SPP Southwest Power Pool

System Impact Study SPP-2002-127

Linn County 345/161kV Transformer Addition

For Transmission Service
Requested By Power Resource Group, Inc.
From AEPW To Entergy for 620MW
From 6/1/03 To 6/1/13

SPP Transmission Planning

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1. Executive Summary

Power Resource Group, Inc. requested long-term Firm Point-to-Point transmission service, Oasis Reservation 212202, from AEPW to EES for an amount of 670MW to start on 1/1/2003 and end 1/1/2006. The period of this transfer has been deferred to a start date of 6/1/2003 and extended to an end date of 6/1/2013. This initial transmission service request was studied in system impact study SPP-2000-108. This study supplements SPP-2000-108 by evaluating the addition of a 345/161kV transformer.

The system impact study completed for SPP-2000-108 identifies the La Cygne to Stilwell 345kV transmission line as a limiting constraint for the AEPW to EES transfer. One option for relieving this constraint is the addition of a 345/161kV transformer at Linn County. This transformer is added on the 345kV system between La Cygne and Wolf Creek and on the 161kV system between the Paola and Centerville substations.

The objective of this study is to identify any system problems and potential system modifications that may be necessary to facilitate the addition of the 345/161kV transformer while maintaining system reliability. These problems were determined through the results of stability, short circuit, and steady-state analyses.

The thermal analysis shows that new overloads occur on the SPP system due to the addition of the Linn County 345/161kV transformer. These overloads are in addition to the facilities identified in the SPP-2000-108 study. Upgrades for these new facilities must be completed along with the construction of the Linn County substation.

The results of the stability analysis show that the addition of the Linn County substation has little or no effect on the Wolf Creek power plant.

The short circuit analysis found no circuit breaker replacements were required to accommodate the addition of the 345/161kV transformer.

The results of this study show only the effects of the system due to the addition of the Linn County substation. Any upgrades previously assigned to the 620MW transfer study still apply.

2. Introduction

The addition of a 345/161kV transformer at Linn County on the Kansas City Power & Light system is being studied in order to relieve the loading on the La Cygne to Stilwell 345kV line for the outage of the La Cygne to West Gardner 345kV line. The La Cygne to Stilwell 345kV line was identified as a limiting constraint in the initial system impact study performed for 670MW from AEPW to EES.

The new 345/161kV transformer will be added to the system on the Wolf Creek to La Cygne 345kV line and the Paola to Centerville 161kV line. The construction of the Linn County transformer causes increases in flows on the 161kV system around the proposed Linn County substation. This increase in flows on the system requires additional upgrades to be completed in the area of the Linn County substation. Great system reliability would be obtained by expanding the system at the EHV transmission level. However, the lowest cost alternative for relieving the limiting facility should be provided to the customer.

The principal objective of this study is to identify the restraints on the SPP Regional Tariff System caused by the addition of the 345/161kV transformer. This study includes steady-state contingency analyses (PSS/E function ACCC), stability analyses, and short circuit analyses

The thermal analysis considers the impact of the Linn County substation on transmission line loading and transmission bus voltages for outages of single and selected multiple transmission lines and transformers on the SPP system.

The stability analysis determines the effect of the Linn County substation on the Wolf Creek power plant for each scenario in which one of the Wolf Creek 345kV exit circuits is out of service and a fault occurs.

The short circuit analysis considers the impact of the Linn County substation on circuit breakers for both three-phase and phase-to-ground faults at each bus in the Kansas City Power & Light system and each bus in the Westar Energy system.

All models available to Southwest Power Pool were used to study the impact of the Linn County substation for the full planning horizon.

3. Linn County Substation

The transmission system in the studied area for the Linn County substation addition currently consists of a 59.7 mile 345kV transmission line from the Wolf Creek nuclear power plant to the La Cygne power plant and a 23.5 mile 161kV transmission line from the Centerville substation to the Paola substation.

For the addition of the Linn County substation to the 345kV system, the Wolf Creek to La Cygne 345kV line was separated and the Linn County 345/161kV transformer was added approximately 14.9 miles from the La Cygne power plant. For the addition of the Linn County substation to the 161kV system, the Paola to Centerville 161kV line was separated and the Linn County 345/161kV transformer was added approximately half way between the Paola and Centerville substations.

Table 1 below details the line characteristics of the existing Wolf Creek to La Cygne 345kV line and Paola to Centerville 161kV line prior to the addition of the Linn County 345/161kV transformer.

Table 2 details the line characteristics of the new Wolf Creek to Linn County to La Cygne 345kV line and Paola to Linn County to Centerville 161kV line after the Linn County 345/161kV transformer addition. The Linn County 345/161kV transformer characteristics are also given.

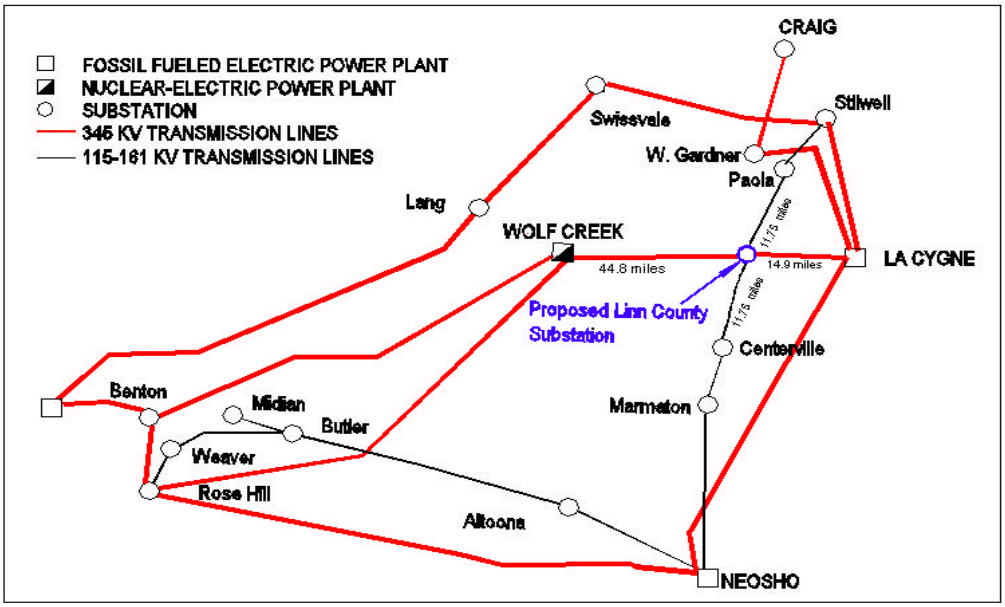
Table 1 - Line Characteristics Without Linn County 345/161kV Transformer Addition

Facility	Length	R	X	B	Rate A	Rate B
Wolf Creek to La Cygne 345kV Line	59.7miles	0.00270	0.02990	0.49390	1195	1195
Centerville to Paola 161kV Line	23.5 miles	0.0081	0.0674	0.0355	293	335

Table 2 - Line Characteristics With Linn County 345/161kV Transformer Addition

Facility	Length	R	X	B	Rate A	Rate B
Wolf Creek to Linn County 345kV Line	44.8 miles	0.00203	0.02242	0.37042	1195	1195
Linn County to La Cygne 345kV Line	14.9 miles	0.00068	0.00747	0.12348	1195	1195
Centerville to Linn County 161kV Line	11.75 miles	0.00405	0.03370	0.01775	293	335
Linn County to Paola 161kV Line	11.75 miles	0.00405	0.03370	0.01775	293	335
Linn County 345/161kV Transformer		0.00000	0.02910		400	440

Figure 1 - Linn County Substation



4. Study Results

A. Thermal Analysis

The thermal analysis was conducted to identify any new thermal overloads caused by the Linn County substation addition.

For the thermal analysis, eight seasonal models were used to study the addition of the Linn County 345/161kV transformer. The SPP 2002 Series Cases 2003 Summer Peak, 2003 Fall, 2003/2004 Winter Peak, 2004 Spring, 2005 Summer Peak, 2005/2006 Winter Peak, 2008 Summer Peak, and 2008/2009 Winter Peak were used to study the impact of the transformer addition for the entire planning horizon. The chosen base case models were modified to reflect the most current modeling information. The cases were modified to reflect future firm transfers during the request period that were not already included in the January 2002 base case series models. For the 2008 models, a Westar Energy 740MW unit is modeled at Neosho. This generation provides heavy loading on the La Cygne to Stilwell 345kV line for the 2008 Summer Peak. Westar Energy was contacted concerning the validity of this plant. Per Westar Energy, this plant was taken out of service and the generation was redispatched onto the Westar Energy system.

Using the created models and the ACCC function of PSS\E, single and select double contingency outages were analyzed. Then full AC solution was used to obtain the most accurate results possible. Any facility overloaded in the transfer case and not overloaded in the base case was flagged.

Tables 3, 4, and 5 found in Appendix A contain the results of the steady-state contingency analysis performed to determine any new facilities that were overloaded due to the Linn County substation addition. The tables identify the seasonal case in which the event occurred; the emergency rating of the overloaded circuit (Rate B), the contingent loading percentage of circuit with and without the studied transfer, the estimated ATC value using interpolation if calculated, any SPP identification or assignment of the event, and any solutions received from the transmission owners.

Table 3 shows the new facility overloads on SPP Regional Tariff participants' transmission system caused by the addition of the Linn County substation. Two facilities upgrades are required due to overloading caused by the substation addition. The line terminal of the Bucyrus 161kV bus must be rebuilt to provide a relief in loading on this facility. The second upgrade required is the reconstruction of the Atlas Junction to Carthage 161kV line. This facility overloads with the addition of the Linn County substation. These upgrades must be completed along with the addition of the substation.

Table 4 documents overloads on Non SPP Regional Tariff participants' transmission systems caused by the addition of the Linn County substation.

Table 5 documents the impact of the Linn County substation addition on previously assigned and identified facilities. The results given in this table verify that the addition of the Linn County transfer does relieve the loading of the La Cygne to Stilwell 345kV transmission line below the emergency rating in the desired cases.

B. Stability Analysis

For the stability analysis, four seasonal models were used. The SPP 2002 Series Cases 2003 Summer Peak, 2003 Fall, 2003/2004 Winter Peak, and 2005 Summer Peak cases were used to study the stability of the system with the addition of the Linn County transformer. The chosen base case models were modified to reflect the most current modeling information. The cases were modified to reflect future firm transfers during the request period that were not already included in the January 2002 base case series models.

