Southwest Power Pool

# Impact Study for Generation Interconnection Request
# GEN – 2002 – 004

*SPP Coordinated Planning*
*(#GEN-2002-004)*

**February 2005**

## Summary

Pterra, LLC as a subcontractor to EPRI Solutions, Inc. (ESI) performed the following study at the request of the Southwest Power Pool (SPP) for Generation Interconnection request Gen-2002-004. 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.

Pursuant to the tariff, ESI was asked to perform a detailed impact study of the generation interconnection requests to satisfy the Impact Study Agreement executed by the requesting customer and SPP.

The Customer requested that the re-study cover using the GE 1.5 sle wind turbine for an anticipated interconnection of 200 MW.

Draft Report:

# STABILITY IMPACT STUDY FOR PROPOSED INTERCONNECTION OF GEN-2002-004

Submitted to:

**Southern Power Pool (SPP)**

Submitted by:

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February 18, 2005

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# 1 EXECUTIVE SUMMARY

This report presents the stability simulation findings of the impact study of a proposed interconnection (Gen-2002-004). The analysis was conducted through the Southwest Power Pool Tariff for a 345kV interconnection of a 200 MW wind farm near Beaumont, Kansas. This wind farm would be interconnected to a new 345 kV three-breaker ring bus on the Rose Hill to Neosho line owned by Kansas Gas and Electric Company (WERE). The wind farm will use GE 1.5 MW wind turbines with the standard ride through package.

The 2005 Summer peak load flow case together with the necessary data needed for the simulations were provided by SPP. Transient stability simulations were conducted with the proposed wind farm in service with a full output of 200 MW. In order to integrate the proposed 200 MW wind farm in SPP system, the existing WERE generation was re-dispatched as provided by SPP.

Eighteen (18) contingencies were considered for the transient stability simulations which included 3-phase faults, as well as, 1-phase to ground faults, at the locations defined by SPP. 1-phase faults were simulated by applying a fault impedance to the positive sequence network at the fault location, representing 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 proposed wind generators were modeled with under/over voltage/frequency ride through protection. The settings were initially in accordance with standard or default settings.

The simulations conducted in the study did not find any angular or voltage instability problems in SPP for the eighteen contingencies. However, the wind farm tripped due to relay actuation in contingencies #1, 7, and 17, using the standard settings. In discussions with the manufacturer[1], it was determined that the threshold settings and time durations for tripping the WTGs can vary significantly from one project to another as equipment designs are modified to meet specific codes or interconnection agreement. Consequently, revised settings, within the acceptable range per the manufacturer, were determined for the study.

[1] "Modeling GE Wind Turbine-Generators for Grid studies", GE Report Version 3.4, December, 2004.

With the revised settings, the system remained stable for all the simulated faults with the proposed 200MW wind farm project in service. The wind farm did not trip in any of the contingencies. All oscillations were well damped. The study finds that the proposed 200MW wind farm project shows stable performance of SPP system for the contingencies tested on the supplied base case.

# 2 INTRODUCTION

The Southwest Power Pool (SPP) contracted EPRI Solutions, Inc. (ESI) to perform a system impact study for a proposed 200 MW wind farm (GEN-2002-004). The study was conducted by Pterra LLC as a subcontractor to ESI.

## *2.1 Project Overview*

The proposed 200 MW wind farm is located near Beaumont, Kansas. This wind farm would be interconnected to a new 345 kV three-breaker ring bus on the 345kV Rose Hill to Neosho line owned by Kansas Gas and Electric Company (WERE). A new 3.8 mile 345 kV line from the ring bus to the wind farm collector bus will be built. Figure 1 shows the interconnection diagram of the proposed GEN 2002-004 project to the 345kV transmission system. The detailed connection diagram of the wind farm is provided by SPP based on Customer data.

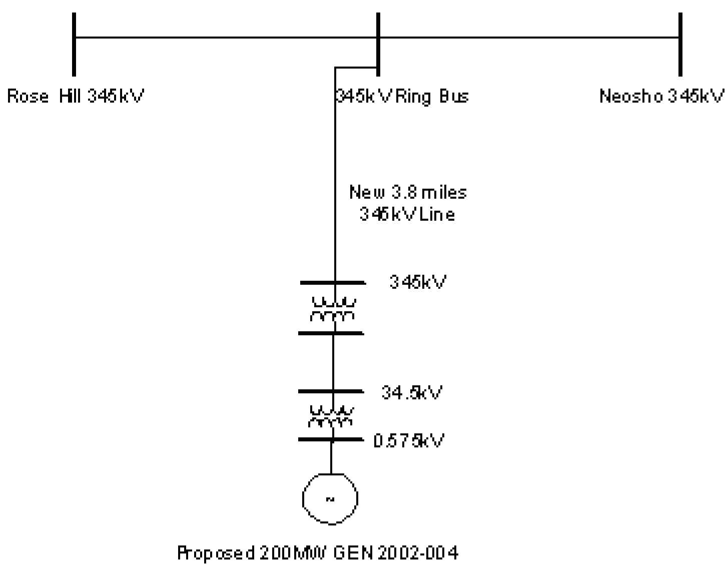


**Figure 1.** ***Interconnection Plan for GEN 2002-004 to the 345kV System***

In order to integrate the proposed 200 MW wind farm in SPP system, the existing WERE generation was re-dispatched as provided by SPP.

