SPP Southwest Power Pool

System Impact Study for Generation Interconnection Request for

>OMITTED TEXT<

SPP Coordinated Planning
(#GEN-2001-037)

February, 2002

Executive Summary

>OMITTED TEXT< has requested a System Impact Study for interconnection of a 100MW >OMITTED TEXT< facility in northwestern Oklahoma in >OMITTED TEXT<. The requested point of interconnection is the Western Farmers Electric Cooperative (WFEC) >OMITTED TEXT< 138kV substation. The projected in-service date of the facility is October, 2002.

Powerflow analysis indicates with local utilities serving their native load and with confirmed long-term transmission transactions occurring, the>OMITTED TEXT<facility causes no new overloads in the local area of the facility. However, this study does not serve as an ATC study of available transmission capacity. The customer must request transmission service through the SPP OASIS in order to operate the facility.

Short circuit analysis indicates that no existing equipment has its fault duties exceeded due to the addition of the >OMITTED TEXT< project.

Dynamic stability analysis indicates that it is possible that the >OMITTED TEXT< facility causes dynamic and voltage instability to other potential merchant generation in the area. Further study, and a change in the connection arrangement of the other project, makes it unlikely that this project would be required to pay for any mitigation facilities. (Red text updated 9-10-02)

The proposed method of interconnection is for >OMITTED TEXT< to build a 138kV switching station at their facility capable of accepting a terminal from WFEC >OMITTED TEXT< substation. The terminal to >OMITTED TEXT< substation shall be protected by a 138kV circuit breaker and at a minimum primary and secondary line relaying. Facilities to be constructed and owned by WFEC include a twelve mile radial line from >OMITTED TEXT< facility and substation construction at >OMITTED TEXT<. The total cost of these facilities not including gross-up for taxes is estimated at $2,660,000 and has a lead time of 18 months. For the conditions that the >OMITTED TEXT< facility causes instability to other merchant generation, >OMITTED TEXT< shall be liable for the addition of the >OMITTED TEXT< 138kV transmission line with an additional cost of $4,930,000 for a total cost of the project estimated at $7,590,000 not including tax gross up.

Introduction

>OMITTED TEXT< requested interconnection for a 100MW generating facility consisting of >OMITTED TEXT<. The Facility is located in northwestern Oklahoma in >OMITTED TEXT< County. The request for a detailed impact study was made in November, 2001.

The proposed method of interconnection specified by >OMITTED TEXT< is to interconnect into Western Farmers Electric Cooperative's (WFEC) >OMITTED TEXT< substation. A one-line of the area can be seen in Figure 1. The in-service date of the proposed generation is October, 2002.

<DIAGRAM OMITTED>

Figure 1. Transmission System in northwestern Oklahoma

The System Impact Study investigates the effect of the new generation on system performance during normal and contingency conditions. For purposes of this study, the power was absorbed into the system by lowering generation in Western Farmers Electric Cooperative system at Hugo Power Station and Anadarko Power Station.

The study investigated the plant's response in steady-state contingency, dynamic stability, and short circuit analysis.

The steady-state contingency analysis considers the impact of the new generation on transmission facility loading and transmission bus voltages for outages of transmission lines, autotransformers, and generators.

Stability analysis shows the effect of the new generation on the transient stability of WFEC and any surrounding utility generators. Transient stability is concerned with the recovery from faults on the transmission system that are in close proximity to generating facilities.

Short circuit analysis determines the whether the interruption capabilities of existing circuit breakers are exceeded with the addition of the new generation.

Steady State Analysis

A steady state analysis was conducted for the facility. The steady-state analysis considers the impact of a 100 MW transfer on transmission line loadings for local area of the proposed facility. This study does not take into account ATC analysis, which is performed when a customer requests transmission service on Southwest Power Pool's OASIS. A modified version of the 01 Series Southwest Power Pool 2004 summer peak base case was used for this study. The modified model includes transmission transactions that have been confirmed on Southwest Power Pool's OASIS since the release of the last model.

The analysis of the >OMITTED TEXT< project shows that with local utilities serving native load and other confirmed long term transmission transactions in progress, no additional overloading of SPP facilities occurs due to the addition of the >OMITTED TEXT< facility for the interconnection method studied. To obtain ATC values, the Customer shall request transmission service on the Southwest Power Pool OASIS.

Table 1. – Facility Overloads caused by >OMITTED TEXT< Generation

Owner	Branch over 100% Rate B	Rate B (MVA)	% Loading before xxx	% Loading After xxx	Outaged Branch Causing Overload
	None				

Powerflow Analysis Methodology

The Southwest Power Pool (SPP) criteria state that the following conditions be met in order to maintain a reliable and stable system.

1) More probable contingency testing .... must conclude that

   a) All facility loadings are within their emergency ratings and all voltages are within their emergency limits (0.90-1.05 per unit) and
   b) Facility loadings can be returned to their normal limits within four hours

2) Less probable contingency testing ... shall conclude that

   a) Neither uncontrolled islanding, nor uncontrolled loss of large amounts of load will result.

More probable contingency testing is defined as losing any single piece of equipment or multi-circuit transmission lines. Less probable contingency testing involves the loss of any two critical pieces of equipment such as 345kV autotransformers and generating units or the loss of critical transmission lines in the same right-of-way.