The transient rotor-angle response for a three phase 3.6 cycle fault near Wolf Creek was performed on each available model. One of the 345kV circuits at Wolf Creek was out in each base case. Wolf Creek generation was reduced to 950MW. The fault was applied at one end of the second 345kV line, the fault was cleared and the faulted circuit was then tripped. The third 345kV Wolf Creek circuit carried the Wolf Creek power plant generation. The system is monitored to determine whether the rotors of the machines being disturbed will return to constant speed operation after the fault.

For the 2003 Summer Peak, the addition of the Linn County substation did not impact the stability of the system. The scenario with the Rose Hill 345 kV circuit carrying the Wolf Creek generation showed the greatest rotor angle swing of 46?. The second swing was damped by 49% in 1.3 seconds. This scenario is stable and adequately damped. The scenarios with the Linn County 345 kV circuit carrying the Wolf Creek generation were stable and well damped. The Linn County transformer did not significantly alter the stability performance of the Wolf Creek unit.

For the 2003 Fall Peak, the addition of the Linn County substation did not impact the stability of the system. The scenario with the Rose Hill 345 kV circuit carrying the Wolf Creek generation showed the greatest rotor angle swing of 41?. The second swing was damped by 50% in 1.1 seconds. This scenario is stable and adequately damped. Similar results were obtained when the Benton 345 kV bus was faulted. The scenarios with Benton 345 kV circuit carrying the Wolf Creek generation show similar results. The scenarios with the Linn County 345 kV circuit carrying the Wolf Creek generation were stable and well damped. The Linn County transformer did not significantly alter the stability performance of the Wolf Creek unit.

For the 2003 Winter Peak, the addition of the Linn County substation did not impact the stability of the system. The scenario with the Rose Hill 345 kV circuit carrying the Wolf Creek generation showed the greatest rotor angle swing of 44?. The second swing was damped by 46% in 1.2 seconds. This scenario is stable and adequately damped. The Linn County transformer did not significantly alter the stability performance of the Wolf Creek unit.

For the 2005 Summer Peak, the addition of the Linn County substation did not impact the stability of the system. The scenario with the Rose Hill 345 kV circuit carrying the Wolf Creek generation showed the greatest rotor angle swing of 46?. The second swing was damped by 51% in 1.3 seconds. This scenario is stable and adequately damped. The Linn County transformer did not significantly alter the stability performance of the Wolf Creek unit.

The stability study results can be found in Appendix B.

C. Short Circuit Analysis

The short circuit analysis was conducted to identify any circuit breakers needing upgrading as a result of the increase in fault currents on the system due to the addition of the Linn County transformer.

For the short circuit analysis, the available SPP 2001 Series 2005 Summer Peak short circuit case was used. This is the most current short circuit model available for use in the study. The chosen base case model was updated with positive, negative, and zero sequence data. The models are modified to reflect the most current modeling information available including the short circuit information for the Linn County substation and the generation added by Kansas City Power & Light in the Paola and West Gardner areas.

Using the ASCC short circuit function of PSS/E, three-phase and phase to ground faults were performed on the designated buses. The fault currents on the lines are monitored and the circuit breakers are analyzed to determine if a replacement is needed.

The three-phase and phase to ground faults were ran on each bus in the entire Kansas City Power & Light control area. Three-phase and phase to ground faults were then ran on each bus in the southeast zone of the Westar Energy control area.

Westar Energy reviewed the impact of the Linn County substation addition on the equipment on the Westar Energy system. Though fault currents were found to have increased on portions of the Westar Energy system, no circuit breakers were overdutied as a result of the Linn County substation addition.

Kansas City Power & Light reviewed the impact of the Linn County substation on the equipment on the Kansas City Power & Light system. No circuit breakers were overdutied as a result of the addition. Therefore, no circuit breaker replacements are required to accommodate the Linn County substation.

5. Conclusion

The addition of the Linn County substation was studied as an option to relieving the loading on the La Cygne to Stilwell 345kV line, which was identified as a limiting constraint for the 620MW transfer from AEPW to EES. This substation would be added to the system on the La Cygne to Wolf Creek 345kV line, with a step down to the 161kV system on the Paola to Centerville line.

Thermal, stability, and short circuit analyses were performed to determine the full impact of the substation addition to the transmission system.

The thermal analysis identifies facility upgrades that are needed due to the addition of the Linn County substation. These upgrades must be completed along with the addition of the substation.

The stability analysis shows no negative effects on the transmission system due the Linn County addition.

The short circuit analysis found that no circuit breaker replacements were needed as a result of the Linn County substation.

The upgrades assigned due to the impact of the Linn County substation are in addition to any upgrades previously assigned to the 620MW transfer.

All available base models were used to study the 620MW throughout the requested time period. Due to the SPP planning horizon for model development, no study cases are available beyond the 2008/2009 Winter Peak. SPP limits the rollover rights of this service due to the insufficient amount of data needed to study this service beyond the 2008/2009 Winter Peak.

Appendix A

Table 3 – SPP Facility Overloads caused by the Linn County 345/161kV transformer addition

Study Year	From Area - To Area	Branch Over 100% Rate B	Rate B	% Loading Without Linn County Transformer	% Loading With Linn County Transformer	Outaged Branch Causing Overload	Solution	Estimated Cost
03SP	KACP-KACP	**PAOLA TO CENTENNIAL, 161KV** 58069 PAOLA 5 161 to 58067 CENTENL5 161 CKT 1	174	71.3	168.4	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Paola substation	N/A
03SP	KACP-KACP	**BUCYRUS TO STILWELL, 161KV** 58057 BUCYRUS5 161 to 57969 STILWEL5 161 CKT 1	224	31.0	104.8	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Bucyrus line terminal - Wavetrap at Stilwell for Bucyrus line terminal must be replaced.	6,000
03FA	KACP-KACP	**PAOLA TO CENTENNIAL, 161KV** 58069 PAOLA 5 161 to 58067 CENTENL5 161 CKT 1	192	31.6	107.0	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Paola substation	N/A
03FA	EMDE-SWPA	**ATLAS JCT TO CARTHAGE, 161KV** 59466 ATL109 5 161 to 52688 CARTHAG5 161 CKT 1	167	99.4	100.6	**TIPTON FORD TO JOPLIN, 161KV** 59472 TIP292 5 161 to 59483 JOP389 5 161 CKT1	Reconstruct and replace 8.2 miles of 556 ACSR with Bundled 556 ACSR	5,200,000
03WP	KACP-KACP	**PAOLA TO CENTENNIAL, 161KV** 58069 PAOLA 5 161 to 58067 CENTENL5 161 CKT 1	192	36.8	116.3	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Paola substation	N/A
03WP	KACP-KACP	**LINN COUNTY TO PAOLA, 161KV** 58200 LINNC1 5 161 to 58069 PAOLA 5 161 CKT 1	237	N/A	124.7	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Incorrect winter rating Rate B = 418MVA	N/A
04G	KACP-KACP	**PAOLA TO CENTENNIAL, 161KV** 58069 PAOLA 5 161 to 58067 CENTENL5 161 CKT 1	192	26.8	110.0	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Paola substation	N/A
05SP	KACP-KACP	**PAOLA TO CENTENNIAL, 161KV** 58069 PAOLA 5 161 to 58067 CENTENL5 161 CKT 1	174	69.0	164.1	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Rebuild Paola substation	N/A
05WP	KACP-KACP	**LINN COUNTY TO PAOLA, 161KV** 58200 LINNC1 5 161 to 58069 PAOLA 5 161 CKT 1	237	N/A	132.4	**STILWELL TO LACYGNE, 345KV** 57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT1	Incorrect winter rating Rate B = 418MVA	N/A
08WP	KACP-KACP	**LINN COUNTY TO PAOLA, 161KV** 58200 LINNC1 5 161 to 58069 PAOLA 5 161 CKT 1	237	N/A	113.6	**WEST GARDNER 345/161KV TRANSFORMER** 57965 W.GRDNR7 345 to 57966 WGARDNR5 161 CKT11	Incorrect winter rating Rate B = 418MVA	N/A

Table 4 – Non - SPP Facility Overloads caused by Linn County 345/161kV transformer addition

Study Year	From Area - To Area	Branch Over 100% Rate B	Rate B	% Loading Without Linn County Transformer	% Loading With Linn County Transformer	Outaged Branch Causing Overload
03SP		NONE				NONE
03FA		NONE				NONE
03WP		NONE				NONE
04G		NONE				NONE
05SP		NONE				NONE
05WP		NONE				NONE
08SP	MIPU-MIPU	**HARRISONVILLE, 161/69KV TRANSFORMER** 59239 HSNVL 5 161 to 59295 HSNVL 2 69.0 CKT 1	63	99.2	100.6	**GRANDVIEW TAP TO RICHARDS-GEBAUER AFB, 69KV** 59284 GRDVWTP269.0 to 59288 RGAFB 2 69.0 CKT1
08WP		NONE				NONE

Table 5 – Previously Assigned and Identified SPP Facilities Impacted by the Linn County 345/161kV transformer addition.