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 43 equivalent units as shown in Figure 2. The number in each circle in the diagram shows the number of individual wind turbine units that were aggregated at that bus. SPP provided the impedance values for the different feeders at 34.5kV level. SPP provided Customer data for the following equipment:

1. 34.5kV feeders
2. Generating unit step up transformers
3. 345kV/34.5kV transformer
4. Data for the new 345kV line

### 2.2 Objective

The objective of the study is, to determine the impact on system stability of connecting 200MW wind farm to SPP's 345 kV transmission system.

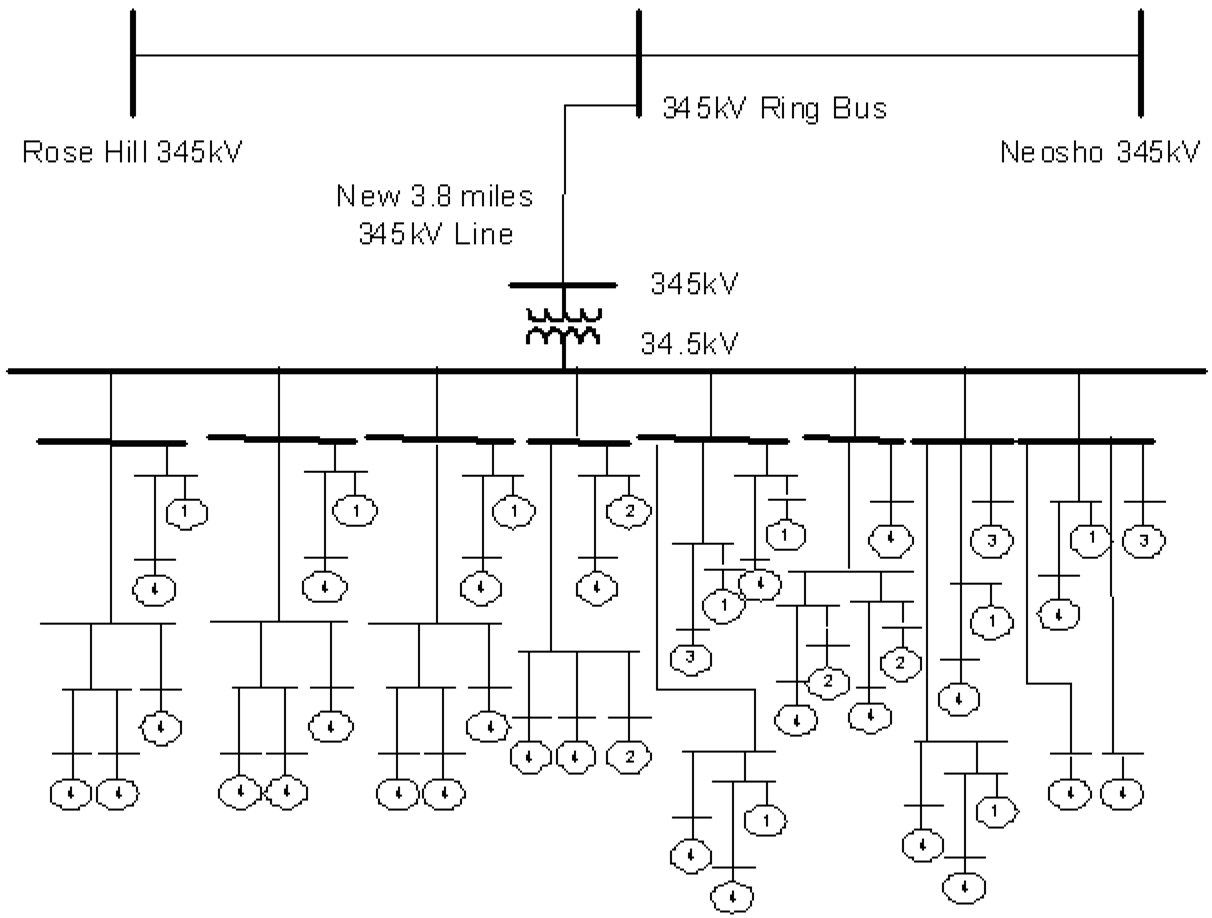


**Figure 2.** ***Wind Farm Equivalent representation in Load Flow***

# 3 STABILITY ANALYSIS

### 3.1 Modeling of the Wind Turbines

GE 1.5 MW wind turbine generators were modeled using the latest GE wind turbine model set available from Siemens PTI. The wind turbine generator model is comprised of several user models for dynamic simulation as follows:

