



# Aquila

**AQUILA NETWORKS**

**WESTPLAINS ENERGY – COLORADO**

**CATEGORY “C” CONTINGENCY STUDIES**

**2008-2012**

**April 2008**

## Table of Contents

1.0	INTRODUCTION.....	2
2.0	RESULTS .....	2
2.1	CATEGORY C NO SOLVE CASES.....	2
2.2	CATEGORY C SIGNIFICANT DEMAND LOSS .....	3
2.3	CATEGORY C FLOW VIOLATIONS .....	4
2.4	CATEGORY C VOLTAGE VIOLATIONS .....	6
2.5	CONCLUSION .....	8

## 1.0 Introduction

This report presents the most severe results or impacts resulting from N-2 contingencies within the WPEC transmission system and are intended to comply with the NERC Standard TPL-003-0. These studies are intended to identify significant transmission deficiencies with potential voltage collapse and cascading outages under NERC category C contingency conditions as defined in Table 1 of TPL-003-0.

Transmission performance was evaluated based on WECC approved 2008 and 2012 summer peak models, which represent the critical system conditions and projected firm transfers. The load flow studies were performed with consideration of all possible double contingencies (N-1-1), a Category B single bulk electric system element contingency (N-1) followed by another Category B bulk electric system element contingency (N-1) after manual system adjustment. No stability simulations were performed locally since the load flow results did not indicate significant potential instability issues, however, the “regional” Colorado Coordinated Planning Group performs regional stability, dynamic, and short circuit studies for category C and category D contingencies.

According to the TPL-003-0 standard, the controlled interruption of customer demands, the planned removal of generators, or the curtailment of firm (non-recallable reserved) power transfers were allowed to meet the NERC standard under Category C contingency. In this report, any voltage-drop below 0.80 pu was judged to be significant voltage violation as it might result in voltage collapse or voltage instability. Similarly, transmission branches loaded over 110% of their emergency ratings under a double outage event were considered to be significant overloading violations since they might lead to cascading transmission outages before operational adjustments.

## 2.0 Results

### 2.1 Category C No Solve Cases

No solve cases involve outages that caused the mathematical model to not converge and reach a solution. Cases that do not solve usually involve a system with low voltage and/or potential voltage collapse.

Neither the 2008 or 2012 models identified any no solve cases, however if the Portland – West Station 115kV line and the West Canon – Canon City 115kV line is simultaneously lost, potential voltage collapse will result in the Canon City area. Again this N-1-1 study allows for operator intervention and load maintenance switching.

## 2.2 Category C Significant Demand Loss

The list below summarizes the most significant of load loss based on the number of busses in the system model that are part of an “island” resulting from the dual outage.

### 2008 Summer Peak

CONTINGENCY '1054' (#1054 OF 2278):

OPEN LINE FROM BUS 70060 [BOONE	115.00]	TO BUS 70249 [LAJUNTAW	115.00]	CKT 1
OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
OPEN LINE FROM BUS 70062 [BOONE	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	14			
LOSS OF LOAD:	18.4 MW			

CONTINGENCY '1333' (#1333 OF 2278):

OPEN LINE FROM BUS 70086 [CANONCTY	115.00]	TO BUS 70390 [SKALA	115.00]	CKT 1
OPEN LINE FROM BUS 70086 [CANONCTY	115.00]	TO BUS 70550 [W CANON	115.00]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	12			
BUS(ES) IN LARGEST ISLAND:	12			
LOSS OF LOAD:	69.7 MW			

CONTINGENCY '630' (#630 OF 2278):

OPEN LINE FROM BUS 70042 [ASPEN TP	69.000]	TO BUS 70353 [READER	69.000]	CKT 1
OPEN LINE FROM BUS 70054 [BMONT TP	69.000]	TO BUS 70455 [W.STATON	69.000]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	9			
BUS(ES) IN LARGEST ISLAND:	9			
LOSS OF LOAD:	47.8 MW			

CONTINGENCY '1029' (#1029 OF 2278):

OPEN LINE FROM BUS 70060 [BOONE	115.00]	TO BUS 70159 [DOT TAP	115.00]	CKT 1
OPEN LINE FROM BUS 70285 [MIDWAYPS	115.00]	TO BUS 70301 [NTHRIDGE	115.00]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	9			
BUS(ES) IN LARGEST ISLAND:	9			
LOSS OF LOAD:	74.7 MW			

CONTINGENCY '1170' (#1170 OF 2278):

OPEN LINE FROM BUS 70063 [BOONE TP	69.000]	TO BUS 70372 [S FWL TP	69.000]	CKT 1
OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
OPEN LINE FROM BUS 70250 [LAJUNTAW	69.000]	TO BUS 70366 [ROCKYFRD	69.000]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	9			
BUS(ES) IN LARGEST ISLAND:	6			
LOSS OF LOAD:	10.9 MW			

