Vail/Eagle Valley Capacitor Bank Sizing Study

October 17, 2022

A. Executive Summary

This study builds upon the previous studies that resulted in the 115kV line rebuilds for Circuits No. 9254 and 9257 and the Avon-Gilman line build projects. Capacitive voltage support for the study area was deemed necessary during these previous studies. In 2015, the Public Utilities Commission of Colorado determined building of the Avon-Gilman line and adding a 45 MVAR capacitor bank at Vail substation was in the ordinary course of business.

This follow-on study was conducted to determine updated requirements for capacitive voltage support in an N-2 condition (loss of 115kV) in the Vail/Eagle Valley out to 2040. The N-2 condition would result in the loss of both 115kV lines from Wolcott to Beaver Creek West and Vail substations. Holy Cross (HCE), a wholesale customer, services the loads from Avon, Beaver Creek West, Vail, and Wolcott substations.

The study found under the N-2 condition (loss of 115 kV) a need for capacitive support of 15 to 25 MVAR for summer peak loads and 65 to 75 MVAR for winter peak loads. Capacitive support under these scenarios restored the study area bus voltages to nominal operating levels (0.95 to 1.05). The N-0 condition, or normal operating condition, did not require capacitive support for any of the study load scenarios.

Transmission Planning recommends a total capacity of 75 MVAR in differing step sizes, having a minimum configuration of 25 MVAR, to be distributed between Beaver Creek West and Vail substations. Capacitor bank location totals and step sizes are detailed below in the Recommendation section. Distributing the total cap bank amount across the study area provides more resiliency in case an event such as a wildfire removed service from one but not both substations.

After sharing initial results with Transmission Operations, a loss of the 230 kV shared corridor to Wolcott substation from both Foidel Creek and Cooley Mesa substations was suggested as a supplemental study. The supplemental study makes the same assumptions as the original study but does not remove any 115 kV lines in the study area and increases the 115 kV service demand by adding the Wolcott load.

An additional 20 – 25 MVAR of capacitive voltage support would be required to support the additional Wolcott load during heavy winter peak scenarios. This brings the total recommended capacitive voltage support to 100 MVAR for the study area. Line overloads did occur with the additional Wolcott load. To address the observed line overloads operational procedures may need to be developed, which are outside the scope of this study.

B. Study Scope

The study was performed to determine the amount of capacitive support necessary to mitigate voltage collapse in the Vail/Eagle Valley resulting from the loss of 115 kV transmission from or at Wolcott Substation and closing of the normally open Avon-Gilman line. Losses include the Wolcott-Beaver Creek West 115kV line (Circuit 8415) and Wolcott-Vail 115kV line (Circuit 8416). The circuits are on separate 115kV structures; however, they are separated by approximately 100 to 200 feet and parallel for 9 miles.

This N-2 condition, "Loss of all Transmission lines on a common Right-of-Way" is considered an Extreme Event [TPL-001-4, Table 1, Extreme Events, 2.b.]. A previous study of the same N-2 condition resulted in the decision to construct the Avon-Gilman 115kV line, uprating of 115 kV Circuits No. 9254 and 9257, and determined a need for capacitive voltage support when the Avon-Gilman line was closed. In 2015 the Public Utility Commission of Colorado found that the Avon-Gilman line and a 45 MVAR cap bank at Vail was found to be in the ordinary course of business through Decision No. C15-0590 and would not require a CPCN.

Continuing and projected economic development and resulting peak loads in the study area indicated a need for an updated study.

This study focused on updating the total MVAR amount, increments, and possible locations of the voltage support required when closing the Avon-Gilman line during an N-2 condition across the loading conditions in the Vail/Eagle Valley.

Beyond the TPL-001-4 requirement, special consideration is being given to this condition for the following reasons:

- Holy Cross (HCE) has expressed concern over the vulnerability and substantial likelihood that such an N-2 condition could occur due to the location and configuration of Circuits No. 8415 and 8416.
- The risk of an Extreme Event and resulting N-2 condition is abnormally high due to the increased probability of wildfire, avalanche, and landslide and severity of the impact.
    - Depending on the severity of the damage, an outage could remain for a prolonged period, which would be exacerbated by the current lead time of critical materials and challenging terrain.
- The Vail Valley is home to two world class ski resorts and is a major tourist destination. A sustained outage would result in significant economic loss for the state economy and attract international media attention depending on the season and time to restoration to the N-0 condition.
- Xcel customers remain in, move to, and visit Colorado to take advantage of the unique experiences this area provides.