The 01 Series Southwest Power Pool 2004 summer peak base case was used to model the transmission network and system loads

Using the created models and the ACCC function of PSS\E, single contingencies in the western Oklahoma zones of WFEC, Oklahoma Gas & Electric, and Public Service Company of Oklahoma were analyzed.

Transient Stability Analysis

General Discussion

Transient stability analysis was performed to verify dynamic system response to disturbances on the transmission system using the 2002 summer peak model. The machine data for the >OMITTED TEXT< was supplied by >OMITTED TEXT<. >OMITTED TEXT< use a dynamic var (DVAR) controller. The DVAR control of the turbines was modeled as an SVC as it had been for previous studies ahead of the >OMITTED TEXT< request. The machine data for the rest of the eastern interconnection was obtained from the SPP dynamics database.

The >OMITTED TEXT< substation consists of a 138kV bus with terminals to the >OMITTED TEXT< facility and a terminal to < Omitted Text>. >OMITTED TEXT< 138kV substation has transmission terminals to >OMITTED TEXT<. Three phase faults were simulated to each of these 138kV transmission terminals and were cleared using a 5 cycle clearing time.

For a three-phase fault at the >OMITTED TEXT< 138kV bus cleared in 5 cycles by tripping the >OMITTED TEXT< 138kV transmission line, the >OMITTED TEXT< facility was knocked off line due to undervoltage. The analysis was run again with the >OMITTED TEXT< plant off-line. For the outage of the >OMITTED TEXT< line 138kV, the >OMITTED TEXT< facility maintains stability.

Background of >OMITTED TEXT< Facility

The >OMITTED TEXT< facility is a proposed >OMITTED TEXT< that is in front of the >OMITTED TEXT< facility in the SPP interconnection study queue. >OMITTED TEXT< requested a >OMITTED TEXT<facility to be interconnected into the >OMITTED TEXT< substation. Due to stability and thermal issues, the >OMITTED TEXT< facility was conditionally limited to an output of 70MW. SPP has approved the interconnection of the >OMITTED TEXT< facility at 70MW.

>OMITTED TEXT< also requested that SPP determine what transmission improvements are necessary to receive the full 96 MW out of their >OMITTED TEXT< facility. SPP has determined a 138kV line from >OMITTED TEXT<Supply to Oklahoma Gas and Electric’s >OMITTED TEXT< substation is necessary for the >OMITTED TEXT< facility to able to sign an interconnection agreement for 96MW. The cost of these facilities is approximately $4,930,000.

The >OMITTED TEXT< facility was studied assuming the >OMITTED TEXT< facility is interconnected at 70MW and that there are no additional transmission improvements. Under this scenario, the addition of the >OMITTED TEXT< facility is therefore the cause of instability of the >OMITTED TEXT< facility. In this scenario, >OMITTED TEXT< would have to pay for the transmission improvements to keep the >OMITTED TEXT< facility on line. This would be the >OMITTED TEXT< 138kV line mentioned above at the cost of $4,930,000.

The second scenario would be that >OMITTED TEXT< would interconnect at a reduced value of 50 MW. For a 50 MW load level, the fault at >OMITTED TEXT< does not cause instability to the >OMITTED TEXT< plant. No additional facilities beyond station and the line to >OMITTED TEXT< would be needed for >OMITTED TEXT< to interconnect at that reduced value.

The third scenario would be that >OMITTED TEXT< signs an interconnection agreement for 96MW and agrees to build the >OMITTED TEXT< 138kV line. In this case >OMITTED TEXT< would pick up the cost of the line and no additional cost would be charged to >OMITTED TEXT<.

Stability study results can be seen in Appendix B.

Short Circuit Analysis

Western Farmers Electric Cooperative performed a short circuit analysis of the local area to determine impacts of the addition of the >OMITTED TEXT< project. Their analysis showed that the addition of the >OMITTED TEXT< project does not cause any existing breakers in the local area to exceed their fault duty ratings.

Facility Analysis

The proposed method of interconnection specified by >OMITTED TEXT< was to connect directly into the WFEC >OMITTED TEXT< 138kV substation via a switching substation at the facility connected by an approximate 12 mile long radial 138kV transmission line.

>OMITTED TEXT< facility substation - The >OMITTED TEXT< switching station shall be constructed by >OMITTED TEXT< and will consist of terminals to their facility and to WFEC >OMITTED TEXT< substation. The terminal to >OMITTED TEXT< substation shall be protected by a circuit breaker and both primary and secondary line relaying. WFEC shall reserve the right to observe construction and commission testing of the facility.

138kV Transmission Line - WFEC will construct, own, and maintain an approximately 12 mile long 138kV transmission line from the >OMITTED TEXT< facility to >OMITTED TEXT< substation. The line will consist of wood H-frame structures and 795MCM ACSR conductor or smaller conductor sized for the output of the facility. The cost to construct the new line is estimated at $2,160,000 before tax gross-up and has a lead time of 18 months.

>OMITTED TEXT< Substation Construction – Upgrade the WFEC >OMITTED TEXT< substation to accommodate the new line from the >OMITTED TEXT< substation. Construction includes the installation of one 138kV circuit breaker. The cost of the construction at >OMITTED TEXT< substation is estimated at $500,000 before tax gross-up and has a lead time of 12 months.

Costs for the work necessary to interconnect the >OMITTED TEXT< are detailed in Table 2. A one-line of the system is shown in Appendix A.