CONTINGENCY '1363' (#1363 OF 2278):

OPEN LINE FROM BUS 70086 [CANONCTY	115.00]	TO BUS 70390 [SKALA	115.00]	CKT 1
OPEN LINE FROM BUS 70330 [PORTLAND	115.00]	TO BUS 70456 [W.STATON	115.00]	CKT 1
BUS(ES) NOT CONNECTED BACK TO A SWING BUS:	7			
BUS(ES) IN LARGEST ISLAND:	7			
LOSS OF LOAD:	57.5 MW			

## 2012 Summer Peak

CONTINGENCY '630' (#630 OF 2278):

OPEN LINE FROM BUS 70042 [ASPEN TP 69.000] TO BUS 70353 [READER 69.000] CKT 1  
OPEN LINE FROM BUS 70054 [BMONT TP 69.000] TO BUS 70455 [W.STATON 69.000] CKT 1  
BUS(ES) NOT CONNECTED BACK TO A SWING BUS: 9  
BUS(ES) IN LARGEST ISLAND: 9  
LOSS OF LOAD: 33.6 MW

CONTINGENCY '1170' (#1170 OF 2278):

OPEN LINE FROM BUS 70063 [BOONE TP 69.000] TO BUS 70372 [S FWL TP 69.000] CKT 1  
OPEN LINE FROM BUS 70271 [LS ANMAS 69.000] TO BUS 70320 [PHLPS TP 69.000] CKT 1  
OPEN LINE FROM BUS 70250 [LAJUNTAW 69.000] TO BUS 70366 [ROCKYFRD 69.000] CKT 1  
BUS(ES) NOT CONNECTED BACK TO A SWING BUS: 9  
BUS(ES) IN LARGEST ISLAND: 6  
LOSS OF LOAD: 13.8 MW

CONTINGENCY '1363' (#1363 OF 2278):

OPEN LINE FROM BUS 70086 [CANONCTY 115.00] TO BUS 70390 [SKALA 115.00] CKT 1  
OPEN LINE FROM BUS 70330 [PORTLAND 115.00] TO BUS 70456 [W.STATON 115.00] CKT 1  
BUS(ES) NOT CONNECTED BACK TO A SWING BUS: 7  
BUS(ES) IN LARGEST ISLAND: 7  
LOSS OF LOAD 66.9 MW

Contingency numbers 1054, 1333 and 1029 resulted in loss of load in the 2008 case, but due to system additions there was no loss of load for these contingencies in the 2012 case. The loss of load in the Contingency no. 1054 was mitigated in the 2012 case by the planned addition of a 115 KV interconnection with Tri State at LaJunta. The loss of load in the Contingency no. 1333 was mitigated in the 2012 case by the planned addition of a 115 KV line from Canon West to Arequa Gulch where it will connect through a 115-69 KV transformer to the 69 KV system in the Cripple Creek area. The loss of load in the Contingency no. 1029 was mitigated in the 2012 case by the planned addition of the Airport to Reader 115 KV line.

## 2.3 Category C Flow Violations

The most severe results from the N-1-1 analysis with category B violations filtered out are presented here.

Loss of both West Station 115/69kV transformers loads the northern Pueblo 69kV system along with the Reader 115/69kV transformers in the near term. With load shifted to the 115kV system at Freemary and Overton in the 2012 system, this loading is resolved.

X--- MONITORED ELEMENT ----X	X---LABEL--X	...\08SP _NG.sav	...\12SP _NG.sav
70042 ASPEN TP 69.000 70051 BLENDE 69.000 1	2278	146.6% 83MVA	
70042 ASPEN TP 69.000 70353 READER 69.000 1	2278	146.6% 83MVA	
70049 BELMONT 69.000 70051 BLENDE 69.000 1	2278	180.6% 55MVA	
70352 READER 115.00 70353 READER 69.000 1	2278	119.3% 56MVA	
70352 READER 115.00 70353 READER 69.000 2	2278	123.1% 58MVA	

Loss of one of the West Station 115/69kV transformers and the Reader-Blende 69kV line causes extreme loading of the remaining West Station 115/69kV transformer. It will be necessary to shed load on the 69 KV loop between West Station and Blende in the event of this outage.

X--- MONITORED ELEMENT ----X	X---LABEL--X	...\08SP _NG.sav	...\12SP _NG.sav
70455 W.STATON 69.000 70456 W.STATON 115.00 2	681	203.9% 86MVA	150.1% 63MVA

Outage of the line from Blende to St. Charles and an outage of the Boone 115-69 KV transformer results in the following overloads in 2008. The planned interconnection with Tri-State at LaJunta mitigated the overloads in 2012.

