SIS-21-CD02: Prewitt Data Center Feasibility Study for Continental Divide Electric Cooperative

Member:	Continental Divide Electric Cooperative
Project Delivery Point Application	None
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Contents

Executive Summary

CDEC requested this study to evaluate the load-serving capability of Tri-State's PEGS, Bluewater, and San Fidel substations for the purpose of serving a datacenter customer in the 200 – 500 MW range. Benchmark contingency analysis of Scenario A was compared to each of the four load-growth scenarios as described below. Scenario B analyzed Bluewater load-serving, Scenario C analyzed San Fidel load-serving, Scenario D analyzed the load serving ability of a new Ambrosia – PEGS 230 kV double circuit, and Scenario E analyzed the load serving ability of a new Yah-ta-hey – PEGS 345 kV circuit.

As evaluated, Bluewater (Scenario B) and San Fidel (Scenario C) demonstrated limited load serving capabilities. San Fidel was unable to support the 200 and 500 MW load levels. Scenario B demonstrated voltage in compliance with Tri-State's system normal and contingency criteria. Additionally, the 200 MW modeled load resulted in minimal overloads when compared to Scenario A. However, Scenario B's 500 MW load could not be supported due to serious negative impact to the transmission system.

The addition of a second 230 kV PEGS – Ambrosia circuit (Scenario D) and Scenario A demonstrated comparable load serving capabilities for the 200 MW level, with numerous identified system overloads and voltage violations. Substantial capacitive VAR injection was required to meet system normal voltage criteria and would require a load-shedding scheme that dropped datacenter load under select contingencies.

The addition of a new Yah-ta-hey to PEGS 345 kV line and 345 kV PEGS interconnection (Scenario E) demonstrated the least impact the transmission system at every datacenter load level and was the only scenario with no voltage and loading violations at the datacenter's 500 MW load level.

Background

Continental Divide Electric Cooperative (CDEC) is a member of Tri-State Generation and Transmission (Tri-State) with a service territory located in western New Mexico. CDEC is served by transmission lines owned by the Public Service Company of New Mexico (PNM), Tucson Electric Power (TEP), and Tri-State. A potential customer has requested service for a datacenter load that may be located in the Prewitt Industrial area.

Objectives

According to information received from the customer, load would start at 10 MW, grow to 100 MW in year 2, and up to 500MW from the end of year 2 through year 5. For the purposes of this feasibility study, load levels between these 200 – 500 MW bounds were investigated.

Scope

The scope of this report was limited to the transmission system in northwest New Mexico with a focus on the PEGS 230 kV and 115 kV substation. Requested load was integrated into models at the transmission bus-level in order to stress the system at a high level.

Loading on the Western Electricity Coordinating Council (WECC) Southern New Mexico (NM1) transfer path (i.e Path 47) was not monitored or stressed from the originating WECC cases.

