Southwest Power Pool

Impact Study For Generation Interconnection Request GEN-2005-013

SPP Tariff Studies

(#GEN-2005-013)

February 2006

Executive Summary

<OMITTED TEXT> (Customer) has requested an Impact Study under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of a 201 MW wind powered generation facility in Elk County, Kansas to the transmission system of Kansas Gas and Electric, an affiliate of Westar. The wind powered generation facility was studied with one hundred thirty four (134) individual GE 1.5 MW wind turbines. The requested in-service date for the 201MW facility is November 1, 2007. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the Westar 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 generation facility will interconnect Latham-Neosho 345kV line via a new 345kV switching station. This interconnection facility is estimated to cost $4,101,000. From this station, the Customer will build a 345kV line to its 345/34.5kV collector substation. This substation will have feeder connections to the wind turbine collection circuits.

Four seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were the 2006 winter peak, 2006 fall case, 2006 light loading, and the 2010 summer peak case. There were several variations of the 2010 summer loading case used. Each case was modified to include prior queued projects that are discussed in the body of the report. The GE 1.5s wind turbines were modeled using information provided by the manufacturer. Nine-teen contingencies were simulated.

Due to the reactive power losses on the collector system including the substation transformer, the GE turbines should not be allowed to operate below a unity power factor. The Customer will be required to install a 34.5kV, 12MVAR capacitor bank in its substation. With the addition of the capacitor bank, the reactive capability of the GE turbines allows the wind farm to operate at unity power factor and have enough reactive reserve for fault recovery.

Stability Study results show that the transmission system remains stable for all simulated contingencies studied.

Further Stability study results show that in order for the wind farm to meet the ‘Transitional’ provisions of FERC Order #661A’s Low Voltage Ride Through (LVRT) provisions, the Customer shall purchase the GE turbines with the LVRT I 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 interconnecting up to a 201 MW wind powered generation facility in Elk County, Kansas to the transmission system of Kansas Gas & Electric Company, an affiliate of Westar. The wind powered generation facility studied was comprised of one-hundred-thirty-four (134) individual 1.5MW General Electric wind turbines. The requested in-service date for the 201 MW facility is November 1, 2007. The wind powered generation facility will interconnect into the existing Latham-Neosho 345kV transmission line. This study will address the stability and reactive compensation issues associated with 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 (iii) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the Interconnection System Impact Study is commenced: (i) are directly interconnected to the Transmission System; (ii) are interconnected to Affected Systems and may have an impact on the Interconnection Request; (iii) have a pending higher queued Interconnection Request to interconnect to the Transmission System; and (iv) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

There are two previously queued projects in the immediate area ahead of this request in the SPP Generation Interconnection queue. It was assumed for purposes of this study that those projects would be in-service if this project is built. Any changes to this assumption, i.e. one or more of the previously queued projects not included in the study signing an interconnection agreement, may require a re-study of this request at the expense of the customer. Other wind farms which have higher queue priority than this request, were modeled in this case.

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 GE 1.5s wind turbines. The nameplate rating of each turbine is 1.5MW (1500kW) with a machine base of 1667kVA. The turbine output voltage is 575V. 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 1.5MW 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.

GE has provided optional equipment configurations that consist of enhanced low voltage ride through capability and improved power electronics that will improve efficiency and grid response to power fluctuations. This study was performed using the latest GE Standard Voltage and Frequency Settings with Fault Ride Through modeling stability package available from PTI

3.2 Interconnection Facility

The Customer has proposed an interconnection facility, which would connect to the Westar Energy transmission system via a new substation located in Elk County, Kansas on the existing Latham – Neosho 345kV line. The new substation would be configured to accept a terminal from an adjacent 345/34.5kV transformation substation containing one transformer that serves the wind powered generation facility.

Analysis of the reactive compensation requirements of the wind farm determined the need for a 34.5kV, 12VAR capacitor bank to be located on the secondary side of the substation transformer. This bank is necessary for reactive compensation for the wind farm (turbine and collector system losses) and to preserve a margin of the wind turbine’s reactive capability for fault recovery. The reactive compensation does not need to be dynamic (SVC).

The total cost for adding a new 345kV switching station, the required interconnection facility is estimated at $4,101,000. This cost does not include the Customer 345/34.5kV substation, the 34.5kV 12 MVAR capacitor bank, or the 345kV line connecting the Customer substation to the new substation on the Latham – Neosho 345kV line. The one-line diagram for this configuration is shown in Figure 1.

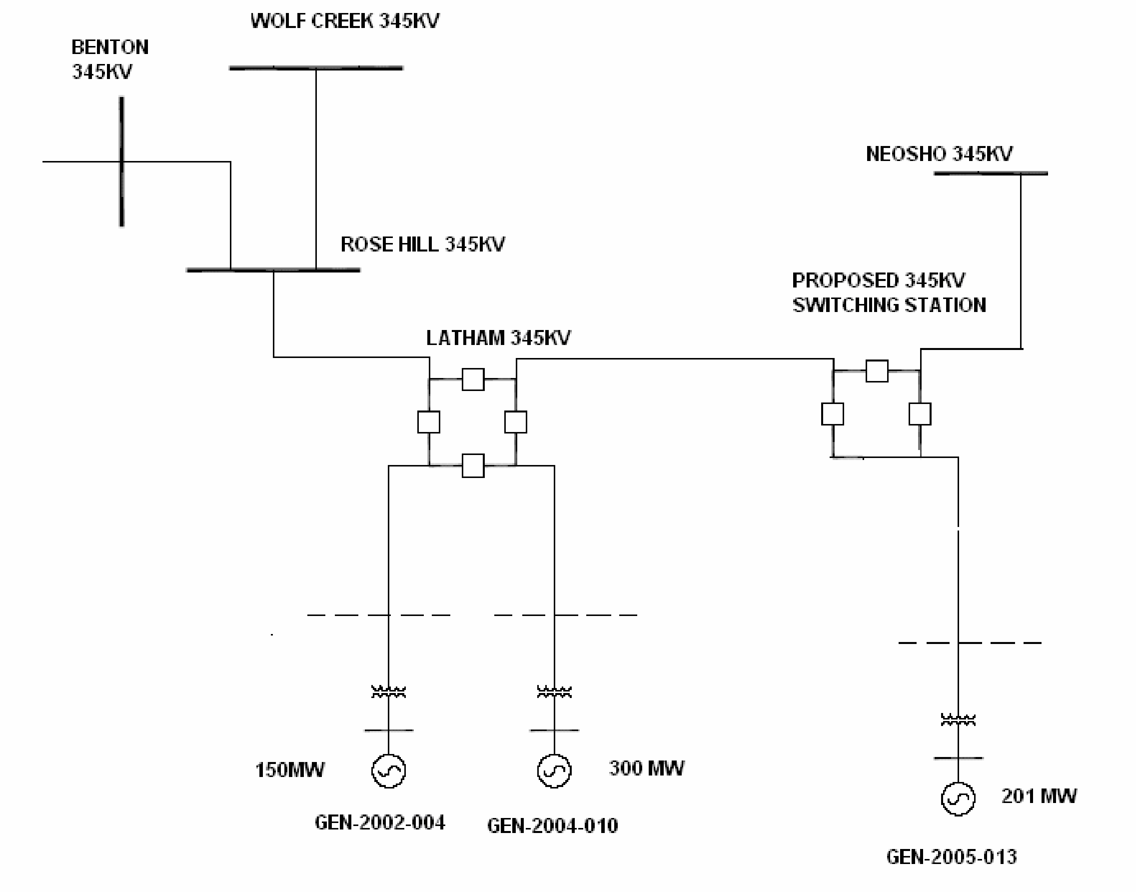


Figure 1: Proposed Interconnection Configuration #1
(Final substation design to be determined)

Another option that may be pursued at the Facility Study stage of this project concerns the close proximity of the Customer's generation facility to the newly constructed Westar Latham 345kV switching station. The Latham 345kV substation is located approximately 6 miles from the center of the Customer's property.

If the Customer continues on in the generation interconnection process into a Facility Study, the Facility Study may determine if it is more cost effective to interconnect the Customer's generation facility into a new switching station on the Latham-Neosho 345kV line or to build a short line and add a position in the ring bus at Latham. This configuration is shown in Figure 2.