C. Study Cases

The following WECC approved planning cases were used for the study:

- 2033 Heavy Winter 1
- 2033 Heavy Summer 1

These were used as the starting cases for the winter and summer peak scenarios, respectively. The study area, Vail/Eagle Valley, is winter peaking.

To determine capacitive support for light load scenarios, the following study cases were created:

- 2033 Light Winter case was developed by reducing conforming study area loads to 60% of winter peak load demands in the study area
- 2033 Light Summer case was developed by reducing conforming study area loads to 60% of summer peak load demands in the study area.

Load forecasts used in the study area were developed internally and provided by Holy Cross (HCE). The 2033 Heavy Winter 1 and Heavy Summer 1 cases were used for generation and loading outside of the study area.

D. Study Assumptions

The following assumptions were used for the study:

- The Avon-Gilman 115kV line is in-service and closed.
- The Leadville–Climax and Climax-Robinson Rack-Gilman (Circuit No. 9257) line uprate is in-service.
- The Leadville-Robinson Rack (Circuit No. 9254) line uprate is in-service.
- PI data or forecasts were extrapolated to 2042 using a WECC approved 1% year-over-year increase except for the industrial loads, 70281 Mayflower IN and 70114 Climax IN, which are static or non-conforming.
- The forecasted load data, provided by HCE, was capacitive for Beaver Creek West, Vail, and Avon. The capacitive attribute of the loads is representative of extensive underground conductor used to supply load demand.
- The study area is winter peaking.
- The N-2 conditions results in a sustained outage for Circuits No. 8415 and 8416 out of Wolcott removing the lines from Wolcott to Beaver Creek West and Vail, respectively.
- Beaver Creek West, Vail, and Avon will experience total loss of service until the new 115 kV Avon-Gilman line is closed, and the capacitor banks are energized.
- An operational procedure for energizing the Avon-Gilman line is outside the scope of this study.
- After a single event resulting in a N-2 condition, restoration of Circuits No. 8415 and 8416 could take weeks to months, and the study area voltage levels will need to remain between 0.95 to 1.05 pu.

- Siting a capacitor bank at Avon is unreasonable due to footprint constraints at and around the facility.

E. Findings

- No line overloads observed in the N-0 and N-2 condition.
- Capacitive support of 15 to 25 MVAR for summer peak and 65 to 75 MVAR for winter peak restored the study area bus voltages to between 0.95 to 1.05 pu for both the 2033 and 2042 case scenarios.
- The light load scenarios, 60% winter and 60% summer, did not require additional capacitive support to maintain voltage levels between 0.97 to 1.03 pu in the study area.
- The total capacitive compensation, total MVAR, can be configured and distributed between Beaver Creek West and Vail without materially reducing the effectiveness of the total capacitive compensation
    - The total amount of MVAR must meet peak demand
    - The minimum amount of MVAR must be available
- The N-2 condition creates a radial line to Beaver Creek West and Vail resulting in a weak system in the N-2 condition. After Avon-Gilman is energized, significant voltage swings (>5%) were observed when switching in large increments of capacitive support.
    - Mitigation of the observed large voltage swings can be addressed by decreasing the step sizes to reach the total MVAR required.

F. Conclusion

Cap banks are not needed for the N-0 condition. Capacitive compensation is required to restore the system to within normal operating voltage limits (0.95 – 1.05 pu) following a single-event double-line contingency (N-2). A sustained outage will exist until the Avon-Gilman line is closed and the capacitive compensation is energized. An unmitigated system without capacitive compensation in heavily loaded scenarios resulted in voltage collapse in the study area when the Avon-Gilman line was closed.

To maintain maximum operational flexibility and reliability during the single-event double-line outage of Circuits No. 8415 and 8416 capacitive compensation of 65 -75 MVAR and 15 – 25 MVAR compensation is required across Beave Creek West and Vail for peak winter and summer loads, respectively.

During a sustained outage, significant daily fluctuations are expected in the hourly load profile for the area. Therefore, an automatic voltage control system is recommended to regulate the voltage swings during the N-2 condition.

Step increments within the study area must be divisible to an extent that compensates for the heavy winter versus heavy summer loading whether at one or multiple locations. Smaller step sizes distributed across the three substations reduce the likelihood of introducing problematic transients into the study area as the capacitive support is energized. Furthermore, if a wildfire creates the N-2 condition and removes service to Vail or Beaver Creek West, cap banks at multiple locations may allow the remaining substation to operate within voltage limits depending on incremental sizing.