Study Year	From Area - To Area	Branch Over 100% Rate B	Rate B	% Loading Without Linn County Transformer	% Loading With Linn County Transformer	Outaged Branch Causing Overload
		STILWELL TO LACYGNE, 345KV				**WEST GARDNER TO LA CYGNE, 345KV**
03SP	KACP-KACP	57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT 1	1251	110.5	95.1	57965 W.GRDNR7 345 to 57981 LACYGNE7 345 CKT1
		STILWELL TO LACYGNE, 345KV				**WEST GARDNER TO LA CYGNE, 345KV**
05SP	KACP-KACP	57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT 1	1251	108.3	92.6	57965 W.GRDNR7 345 to 57981 LACYGNE7 345 CKT1
		STILWELL TO LACYGNE, 345KV				**WEST GARDNER TO LA CYGNE, 345KV**
08SP	KACP-KACP	57968 STILWEL7 345 to 57981 LACYGNE7 345 CKT 1	1251	105.0	89.8	57965 W.GRDNR7 345 to 57981 LACYGNE7 345 CKT1

Appendix B

Wolf Creek and Linn County Substation Fault Study

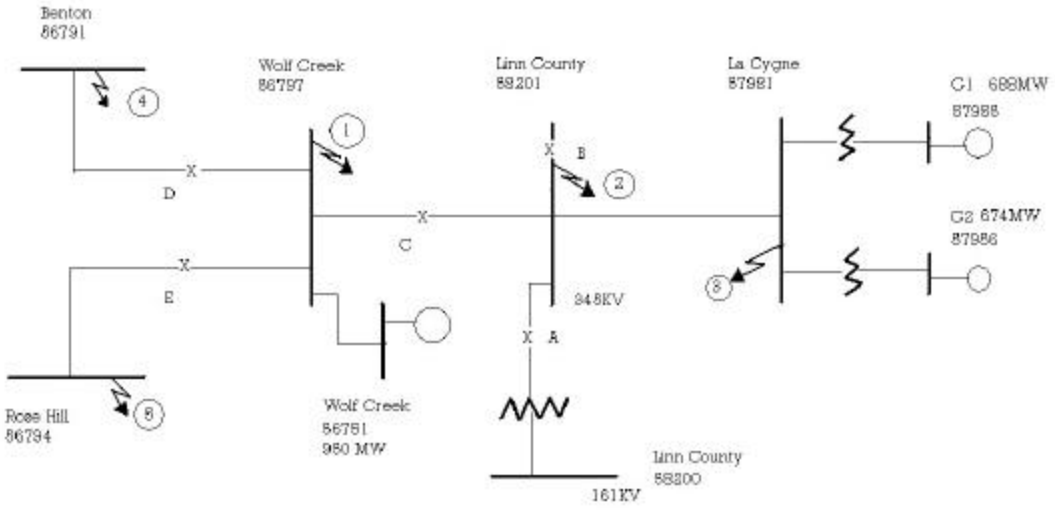
The transient rotor-angle response for a three phase 3.6 cycle fault near Wolf Creek was performed on the Summer, Fall, and Winter Peak 2003 models and the 2005 Summer Peak model. One of the 345 kV circuits out of Wolf Creek was out in each base case. The Wolf Creek generation was reduced to 950 MW in each base case. The fault was applied at one end of the second line, the fault was cleared and the faulted circuit was then tripped. The third 345 kV Wolf Creek circuit carried the Wolf Creek power plant generation. The Wolf Creek and La Cygne generation is in **Figure 2**.

Figure 2: Wolf Creek and LaCygne generation

MODEL GENERATION				
		Wolf Creek	La Cygne #1	La Cygne #2
Year	Season & Load	MW	MW	MW
2003	Summer Peak	950	688	674
2003	Fall Peak	950	655	655
2003	Winter Peak	950	625	625
2005	Summer Peak	950	688	674

A transmission one-line diagram of the Wolf Creek, La Cygne, and proposed Linn County Substation is in **Figure 3**.

Figure 3: Wolf Creek, Linn County, & La Cygne One Line



The Linn County transient stability scenarios studied are given in bold letters in **Figure 4.**

Figure 4: Linn County Transient Stability Scenarios

A=Linn C. Xf out, 0=Xf in service	Base Case line outage	Year and Season	Tripped Line/Faulted Bus	Tripped Line/Faulted Bus	Tripped Line/Faulted Bus	Tripped Line/Faulted Bus
A	B	03S	**D1**	D4	E1	E5
0	C	03S	**D1**	D4	E1	E5
A	D	03S	B1	B3	**E1**	E5
0	D	03S	C1	C2	**E1**	E5
A	E	03S	B1	B3	**D1**	D4
0	E	03S	C1	C2	**D1**	D4
A	B	03F	**D1**	**D4**	**E1**	E5
0	C	03F	**D1**	**D4**	**E1**	E5
A	D	03F	B1	B3	**E1**	E5
0	D	03F	C1	C2	**E1**	E5
A	E	03F	B1	B3	D1	D4
0	E	03F	C1	C2	D1	D4
A	B	03W	**D1**	D4	E1	E5
0	C	03W	**D1**	D4	E1	E5
A	D	03W	**B1**	B3	E1	E5
0	D	03W	**C1**	C2	E1	E5
A	E	03W	B1	B3	D1	D4
0	E	03W	C1	C2	D1	D4
A	B	05S	**D1**	D4	E1	E5
0	C	05S	**D1**	D4	E1	E5
A	D	05S	B1	B3	E1	E5
0	D	05S	C1	C2	E1	E5
A	E	05S	B1	B3	D1	D4
0	E	05S	C1	C2	D1	D4

1) Base Case Line Outage:
   B=Wolf Creek to La Cygne 345 kV
   C=Wolf Creek to Linn County 345 kV
   D=Wolf Creek to Benton 345 kV
   E=Wolf Creek to Rose Hill 345 kV
2) Tripped Line:
   B=Wolf Creek to La Cygne 345 kV
   C=Wolf Creek to Linn County 345 kV
   D=Wolf Creek to Benton 345 kV
   E=Wolf Creek to Rose Hill 345 kV
3) Fault at bus:
   1=Wolf Creek 345 kV bus 56797
   2=Linn County 345 kV bus 58201
   3=La Cygne 345 kV bus 57981
   4=Benton 345 kV bus 56791
   5=Rose Hill 345 kV bus 56794

Figure 5 below shows time and angle response values from selected stability plots for each season and gives the estimated damping percent drop and maximum swing angle change.

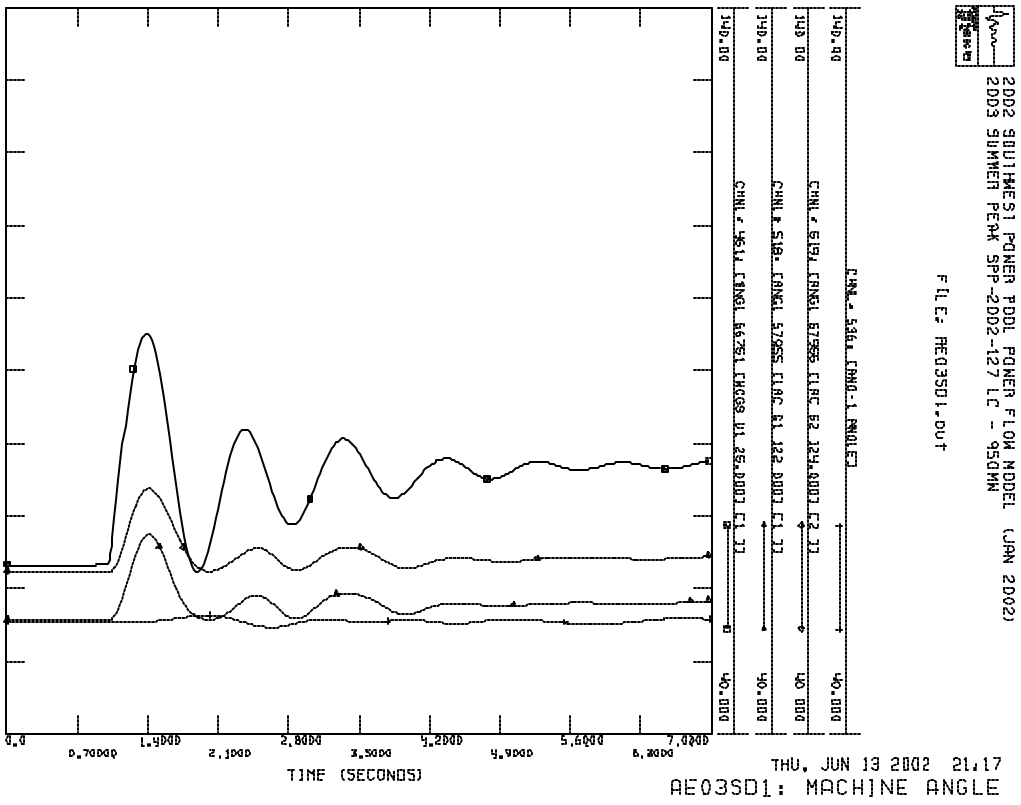
Figure 5: Wolf Creek Rotor Angle Response Data

Wolf Creek Rotor Angle Response Data				
	Time (s)	**Angle**	**Mean to Peak Angle**	**Damping Percent Drop**
2003 Summer Peak Case: Rose Hill 345 kV circuit carries Wolf Creek Generation				
Start value	1	67.2		
Swing 1 peak	1.5	113.3	32.2	
Swing 2 peak	2.8	97.5	16.4	49
Mean value	6.7	81.1		
Swing 1 angle change		46		
Case: Linn County 345 kV circuit carries Wolf Creek Generation				
Start value	1	60.9		
Swing 1 peak	1.4	89.7	16.7	
Swing 2 peak	2.3	77.5	4.5	73
Mean value	6.7	73		
Swing 1 angle change		29		
2003 Fall Peak Case: Rose Hill 345 kV circuit carries Wolf Creek Generation				
Start value	1	73.2		
Swing 1 peak	1.5	114.5	30.7	
Swing 2 peak	2.6	99	15.2	50
Mean value	6.4	83.8		
Swing 1 angle change		41		
2003 Winter Peak Case: Rose Hill 345 kV circuit carries Wolf Creek Generation				
Start value	1	72.3		
Swing 1 peak	1.5	116.4	28.7	
Swing 2 peak	2.7	103.3	15.6	46
Mean value	6.4	87.7		
Swing 1 angle change		44		
2005 Summer Peak Case: Rose Hill 345 kV circuit carries Wolf Creek Generation				
Start value	1	68.4		
Swing 1 peak	1.5	113.9	31.1	
Swing 2 peak	2.8	97.9	15.1	51
Mean value	6.7	82.8		
Swing 1 angle change		46		

Note: The “damping percent drop” is the reduction in angle swing from swing 1 to swing 2.