This impact study will address both of these configurations so that either scenario will have been analyzed.

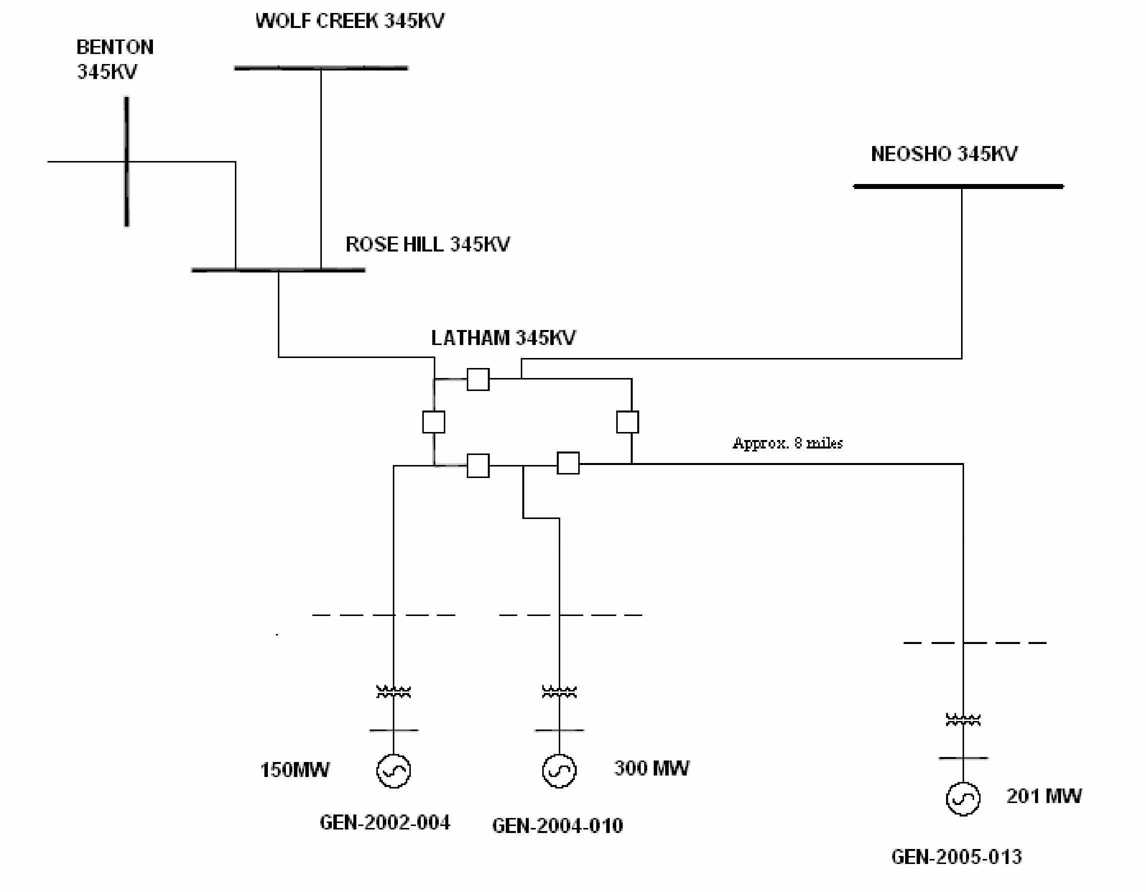


Figure 2: Proposed Interconnection Configuration #2
(Final substation design to be determined)

4.0 Stability Analysis

4.1 Objective

The objective of the stability study is to determine the impact on system stability of connecting the proposed GEN-2005-013 wind farm to SPP's 345 kV transmission system.

4.2 Equivalent Modeling of the Wind Generating Facility

The rated output of the generation facility is 201MW, comprised of 134 GE 1.5s wind turbines. The base voltage of the GE turbine is 575 V, and a generator step up transformer (GSU) of 1.75MVA connects each unit to the high side of 34.5kV.

The rated power output of each turbine is 1.5MW while the actual power output depends on the wind.

In performing a system impact study, the wind farm generation from the study customer and previously queued customers is dispatched into the SPP footprint.

The generating facility 345/34.5 substation will consist of (1) 345/34.5kV transformer with an impedence of 10% on a 150 MVA OA Base with a top rating of 250MVA. From the one-lines received from the customer, on the 34.5kV side of the transformer, 9 feeder circuits each will extend from the Customer's 345/34.5kV substation. The feeders will consist of 15, 18, 18, 16, 9, 16, 17, 12, and 13 wind turbines respectively on each circuit as shown in Figure 3.

4.3 <u>Modeling of the Wind Turbines in the Power Flow</u>

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 connected to the same 34.5kV feeder end points were aggregated into one equivalent unit. An equivalent impedance of that feeder is represented in the load flow database by taking the equivalent series impedances of the different feeders connecting the wind turbines. Using this approach, the wind farm was modeled with equivalent units as indicated in Table 1. below.

Circuit	Collector buses	Number of Turbines Aggregated
1	3	6,4, 5
2	4	4,6,3,5
3	3	8,6,4
4	3	6,4,6
5	2	3,6
6	3	5,6,5
7	4	3,5,6,3
8	3	4,2,6
9	2	6,7

Table 1. Equivalent Generators with GE 1.5 MW Turbines

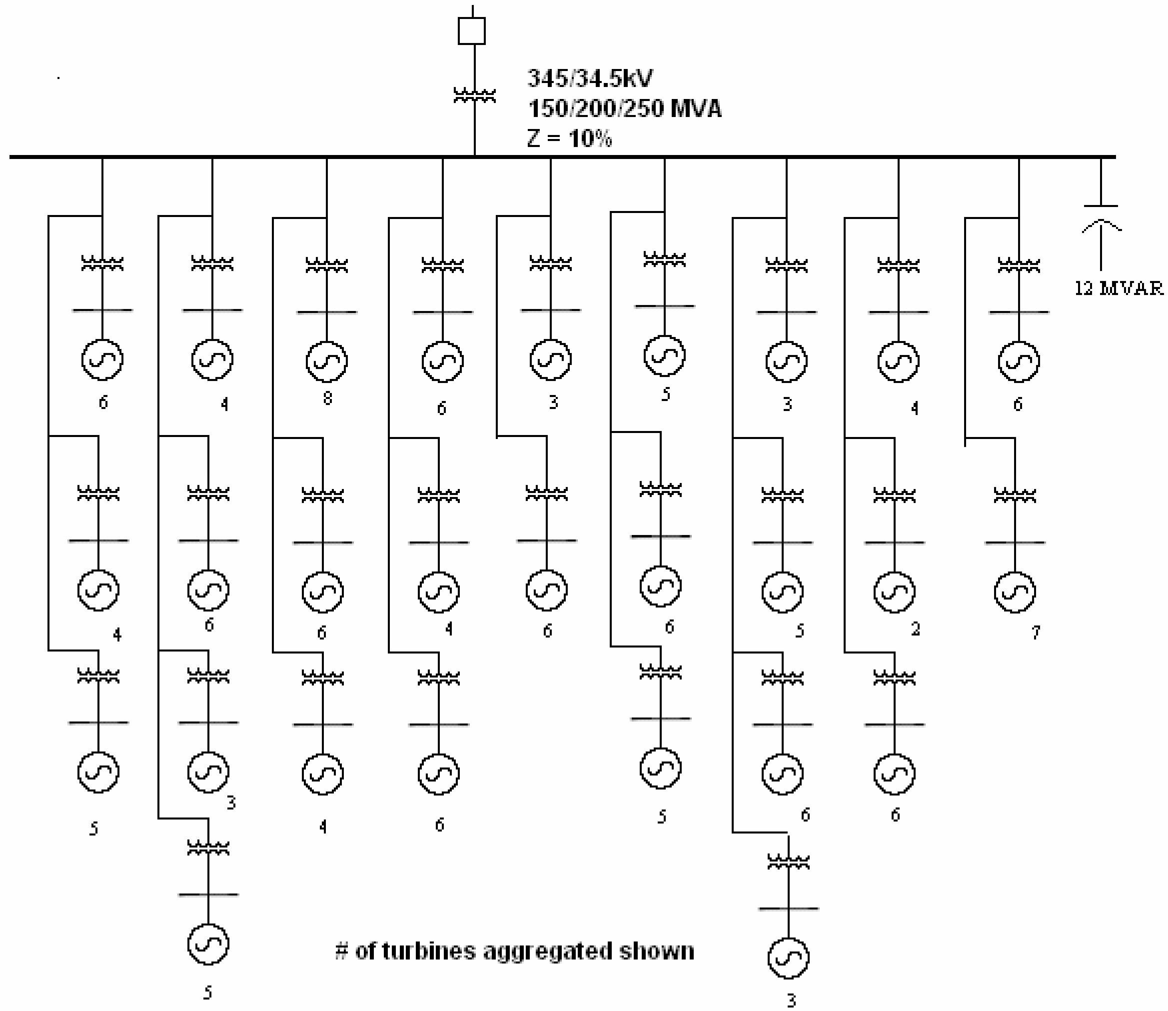


Figure 3. One-Line Drawing of the GEN-2005-013 Facility

4.4 Modeling of the Wind Turbines for the Stability Simulation

4.4.1 Machine Dynamics Data

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 1.5MW 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.