An EMTP analysis may be necessary to determine precise cap bank sizing, transient levels, and operating procedures.

G. Recommendations

The alternative sizing and location recommendations are made due to the concern over Sighting and Land Rights limitations at the substations. Smaller increments dispersed across the study area are recommended if reasonable. Automatic voltage controllers (AVSO) to manage switching operations during a sustained outage are recommended.

Preferred Solution (2-substation, expanded):
Total of 75 MVAR installed Cap Bank capacity throughout the Vail Valley in the following configuration:

- 30 MVAR at Beaver Creek West in increments of 5,10, and 15 MVAR
- 30 MVAR at Vail in increments of 5,10, and 15 MVAR
- Additional 15 MVAR step at Beaver Creek West or Vail.

This solution sufficiently supports voltage drop across the Vail Valley. Reduced step size allows for expanded operational flexibility and decreased rapid voltage swings due to the smaller step sizes

Alternative 1 (2-Substation, consolidated):
A combined total of 75 MVAR at Beaver Creek West and Vail with multiple steps at one or both locations. Examples:

- 50 MVAR at Beaver Creek West in increments of 5, 10, 15, and 20 MVAR
- 35 MVAR at Vail in increments of 10 and 25 MVAR

OR

- 50 MVAR at Beaver Creek West in increments of 20 and 30
- 25 MVAR single step at Vail

This alternative maintains operational flexibility and voltages in the study area, while reducing the potential for large voltage swings when energizing the Cap Banks.

Alternative 2 (2-Substation, Single Step):
25 and 50 MVAR single-step cap banks at Beaver Creek West and Vail, the location of either does not materially affect the compensation effectiveness.

This alternative address both the minimum and maximum sizing needed to support voltages in the area; however, this alternative limits operational flexibility. Energizing cap banks of this amount will likely produce large voltage swings and transients.

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H. Supplemental Study

After analyzing the results for the initial N-2 condition, Transmission Operations suggested Transmission Planning evaluate the capability of the original 75 MVAR recommended capacitive voltage support if the 230 kV corridor to Wolcott was lost. The supplemental study removes 230 kV service to Wolcott and serves the Wolcott load via an intact 115 kV corridor from Robinson Rack to Wolcott substations.

The addition of the Wolcott load extends the radial 115 kV corridor from Robinson Rack to Wolcott by approximately 11 miles. Loss of both 230 kV circuits from Wolcott substation while paralleling or after they diverge is reasonable due to wildfire risk.

Study Cases: same as above.

Study Assumptions:

- Total loss of 230kV service to Wolcott
    - Loss of the 230kV Cooley Mesa - Wolcott (Circuit No. 5785)
    - Loss of the 230kV Wolcott – Foidel Creek (Circuit No. 5813)
- 115kV service to Wolcott is intact
    - Wolcott – Beaver Creek West (Circuit No. 8415) is intact
    - Wolcott – Vail (Circuit No. 8416) is intact
- The Avon-Gilman 115kV line is in-service and closed.
- The Leadville–Climax and Climax-Robinson Rack-Gilman (Circuit No. 9257) line uprate is in-service.
- The Leadville-Robinson Rack (Circuit No. 9254) line uprate is in-service.
- PI data or forecasts were further extrapolated to 2042 using a WECC approved 1% year-over-year increase except for the industrial loads 70281 Mayflower IN and 70114 Climax IN, which are static or non-conforming.
- The forecasted load data provided by HCE was capacitive for Beaver Creek West, Vail, Avon, and Wolcott. The capacitive attribute of the loads is representative of extensive underground conductor used to supply load demand.
- The 2033 Heavy Summer 1 and 2033 Heavy Winter 1 load values were used for Wolcott
- The study area is winter peaking.
- Beaver Creek West, Vail, Avon, and Wolcott will experience total loss of service until the 115 kV Avon-Gilman line is closed, and the capacitor banks are energized.