1. DFIGPQ6: doubly-fed induction generator model including provision for rotor control using desired P and Q set-points,
2. CGECN7: active rotor control model (representation of rotor converter circuit)
3. TGPTCH1: pitch angle control model
4. TWIND1: wind model allowing wind gusts and ramps to be applied,
5. TSHAFT2: 2-mass shaft model to represent the effects of the rotor/hub connected via a 'flexible' shaft to the generator,
6. GEAERO1: aerodynamic model which calculates the aerodynamic torque applied to the rotor taking into account wind speed, tip speed ratio Lambda, performance coefficient Cp etc.,
7. READCP: model to read the turbine Cp matrix,
8. FRQTRP: under/over frequency generator tripping relay.
9. VTGTRP: under/over voltage generator tripping relay.

An essential component of the GE wind turbine model package is an IPLAN program that creates the equivalents for the wind turbine and generator step-up (GSU) transformer in the load flow case. In addition, the program generates a dynamic data input file (*.dyr) for the wind turbines and the different models listed above, plus the voltage/frequency protection components. Since the wind turbine generators have ride-through capability for voltage and frequency, detailed relay settings for voltage/frequency protection schemes are included in the model.

Appendix A gives the DOCU output of an equivalent generator at collector bus 90814. Note that the same models and setup are applied to all the wind turbine generators.

### 3.2 Under/Over Voltage/Frequency Relay Models

The under/over frequency, FRQTRP, and under/over voltage, VTGTRP, models are protection models, which are located at the generator bus to which the WTG equivalent is connected. These models monitor the frequency/voltage on that bus or a remote bus specified by the user over the course of a simulation period. They trip the WTG equivalent for under- and over- frequency or voltage conditions on the generator (or remote bus). The current standard ride-through capability available from GE Wind Energy is reflected in the latest GE wind turbine model package as shown in Table 1 and Table 2 for frequency and voltage, respectively. These standard settings were used in the study.

**Table 1: Over/Under Frequency Relay Settings for GE Wind Turbine**

| Frequency Settings in Hertz | Time Delay in Seconds | Breaker time in Seconds |
|---|---|---|
| $F \leq 56.5$ | 0.02 | 0.15 |
| $56.5 < F \leq 57.5$ | 10.0 | 0.15 |
| $61.5 < F \leq 62.5$ | 30.0 | 0.15 |
| $F \geq 62.5$ | 0.02 | 0.15 |

**Table 2. Over/Under Voltage Relay Settings for GE Wind Turbine**

| Voltage Settings Per Unit | Time Delay in Seconds | Breaker time in Seconds |
|---|---|---|
| $V \leq 0.30$ | 0.02 | 0.15 |
| $0.30 < V \leq 0.70$ | 0.10 | 0.15 |
| $0.70 < V \leq 0.75$ | 1.00 | 0.15 |
| $0.75 < V \leq 0.85$ | 10.0 | 0.15 |
| $V \geq 1.10$ | 1.00 | 0.15 |
| $1.10 > V \geq 1.15$ | 0.10 | 0.15 |
| $1.15 > V \geq 1.3$ | 0.02 | 0.15 |

### *3.3 GE 1.5 MW Wind Generator Parameters*

The data for the GE 1.5 MW wind generator and generator step-up transformer are shown in Table 3.

### *3.4 Assumptions*

The following assumptions were adopted for the study:

1. A constant maximum and uniform wind speed was considered during the entire period of study.
2. The wind turbine control models available from Siemens PTI PSS/E package such as CGECN2, TWIND1, and TGPTCH were used with their default values.
3. The settings for the under/over voltage/frequency were initially set according to the standard manufacturer data.

**Table 3.** ***GE 1.5 MW Wind Generator Data***

| Parameter | Value |
|---|---|
| BASE KV | 0.575 |
| WTG MBASE | 1.667 |
| TRANSFORMER MBASE | 1.75 |
| TRANSFORMER R ON TRANSFORMER BASE | 0.0077 |
| TRANSFORMER X ON TRANSFORMER BASE | 0.0579 |
| GTAP | 1.05 |
| PMAX (MW) | 1.5 |
| PMIN | 0.0 |
| RA | 0.00706 |
| LA | 0.1714 |
| LM | 2.904 |
| R1 | 0.005 |
| L1 | 0.1563 |
| INERTIA | 0.57 |
| DAMPING | 0.0 |
| QMAX (MVAR) | 0.49 |
| QMIN (MVAR) | -0.73 |

### *3.5 Contingencies Simulated*

Eighteen (18) 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. 1-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. Table 4 shows the list of simulated contingencies. The table also shows the fault clearing time and the time delay before re-closing for all the study contingencies.