For most of the simulations, the wind farm was dispatched directly by the user to the level specified (100% rated power). There was one set of simulations run at 20% production to gauge response of the wind farm when it may not be running at full potential.

For most of the simulations in this study, it was assumed the turbines would operate at 1.0 unity power factor. However, varying power factors were also studied for the summer case. This is explained further in sections 4.6.

4.4.2 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 before December 31, 2006, wind farms shall stay on line for faults at the point of interconnection (POI) that draw the voltage down to 0.15 pu at the POI (Customer’s 345kV bus at the Westar switching station). For Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draws the voltage down at the POI to 0.0 pu.

In order to meet Order #661A, GE has three different LVRT packages. LVRT I allows the turbines to stay on line as long as the turbine voltage stays at or above 0.30pu for 6 cycles. LVRT II allows the turbines to stay on line for 37.5 cycles for voltages as low as 0.15 pu. LVRT III allows the turbines to stay on line for 60 cycles for 0.0 pu voltage. All settings are shown in Table 1.

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	6 cycles (0.1s)
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 1: G.E. 1.5s Turbine Voltage Protection

The frequency protection scheme for the GE turbines is outlined in Table 2 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 2: G.E. Turbine Frequency Protection

4.5 Contingencies Simulated

Nineteen (19) contingencies were considered for the transient stability simulations which included three phase faults, as well as single phase line faults, at the 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 3.

Table 3. Contingencies Evaluated

Cont. No.	*Cont. Name*	*Description*
1	*FLT13PH*	Three phase fault on the Rose Hill to the Latham Switching Station, 345kV line, (at Mid Line). Apply Fault at the Mid-line bus. a. Clear Fault after 5 cycles by removing the line from Rose Hill to Mid-line bus and from Mid-line bus to Latham Switching Station b. Wait 300 cycles, and then re-close the line in (b) back into the fault. c. 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	Three phase fault on the Wind Farm Switching Station to Neosho 345 kV line, near Neosho. a. Apply fault at the Neosho. b. Clear fault after 5 cycles by removing the line from the Wind Farm Switching Station to Neosho. c. Wait 300 cycles, and then re-close the line in (b) 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	Three phase fault on the Neosho to Morgan (96045), 345kV line, (at Mid-line). Establish a new bus (Mid-line bus) in the electrical middle of this 345 kV line. a. Apply Fault at the Mid-line bus. b. Trip the line after 5 cycles by removing the line from Neosho to the Mid-line bus to Morgan and remove the fault. c. Wait 300 cycles, and then re-close the line in (b) 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	Three phase fault on the Rose Hill to Wolf Creek 345 kV line, near Rose Hill. a. Apply fault at the Rose Hill. b. Clear fault after 5 cycles by tripping the line from Rose Hill to Wolf Creek. c. Wait 300 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	Three phase fault on the Rose Hill to Benton 345 kV line, near Benton. a. Apply fault at the Benton. b. Clear fault after 5 cycles by tripping the line from Rose Hill to Benton . c. Wait 60 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	Three phase fault on the Benton to Wichita 345 kV line, near Wichita. a. Apply fault at the Wichita bus b. Clear fault after 5 cycles by tripping the line Benton to Wichita. c. Wait 60 cycles, and then re-close 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	Three phase fault on the Benton to Midian 138 kV line, near Midian. a. Apply fault at the Midian bus. b. Clear fault after 7 cycles by tripping the line from Benton to Midian. c. Wait 25 cycles, and then re-close line in (b) back into the fault.

Cont. No.	*Cont. Name*	*Description*
		d. Leave fault on for 7 cycles, then trip the line in (b) and remove fault.
14	FLT141PH	*Single phase fault and sequence like Cont. No. 13*
15	FLT153PH	Three Phase fault on the Midian to Butler 138 kV line, near Butler. a. Apply fault at the Butler bus. b. Clear fault after 7 cycles by tripping the line from Midian (56990) to Butler c. Wait 25 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 7 cycles, then trip the line in (b) and remove fault.
16	FLT161PH	*Single phase fault and sequence like Cont. No. 15*
17	FLT173PH	Three phase fault on the Rose Hill (57062) to Weaver (56991) 138 kV line a. Apply fault at the Weaver bus (56991). b. Clear fault after 7 cycles by tripping the line from Rose Hill (57062) to Weaver (56991). c. Wait 25 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 7 cycles, then trip the line in (b) and remove fault.
18	FLT181PH	*Single phase fault and sequence like Cont. No. 17*
19	FLT193PH	Three phase fault on the Wind Farm Switching Station to Neosho 345 kV line, at the POI. a. Apply fault at the Wind Farm Switching Station 345kV. a. Clear fault after 5 cycles by removing the line from the Wind Farm Switching Station to Neosho.

4.6 Further Model Preparation

The contingencies were simulated for the following scenarios

- 2010 Summer Peak Loading (SPP MDWG Case)(Turbines running at 100% except where noted)
    - Case #1 (All contingencies)
        - Turbines running at 1.0 PF
        - 12 MVAR capacitor bank
    - Case #2 (All contingencies)
        - Turbines running at 1.01 pu voltage schedule (producing vars) such that wind farm is operating at unity at POI
        - 12 MVAR capacitor bank
    - Case #3 (All contingencies)
        - Turbines running at 20% production
        - Turbines operating 1.0 PF
    - Case #4 (Power Flow Only - Case would not initialize)
        - Turbines running at 0.95 leading (drawing vars)
        - Wind farm runs at .88 lagging power factor (drawing vars), voltage is too low for turbines to operate (0.89 pu)

- Case #5 (Power Flow Only)
  - Turbines running 0.99 leading (drawing vars)
  - Wind Farm runs at 0.95 lagging (drawing vars); 34.5kV collector system voltage is below steady state limits (0.94 pu)

- 2006 Winter Peak Loading (All contingencies)
  - Case #1 – same as 2010 summer

- 2007 Spring Loading (All contingencies)
  - Case #1 – same as 2010 summer

- 2007 Fall Loading (All contingencies)
  - Case #1 – same as 2010 summer

All four seasonal models were run with the following interconnection options

- Option 1 - New Station on the Latham-Neosho 345kV Line (See Figure 1.)
- Option 2 - Radial feed out of the Latham 345kV station (See Figure 2.)

The previously queued projects which were added to the stability base case are summarized in Table 4.

Study Plant	Total MW
GEN-2002-004	150
GEN-2004-010	300

Table 4 – Summary of Prior Queued Projects

4.7 <u>Results</u>

Results are summarized in Table 5. for the interconnection configuration with a new substation and Table 6. for the radial configuration. The results indicate that for all contingencies, the transmission system remains stable.

When the wind farm is modeled with the wind turbines operating at the default 1.0 pf, the wind farm collector circuit and substation transformer losses result in the wind farm drawing approximately 30MVAR at the point of interconnection. As indicated above, with this configuration, the transmission system remains stable.

An additional case was modeled using the wind turbines reactive capabilities to maintain unity power factor at the point of interconnection. Using this configuration, the turbines still have enough reactive reserve to maintain a stable transmission system during faults.

When the turbines are modeled as drawing vars, less than desirable conditions occur. If the wind turbines are running at anything below unity, system voltages begin to deteriorate. The 34.5kV wind farm collector system cannot maintain a 0.95 pu voltage, a NERC violation.