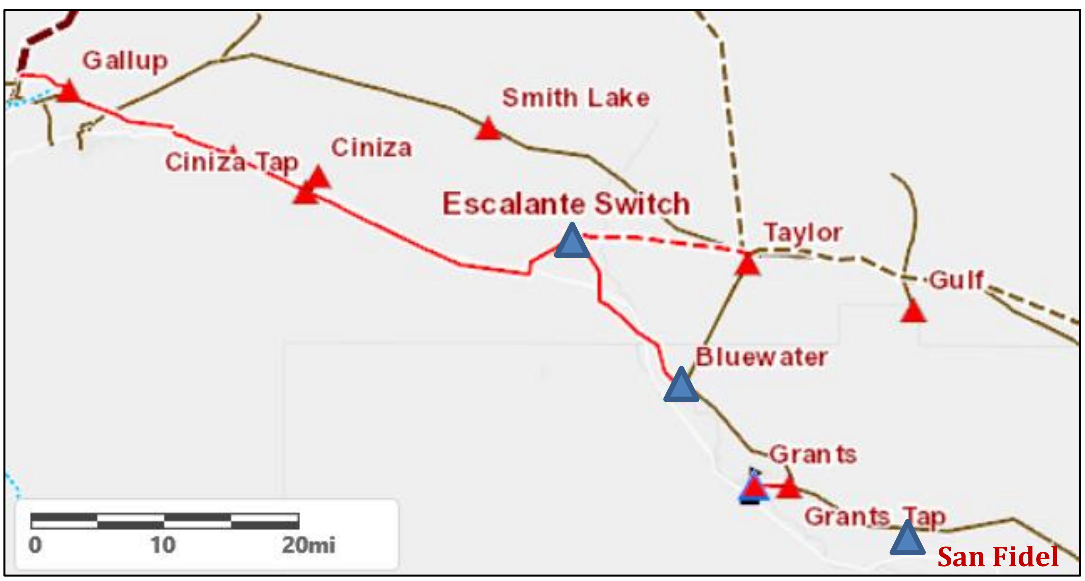

Figure 1: Project Area Map

Study Assumptions

Base Case

This study used the WECC heavy summer (HS) case:

- 2024 HS (used to gauge mid to long term heavy loading)

Load Modifications

Loads modeled in the originating case were not changed with the exception of the simulated datacenter load. The load was assumed to have a constant 0.96 lagging power factor.

Topology Modifications

Topology modeled in the originating case was not changed with the exception of simulated 230 kV and 345 kV transmission lines.

Study Scenarios

Scenario A: Existing System

The existing system was evaluated with simulated datacenter load on the PEGS 230 kV bus. The scenarios below were compared to the benchmark case to determine impact to the system.

Scenario B: Bluewater Service

This scenario modeled the datacenter's additional 200 MW and 500 MW of load at Bluewater's 115 kV bus. A new transformer and distribution system were not modeled.

Scenario C: San Fidel Service

This scenario modeled the datacenter's additional 200 MW and 500 MW of load at San Fidel's 115 kV bus. A new transformer and distribution system were not modeled.

Scenario D: Double 230 kV circuit

This scenario modeled the addition of a double 230 kV PEGS – Ambrosia circuit to serve 200 MW and 500 MW of datacenter load on the PEGS 230 kV bus.

Scenario E: New 345 kV circuit

This scenario modeled the addition of a 345 kV transmission line from Yah-ta-hey substation to PEGS and a 345/230 kV transformer at PEGS. Load was modeled on the PEGS 230 kV bus. Transformer losses were not modeled.

Methodology

According to Tri-State's Engineering Standards Bulletin-Criteria for System Planning and Service Standards, the maximum loading on any transmission line will not exceed 100% of its established continuous rating, as determined by the static thermal limits of the transmission line. Facilities exceeding 80% of their ratings will be closely monitored during the study process for remediation.

Other facilities such as transformers and terminal equipment will be allowed to load to 100% continuous capabilities. Acceptable loading for all transmission lines and transformers is to be below 100 percent of their continuous ratings or any applicable emergency ratings during contingencies as specified by the owner of a particular element. No applicable emergency ratings were identified for this study. Tri-State's planning criteria is summarized in Appendix B.

Power flow simulations were performed using PSS/E V33 software. Contingency analysis was performed using ACCC and TPL-004 P-1 contingencies. Results were compared to the benchmark case results. Transformer LTC tap adjustments and Switched Shunts were not allowed to adjust for initial contingency voltage comparisons. Phase Shifting Transformers and Area interchange controls were not utilized.

Study Results

System Normal Analysis

Table 1: Scenario Comparison

	Case	Scenario A: Benchmark		Scenario B: Bluewater		Scenario C: San Fidel		Scenario D: 230 Double Circuit		Scenario E: 345 Line	
	Load Level (MW)	**200**	**500**	**200**	**500**	**200**	**500**	**200**	**500**	**200**	**500**
Bus Voltages (p.u)	Ambrosia	1.031	0.917	1.025	N/A	N/A	N/A	1.033	0.919	1.035	1.018
	Bisti	1.023	0.971	1.022	N/A	N/A	N/A	1.024	0.972	1.028	1.020
	Ciniza	1.026	0.963	1.023	N/A	N/A	N/A	1.027	0.966	1.031	1.019
	PEGS 115	1.027	0.916	1.017	N/A	N/A	N/A	1.029	0.925	1.035	1.016
	PEGS 230	1.033	0.904	1.033	N/A	N/A	N/A	1.035	0.913	1.037	1.015
Line loading (%)	Yah-ta-hey – Gallup 115 kV	64.20%	106.07%	62.14%	N/A	N/A	N/A	64.29%	101.34%	31.07%	40.63%

Table 2: Capacitor Bank Results

	Scenario D: 230 Double Circuit		
	Cap Size	50 MVAR	100 MVAR
	Load Level (MW)	**500**	**500**
Bus Voltages (p.u)	Ambrosia	0.940	0.976
	Bisti	0.979	0.992
	Ciniza	0.978	0.992
	PEGS 115	0.946	0.975
	PEGS 230	0.938	0.976

In the above table, "N/A" entries signify that the system cannot support the given load levels in the given area.