Table 2.: Interconnection Facilities

Facility	ESTIMATED COST (2002 DOLLARS)	Lead Time
Build 138kV switching station at Customer facility. The terminal to WFEC >OMITTED TEXT< shall consist of a 138kV circuit breaker and primary and secondary line relaying.	Customer Cost	Customer build
Build twelve (12) miles of 138kV, 795MCM transmission line from >OMITTED TEXT< to >OMITTED TEXT< switching substation	2,160,000	18months
Add a 138kV transmission line terminal and install (1) breakers at >OMITTED TEXT< substation	500,000	12 months
TOTAL	**$2,660,000**	

As mentioned in the Transient Stability portion of this study, under certain circumstances, >OMITTED TEXT< could be required to pay for the following facilities in addition to the facilities in Table 2.

<u>>OMITTED TEXT< 138kV Transmission Line</u> – WFEC will build an construct an approximately 21 mile 138kV transmission line from the >OMITTED TEXT< >OMITTED TEXT< substation to the OG&E >OMITTED TEXT< 138kV substation. The line will be constructed on H-frame wood structures and will consist of 795MCM ACSR.

The cost of the line will be approximately $3,780,000 and will have a 18 month lead time. The cost of the substation terminal at the >OMITTED TEXT< station will cost $250,000.

<u>OG&E >OMITTED TEXT< Substation</u> – OG&E will construct a new 138kV terminal at its >OMITTED TEXT< substation capable of accepting the new 138kV line to >OMITTED TEXT<. The construction consists of converting the 138kV station at >OMITTED TEXT< to a ring bus and includes the addition of (3) 138kV circuit breakers.

The cost of the substation work will be approximately $900,000 and will have a 16 month lead time.

These additional costs are listed in Table 3.

Table 3.: Additional Facilities Required for Stability

Facility	ESTIMATED COST (2002 DOLLARS)	Lead Time
Build 138kV terminal at >OMITTED TEXT<’s >OMITTED TEXT< facility	250,000	12 months
Build twenty-one (21) miles of 138kV, 795MCM transmission line from >OMITTED TEXT< to OG&E >OMITTED TEXT<	3,780,000	18 months
Build 138kV terminal at OG&E >OMITTED TEXT< substation including the addition of (3) 138kV circuit breakers	900,000	16 months
Subtotal for Additional Facilities	**$4,930,000**	
Subtotal for Interconnection Facilities (from Table 2.)	**$2,660,000**	
TOTAL for All Facilities	**$7,590,000**	

Conclusions

System Impact Study analysis of the >OMITTED TEXT< 100MW wind turbine facility indicates that, depending on what customers in front of >OMITTED TEXT< in the interconnection study queue decide to do, the facility may or may not cause adverse affects to the SPP transmission system.

If >OMITTED TEXT< Energy signs an interconnection agreement with SPP for its >OMITTED TEXT< facility for 96MW and agrees to build the >OMITTED TEXT<->OMITTED TEXT< 138kV line, the >OMITTED TEXT< facility can be interconnected to the WFEC transmission system at its full output for a cost of $2,660,000 including tax gross-up with a lead-time of 18 months. This estimate includes the provision of the customer building, owning, and maintaining the switching substation at the facility.

If >OMITTED TEXT< signs an interconnection agreement with SPP for its >OMITTED TEXT< facility for 70MW, it is not required to build the >OMITTED TEXT<->OMITTED TEXT< 138kV line. In this case, >OMITTED TEXT< would be required to build this line in order to keep the >OMITTED TEXT< line from being tripped off due to a three phase fault on the >OMITTED TEXT<-line (close in to >OMITTED TEXT<). In the case the cost to >OMITTED TEXT< to interconnect the plant would cost $7,590,000 and have a lead time of 18 months.

A third option for >OMITTED TEXT< would be to interconnect at 50 MW in which the >OMITTED TEXT<->OMITTED TEXT< line would not be necessary.

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 >OMITTED TEXT< requests transmission service on Southwest Power Pool's OASIS.

Appendix A. Interconnection Configuration

Interconnection Configuration of >OMITTED TEXT< proposed facility

Appendix B. Stability Study Results

Case 1-9 results based on the following -

- Customer 100MW facility consisting of >OMITTED TEXT< with DVAR control interconnected into the WFEC >OMITTED TEXT< 138kV substation via a 12 mile long 138kV radial 795MCM ACSR transmission line.
- >OMITTED TEXT< >OMITTED TEXT< facility running at 70 MW
- >OMITTED TEXT< South Buffalo facility running at 25.5 MW

Simulation Cases

Case Description	**Results**
Case 1 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	>OMITTED TEXT< Facility Unstable
Case 2 - Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable
Case 3 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable
Case 4 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<-OG&E >OMITTED TEXT< 138kV line	Stable
Case 5 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable
Case 6– Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable
Case 7 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable
Case 8 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT< 138/69kV transformer	Stable
Case 9 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping >OMITTED TEXT< #2 generating unit (135MW)	Stable

Case 10 results based on the following –

- Customer facility not in service
- >OMITTED TEXT< >OMITTED TEXT< facility running at 70 MW
- >OMITTED TEXT< >OMITTED TEXT< facility running at 25.5 MW

Case Description	Results
Case 10 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable

Case 11 results based on the following –

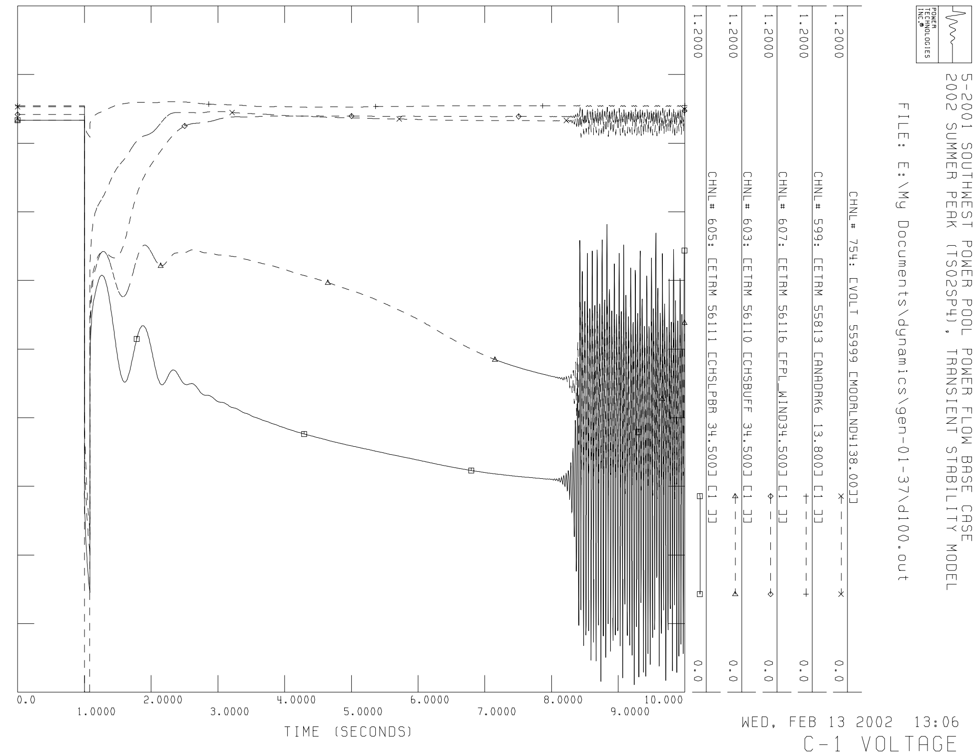
- Customer 100MW facility consisting of >OMITTED TEXT< with DVAR control interconnected into the WFEC >OMITTED TEXT< 138kV substation via a 12 mile long 138kV radial 795MCM ACSR transmission line.
- >OMITTED TEXT< >OMITTED TEXT< facility running at 96 MW. >OMITTED TEXT<->OMITTED TEXT< 138kV line in-service
- >OMITTED TEXT< >OMITTED TEXT< facility running at 25.5 MW.

Case Description	Results
Case 11 – Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable

Case 12-13 results based on the following –

- Customer facility (dispatched at level listed below) consisting of >OMITTED TEXT< with DVAR control interconnected into the WFEC >OMITTED TEXT< 138kV substation via a 12 mile long 138kV radial 795MCM ACSR transmission line.
- >OMITTED TEXT< >OMITTED TEXT< facility running at 70 MW.
- >OMITTED TEXT< >OMITTED TEXT< facility running at 25.5 MW.