Therefore, the wind turbines should always either be in voltage control mode in which they are maintaining at least 1.0 pu voltage or should never be in power factor mode in which case they are drawing vars. The addition of the 12MVAR capacitor bank allows for some reactive reserve for the wind turbines for fault recovery.

An additional run was made with the turbines running at 20% production. This reduced output from the turbines was chosen to closer simulate actual conditions during the summer peak. Results did not change from the 100% production runs.

There were no material changes in response for the wind farm whether the wind farm was interconnected into a new 345kV switching station or whether is was interconnected radially out of Latham 345kV switching station.

<u>FERC Order #661A Compliance</u> – Contingency FLT193PHThere was simulated made explicitly for determining compliance with FERC Order #661A. This request will fall under the ‘Transitional’ clause of the Order’s Low Voltage Ride Through (LVRT) provisions if an Interconnection Agreement is signed before December 31, 2006. The ‘Transitional’ clause states that the turbines should stay on line for a 5-9 cycle fault that produces 0.15 pu voltage at the point of interconnection. For this study, the fault duration was treated the same as the other faults simulated (5 cycles).

The wind farm was first modeled using the GE LVRT I package in which turbines will trip when the turbine voltage goes below 0.30 pu for 5 cycles. Fault FLT_193PH was run with a 3 phase fault at the switching station 345kV bus bringing the voltage down to 0.15 pu, which simulates conditions specified in the ‘Transitional’ clause of Order #661A. The wind farm was able to stay on line for this contingency. Analysis of the fault show that portions of the wind farm dipped below the 0.30 pu threshold but not longer than 6 cycles. Therefore, if an interconnection agreement is signed for this wind farm before December 31, 2006, the Customer will be responsible for buying the GE LVRT I package with its wind turbines.

If this agreement is not signed until after January 1, 2007, a more strict requirement of a fault that brings the POI voltage down to 0.0 pu will be in force. The 6 cycle fault was applied to the model with the LVRT I package and again the wind farm stayed on line during the fault. It should be noted though, that for a fault longer than 6 cycles, the turbines would trip.

FAULT	FAULT DEFINITION	2010 SP Case 1	2010 SP Case 2	2010 SP Case 3	2006 WP	2006 Fall	2006 Spring
FLT13PH	Three phase fault on the Rose Hill to the Latham Switching Station, 345kV line, (at Mid Line).	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT21PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT33PH	Three phase fault on the Wind Farm Switching Station to Neosho 345 kV line, near Neosho.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT41PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT53PH	Three phase fault on the Neosho to Morgan (96045), 345kV line, (at Mid-line).	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT61PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT73PH	Three phase fault on the Rose Hill to Wolf Creek 345 kV line, near Rose Hill.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT81PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT93PH	Three phase fault on the Rose Hill to Benton 345 kV line, near Benton	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT101PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT113PH	Three phase fault on the Benton to Wichita 345 kV line, near Wichita.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT121PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT133PH	Three phase fault on the Benton to Midian 138 kV line, near Midian.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE -PQ2-
FLT141PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT153PH	Three Phase fault on the Midian to Butler 138 kV line, near Butler.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT161PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT173PH	Three Phase fault on the Midian to Butler 138 kV line, near Butler.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT181PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT193PH	6 cycle fault at the POI that produce 0.15 pu voltage	STABLE -PQ1 -PQ2	n/a	n/a	n/a	n/a	n/a
FLT193PH_1	6 cycle fault at the POI that produce 0.0 pu voltage	STABLE -PQ1 -PQ2	N/A	N/A	N/A	N/A	N/A

PQ1 – Trip of Previous Queued project #1 (GEN-2002-004)
PQ2 – Trip of Previous Queued project #2 (GEN-2004-010)

Table 5. SUMMARY OF FAULT SIMULATION RESULTS (New Station)

FAULT	FAULT DEFINITION	2010 SP Case 1	2010 SP Case 2	2010 SP Case 3	2006 WP	2006 Fall	2006 Spring
FLT13PH	Three phase fault on the Rose Hill to the Latham Switching Station, 345kV line, (at Mid Line).	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT21PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT33PH	Three phase fault on the Wind Farm Switching Station to Neosho 345 kV line, near Neosho.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT41PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT53PH	Three phase fault on the Neosho to Morgan (96045), 345kV line, (at Mid-line).	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT61PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT73PH	Three phase fault on the Rose Hill to Wolf Creek 345 kV line, near Rose Hill.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT81PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT93PH	Three phase fault on the Rose Hill to Benton 345 kV line, near Benton	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT101PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT113PH	Three phase fault on the Benton to Wichita 345 kV line, near Wichita.	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2	STABLE -PQ2
FLT121PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT133PH	Three phase fault on the Benton to Midian 138 kV line, near Midian.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE -PQ2-
FLT141PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT153PH	Three Phase fault on the Midian to Butler 138 kV line, near Butler.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT161PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT173PH	Three Phase fault on the Midian to Butler 138 kV line, near Butler.	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE
FLT181PH	Single phase fault same as above	STABLE	STABLE	STABLE	STABLE	STABLE	STABLE

PQ1 – Trip of Previous Queued project #1 (GEN-2002-004)
PQ2 – Trip of Previous Queued project #2 (GEN-2004-010)

Table 6. SUMMARY OF FAULT SIMULATION RESULTS (Radial)

5.0 Conclusion

No stability concerns presently exist for the GEN-2005-013 wind farm as proposed and studied using one hundred thirty four (134) GE 1.5 MW wind turbines with the exceptions for LVRT considerations summarized below. The wind farm and the transmission system remain stable for all contingencies studied.

The Network Upgrade cost of interconnecting the Customer project is approximately $4,101,000. This figure does not address the cost of the Customer substation, the Customer 34.5kV, 12 MVAR capacitor bank, or the transmission line between the Customer substation and the Westar switching substation located on the Latham-Neosho 345kV line. An alternate configuration may be investigated in the Facility Study in which the wind farm could be interconnected radially out of the Westar Latham 345kV switching station.

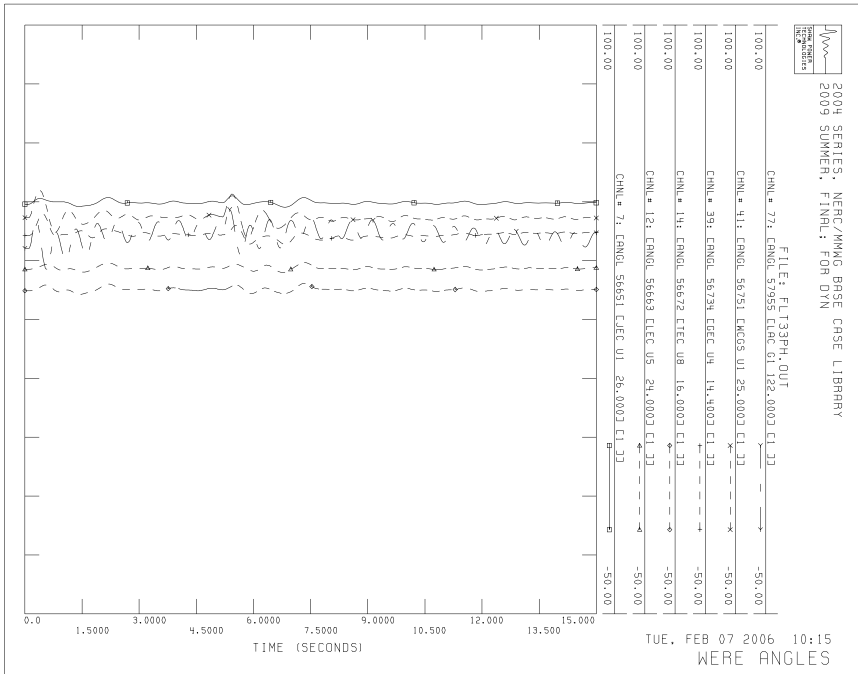
In order for the wind farm to meet the LVRT provisions of FERC Order #661A, the Customer will be required to purchase the GE turbines with the LVRT I low voltage ride through package offered by the manufacturer.

The costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if 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

All Plots available upon request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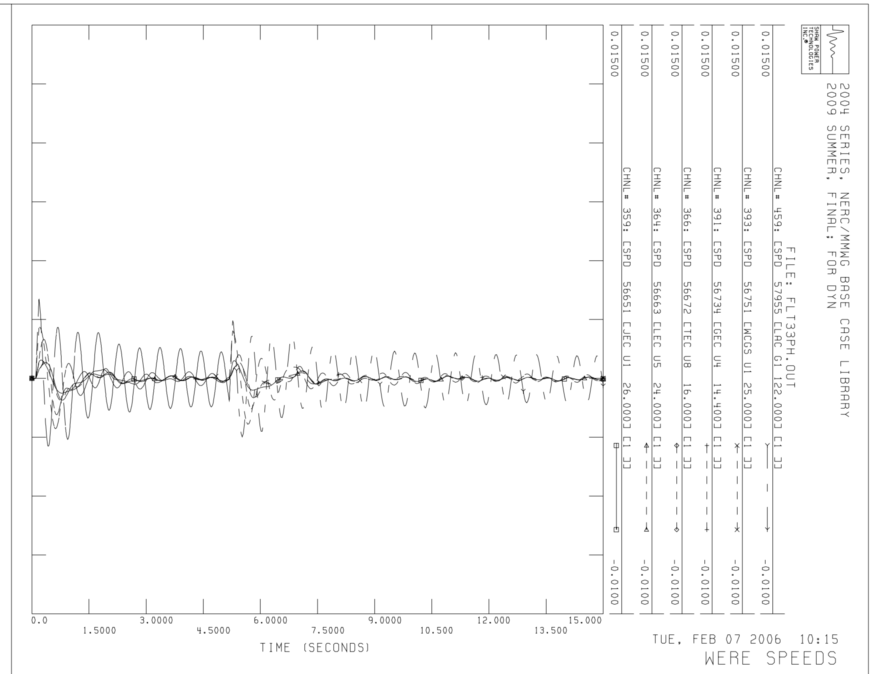
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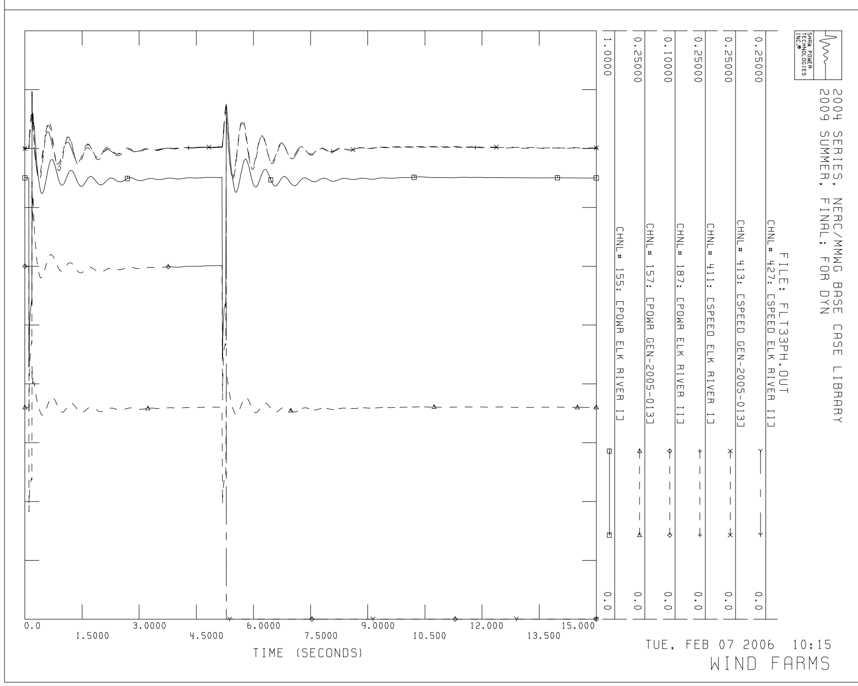
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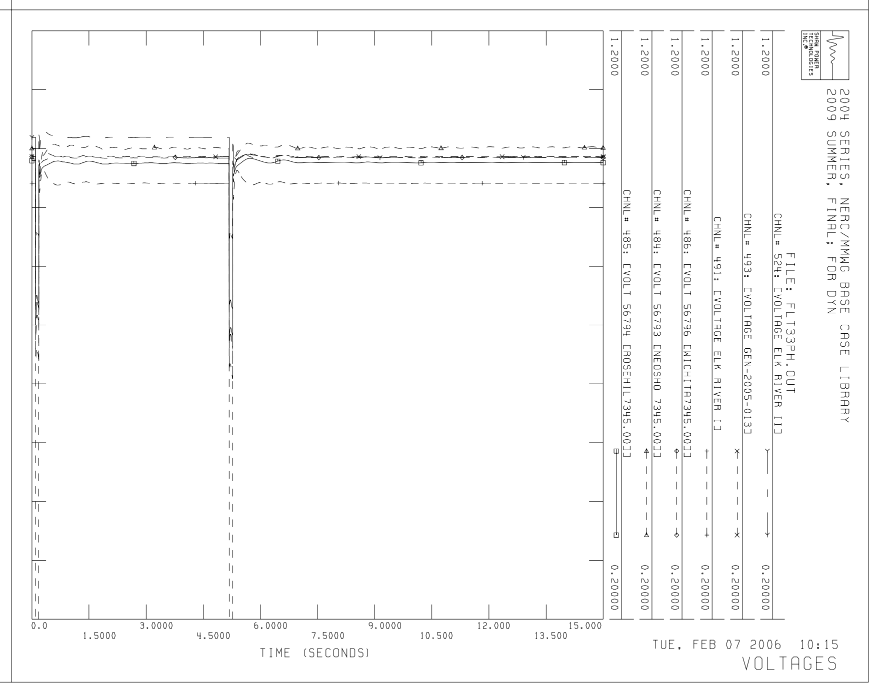