DS-AE03SD1.IDV

1) No Linn County Transformer
2) 2003 Summer Peak Model
3) Wolf Creek to Rose Hill 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to La Cygne 345 kV circuit in service



DS-0E03SD1.IDV

1) Linn County Transformer in service
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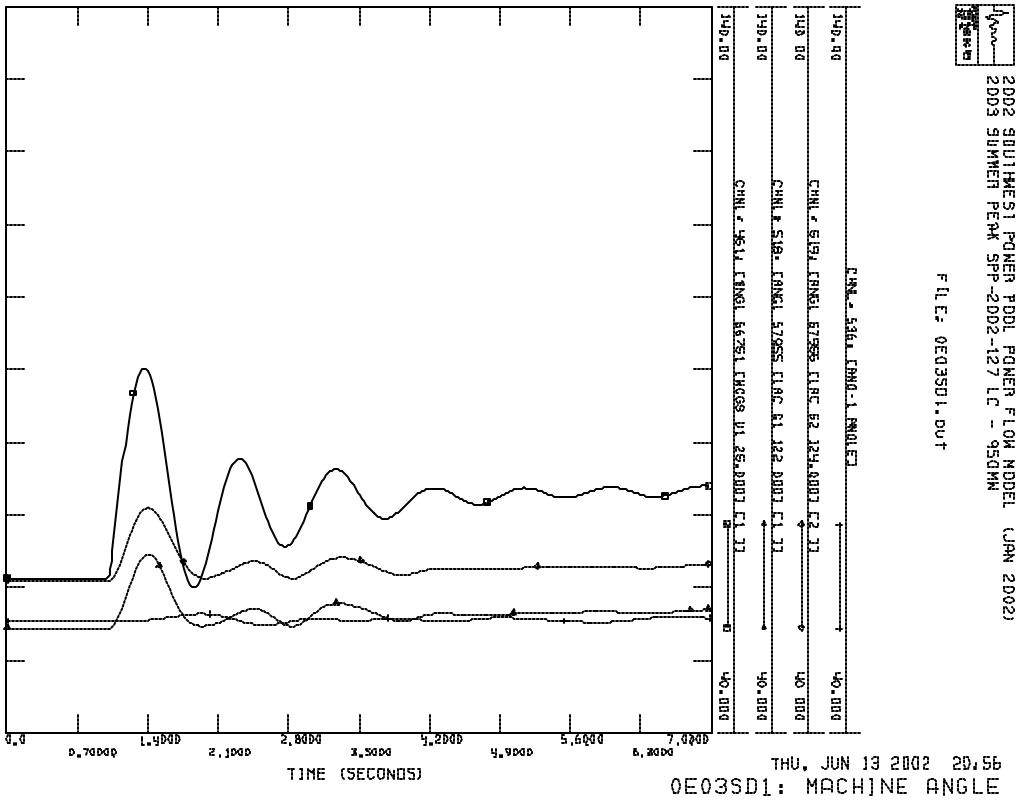
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Linn County 345 kV circuit in service



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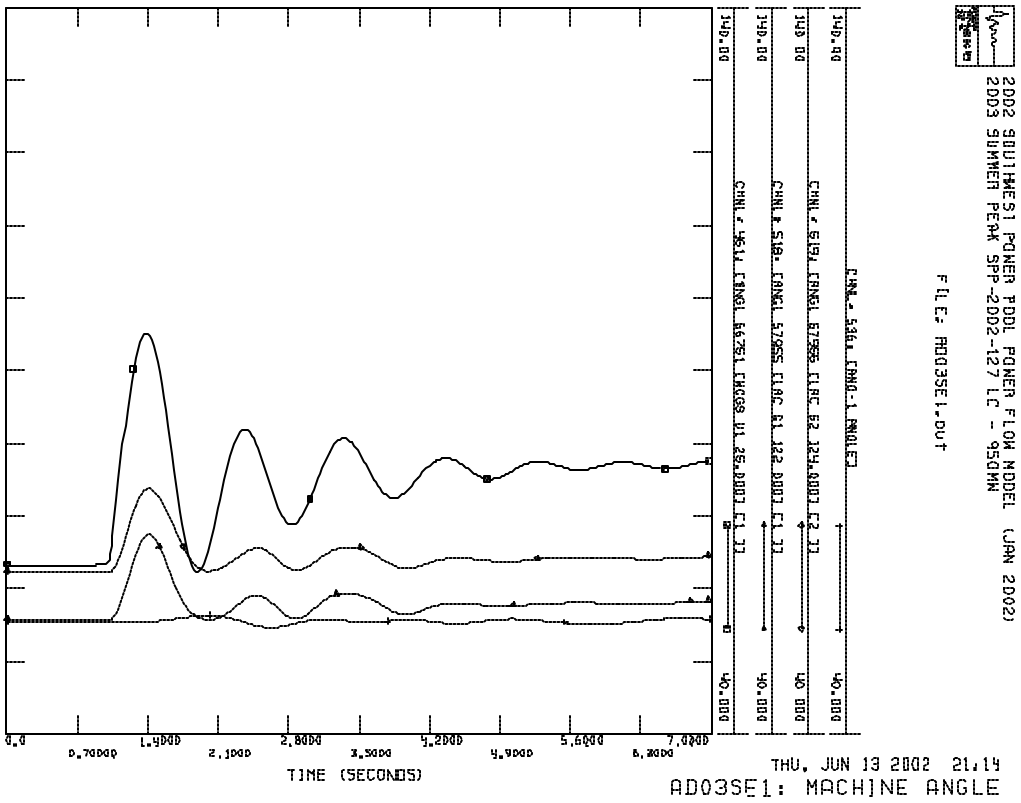
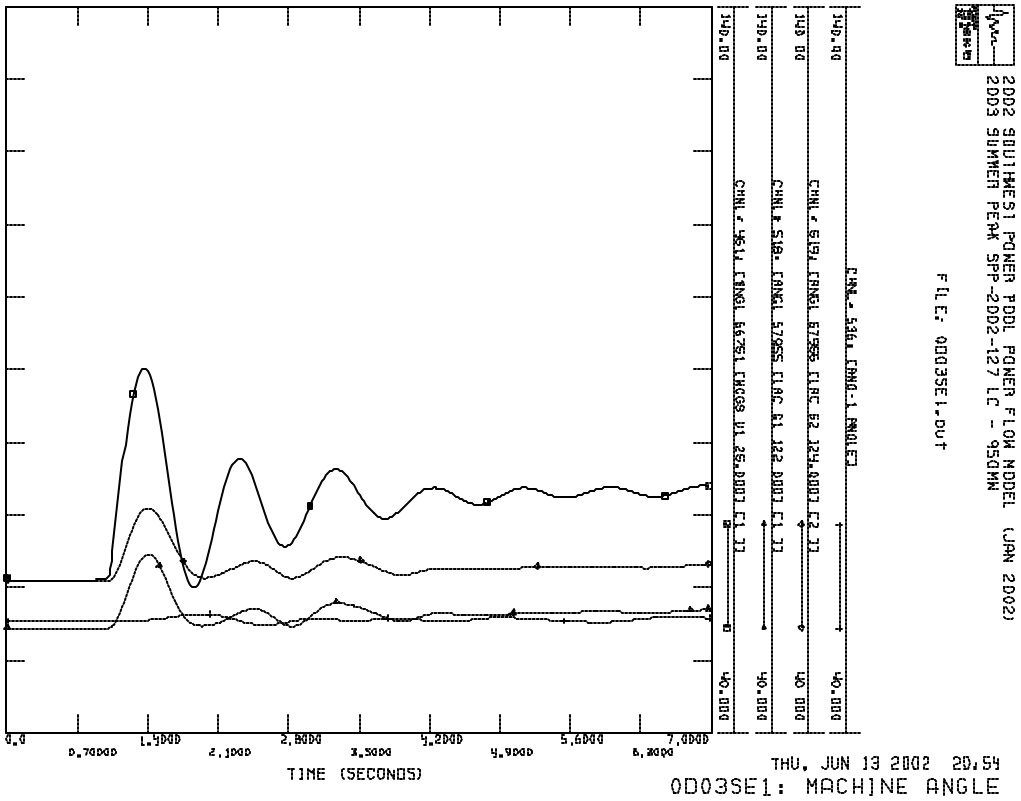


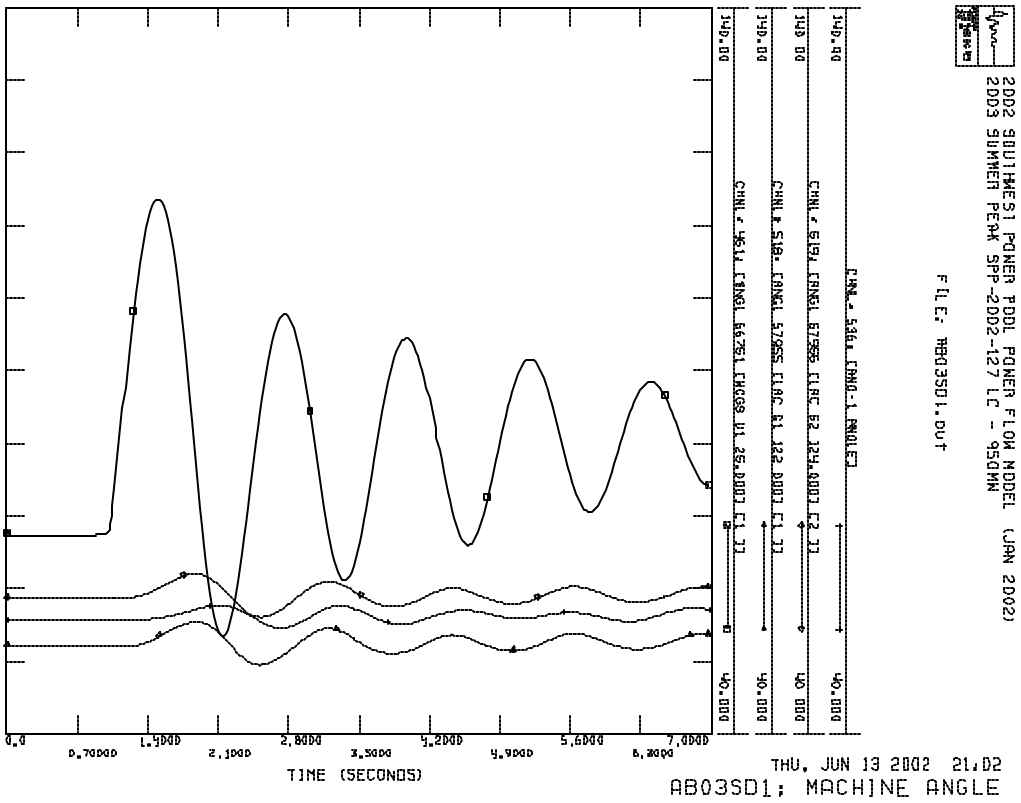
DS-0D03SE1.IDV

1) Linn County Transformer in service
2) 2003 Summer Peak Model
3) Wolf Creek to Benton 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Rose Hill 345 kV circuit
8) Wolf Creek to Linn County 345 kV circuit in service



DS-AB03SD1.IDV

1) No Linn County Transformer
2) 2003 Summer Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



