED

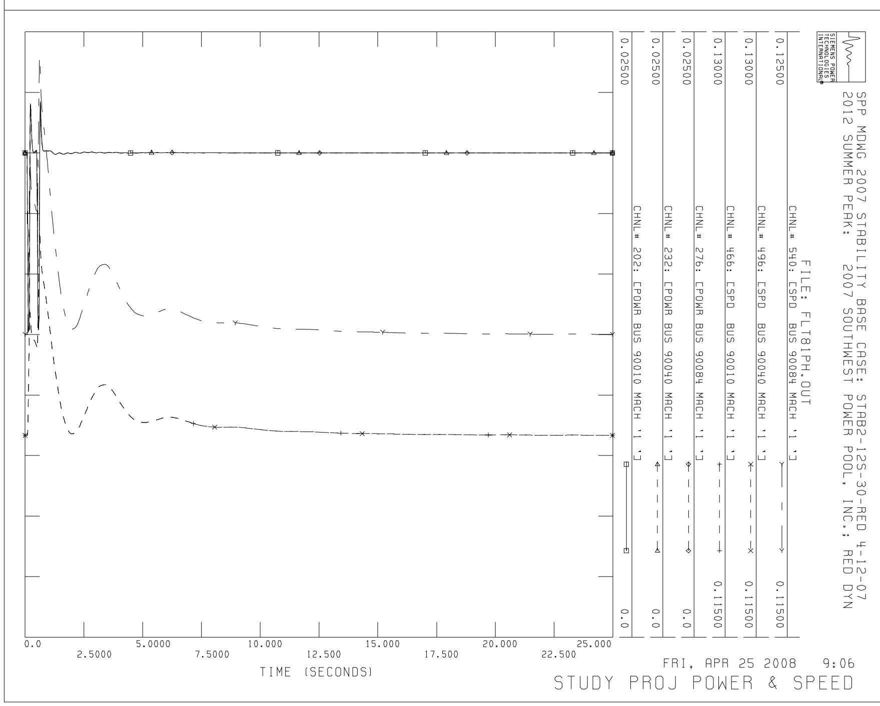

SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT73PH.OUT
CHNL# 465: [ETRM BUS 560173 MACH '1 '] 1.2000 0.20000
CHNL# 464: [ETRM BUS 528098 MACH '1 '] 1.2000 0.20000
CHNL# 452: [ETRM BUS 90084 MACH '1 '] 1.2000 0.20000
CHNL# 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
0.0 2.5000 5.0000 7.5000 10.000 12.500 15.000 17.500 20.000 22.500 25.000
TIME (SECONDS)
FRI, APR 25 2008 9:06
VOLTAGES



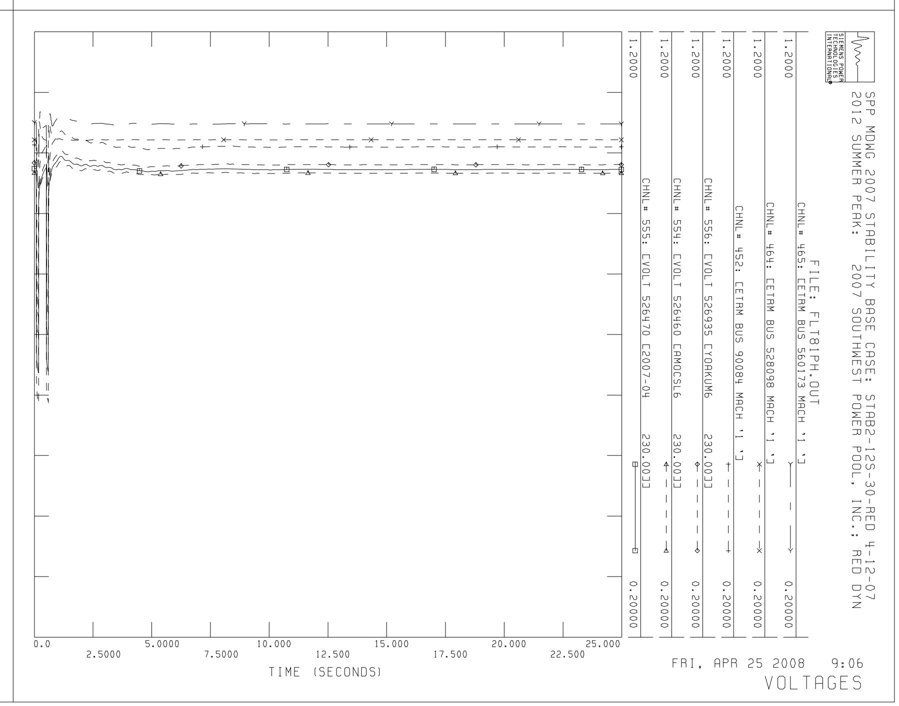
SPP MDWG 2007 STABILITY BASE CASE: STAB2-12S-30-RED 4-12-07
2012 SUMMER PEAK: 2007 SOUTHWEST POWER POOL, INC.; RED DYN
FILE: FLT81PH.OUT
CHNL# 183: CANGL BUS 526331 MACH '1 ' 50.000 40.000
CHNL# 193: CANGL BUS 527883 MACH '1 ' 100.00 75.000
CHNL# 197: CANGL BUS 527903 MACH '1 ' 100.00 75.000
CHNL# 188: CANGL BUS 527164 MACH '1 ' 85.000 60.000
CHNL# 180: CANGL BUS 525561 MACH '1 ' 100.00 75.000
CHNL# 6: CANGLE SPREAD] 250.00 225.00
TIME (SECONDS)
FRI, APR 25 2008 9:06
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: FLT81PH.OUT
CHNL# 541: CSPD BUS 90105 MACH '1 ' 0.12150 0.11900
CHNL# 552: CSPD BUS 528098 MACH '1 ' 0.20150 0.19900
CHNL# 553: CSPD BUS 560173 MACH '1 ' 0.11500 0.09000
CHNL# 277: CPOWR BUS 90105 MACH '1 ' 0.95000 0.70000
CHNL# 288: CPOWR BUS 528098 MACH '1 ' 2.3000 1.8000
CHNL# 289: CPOWR BUS 560173 MACH '1 ' 1.6500 1.4000
TIME (SECONDS)
FRI, APR 25 2008 9:06
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: FLT81PH.OUT
CHNL# 540: CSPD BUS 90084 MACH '1 ' 0.12500 0.11500
CHNL# 496: CSPD BUS 90040 MACH '1 ' 0.13000 0.11500
CHNL# 466: CSPD BUS 90010 MACH '1 ' 0.13000 0.11500
CHNL# 276: CPOWR BUS 90084 MACH '1 ' 0.02500 0.0
CHNL# 232: CPOWR BUS 90040 MACH '1 ' 0.02500 0.0
CHNL# 202: CPOWR BUS 90010 MACH '1 ' 0.02500 0.0
TIME (SECONDS)
FRI, APR 25 2008 9:06
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: FLT81PH.OUT
CHNL# 465: CETRM BUS 560173 MACH '1 ' 1.2000 0.20000
CHNL# 464: CETRM BUS 528098 MACH '1 ' 1.2000 0.20000
CHNL# 452: CETRM BUS 90084 MACH '1 ' 1.2000 0.20000
CHNL# 556: CVOLT 526935 CYOAKUM6 230.00] 1.2000 0.20000
CHNL# 554: CVOLT 526460 CAMOCSL6 230.00] 1.2000 0.20000
CHNL# 555: CVOLT 526470 C2007-04 230.00] 1.2000 0.20000
TIME (SECONDS)
FRI, APR 25 2008 9:06
VOLTAGES