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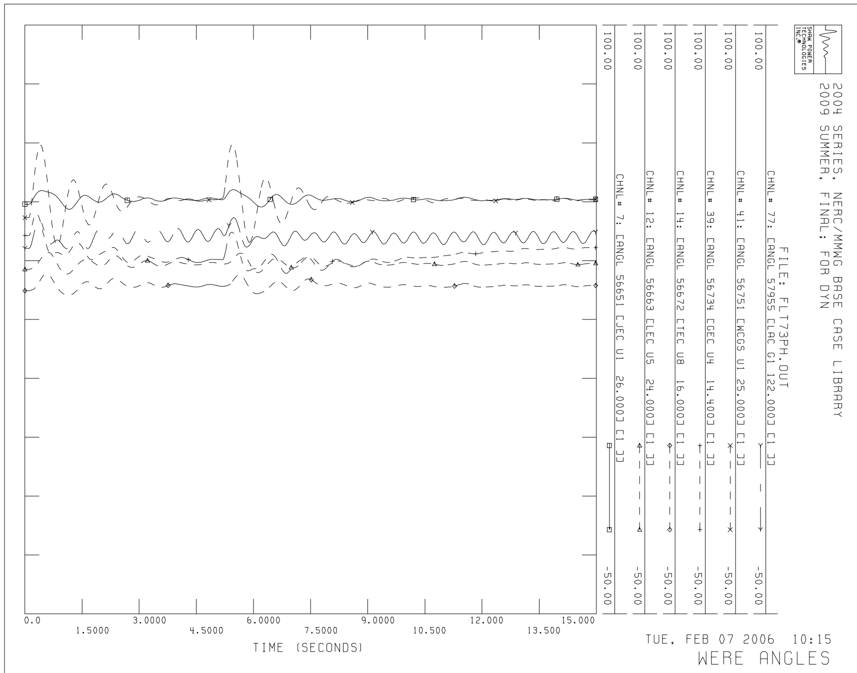
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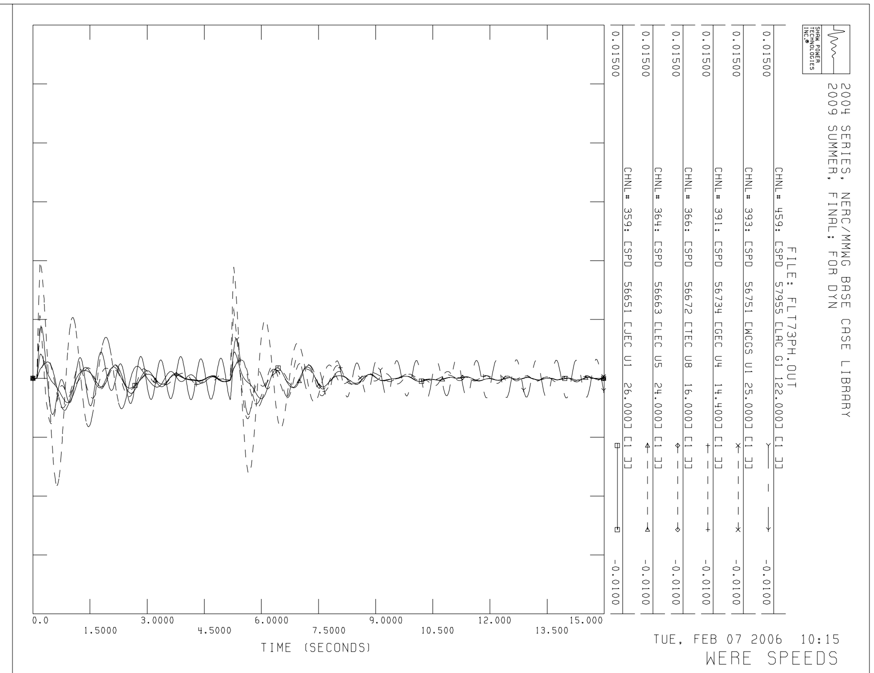
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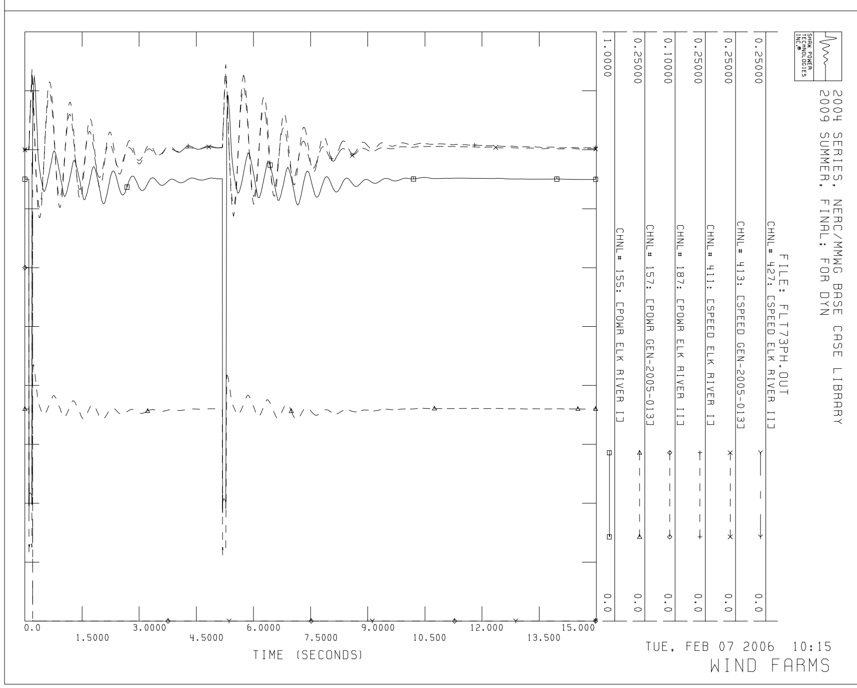
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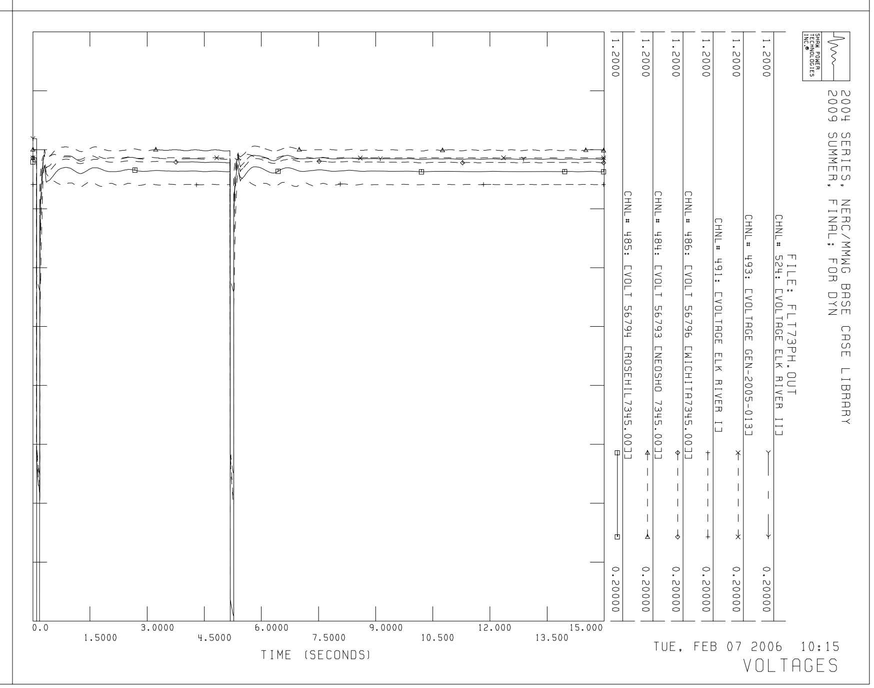
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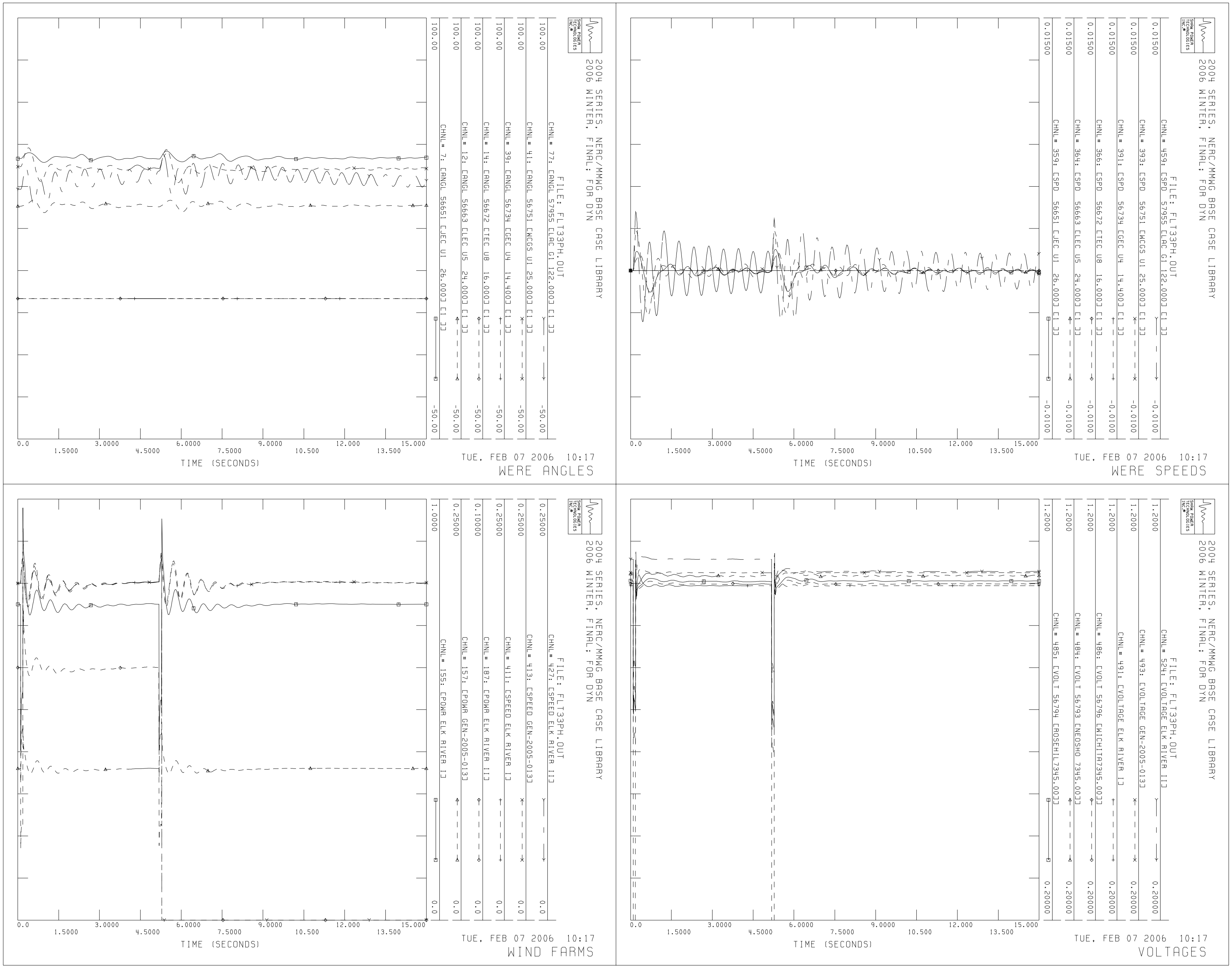