For Scenario A and D, datacenter load of 500 MW caused a system normal overload on the Yah-ta-hey – Gallup 115 kV line, shown in red text.

To facilitate 500 MW load in Scenario D, a capacitor bank in the range of 50 – 100 MVAR must be added to support voltages above Planning's system normal criteria of 0.95 p.u (Appendix B) as shown above in Table 2.

Contingency Analysis

Table 3: ACCC Comparison

Monitored Element	Contingency	Bench 0 MW	Bench 200 MW	Bench 500 MW	BW 0 MW	BW 200 MW	230 kV Double 0 MW	230 kV Double 200 MW	230 kV Double 500 MW	345 kV 0 MW	345 kV 200 MW	345 kV 500 MW
Rio Puerco 345 – Cabezon 345	4CORN_RIOPUERC			107%					106%			
Yahtahey 115 – Gallup 115	AMBROS_BISTI			138%					134%			
Mendoza 115 – Gallup 115	AMBROS_BISTI			123%					118%			
Mendoza 115 – Wingate 115	AMBROS_BISTI			117%					112%			
Cinza 115 – PEGS 115	AMBROS_BISTI			108%					102%			
Ciniza 115 – Wingate 115	AMBROS_BISTI			116%					111%			
Yahtahey 115 – McKinley 345	MCKIN_YATAHEY2			127%					126%			
Ambrosia 115 – Taylor 115	PEGS_BLUWATER					168%						
Bluewater 115 – Taylor 115	PEGS_BLUWATER					167%						
Ambrosia 230 - PEGS 230	PEGS_GEN			160%								
Yahtahey 115 – Gallup 115	PEGS_GEN			147%					128%			
Mendoza 115 – Gallup 115	PEGS_GEN			132%					112%			
Mendoza – Wingate 115	PEGS_GEN			126%					106%			
Wingate 115 – Ciniza 115	PEGS_GEN			125%					105%			
Ciniza 115 – PEGS 115	PEGS_GEN			118%								
Rio Puerco 345 – Four Corners 345	SANJN_CABEZON			109%					108%			
Bluewater 115 – PEGS 115	TAYLOR_AMBROS					118%						

Scenario A (benchmark) and Scenario D (230 kV double circuit) models did not converge for a single circuit PEGS – Ambrosia 230 kV outage and a double circuit PEGS – Ambrosia 230 kV outage respectively for datacenter load of 500 MW.

As shown above in Table 3, the 230 kV double circuit scenario decreased overloads for some contingencies but did not eliminate them. The only scenario that did not demonstrate any overloads was the 345 kV circuit addition of Scenario E.

Additionally, an outage of the PEGS generator or the Ambrosia – Bisti 230 kV line overloaded the 115 kV system from Yah-ta-hey to Ciniza in Scenario A and D for a 500 MW load level.

Numerous voltage violations were recorded for Scenario A and D for a PEGS generator outage. In Scenario D, the addition of a 100 MVAR capacitor bank removed some violations but a large number of violations still remained.

Cost Estimates

The cost estimates included are planning level and within ±30% of actual project cost.

Scenario B

This scenario would require multiple 115/2.49 kV transformers with a combined maximum capacity of 240 MW and a substation expansion. The 500 MW was scenario was not considered as a viable alternative. Further study is required to determine if 115 kV system upgrades are necessary to maintain reliability while supporting the datacenter's 200 MW load level.

Table 4: Scenario B Cost Estimate

Cost	Qty	Unit Value	Total ($000)
3PH, 115/24.9kV, 80MVA, w/LTC xfmr	3	$1,100.00	$3,300.00
Foundation		1.00%	
Installation		3.00%	
Total Factor		4.00%	$80.00
Subtotal			$3,380.00
Substation Yard Expansion	1		$1,000.00
Subtotal			$4,380.00
Land and permitting		1.00%	
Environmental		1.00%	
Surveying		1.00%	
Planning, design and specifications		5.00%	
Non-labor overhead		15.00%	
Supervision and commissioning		3.00%	
Total Factor		26.00%	$1,138.80
Subtotal			$5,518.80
Total project cost in Yr 2022		2.50%	$5,656.77
Interest during construction (IDC) for 2022		4.70%	$259.38
Cost Estimate with IDC in 2022 dollars			**$5,916.15**

Scenario D

This scenario would require an additional 230 kV PEGS – Ambrosia circuit, a 50 – 100 MVAR capacitor bank, and potential 115 kV system upgrades. Further study is required to determine optimal size and cost of capacitor bank.