DS-0C03SD1.IDV

1) Linn County Transformer in service
2) 2003 Summer Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
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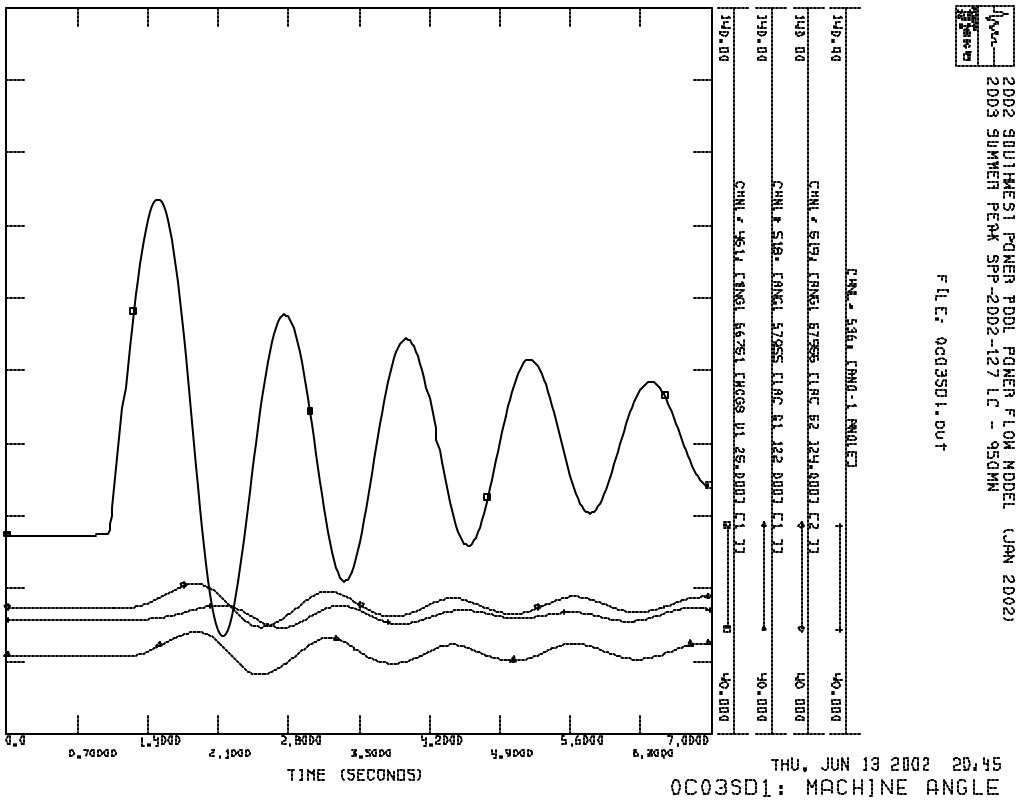
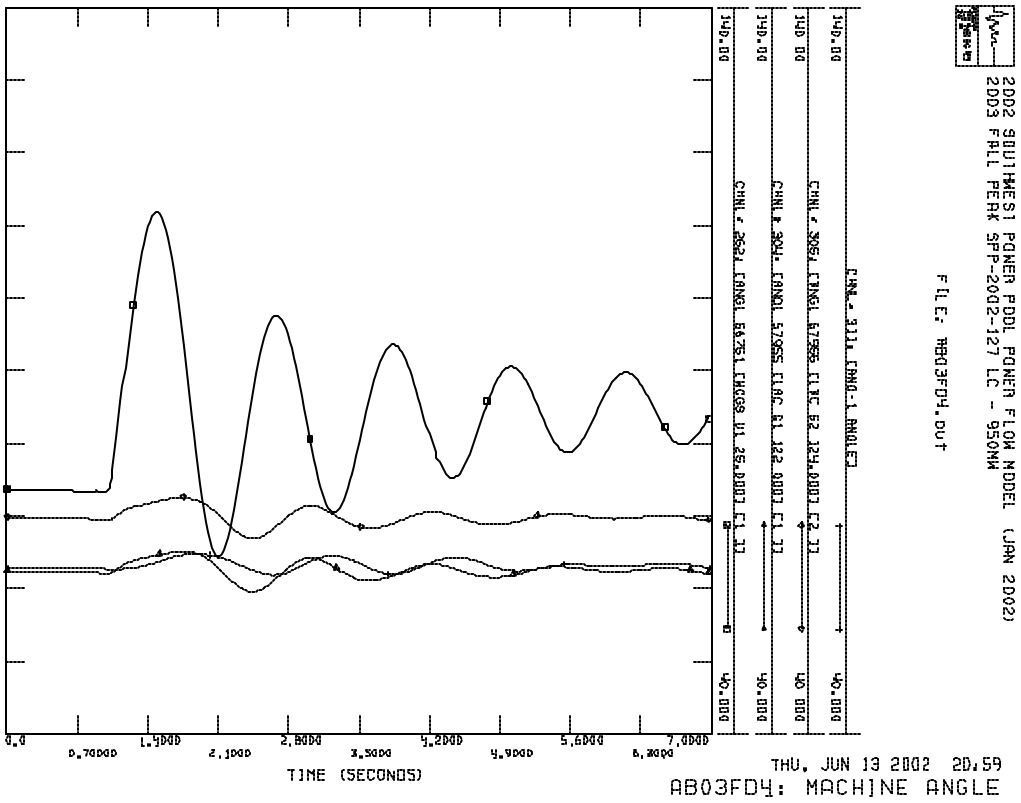
8) Wolf Creek to Rose Hill 345 kV circuit in service



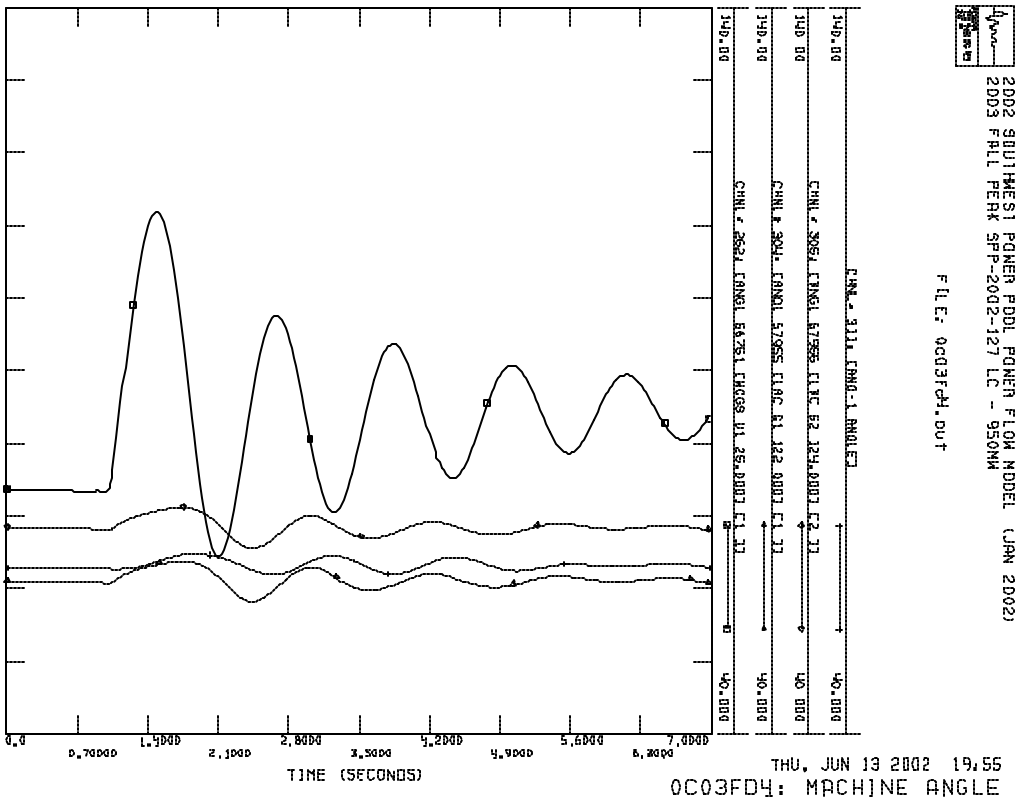
DS-AB03FD4.IDV

1) No Linn County Transformer
2) 2003 Fall Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Benton 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



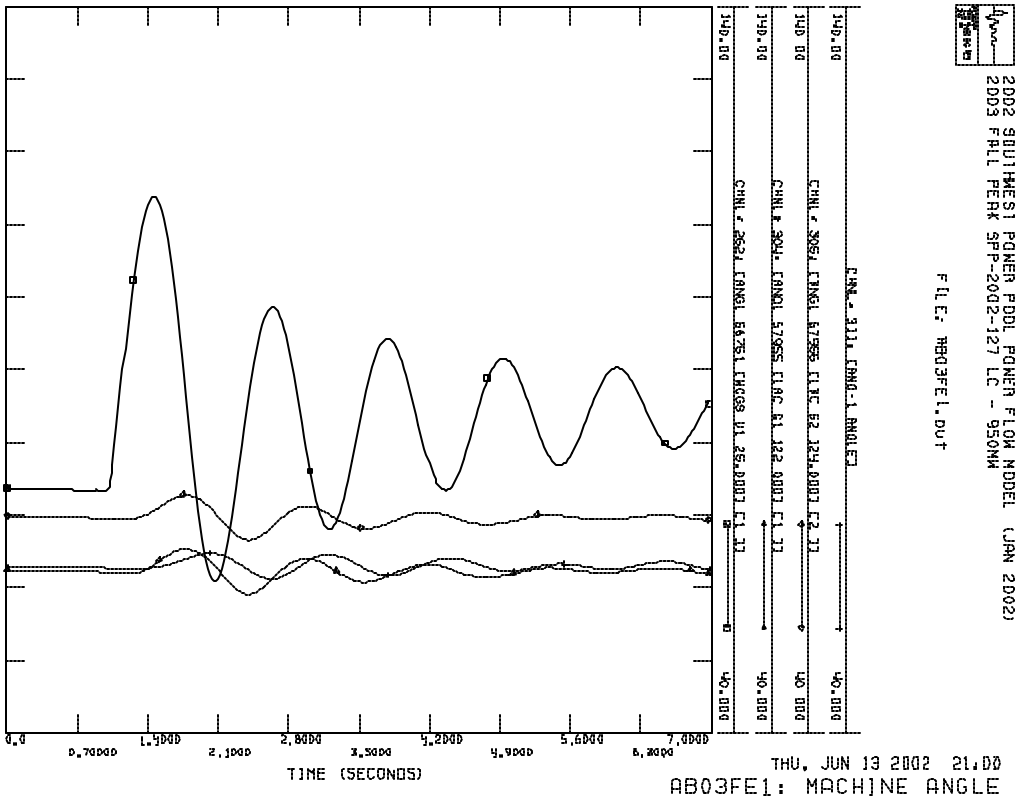
DS-0C03FD4.IDV

1) Linn County Transformer in service
2) 2003 Fall Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Benton 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