**Table 4. *List of Contingencies***

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 1 | FLT13PH | Three phase fault on the Rose Hill to the Wind Farm Switching Station, 345kV line, (at Mid Line). Apply Fault at the Mid-line bus.<br>a. Clear Fault after 5 cycles by removing the line from Rose Hill to Mid-line bus and from Mid-line bus to the Wind Farm Switching Station<br>b. Wait 300 cycles, and then re-close the line in (b) back into the fault.<br>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.<br>a. Apply fault at the Neosho.<br>b. Clear fault after 5 cycles by removing the line from the Wind Farm Switching Station to Neosho.<br>c. Wait 300 cycles, and then re-close the line in (b) into the fault.<br>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.<br>a. Apply Fault at the Mid-line bus.<br>b. Trip the line after 5 cycles by removing the line from Neosho to the Mid-line bus to Morgan and remove the fault.<br>c. Wait 300 cycles, and then re-close the line in (b) 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 | Three phase fault on the Rose Hill to Wolf Creek 345 kV line, near Rose Hill.<br>a. Apply fault at the Rose Hill.<br>b. Clear fault after 5 cycles by tripping the line from Rose Hill to Wolf Creek.<br>c. Wait 300 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 | Three phase fault on the Rose Hill to Benton 345 kV line, near Benton.<br>a. Apply fault at the Benton.<br>b. Clear fault after 5 cycles by tripping the line from Rose Hill to Benton .<br>c. Wait 60 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 | Three phase fault on the Benton to Wichita 345 kV line, near Wichita.<br>a. Apply fault at the Wichita bus<br>b. Clear fault after 5 cycles by tripping the line Benton to Wichita.<br>c. Wait 60 cycles, and then re-close 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 |

| Cont. No. | Cont. Name | Description |
|---|---|---|
| 13 | FLT133PH | Three phase fault on the Benton to Midian 138 kV line, near Midian.<br>a. Apply fault at the Midian bus.<br>b. Clear fault after 7 cycles by tripping the line from Benton to Midian.<br>c. Wait 25 cycles, and then re-close line in (b) back into the fault.<br>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.<br>a. Apply fault at the Butler bus.<br>b. Clear fault after 7 cycles by tripping the line from Midian (56990) to Butler<br>c. Wait 25 cycles, and then re-close the line in (b) back into the fault.<br>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<br>a. Apply fault at the Weaver bus (56991).<br>b. Clear fault after 7 cycles by tripping the line from Rose Hill (57062) to Weaver (56991).<br>c. Wait 25 cycles, and then re-close the line in (b) back into the fault.<br>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 |

The set of PSAS files to simulate the above listed disturbances are given in Appendix B.

### 3.6 Simulation Results

Simulations were performed with a 0.1-second steady-state run followed by the appropriate disturbance as described in Table 4. Simulations were run for a minimum 10-second duration to confirm proper machine damping. Based on the obtained simulation results, the system remained stable for all the simulated faults with the proposed 200MW wind farm project in service. All oscillations were well damped. The study finds that the proposed 200MW wind farm project, on the basis of base case, modeling assumptions described within this report, and for the tested contingencies (on the supplied base case) show stable performance of SPP system.

Transient stability plots for rotor angle, speed, and voltages for disturbance # 9 (refer to Table 4) for some monitored buses in SPP and for the 200MW wind farm project are provided as an example. The complete set of the plots for all contingencies will be sent in an electronic format on a CD.

The wind farm trips in three of the simulated disturbances 1, 7, and 17 (see Table 4 for descriptions). For disturbances 1 and 7, both under voltage and over frequency relays pick up. However, the over frequency relay was faster to trip the wind turbines. For disturbance 17, the wind farm trips because of the under-voltage relay. To keep the wind farm in service during these disturbances, modified settings, within the range of manufacturer specifications, for the under/over voltage/frequency relays were determined and applied. Tables 5 and 6 show the new settings.