Table 5: Scenario D Cost Estimate

Cost	Qty	Unit Value	Total ($000)
230kV, 1272kcmil ACSR "Bittern"	14.5 miles	$735.00	$17,052.00
Yah-ta-hey - Gallup 115 kV upgrade	4 miles	$500.00	$2,000.00
Subtotal			$19,052.00
230 kV breaker	1	$109.00	$109.00
Other protection		50.00%	$54.50
Subtotal			$19,215.50
Land and permitting		10.00%	
Environmental		1.00%	
Surveying		1.00%	
Planning, design and specifications		5.00%	
Non-labor overhead		15.00%	
Supervision and commissioning		3.00%	
Total Factor		35.00%	$6,725.43
Subtotal			$25,940.93
Total project cost in Yr 2022		2.50%	$26,589.45
Interest during construction (IDC) for 2022		4.70%	$1,219.22
Cost Estimate with IDC in 2022 dollars			**$27,808.67**

Scenario E

This scenario would require the installation of a 40-mile 345 kV circuit from Yah-ta-hey to PEGS with a 345/230 and two 500 MVA transformers.

Table 6: Scenario E Cost Estimate

Cost	Qty	Unit Value	Total ($000)
Lattice, 345kV, Bundled 1272kcmil ACSR "Bittern"	40 miles	$30,160.00	$1,206,400.00
Subtotal			$1,206,400.00
3PH, 345/230kV, 500MVA xfmr	2	$2,000.00	$4,000.00
Subtotal			$1,210,400.00
Land and permitting		1.00%	
Environmental		1.00%	
Surveying		1.00%	
Planning, design and specifications		5.00%	
Non-labor overhead		15.00%	
Supervision and commissioning		10.00%	
Total Factor		33.00%	$399,432.00
Subtotal			$1,609,832.00
Total project cost in Yr 2022		2.50%	$1,650,077.80
Interest during construction (IDC) for 2022		4.70%	$75,662.10
Cost Estimate with IDC in 2022 dollars			**$1,725,739.90**

Conclusion

CDEC requested this study to evaluate the load-serving capability of Tri-State's PEGS, Bluewater, and San Fidel substations for the purpose of serving a datacenter customer in the 200 – 500 MW range. Benchmark contingency analysis in Scenario A was compared to each of the four load-growth scenarios as described below.

As evaluated, Scenario B and C demonstrated limited load serving capabilities. San Fidel was unable to support the 200 and 500 MW load levels. Scenario B (Bluewater) demonstrated voltage in compliance with Tri-State's system normal and contingency criteria. Additionally, fewer overloads were recorded when compared to Scenario A. However, Scenario B's 500 MW load could not be supported due to serious negative impact to the transmission system.

Scenario A and D demonstrated comparable load serving capabilities; numerous system overloads and voltage violations were measured for select contingencies at the datacenter's 500 MW load level. For Scenario D, substantial capacitive VAR injection was required to meet system normal voltage criteria and would require a load-shedding scheme that dropped datacenter load under select contingencies.

Scenario E demonstrated the least impact the transmission system at every load level and was the only scenario with no voltage and loading violations at the datacenters' 500 MW load level.

Appendix A: Modifications

Topology Modifications

Table A1: Line Additions						
Element	Voltage	Conductor Size	Length (miles)	R (p.u)	X (p.u)	B (p.u)
Yah-ta-hey – PEGS 230 kV	345 kV	1272 ACSR	40.0	0.002	0.025	0.275
Ambrosia – PEGS 230 kV (2nd circuit)	230 kV	1272 ACSR	14.5	0.002	0.021	0.045

Appendix B: Tri-State System Planning Standards

Summary of Tri-State Steady-State Planning Criteria

System Condition	Operating Voltages [1] (per unit)		Maximum Loading [2] (Percent of Continuous Rating)	
	Maximum	Minimum	Transmission Lines	Other Facilities
Normal	1.05	0.95	80/100	100
N – k	1.10	0.90	100	100

(1) Exceptions may be granted for high side buses of Load-Tap-Changing (LTC) transformers that violate this criterion, if the corresponding low side busses are well within the criterion.