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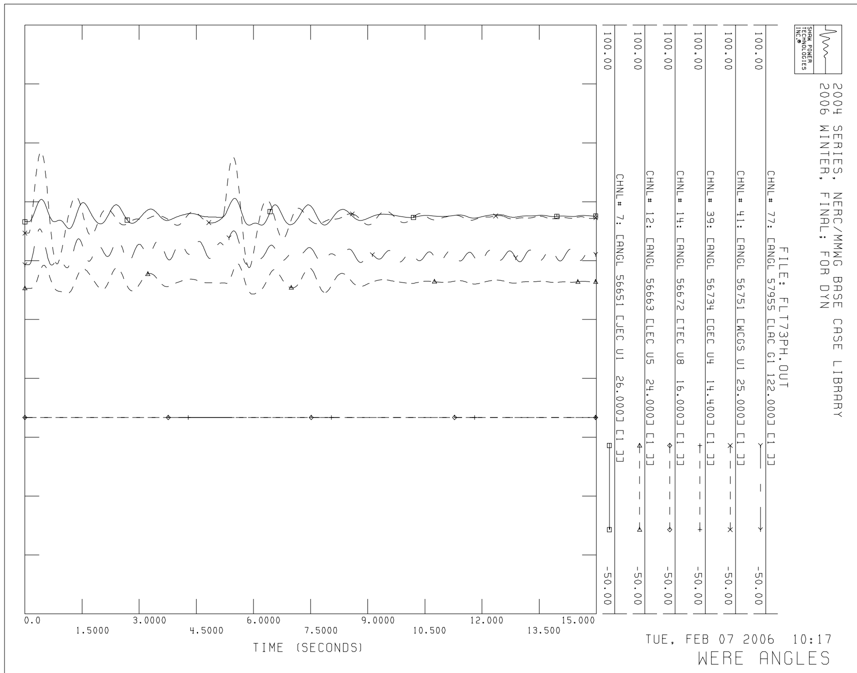
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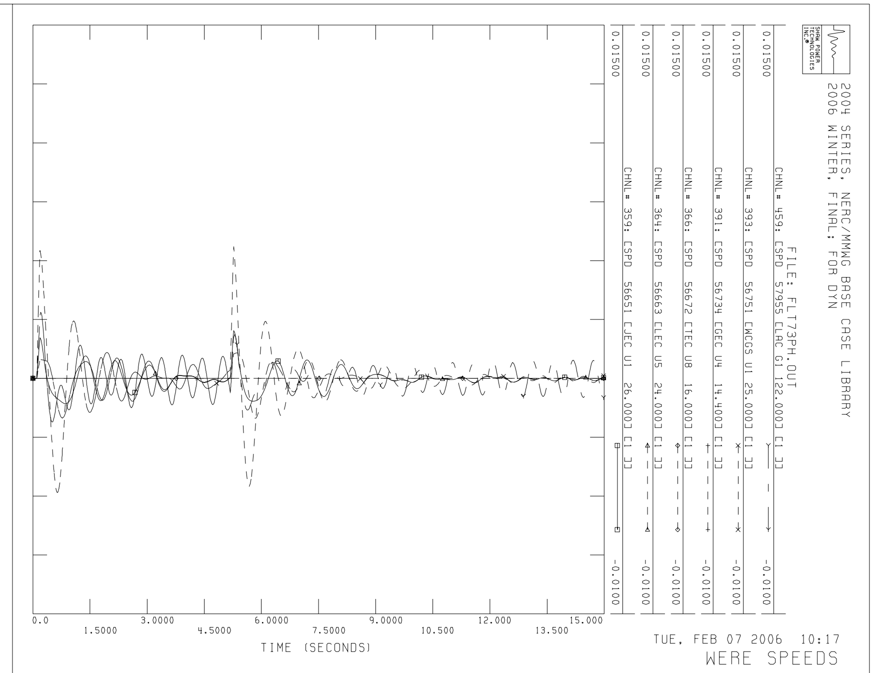
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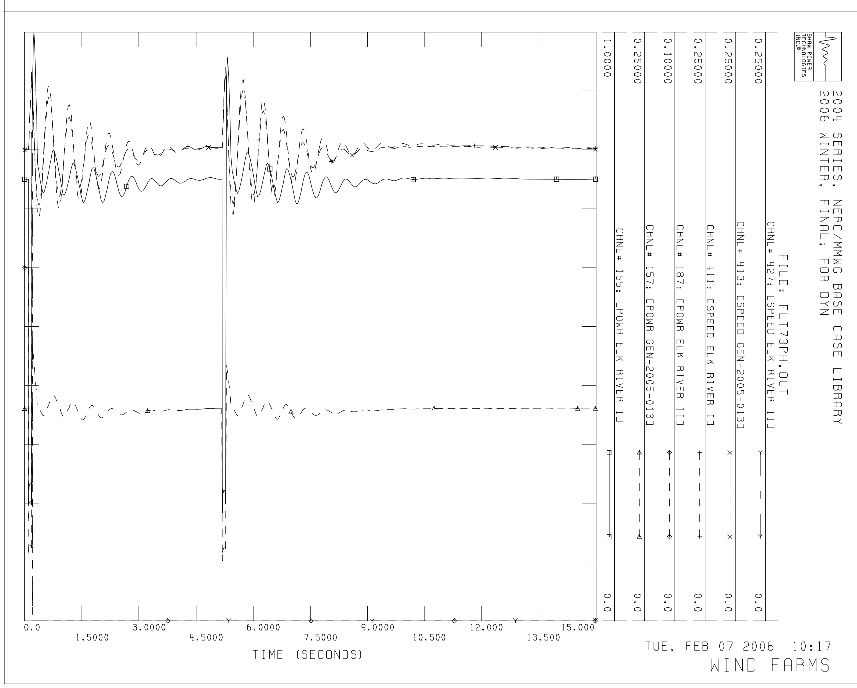
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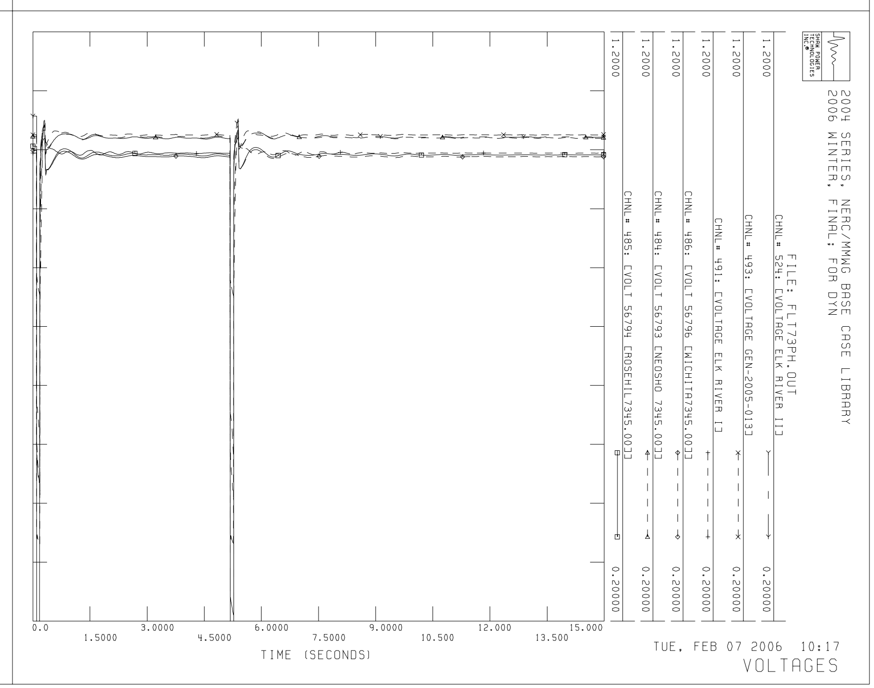