Case Description	Results
Case 12 – >OMITTED TEXT< dispatched at 60 MW. Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	>OMITTED TEXT< Unstable
Case 13 – >OMITTED TEXT< dispatched at 50 MW. Three phase fault at >OMITTED TEXT< 138kV bus; cleared in 5 cycles by tripping the >OMITTED TEXT<->OMITTED TEXT< 138kV line	Stable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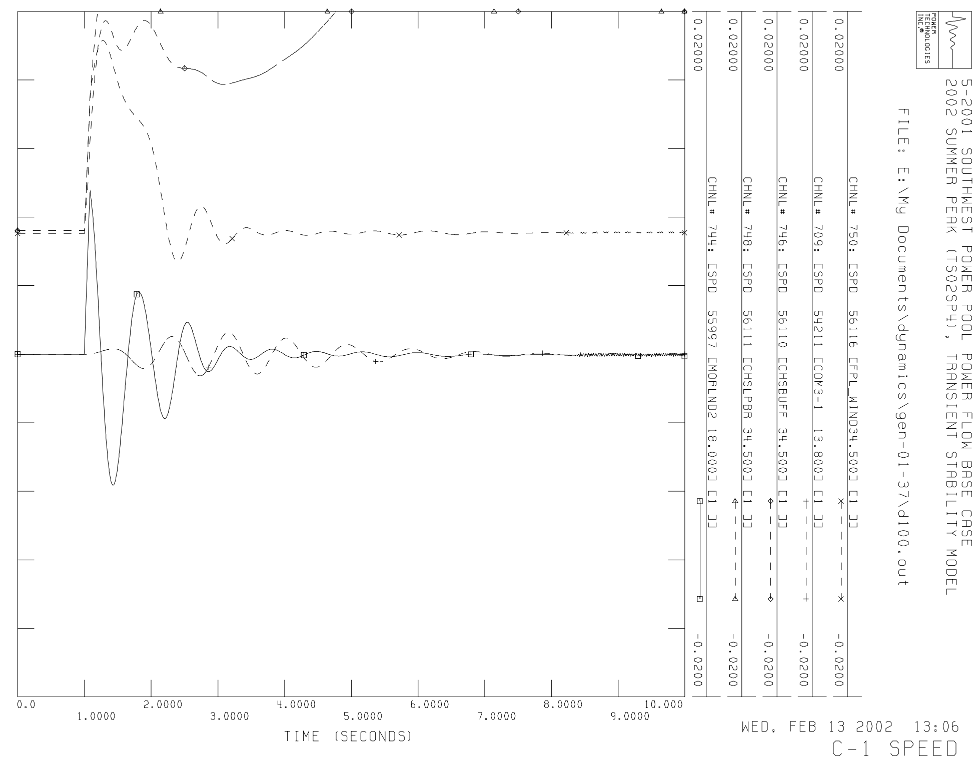
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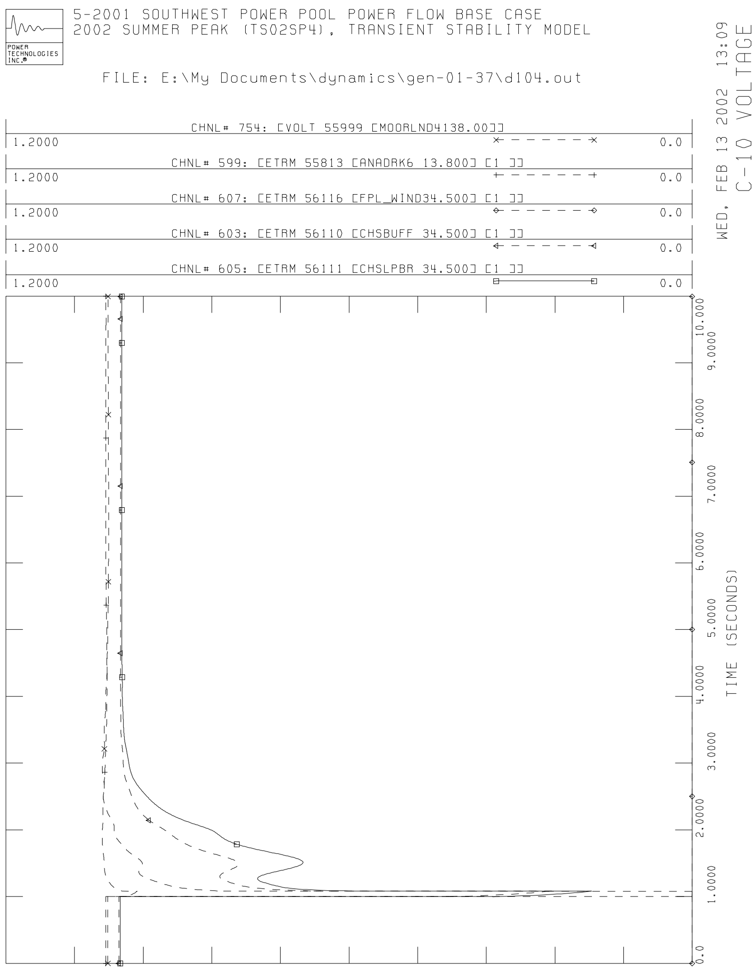

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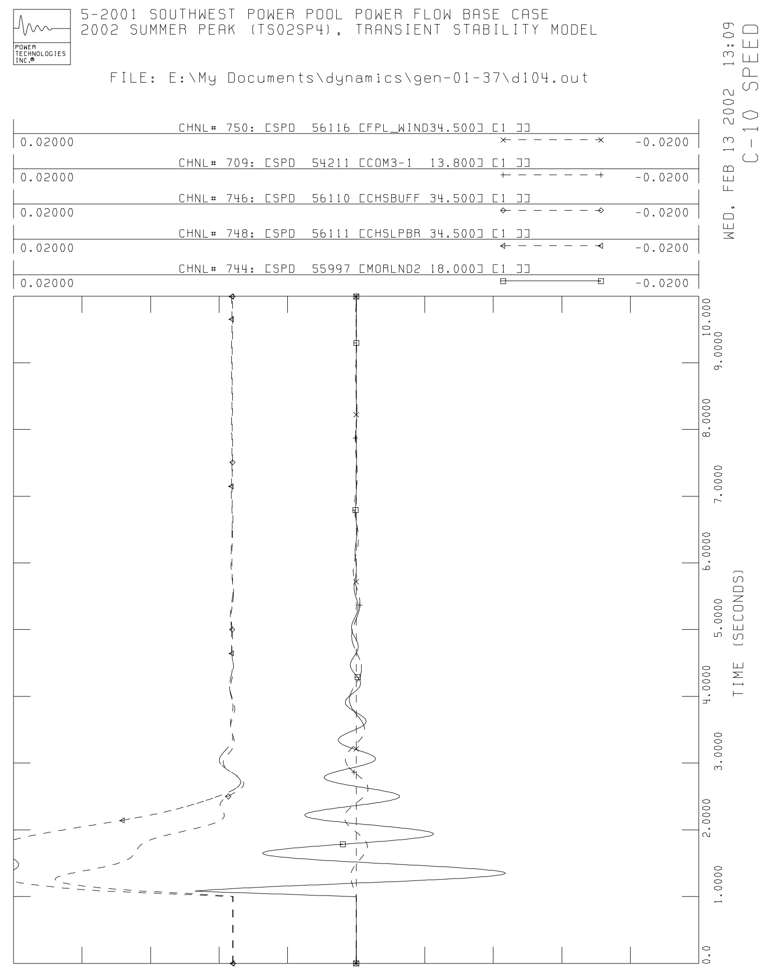