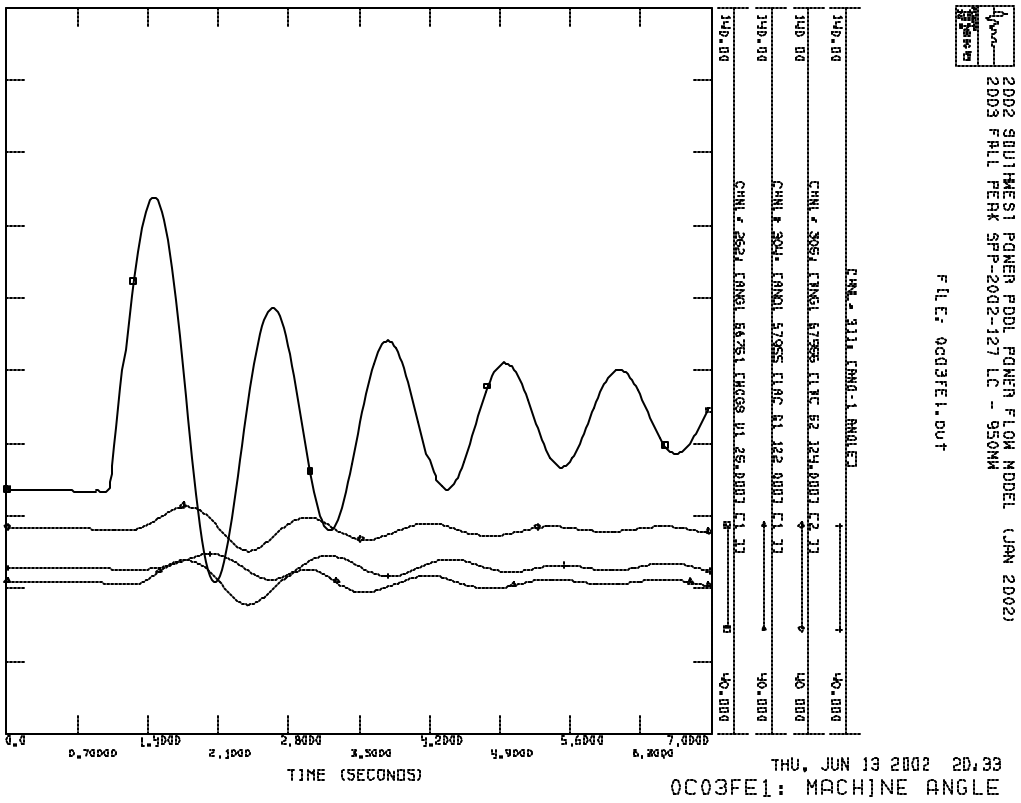
DS-AB03FE1.IDV

1) No Linn County Transformer
2) 2003 Fall Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Rose Hill 345 kV circuit
8) Wolf Creek to Benton 345 kV circuit in service



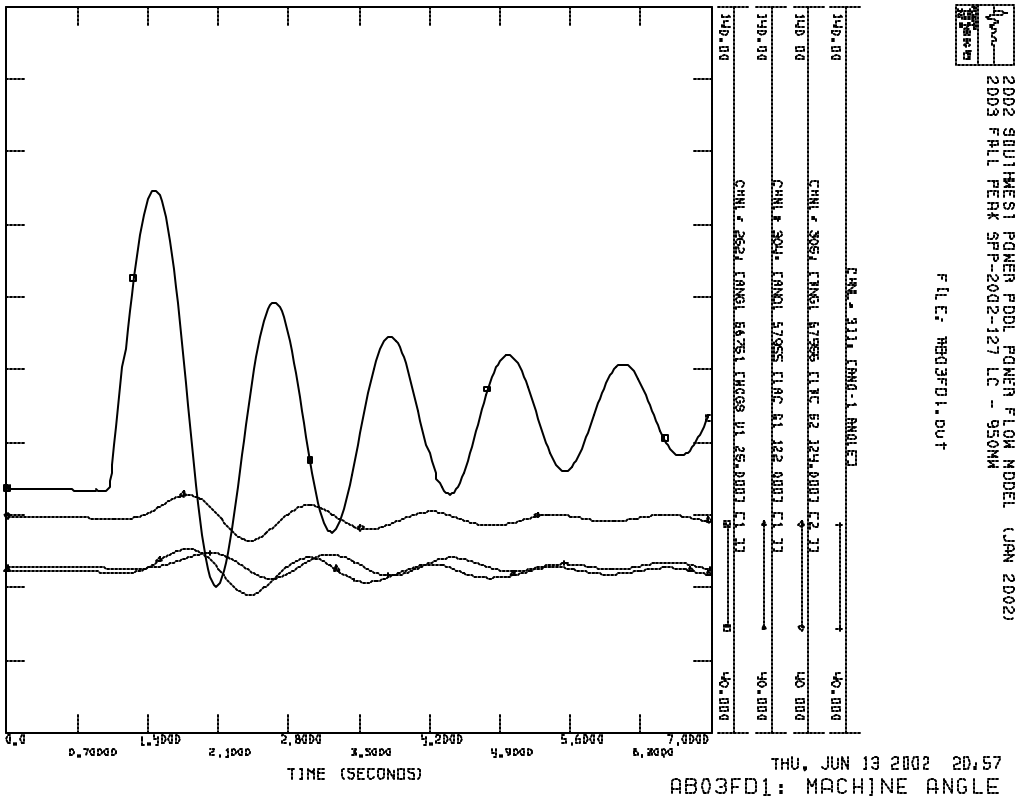
DS-0C03FE1.IDV

1) Linn County Transformer in service
2) 2003 Fall Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Rose Hill 345 kV circuit
8) Wolf Creek to Benton 345 kV circuit in service



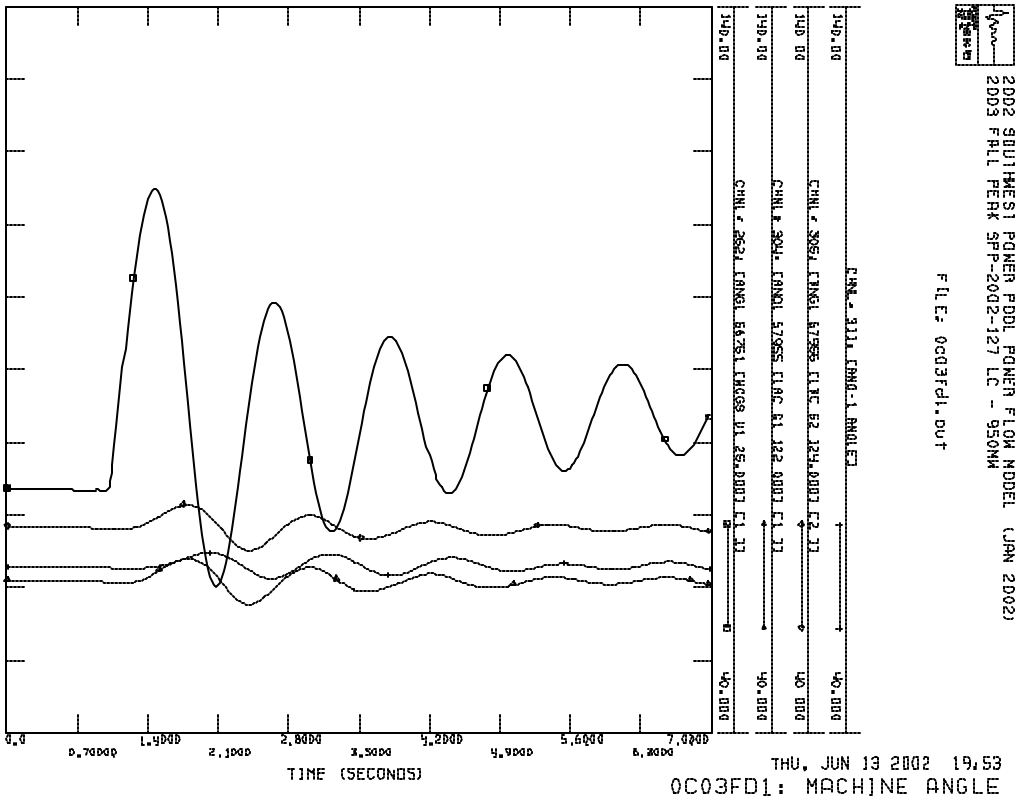
DS-AB03FD1.IDV

1) No Linn County Transformer
2) 2003 Fall Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