X--- MONITORED ELEMENT ----X	X---LABEL--X	...\08SP _NG.sav	...\12SP _NG.sav
70249 LAJUNTAW 115.00 70250 LAJUNTAW 69.000	796	128.9% 32MVA	
70366 ROCKYFRD 69.000 70250 LAJUNTAW 69.000	796	115.5% 28MVA	

Loss of the Canon City 115 KV transformer and the Canon City to Skala 115 KV line results in the following overloads. The planned construction of the 115 KV line from Canon West to Arequa Gulch significantly reduces the loading in the 2012 case.

X--- MONITORED ELEMENT ----X	X---LABEL--X	...\08SP _NG.sav	...\12SP _NG.sav
70236 HYDEPARK 115.00 70339 PUEBPLNT 115.00	1200		105.0% 102MVA
70330 PORTLAND 115.00 70456 W.STATON 115.00	1200	137.0% 99MVA	103.9% 76MVA
70220 HIGHLND 115.00 70339 PUEBPLNT 115.00	1200	116.8% 49mva	

Outage of the Canon City 115-69 KV transformer and the Portland 115-69 KV transformer results in overloads as shown below. It will be necessary to shed load on the 69 KV system between Portland and Canon City in the event of this outage.

X--- MONITORED ELEMENT ---X	X---LABEL--X	_NG.sav	_NG.sav
70329 PORTLAND 69.00	1228	254.0%	148.2%
70330 PORTLAND 2 115.00		57MVA	35MVA
70220 HIGHLND 69.00	1228	116.0%	
70329 PORTLAND 69.00		49MVA	

## 2.4 Category C Voltage Violations

The Category C voltage violations for the WPEC system are shown below:

X----- BUS -----X	OUTAGE X---LABEL--X	...\08SP _NG.sav	...\12SP _NG.sav
70062 BOONE 69.000	796		0.83358
70062 BOONE 69.000	994		0.83884
70062 BOONE 69.000	995		0.83884
70062 BOONE 69.000	1568		0.61408
70063 BOONE TP 69.000	796		0.83354
70063 BOONE TP 69.000	799		0.83797
70063 BOONE TP 69.000	994		0.83880
70063 BOONE TP 69.000	995		0.83880
70063 BOONE TP 69.000	1141		0.83755
70063 BOONE TP 69.000	1142		0.83755
70063 BOONE TP 69.000	1568		0.47088
70083 CANON 55 13.800	1404		0.84547
70084 CANON 59 13.800	1404		0.83458
70086 CANONCTY 115.00	1404		0.81647
70130 CRPLE CK 69.000	1200	0.81879	
70130 CRPLE CK 69.000	1228	0.82799	
70130 CRPLE CK 69.000	1230	0.83779	
70160 E CANON 69.000	1249		0.81942
70160 E CANON 69.000	1255		0.78619
70176 FLORENCE 69.000	1249		0.81102
70176 FLORENCE 69.000	1255		0.77585
70178 FOWLER 69.000	1568		0.00000
70220 HIGHLND 69.000	1255		0.77564
70235 HUERFANO 69.000	796		0.81514
70235 HUERFANO 69.000	799		0.81968
70235 HUERFANO 69.000	994		0.82053
70235 HUERFANO 69.000	995		0.82053
70235 HUERFANO 69.000	1141		0.81925
70235 HUERFANO 69.000	1142		0.81925
70293 NCANON 69.000	1249		0.83440
70293 NCANON 69.000	1255		0.80320



70294	NCANON W	69.000	1249		0.83477
70294	NCANON W	69.000	1255		0.80360
70306	P P MINE	69.000	1200	0.82271	
70306	P P MINE	69.000	1228	0.83187	
70306	P P MINE	69.000	1230	0.84162	
70316	PDA	69.000	796	0.84569	0.80464
70316	PDA	69.000	799	0.84408	0.80925
70316	PDA	69.000	994	0.84515	0.81011
70316	PDA	69.000	995	0.84515	0.81011
70316	PDA	69.000	1141	0.84355	0.80881
70316	PDA	69.000	1142	0.84354	0.80881
70317	PDA TAP	69.000	796	0.84738	0.80663
70317	PDA TAP	69.000	799	0.84577	0.81122
70317	PDA TAP	69.000	994	0.84685	0.81209
70317	PDA TAP	69.000	995	0.84685	0.81209
70317	PDA TAP	69.000	1141	0.84524	0.81079
70317	PDA TAP	69.000	1142	0.84524	0.81079
70372	S FWL TP	69.000	1568		0.00776
70390	SKALA	115.00	1404		0.81162
70405	ST.CHAS.	69.000	796	0.83466	0.78796
70405	ST.CHAS.	69.000	799	0.83303	0.79266
70405	ST.CHAS.	69.000	994	0.83412	0.79355
70405	ST.CHAS.	69.000	995	0.83411	0.79355
70405	ST.CHAS.	69.000	1141	0.83249	0.79222
70405	ST.CHAS.	69.000	1142	0.83248	0.79222
70451	VICTOR	69.000	1200	0.82523	
70451	VICTOR	69.000	1228	0.83435	
70451	VICTOR	69.000	1230	0.84406	