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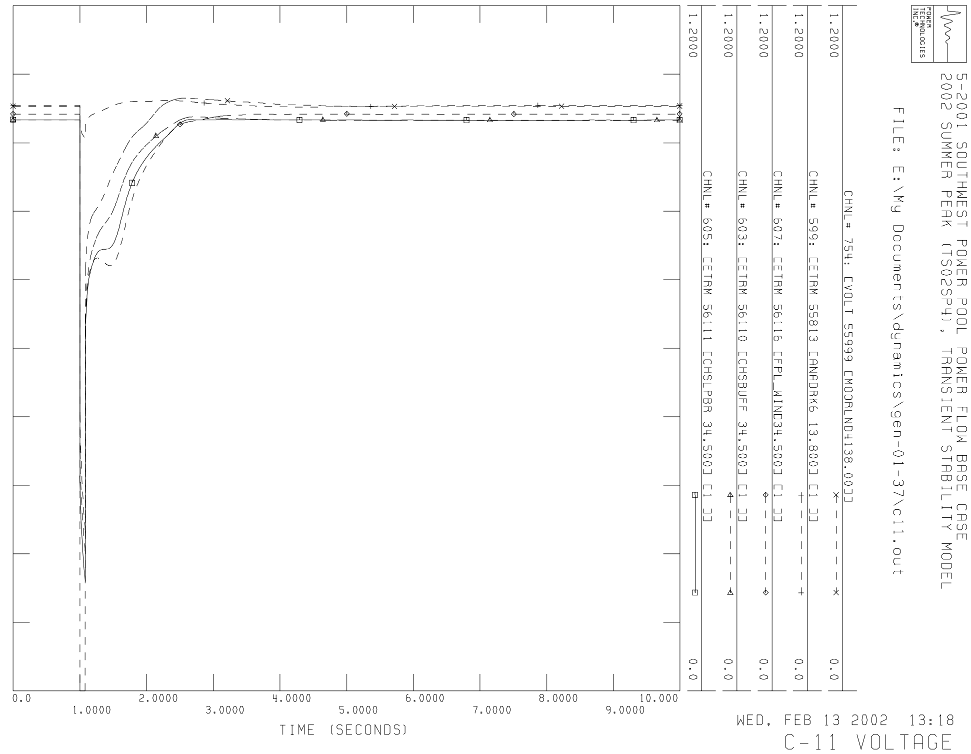

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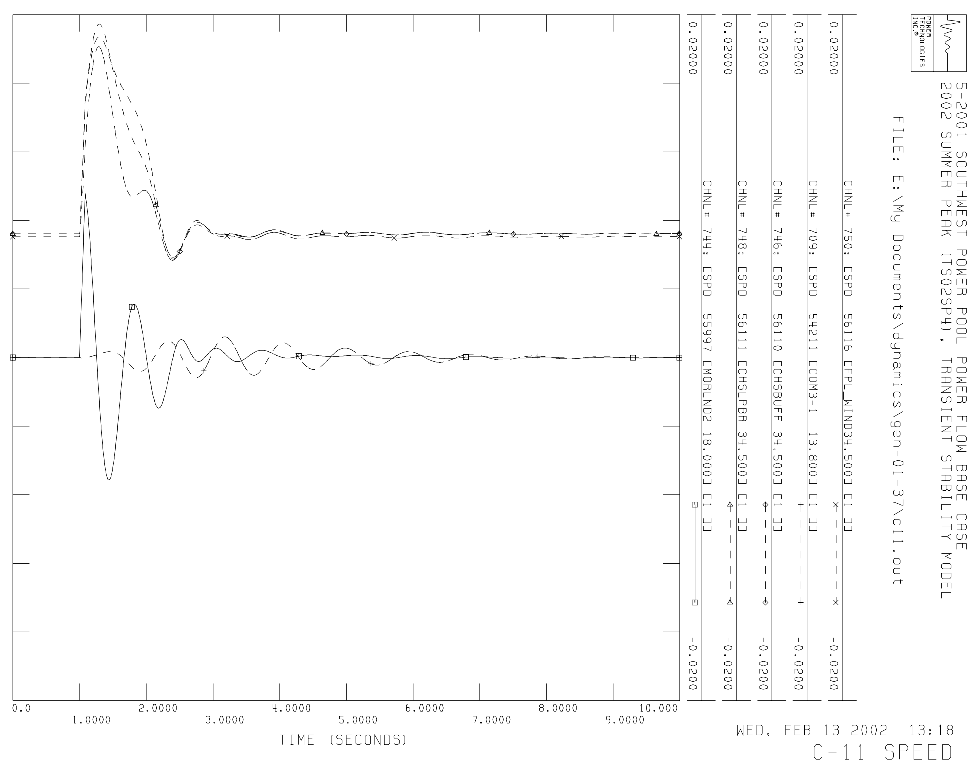