(2) The continuous rating is synonymous with the static thermal rating. Facilities exceeding 80% criteria will be flagged for close scrutiny. By no means, shall the 100% rating be exceeded without regard in planning studies.

Tri-State Voltage Criteria		
Conditions	**Operating Voltages**	**Delta-V**
Normal (P0 event)	0.95 - 1.05	
Contingency (P1 event)	0.90 - 1.10	8%
Contingency (P2-P7 event)	0.90 - 1.10	-

Appendix C: Contingency List

The CON file used with the PSS/E ACCC function is seen below.

CONTINGENCY PEGS_GEN
DISCONNECT BUS 12058
END

COM YATAHEY - FT WINGATE
CONTINGENCY TATAHEY_FTWIN
DISCONNECT BUS 12030
DISCONNECT BUS 10533
END

COM PEGS XFMR
CONTINGENCY PEGS_XMFR
TRIP LINE FROM BUS 12056 TO BUS 12057 CKT 1
END

COM FT WINGATE - PEGS
CONTINGENCY FTWIN_PEGS
DISCONNECT BUS 12017
END

COM YATAHEY - PEGS
CONTINGENCY YATAHEY_PEGS
DISCONNECT BUS 12030
DISCONNECT BUS 10533
DISCONNECT BUS 12089
DISCONNECT BUS 12017
END

COM YATAHEY - GALLUP
CONTINGENCY YATAHEY_GALL
TRIP LINE FROM BUS 10382 TO BUS 12030 CKT 1
END

COM GALLUP - PEGS
CONTINGENCY GALLUP_PEGS
DISCONNECT BUS 10533
DISCONNECT BUS 12089
DISCONNECT BUS 12017
END

COM PEGS - BLUEWATER
CONTINGENCY PEGS_BW
TRIP LINE FROM BUS 12012 TO BUS 12056 CKT 1
END

COM PEGS - AMBROSIA LAKE
CONTINGENCY PEGS_AMBROS
TRIP LINE FROM BUS 10011 TO BUS 12057 CKT 1
END

COM PEGS - AMBROSIA LAKE
CONTINGENCY PEGS_AMBROS_both
TRIP LINE FROM BUS 10011 TO BUS 12057 CKT 1
TRIP LINE FROM BUS 10011 TO BUS 12057 CKT 2
END

CONTINGENCY AMBROS_BISTI
TRIP LINE FROM BUS 10011 TO BUS 10041 CKT 1
END

COM BLUEWATER - TAYLOR
CONTINGENCY BW_TAYLOR
TRIP LINE FROM BUS 12012 TO BUS 12083 CKT 1
END

CONTINGENCY TAYLOR_AMBROS
TRIP LINE FROM BUS 10010 TO BUS 12083 CKT 1
END

COM BLUEWATER - AMBROSIA LAKE
CONTINGENCY BW_AMBROS
DISCONNECT BUS 12083
END

COM AMBROSIA LAKE - RED MESA
CONTINGENCY AMBROS_REDMESA
DISCONNECT BUS 10164
DISCONNECT BUS 10260
DISCONNECT BUS 10322
DISCONNECT BUS 12036
END

COM AMBROSIA - WEST MESA
CONTINGENCY AMBROS_WESTMESA
TRIP LINE FROM BUS 10011 TO BUS 10368 CKT 1
END

COM RED MESA - WEST MESA

CONTINGENCY REDMESA_WESTMESA
DISCONNECT BUS 10198
DISCONNECT BUS 10252
END

COM BLUE WATER - GRANTS TAP
CONTINGENCY BW_GRANTS
TRIP LINE FROM BUS 12012 TO BUS 12035 CKT 1
END

COM GRANTS - SAN FIDEL
CONTINGENCY GRANTS_SFIDEL
TRIP LINE FROM BUS 12035 TO BUS 12126 CKT 1
END

CONTINGENCY SFIDEL_RT66
TRIP LINE FROM BUS 10709 TO BUS 12126 CKT 1
END

COM GRANTS - RT66
CONTINGENCY GRANTS_RT66
TRIP LINE FROM BUS 12035 TO BUS 12126 CKT 1
TRIP LINE FROM BUS 10709 TO BUS 12126 CKT 1
END