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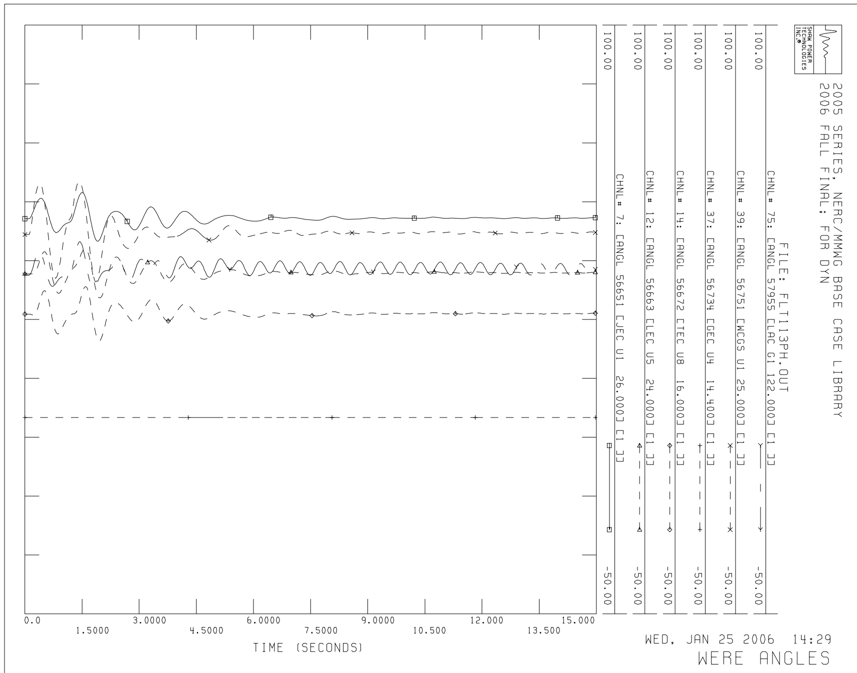
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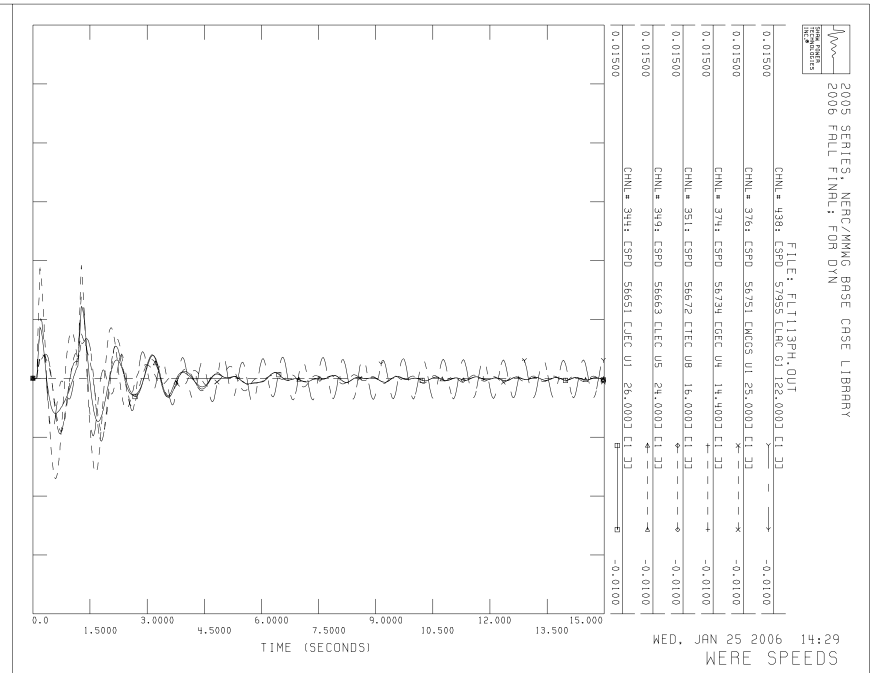
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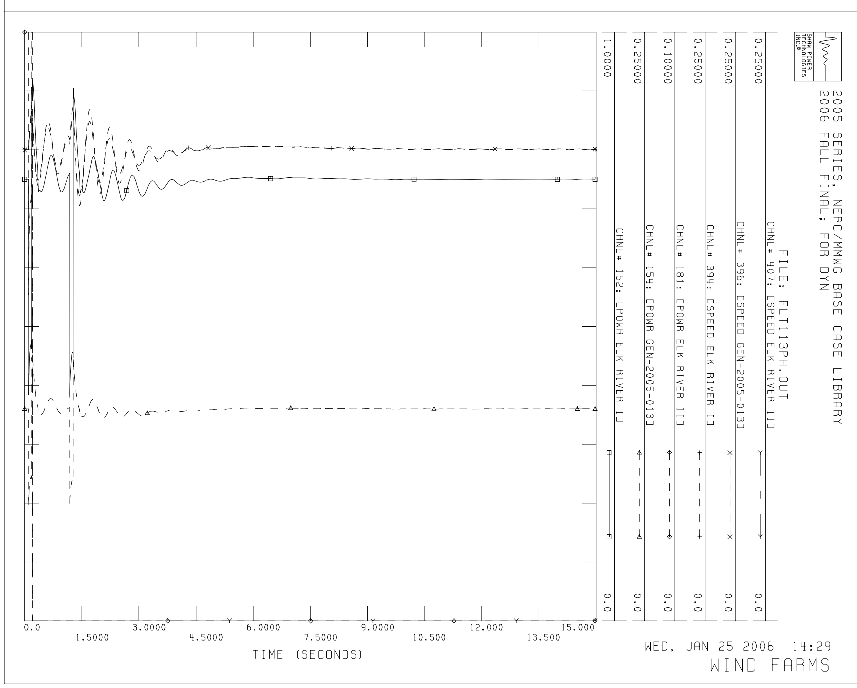
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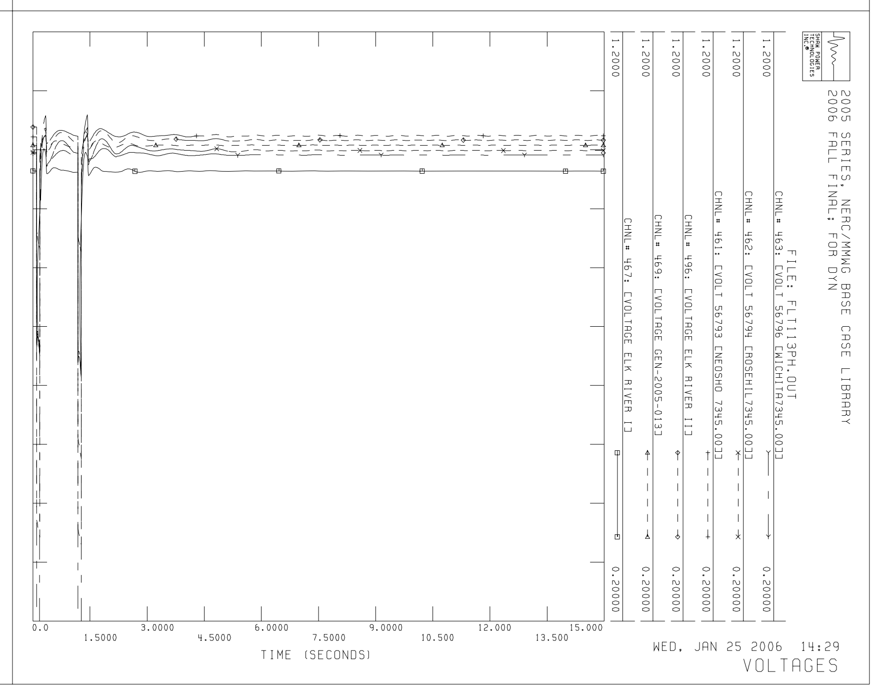
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