The Outage Label definitions for the voltage violations shown above are given below:

CONTINGENCY LEGEND:

X--LABEL---	EVENTS				
796	: OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
	CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70060 [BOONE	115.00]	TO BUS 70062 [BOONE	69.000]	CKT 1
	OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
799	: OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
	CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70062 [BOONE	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
994	: OPEN LINE FROM BUS 70060 [BOONE	115.00]	TO BUS 70062 [BOONE	69.000]	CKT 1
	OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70352 [READER	115.00]	TO BUS 70353 [READER	69.000]	CKT 1
	CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	
	OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
	OPEN LINE FROM BUS 70042 [ASPEN TP	69.000]	TO BUS 70051 [BLENDE	69.000]	CKT 1
995	: OPEN LINE FROM BUS 70060 [BOONE	115.00]	TO BUS 70062 [BOONE	69.000]	CKT 1
	OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70352 [READER	115.00]	TO BUS 70353 [READER	69.000]	CKT 2
	CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	
	OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
	OPEN LINE FROM BUS 70042 [ASPEN TP	69.000]	TO BUS 70051 [BLENDE	69.000]	CKT 1
1141	: OPEN LINE FROM BUS 70062 [BOONE	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
	OPEN LINE FROM BUS 70352 [READER	115.00]	TO BUS 70353 [READER	69.000]	CKT 1
	CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	

		OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
		OPEN LINE FROM BUS 70042 [ASPEN TP	69.000]	TO BUS 70051 [BLENDE	69.000]	CKT 1
1142	:	OPEN LINE FROM BUS 70062 [BOONE	69.000]	TO BUS 70063 [BOONE TP	69.000]	CKT 1
		OPEN LINE FROM BUS 70271 [LS ANMAS	69.000]	TO BUS 70320 [PHLPS TP	69.000]	CKT 1
		OPEN LINE FROM BUS 70352 [READER	115.00]	TO BUS 70353 [READER	69.000]	CKT 2
		CLOSE LINE FROM BUS 70235 [HUERFANO	69.000]	TO BUS 70063 [BOONE TP	69.000]	
		OPEN LINE FROM BUS 70051 [BLENDE	69.000]	TO BUS 70405 [ST.CHAS.	69.000]	CKT 1
1200	:	OPEN LINE FROM BUS 70042 [ASPEN TP	69.000]	TO BUS 70051 [BLENDE	69.000]	CKT 1
		OPEN LINE FROM BUS 70085 [CANONCTY	69.000]	TO BUS 70086 [CANONCTY	115.00]	CKT 1
		OPEN LINE FROM BUS 70293 [NCANON	69.000]	TO BUS 70294 [NCANON W	69.000]	CKT 1
		CLOSE LINE FROM BUS 70160 [E CANON	69.000]	TO BUS 70293 [NCANON	69.000]	CKT 1
		CLOSE LINE FROM BUS 70220 [HIGHLND	69.000]	TO BUS 70370 [S CANON	69.000]	CKT 1
		OPEN LINE FROM BUS 70086 [CANONCTY	115.00]	TO BUS 70390 [SKALA	115.00]	CKT 1
1228	:	OPEN LINE FROM BUS 70085 [CANONCTY	69.000]	TO BUS 70086 [CANONCTY	115.00]	CKT 1
		OPEN LINE FROM BUS 70293 [NCANON	69.000]	TO BUS 70294 [NCANON W	69.000]	CKT 1
		CLOSE LINE FROM BUS 70160 [E CANON	69.000]	TO BUS 70293 [NCANON	69.000]	CKT 1
		CLOSE LINE FROM BUS 70220 [HIGHLND	69.000]	TO BUS 70370 [S CANON	69.000]	CKT 1
		OPEN LINE FROM BUS 70329 [PORTLAND	69.000]	TO BUS 70330 [PORTLAND	115.00]	CKT 1
1230	:	OPEN LINE FROM BUS 70085 [CANONCTY	69.000]	TO BUS 70086 [CANONCTY	115.00]	CKT 1
		OPEN LINE FROM BUS 70293 [NCANON	69.000]	TO BUS 70294 [NCANON W	69.000]	CKT 1
		CLOSE LINE FROM BUS 70160 [E CANON	69.000]	TO BUS 70293 [NCANON	69.000]	CKT 1

## 2.5 CONCLUSION

The Category C study in this report was confined to the WPEC transmission system. There are several planned system improvements discussed above that will mitigate issues that resulted from Category C outages in the 2008 case. There was no evidence of system instability, voltage collapse, or cascading outages as a result of the outages that were studied.