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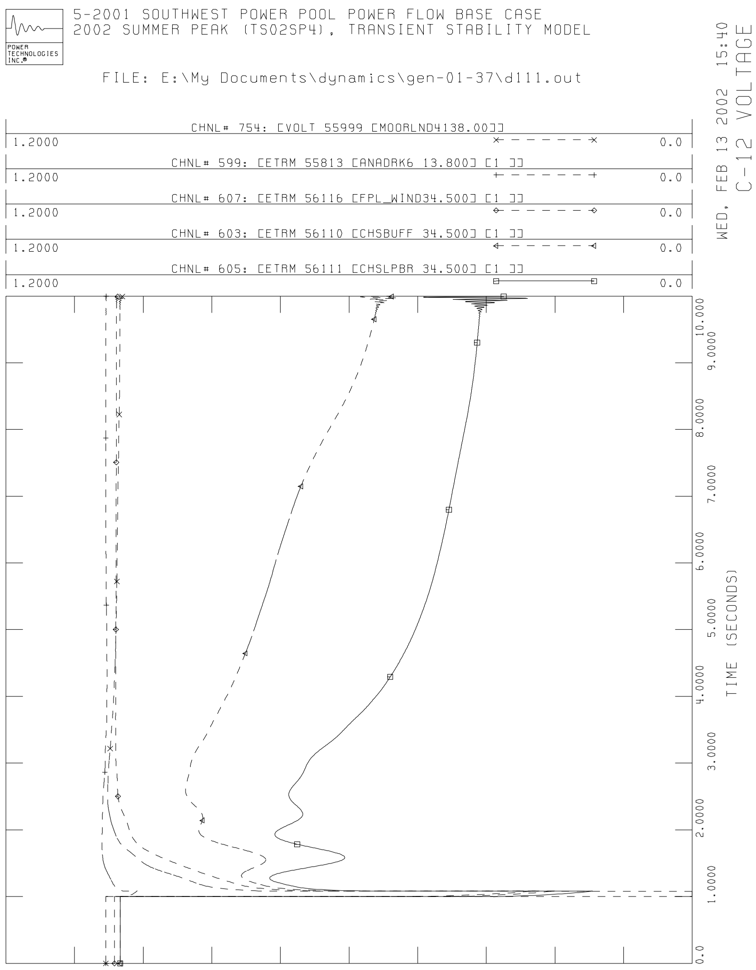

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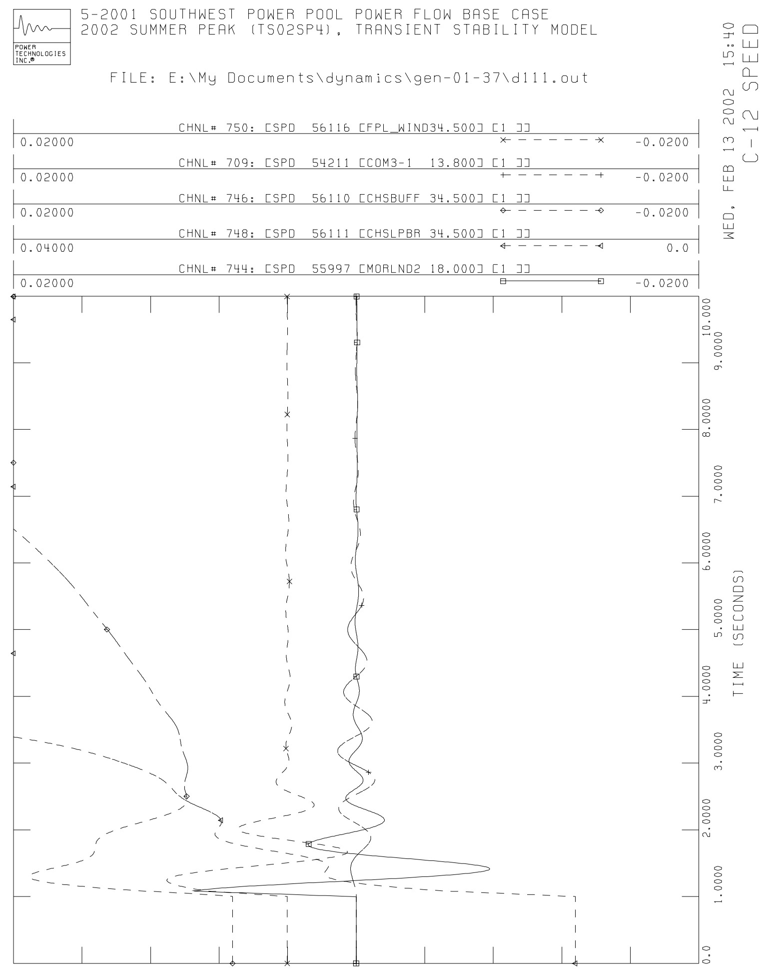