**Table 5. Over/Under Frequency Relay Settings for GE Wind Turbine**

| Frequency Settings in Hertz | Time Delay in Seconds | Breaker time in Seconds |
|---|---|---|
| F ≤ 56.5 | 0.02 | 0.15 |
| 56.5 < F ≤ 57.5 | 10.0 | 0.15 |
| 61.5 < F ≤ 62.5 | 30.0 | 0.15 |
| F ≥ 62.5 | 0.20 | 0.15 |

**Table 6. Over/Under Voltage Relay Settings for GE Wind Turbine**

| Voltage Settings Per Unit | Time Delay in Seconds | Breaker time in Seconds |
|---|---|---|
| V ≤ 0.30 | 0.08 | 0.15 |
| 0.30 < V ≤ 0.70 | 0.15 | 0.15 |
| 0.70 < V ≤ 0.75 | 1.00 | 0.15 |
| 0.75 < V ≤ 0.85 | 10.0 | 0.15 |
| V ≥ 1.10 | 1.00 | 0.15 |
| 1.10 > V ≥ 1.15 | 0.10 | 0.15 |
| 1.15 > V ≥ 1.3 | 0.02 | 0.15 |

With the new settings for both under/over voltage and frequency relays, tripping of the wind farm is avoided and oscillations are well damped.

# 4 CONCLUSION

The stability simulation findings of the impact study of a proposed interconnection (Gen-2002-004) were presented in this report. The study was conducted under the Southwest Power Pool Tariff for a 345kV interconnection for a 200 MW wind farm near Beaumont, Kansas. This wind farm would be interconnected to a new 345 kV three-breaker ring bus on the Rose Hill to Neosho line owned by Kansas Gas and Electric Company (WERE). The wind farm is using GE 1.5 MW wind turbines with the standard ride through package.

The 2005 Summer peak load flow case together with the necessary data needed for the transient stability simulations were provided by SPP. The study was performed using Siemens PTI's PSS/E program with the latest PSS/E modeling packages to represent the GE Wind 1.5 MW wind turbine generators (WTG). These packages are suitable for use in studies related to the integration of the aforementioned WTGs into power systems.

Transient stability simulations were conducted with the proposed wind farm in service with a full output of 200 MW. In order to integrate the proposed 200MW wind farm in SPP system, re-dispatch for the existing WERE generation was provided by SPP.

Eighteen (18) contingencies were considered for the transient stability simulations which included three phase faults, as well as single line to ground faults, at the locations defined by SPP. 1-phase 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 proposed wind generators were modeled with voltage/frequency ride through protection. The settings of both under/over voltage and frequency relays were initially in accordance with standard or default settings.

The simulations conducted in the study did not find any angular or voltage instability problems for the eighteen contingencies. However, the wind farm tripped due to relay actuation in contingencies #1, 7, and 17, using the standard settings. In discussions with the manufacturer, it was determined that the threshold settings and time durations for tripping the WTGs can vary significantly from one project to another as equipment designs are modified to meet specific codes or interconnection agreement. Consequently, revised settings, within the acceptable range per the manufacturer, were determined for the study.

With the revised settings, the system remained stable for all the simulated faults with the proposed 200 MW wind farm project in service. The wind farm did not trip in any of the contingencies.  All oscillations were well damped. The study finds that the proposed 200MW wind farm project shows stable performance of SPP system for the contingencies tested on the supplied base case.

# A APPENDIX

## DOCU Output for a Sample Wind Turbine Generator

```
     PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      MON, FEB 14 2005   9:08
SPP MDWG 04 STABILITY;2005 SUMMER PEAK;S05SP-28.CNL;3-12-04
(C) 2004 SOUTHWEST POWER POOL, INC. (SEE DISCLAIMER BELOW)

PLANT MODELS

REPORT FOR ALL MODELS                   BUS 90814 [CLR_1    0.5750] MODELS


THE DFIGPQ6.FOR MODEL, RELEASE # 03, WAS UPDATED ON MARCH 03, 2004

** DFIGPQ **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S       VAR        ICON
         90814     CLR_1    0.5750 1   77484-77491   33969-33970     511-528       497

    RA       LA       LM       R1       L1       H        DAMP
  0.0071   0.1714   2.9040   0.0050   0.1563   0.5700   0.0000

     -SLIP
  0.2000


THE CGECN2.FOR MODEL, RELEASE # 03, WAS UPDATED ON MAY 07, 2004

** CGECN2 for DFIGPQ **  BUS X-- NAME --X BASEKV MC    C O N S     S T A T E S       VAR        ICON
                90814     CLR_1    0.5750 1  166225-166245  64595-64602    6996-7002     4034-4037
```

| TFV | KPV | KIV | RC | XC | TFP | KPP |
|---|---|---|---|---|---|---|
| 0.1500 | 20.0000 | 2.0000 | 0.0000 | 0.0000 | 0.0500 | 3.0000 |

| KIP | PMX | PMN | QMX | QMN | IQMAX | TRV |
|---|---|---|---|---|---|---|
| 0.6000 | 1.1200 | 0.0900 | 0.3000 | -0.4300 | 1.1100 | 0.0500 |

| RPMX | RPMN | T_POWER |
|---|---|---|
| 0.4500 | -0.4500 | 5.0000 |

| KQV | VMINCL | VMAXCL | KVQ |
|---|---|---|---|
| 0.0500 | 0.9000 | 1.1000 | 30.0000 |

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      MON, FEB 14 2005   9:08
SPP MDWG 04 STABILITY;2005 SUMMER PEAK;S05SP-28.CNL;3-12-04
(C) 2004 SOUTHWEST POWER POOL, INC. (SEE DISCLAIMER BELOW)