- An operational procedure for energizing the Avon-Gilman line is outside the scope of this study.
- After a single event resulting in a N-2 condition, restoration of Circuits No. 5785 and 5813 could take weeks to months, and the study area voltage levels will need to remain between 0.95 to 1.05 pu.
- Siting a capacitor bank at Avon is unreasonable due to footprint constraints at and around the facility.
- A capacitor bank was not placed at Wolcott
    - Access to the cap bank would be lost during the 115kV N-2 condition
    - Wolcott already operates at a higher normal operating voltage in the N-0 condition
    - The two 20 MVAR (40 total) reactor on the 230kV Wolcott bus is off

Findings:

- Line overloads were observed in the N-2 condition during heavy winter loading.
    - 110 - 113% Robinson Rack-Gilman 115kV line (Circuit No. 9257)
    - 108 - 112% Avon-Gilman 115kV line
    - 91 - 100% Climax-Mayflower 115kV line (Circuit No. 8174)
- Capacitive support of 20 to 30 MVAR for summer peak and 85 to 95 MVAR for winter peak restored the study area bus voltages to between 0.95 to 1.05 pu for both the 2033 and 2042 case scenarios depending on the forecasted data set.
- Capacitive support of 75 MVAR raised all bus voltages above 0.9 for all Heavy Winter forecast scenarios
- The light load scenarios, 60% winter and 60% summer, required additional capacitive support of 5 to 15 MVAR and 45 to 55 MVAR, respectively, to maintain voltage levels between 0.95 to 1.05 pu in the study area.
- The total capacitive compensation, total MVAR, can be configured and distributed between Beaver Creek West and Vail without materially reducing the effectiveness of the total capacitive compensation
    - The total amount of MVAR must meet peak demand
    - The minimum amount of MVAR must be available
- The N-2 230kV condition places Wolcott, Vail, and Beaver Creek West on a ring at the end of a radial line from Robinson Rack to Avon resulting in a weak system in the N-2 condition. After Gilma-Avon is energized, significant voltage swings (>5%) are observed when switching in large increments of capacitive support during peak loading.

Recommendations:

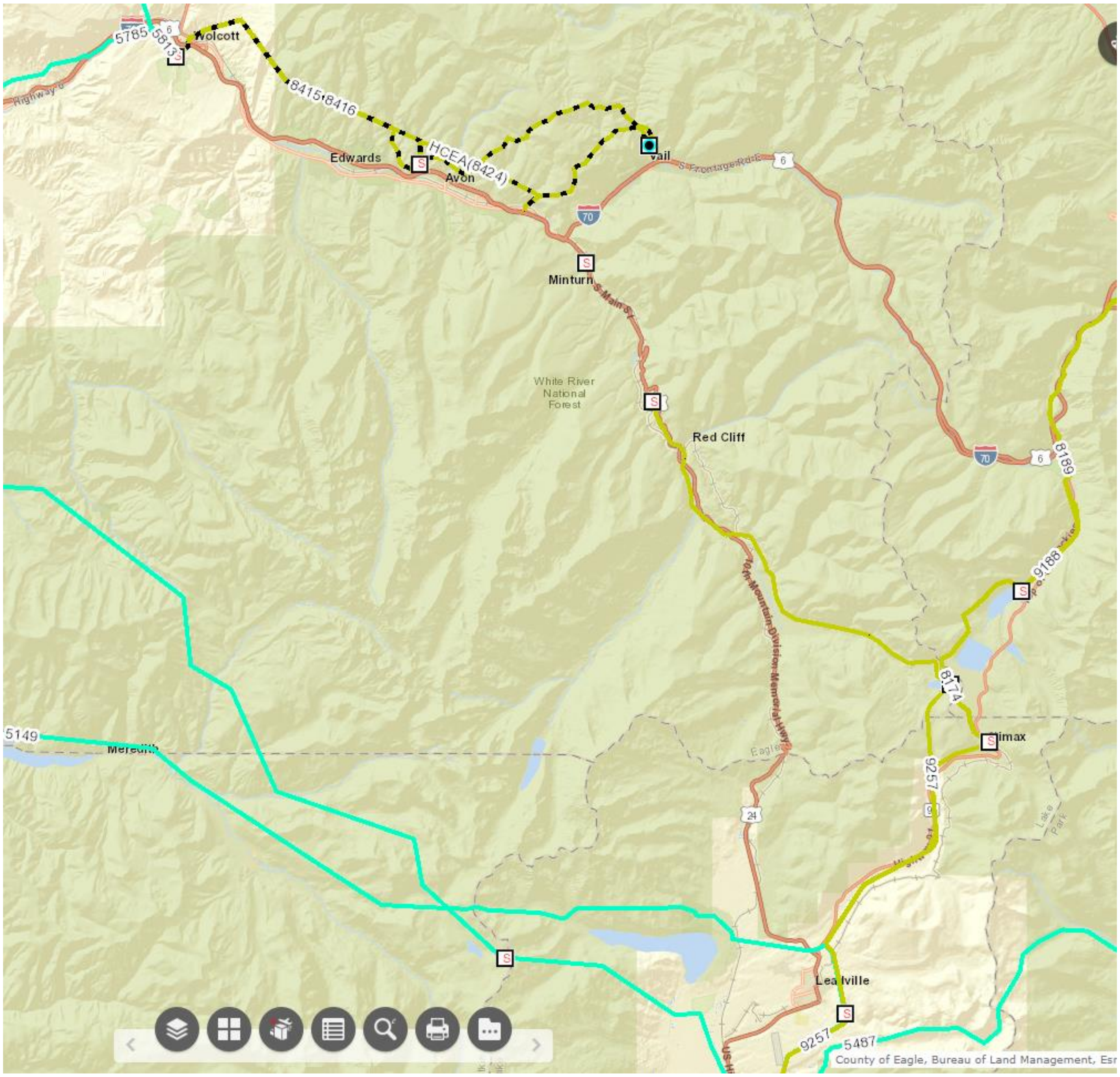
An additional 20 to 25 MVAR of capacitive voltage support distributed proportionately across the previously recommended 115 kV N-2 solutions would likely provide sufficient voltage support for the additional Wolcott load during the Heavy Winter scenarios. Depending on the system conditions during an N-2 event, operational procedures may need to be developed to address the observed line overloads. This additional 25 MVAR compensation for the additional