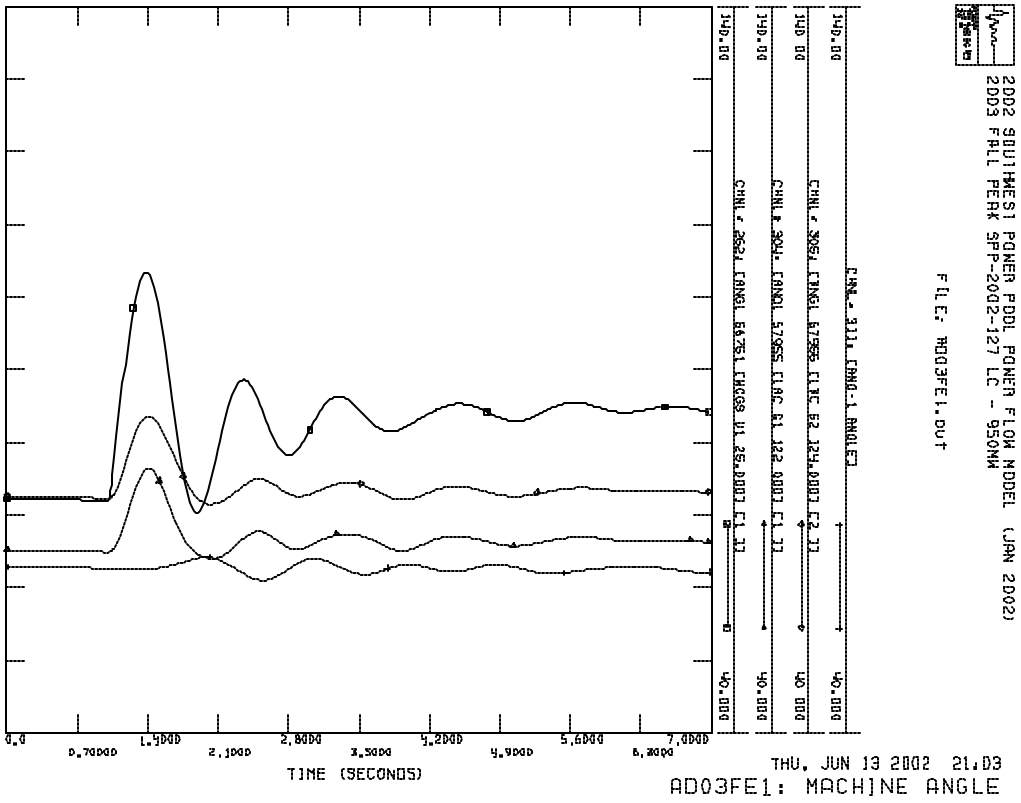
DS-0C03FD1.IDV

1) Linn County Transformer in service
2) 2003 Fall Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



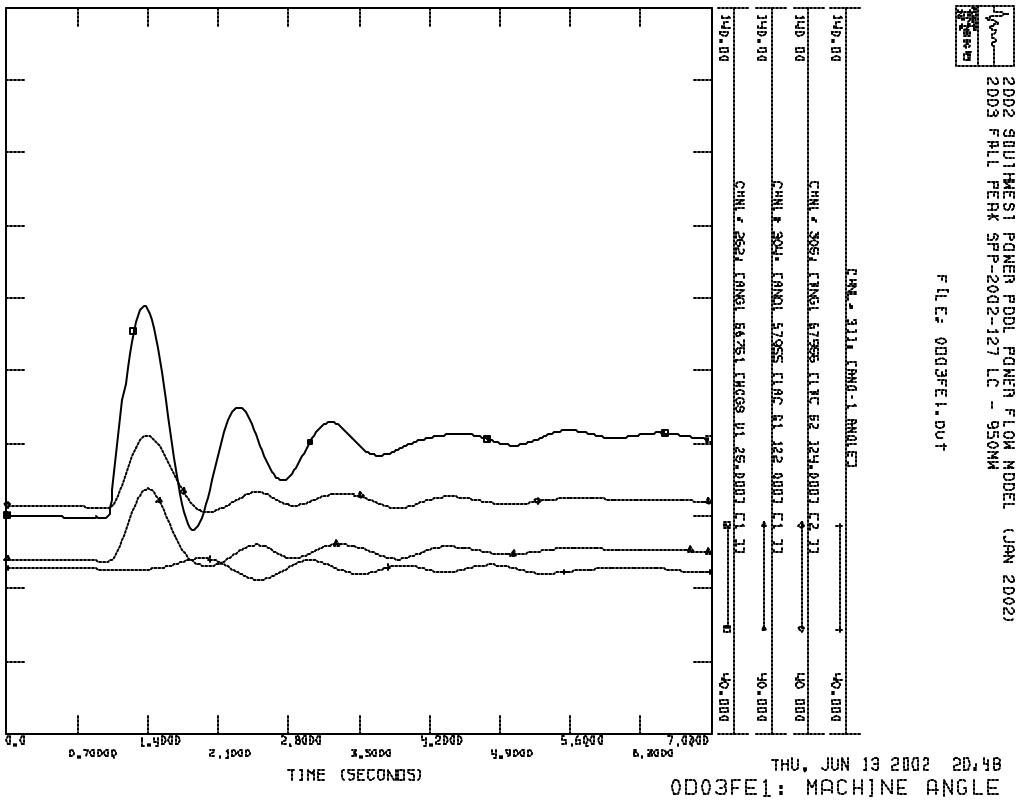
DS-AD03FE1.IDV

1) No Linn County Transformer
2) 2003 Fall Peak Model
3) Wolf Creek to Benton 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Rose Hill 345 kV circuit
8) Wolf Creek to La Cygne 345 kV circuit in service



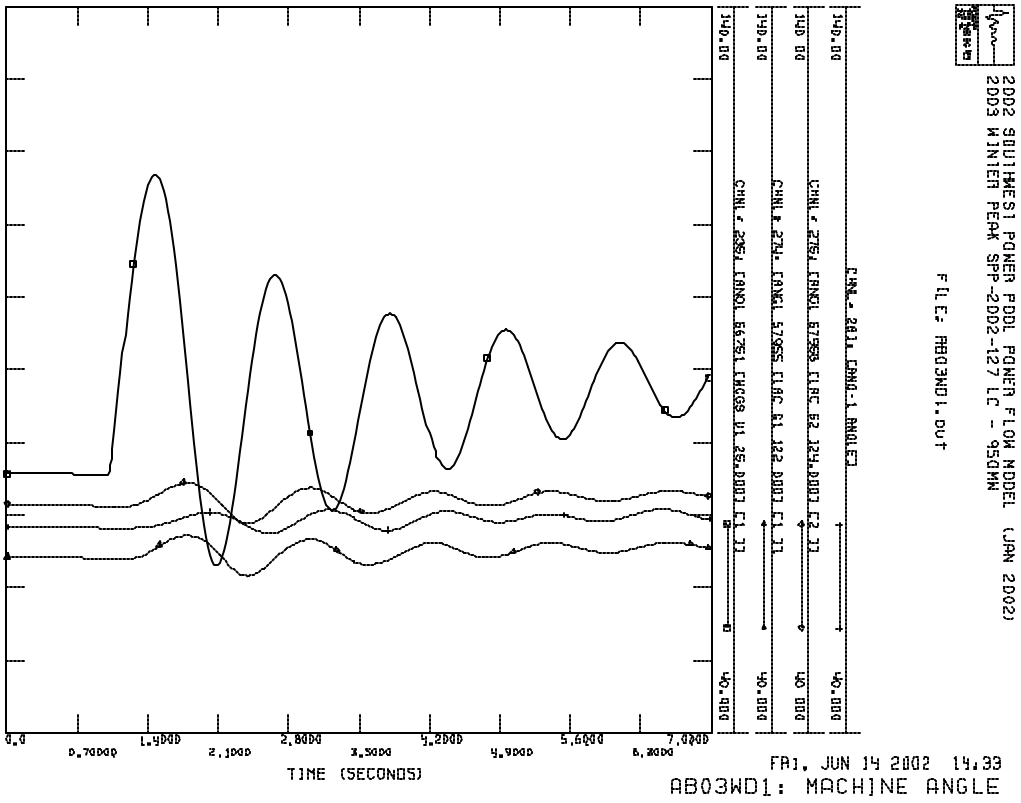
DS-0D03FE1.IDV

1) Linn County Transformer in service
2) 2003 Fall Peak Model
3) Wolf Creek to Benton 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Rose Hill 345 kV circuit
8) Wolf Creek to Linn County 345 kV circuit in service



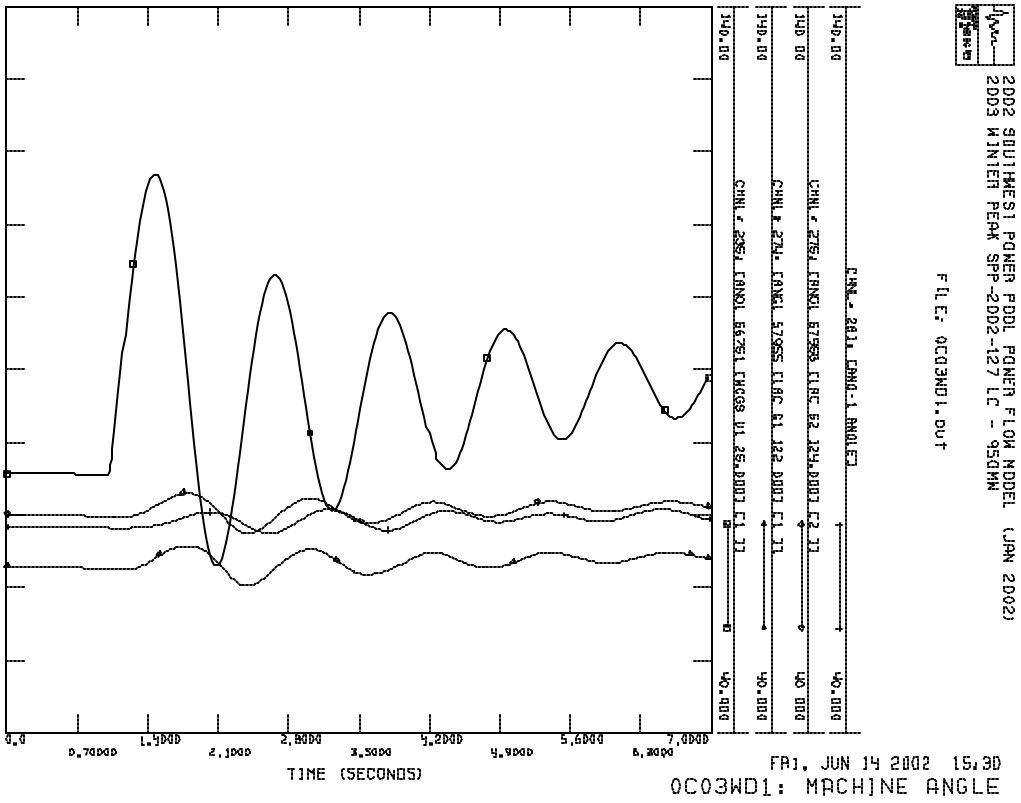
DS-AB03WD1.IDV

1) No Linn County Transformer
2) 2003 Winter Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