CONEC MODELS

REPORT FOR ALL MODELS                    BUS 90814 [CLR_1   0.5750] MODELS

*** CALL TWIND1(  6060,221908,     0, 15886) ***

THE TWIND1.FOR MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

** TWIND1 ** BUS X-- NAME --X BASEKV MC    C O N S       V A R S       ICONS
90814 CLR_1        0.5750 1  221908-221914  15886-15888    6060-6061

VWB    T1G     TG    MAXG     T1R     T2R    MAXR
15.0009999.000   5.000  30.0009999.0009999.000  30.000

Wind generator Bus #  90814
Wind Generator ID        1

THE TSHAFT2.FOR MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

| ** TSHAFT for a machine ** | BUS | X-- NAME --X | BASEKV | MC | C O N S | STATE | VAR | ICON |
|---|---|---|---|---|---|---|---|---|
| | 90814 | CLR_1 | 0.5750 | 1 | 222209-222213 | 82751-82752 | 16015-16017 | 6146-6148 |

| D12 | K12 | Ta1 | p | Rq |
|---|---|---|---|---|
| 1.5000 | 1.2460 | 7.6400 | 3.0000 | 72.0000 |

Wind Generator Bus # 90814

Wind Generator ID 1

THE GEAERO1.FOR MODEL, RELEASE # 01, WAS DEVELOPED ON FEBRUARY 25, 2004

| ** GEAERO for DFIGPQ ** | BUS | X-- NAME --X | BASEKV | MC | C O N S | STATE | VAR | ICON |
|---|---|---|---|---|---|---|---|---|
| | 90814 | CLR_1 | 0.5750 | 1 | 222424-222435 | 82837-82837 | 16144-16147 | 6275-6277 |

| VWinit | Lambda_Max | Lambda_Min | PITCH_MAX | PITCH_MIN | Ta |
|---|---|---|---|---|---|
| 15.0000 | 20.0000 | 0.0000 | 27.0000 | -4.0000 | 0.0000 |
| RHO | Radius | GB_RATIO | SYNCHR | Power_Rate | MBASE1 |
| 1.2250 | 35.2500 | 72.0000 | 1200.0 | 1500.0 | 1.6670 |

Wind Generator Bus # 90814

Wind Generator ID 1

THE TGPTCH1.FOR MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

| ** TGPTCH for DFIGPQ ** | BUS | X-- NAME --X | BASEKV | MC | C O N S | STATE | VAR | ICON |
|---|---|---|---|---|---|---|---|---|
| | 90814 | CLR_1 | 0.5750 | 1 | 222940-222949 | 82880-82882 | 16316-16318 | 6404-6406 |

| Tp | Kpp | Kip | Kpc | Kic |
|---|---|---|---|---|
| 0.2000 | 150.0000 | 25.0000 | 3.0000 | 30.0000 |
| TetaMin | TetaMax | RTetaMin | RTetaMax | PMX |
| -4.0000 | 27.0000 | -10.0000 | 10.0000 | 0.9100 |

Wind Generator Bus #  90814

Wind Generator ID  1

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E  MON, FEB 14 2005  9:08

SPP MDWG 04 STABILITY;2005 SUMMER PEAK;S05SP-28.CNL;3-12-04

(C) 2004 SOUTHWEST POWER POOL, INC. (SEE DISCLAIMER BELOW)

CONET MODELS

REPORT FOR ALL MODELS  BUS 90814 [CLR_1  0.5750] MODELS

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(  7339,223904,  0, 16949) ***

| BUS | NAME | BSKV | GENR BUS | NAME | BSKV |
|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 7339-7343 | 223904-223907 | 16949 |

| VLO | VUP | PICKUP | TB |
|---|---|---|---|
| 0.300 | 5.000 | 0.020 | 0.150 |

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP(  7344,223908,  0, 16950) ***

| BUS | NAME | BSKV | GENR BUS | NAME | BSKV |
|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 7344-7348 | 223908-223911 | 16950 |

| VLO | VUP | PICKUP | TB |
|---|---|---|---|
| 0.700 | 5.000 | 0.100 | 0.150 |

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP( 7349,223912, 0, 16951) ***

BUS NAME BSKV GENR BUS NAME BSKV
90814 CLR_1 .575 90814 CLR_1 .575

I C O N S C O N S V A R
7349-7353 223912-223915 16951

VLO VUP PICKUP TB
0.750 5.000 1.000 0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP( 7354,223916, 0, 16952) ***