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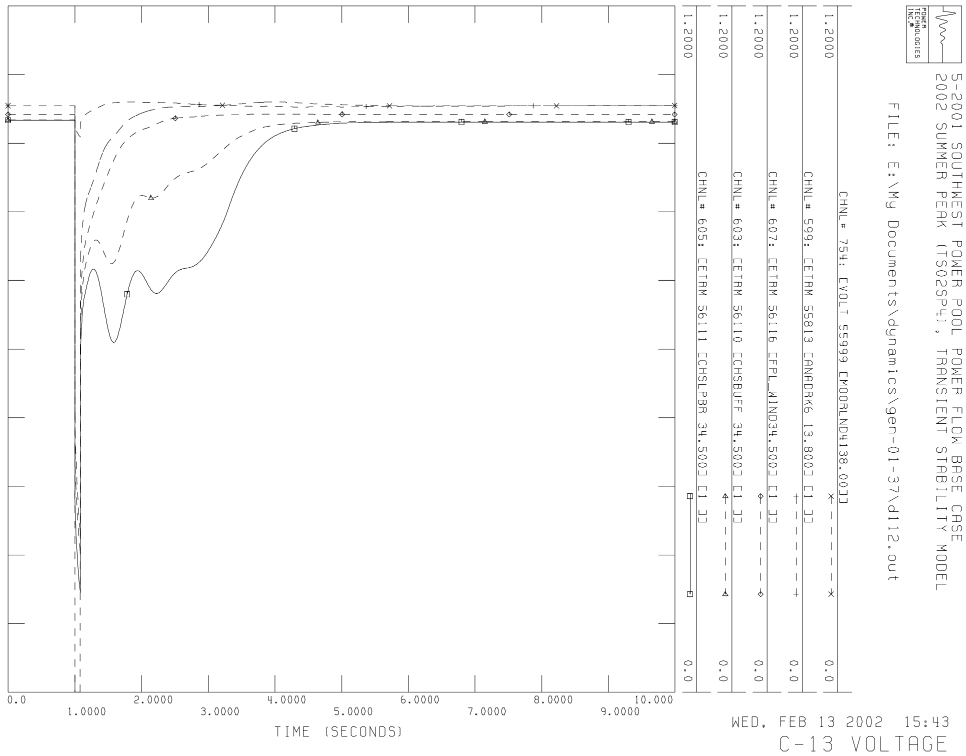
5-2001 SOUTHWEST POWER POOL POWER FLOW BASE CASE
2002 SUMMER PEAK (TS02SP4), TRANSIENT STABILITY MODEL
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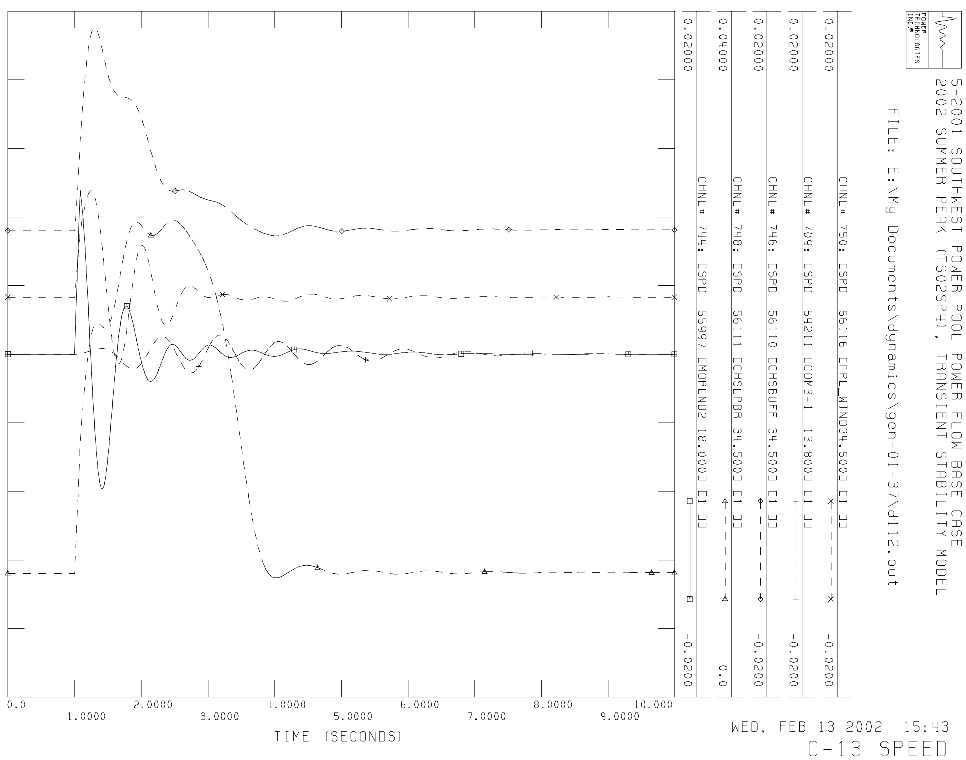
CHNL# 754: [VOLT 55999 [MOORLND4138.00]]
CHNL# 599: [ETRM 55813 [ANADRK6 13.800] [1]]
CHNL# 607: [ETRM 56116 [FPL_WIND34.500] [1]]
CHNL# 603: [ETRM 56110 [CHSBUFF 34.500] [1]]
CHNL# 605: [ETRM 56111 [CHSLPBR 34.500] [1]]
TIME (SECONDS)
WED, FEB 13 2002 15:43
C-13 VOLTAGE


5-2001 SOUTHWEST POWER POOL POWER FLOW BASE CASE
2002 SUMMER PEAK (TS02SP4), TRANSIENT STABILITY MODEL
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CHNL# 750: [SPD 56116 [FPL_WIND34.500] [1]]
CHNL# 709: [SPD 54211 [COM3-1 13.800] [1]]
CHNL# 746: [SPD 56110 [CHSBUFF 34.500] [1]]
CHNL# 748: [SPD 56111 [CHSLPBR 34.500] [1]]
CHNL# 744: [SPD 55997 [MORLND2 18.000] [1]]
TIME (SECONDS)
WED, FEB 13 2002 15:43
C-13 SPEED