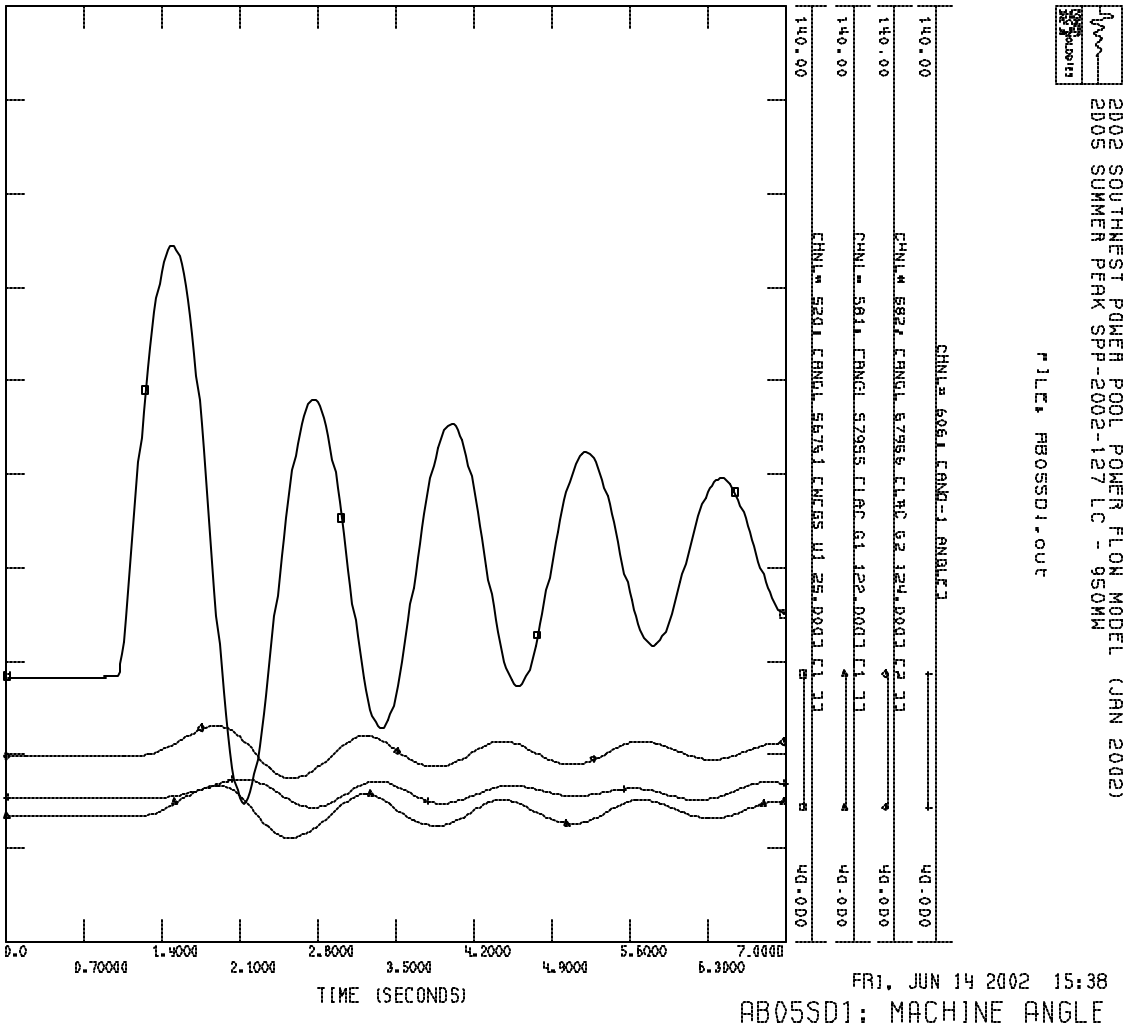
DS-0C03WD1.IDV

1) Linn County Transformer in service
2) 2003 Winter Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



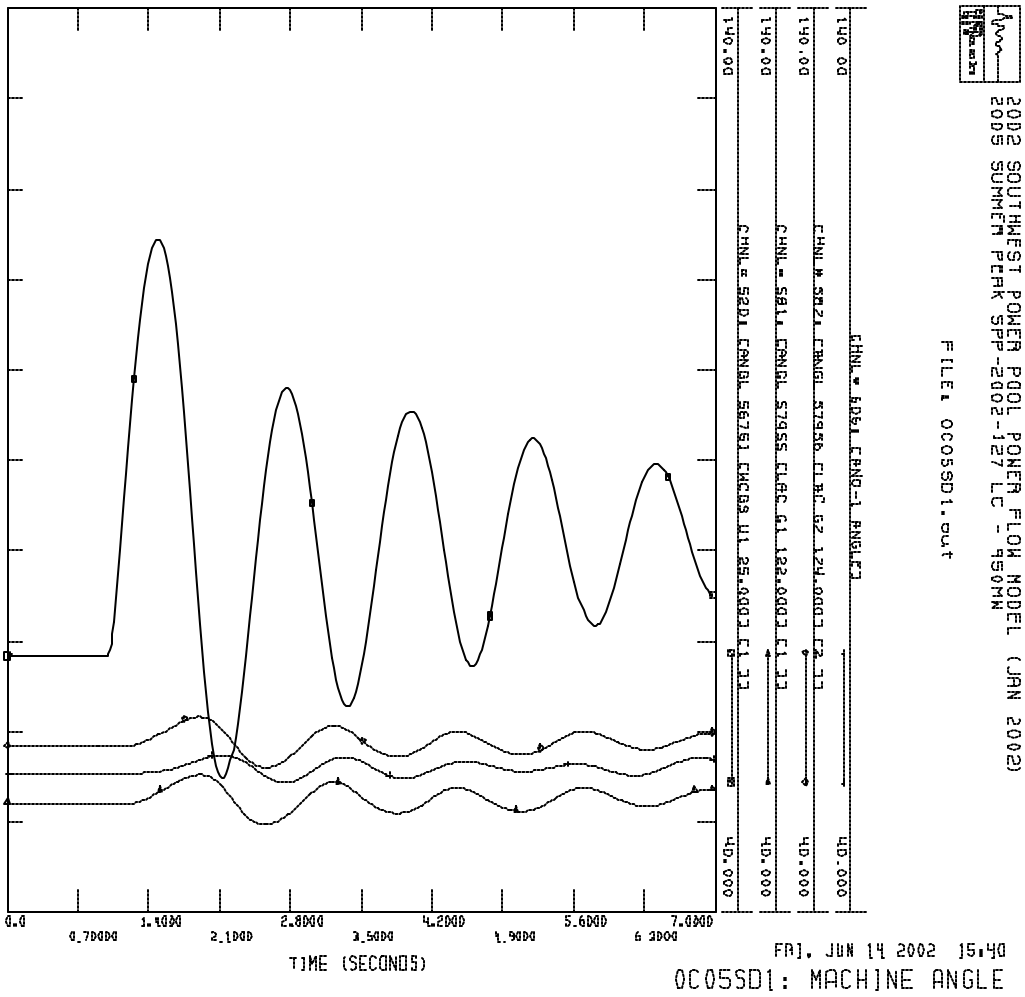
DS-AB05SD1.IDV

1) No Linn County Transformer
2) 2005 Summer Peak Model
3) Wolf Creek to La Cygne 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



DS-0C05SD1.IDV

1) Linn County Transformer in service
2) 2005 Summer Peak Model
3) Wolf Creek to Linn County 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
6) Clear fault
7) Trip Wolf Creek to Benton 345 kV circuit
8) Wolf Creek to Rose Hill 345 kV circuit in service



DS-AD03WB1.IDV

1) No Linn County Transformer
2) 2003 Winter Peak Model
3) Wolf Creek to Benton 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
5) 3 Phase, 3.6 cycle fault on Wolf Creek 345 kV bus
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7) Trip Wolf Creek to La Cygne 345 kV circuit
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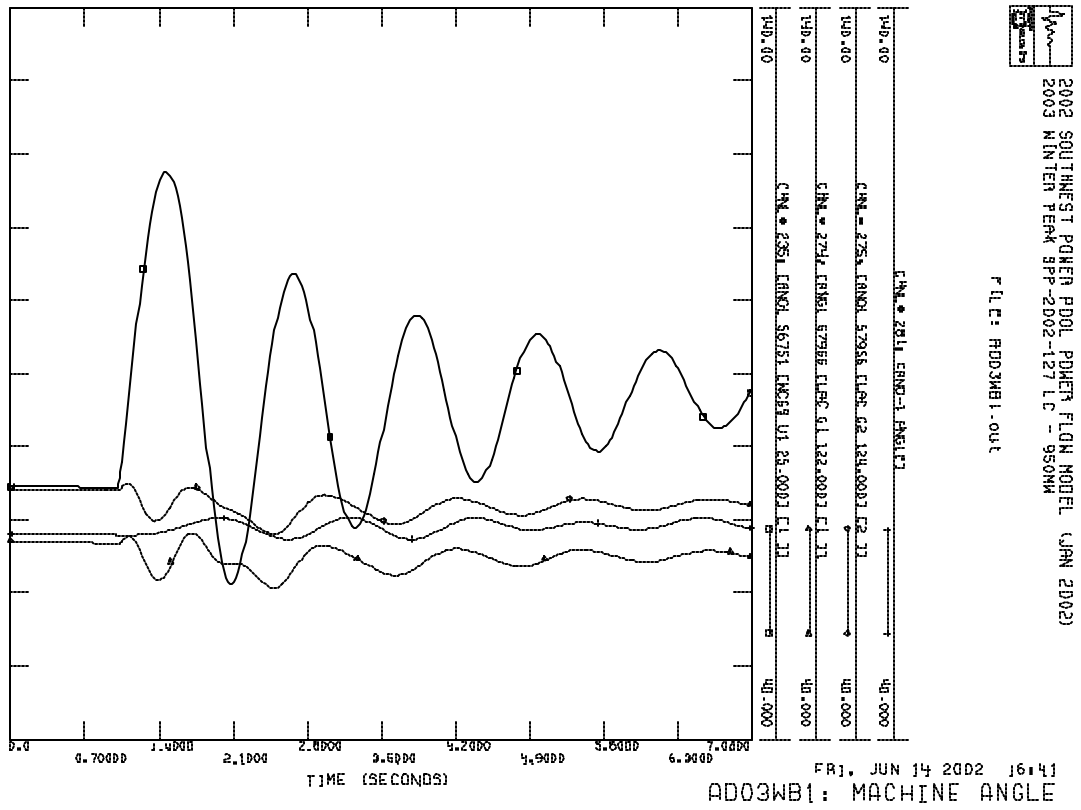

DS-0D03WC1.IDV

1) Linn County Transformer in service
2) 2003 Winter Peak Model
3) Wolf Creek to Benton 345 kV circuit out in base case
4) Wolf Creek Generations at 950 MW
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