BUS NAME BSKV GENR BUS NAME BSKV
90814 CLR_1 .575 90814 CLR_1 .575

I C O N S C O N S V A R
7354-7358 223916-223919 16952

VLO VUP PICKUP TB
0.850 5.000 10.000 0.150

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP( 7359,223920, 0, 16953) ***

BUS NAME BSKV GENR BUS NAME BSKV
90814 CLR_1 .575 90814 CLR_1 .575

I C O N S C O N S V A R

7359-7363 223920-223923 16953

| VLO | VUP | PICKUP | TB |
|---|---|---|---|
| 0.000 | 1.100 | 1.000 | 0.150 |

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP( 7364,223924, 0, 16954) ***

| BUS | NAME | BSKV | GENR BUS | NAME | BSKV |
|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 7364-7368 | 223924-223927 | 16954 |

| VLO | VUP | PICKUP | TB |
|---|---|---|---|
| 0.000 | 1.150 | 0.100 | 0.150 |

THE VTGTRP.FLX MODEL, RELEASE # 02, WAS UPDATED ON FEBRUARY 24, 2004

*** CALL VTGTRP( 7369,223928, 0, 16955) ***

| BUS | NAME | BSKV | GENR BUS | NAME | BSKV |
|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 7369-7373 | 223928-223931 | 16955 |

| VLO | VUP | PICKUP | TB |
|---|---|---|---|
| 0.000 | 1.300 | 0.020 | 0.150 |

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

*** CALL FRQTRP( 8844,225108, 0, 17250) ***

| BUS | NAME | BSKV | GEN BUS | NAME | BSKV | ID |
|---|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 | 1 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 8844-8849 | 225108-225111 | 17250 |

| FLO | FUP | PICKUP | TB |
|---|---|---|---|
| 56.500 | 75.000 | 0.020 | 0.150 |

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

*** CALL FRQTRP( 8850,225112, 0, 17251) ***

| BUS | NAME | BSKV | GEN BUS | NAME | BSKV | ID |
|---|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 | 1 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 8850-8855 | 225112-225115 | 17251 |

| FLO | FUP | PICKUP | TB |
|---|---|---|---|
| 57.500 | 70.000 | 10.000 | 0.150 |

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

*** CALL FRQTRP( 8856,225116, 0, 17252) ***

| BUS | NAME | BSKV | GEN BUS | NAME | BSKV | ID |
|---|---|---|---|---|---|---|
| 90814 | CLR_1 | .575 | 90814 | CLR_1 | .575 | 1 |

| I C O N S | C O N S | V A R |
|---|---|---|
| 8856-8861 | 225116-225119 | 17252 |

| FLO | FUP | PICKUP | TB |
|---|---|---|---|
| 54.000 | 61.500 | 30.000 | 0.150 |

THE FRQTRP1.FLX MODEL, RELEASE # 03, WAS UPDATED ON FEBRUARY 25, 2004

```
*** CALL FRQTRP(  8862,225120,     0, 17253) ***

 BUS    NAME    BSKV      GEN BUS    NAME    BSKV   ID
90814  CLR_1     .575       90814  CLR_1     .575    1

   I C O N S      C O N S       V A R
   8862-8867   225120-225123   17253

    FLO       FUP      PICKUP     TB
   54.000    62.500     0.0200     0.150
```

# B APPENDIX

## PSAS Files for the Simulated Disturbances

- **FLT13PH**

```
PSS
PDEV
2 1 1
PDEV_FLT13PH.TXT
ODEV
2 1 1
PDEV_FLT13PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  1_FLT13PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56700
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
TRIP LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56700
CLOSE LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
CLOSE LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
TRIP LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT21PH**

```
PSS
PDEV
2 1 1
PDEV_FLT21PH.TXT
ODEV
2 1 1
PDEV_FLT21PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  2_FLT21PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56700 ADMITTANCE 130 -3735 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
TRIP LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56700 ADMITTANCE 130 -3735 MVA
CLOSE LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
CLOSE LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56700 CIRCUIT 1
TRIP LINE FROM BUS 56794 TO BUS 56700 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT33PH**

```
PSS
PDEV
2 1 1
PDEV_FLT33PH.TXT
ODEV
2 1 1
PDEV_FLT33PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  3_FLT33PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56793
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56793
CLOSE LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT41PH**

```
PSS
PDEV
2 1 1
PDEV_FLT41PH.TXT
ODEV
2 1 1
PDEV_FLT41PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  4_FLT41PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56793 ADMITTANCE 180 -5900 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56793 ADMITTANCE 180 -5900 MVA
CLOSE LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56795 TO BUS 56793 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT53PH**

```
PSS
PDEV
2 1 1
PDEV_FLT53PH.TXT
ODEV
2 1 1
PDEV_FLT53PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  5_FLT53PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56730
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
TRIP LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56730
CLOSE LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
CLOSE LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
TRIP LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT61PH**