COM BLUE WATER - SAN FIDEL
CONTINGENCY BW_SFIDEL
TRIP LINE FROM BUS 12012 TO BUS 12035 CKT 1
TRIP LINE FROM BUS 12035 TO BUS 12126 CKT 1
END

COM BLUE WATER - RT66
CONTINGENCY BW_RT66
DISCONNECT BUS 12035
DISCONNECT BUS 12126
END

COM RT66 - WEST MESA
CONTINGENCY RT66_WESTMESA
DISCONNECT BUS 12044
DISCONNECT BUS 10444
DISCONNECT BUS 10555
END

COM BLUE WATER - WEST MESA
CONTINGENCY BW_WMESA
DISCONNECT BUS 12035
DISCONNECT BUS 12126
DISCONNECT BUS 12044
DISCONNECT BUS 10444
DISCONNECT BUS 10555
END

COM WEST MESA - ARROYO
CONTINGENCY WESTMESA_ARROYO
TRIP LINE FROM BUS 10369 TO BUS 11014 CKT 1
END

COM WEST MESA xfmr
CONTINGENCY WESTMESA_XFMR
TRIP LINE FROM BUS 10368 TO BUS 10371 CKT 1
END

COM MCKIN - YATAHEY T1
CONTINGENCY MCKIN_YATAHEY1
TRIP LINE FROM BUS 10382 TO BUS 160302 CKT 1
END

COM MCKIN - YATAHEY T2
CONTINGENCY MCKIN_YATAHEY2
TRIP LINE FROM BUS 10382 TO BUS 160302 CKT 2
END

COM MCKIN - SPRINGERVIL CKT 1
CONTINGENCY MCKIN_SPRING1
TRIP LINE FROM BUS 160302 TO BUS 160306 CKT 1
END

COM MCKIN - SPRINGERVIL CKT 2
CONTINGENCY MCKIN_SPRING2
TRIP LINE FROM BUS 160302 TO BUS 160306 CKT 2
END

COM MCKIN - SAN JUAN Dummy 1
CONTINGENCY MCKIN_SNJUAN1
TRIP LINE FROM BUS 160302 TO BUS 10292 CKT '&1'
END

COM MCKIN - SAN JUAN Dummy 2
CONTINGENCY MCKIN_SNJUAN2

TRIP LINE FROM BUS 160302 TO BUS 10292 CKT '&2'
END

COM SPRINGERVILLE - MACHO
CONTINGENCY MACHO_SPRINGER
TRIP LINE FROM BUS 11047 TO BUS 160306 CKT 1
END

COM SAN JUAN T1
CONTINGENCY SANJUAN_XFMR1
TRIP LINE FROM BUS 10292 TO BUS 10318 CKT 1
END

COM SAN JUAN T2
CONTINGENCY SANJUAN_XFMR2
TRIP LINE FROM BUS 10292 TO BUS 10321 CKT 1
END

COM RIO PUERCO - WEST MESA
CONTINGENCY RIOPUERC_WESTMESA1
TRIP LINE FROM BUS 10369 TO BUS 10390 CKT 1
END

COM RIO PUERCO - WEST MESA
CONTINGENCY RIOPUERC_WESTMESA2
TRIP LINE FROM BUS 10369 TO BUS 10390 CKT 2
END

CONTINGENCY 4CORN_RIOPUERC_MULTI
COM Including Multiline Buses
TRIP LINE FROM BUS 10390 TO BUS 14101 CKT '&1'
END

COM FOUR CORN - SAN JUAN
CONTINGENCY SANJUAN_4CORN
TRIP LINE FROM BUS 10292 TO BUS 14101 CKT 1
END

COM SAN JUAN - CABEZON
CONTINGENCY SANJN_CABEZON
TRIP LINE FROM BUS 10292 TO BUS 10403 CKT 1
END

COM JICARILLA - OJO
CONTINGENCY JICARILLA_OJO
TRIP LINE FROM BUS 10232 TO BUS 10842 CKT 1
END

CONTINGENCY GREEN_SPRING_MULTI
TRIP LINE FROM BUS 160301 TO BUS 160306 CKT '&1'
END

END