```
PSS
PDEV
2 1 1
PDEV_FLT61PH.TXT
ODEV
2 1 1
PDEV_FLT561H.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  6_FLT61PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56730 ADMITTANCE 140 -3220 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
TRIP LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56730 ADMITTANCE 140 -3220 MVA
CLOSE LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
CLOSE LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56793 TO BUS 56730 CIRCUIT 1
TRIP LINE FROM BUS 96045 TO BUS 56730 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT73PH**

```
PSS
PDEV
2 1 1
PDEV_FLT73PH.TXT
ODEV
2 1 1
PDEV_FLT73PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  7_FLT73PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56794
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56794
CLOSE LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT81PH**

```
PSS
PDEV
2 1 1
PDEV_FLT81PH.TXT
ODEV
2 1 1
PDEV_FLT81PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  8_FLT81PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56794 ADMITTANCE 165 -4770 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN FOR 300 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56794 ADMITTANCE 165 -4770 MVA
CLOSE LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56794 TO BUS 56797 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT93PH**

```
PSS
PDEV
2 1 1
PDEV_FLT93PH.TXT
ODEV
2 1 1
PDEV_FLT93PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  9_FLT93PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56791
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN FOR 60 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56791
CLOSE LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT101PH**

```
PSS
PDEV
2 1 1
PDEV_FLT101PH.TXT
ODEV
2 1 1
PDEV_FLT101PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  10_FLT101PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56791 ADMITTANCE 185 -5130 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN FOR 60 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56791 ADMITTANCE 185 -5130 MVA
CLOSE LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56794 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT113PH**

```
PSS
PDEV
2 1 1
PDEV_FLT113PH.TXT
ODEV
2 1 1
PDEV_FLT113PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  11_FLT113PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56796
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN FOR 60 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56796
CLOSE LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT121PH**

```
PSS
PDEV
2 1 1
PDEV_FLT121PH.TXT
ODEV
2 1 1
PDEV_FLT121PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  12_FLT121PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56796 ADMITTANCE 195 -5260 MVA
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN FOR 60 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56796 ADMITTANCE 195 -5260 MVA
CLOSE LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN FOR 5 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56791 TO BUS 56796 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT131PH**

```
PSS
PDEV
2 1 1
PDEV_FLT133PH.TXT
ODEV
2 1 1
PDEV_FLT133PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  13_FLT133PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56990
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56990
CLOSE LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT141PH**

```
PSS
PDEV
2 1 1
PDEV_FLT141PH.TXT
ODEV
2 1 1
PDEV_FLT141PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  14_FLT141PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56990 ADMITTANCE 155 -1755 MVA
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56990 ADMITTANCE 155 -1755 MVA
CLOSE LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56986 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT153PH**

```
PSS
PDEV
2 1 1
PDEV_FLT153PH.TXT
ODEV
2 1 1
PDEV_FLT153PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  15_FLT153PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56987
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56987
CLOSE LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT161PH**

```
PSS
PDEV
2 1 1
PDEV_FLT161PH.TXT
ODEV
2 1 1
PDEV_FLT161PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  16_FLT161PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56987 ADMITTANCE 165 -1700 MVA
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56987 ADMITTANCE 165 -1700 MVA
CLOSE LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56990 TO BUS 56987 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT173PH**

```
PSS
PDEV
2 1 1
PDEV_FLT173PH.TXT
ODEV
2 1 1
PDEV_FLT173PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  17_FLT173PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56991
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56991
CLOSE LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```

- **FLT181PH**

```
PSS
PDEV
2 1 1
PDEV_FLT183PH.TXT
ODEV
2 1 1
PDEV_FLT183PH.TXT
FIN
RECOVER FROM BASE_CASE_WIND.SNP AND BASE_CASE_WT_CNV.SAV
INITIALIZE OUTPUT  18_FLT183PH.OUT
RUN TO .1 SECONDS PRINT 240 PLOT 1
APPLY FAULT AT BUS 56991 ADMITTANCE 145 -2975 MVA
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN FOR 25 CYCLES PRINT 240 PLOT 1
APPLY FAULT AT BUS 56991 ADMITTANCE 145 -2975 MVA
CLOSE LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN FOR 7 CYCLES PRINT 240 PLOT 1
CLEAR FAULT
TRIP LINE FROM BUS 56991 TO BUS 57062 CIRCUIT 1
RUN TO 5 SECONDS PRINT 240 PLOT 1
RUN TO 10 SECONDS PRINT 240 PLOT 7
PSS
PDEV
1
ODEV
7
FIN

END
```