Wolcott load results in 100 MVAR to restore the study area bus voltages to between 0.95 and 1.05 pu and provides for further economic development beyond the WECC approved assumption of 1% year-over-year for the study area.

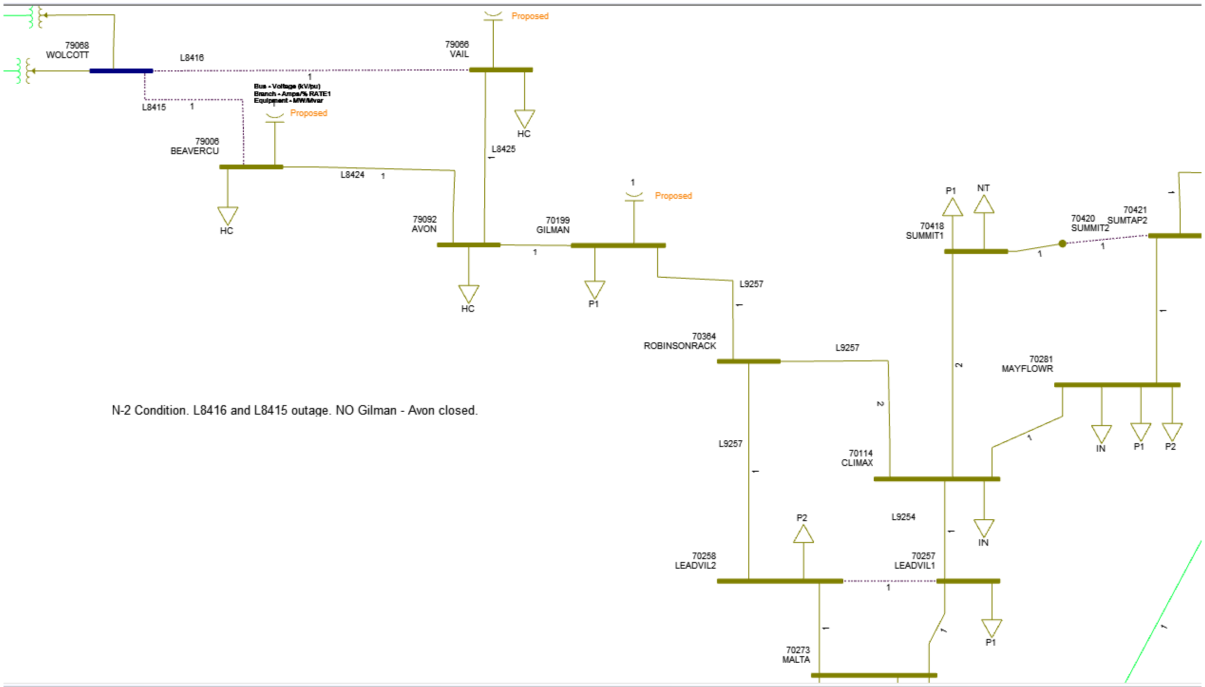
Please reference the map, diagrams, and photos of the study area and substations below. Additionally, cumulative and substation specific load totals are available at the end of the document for each forecast scenario.

I. Appendix

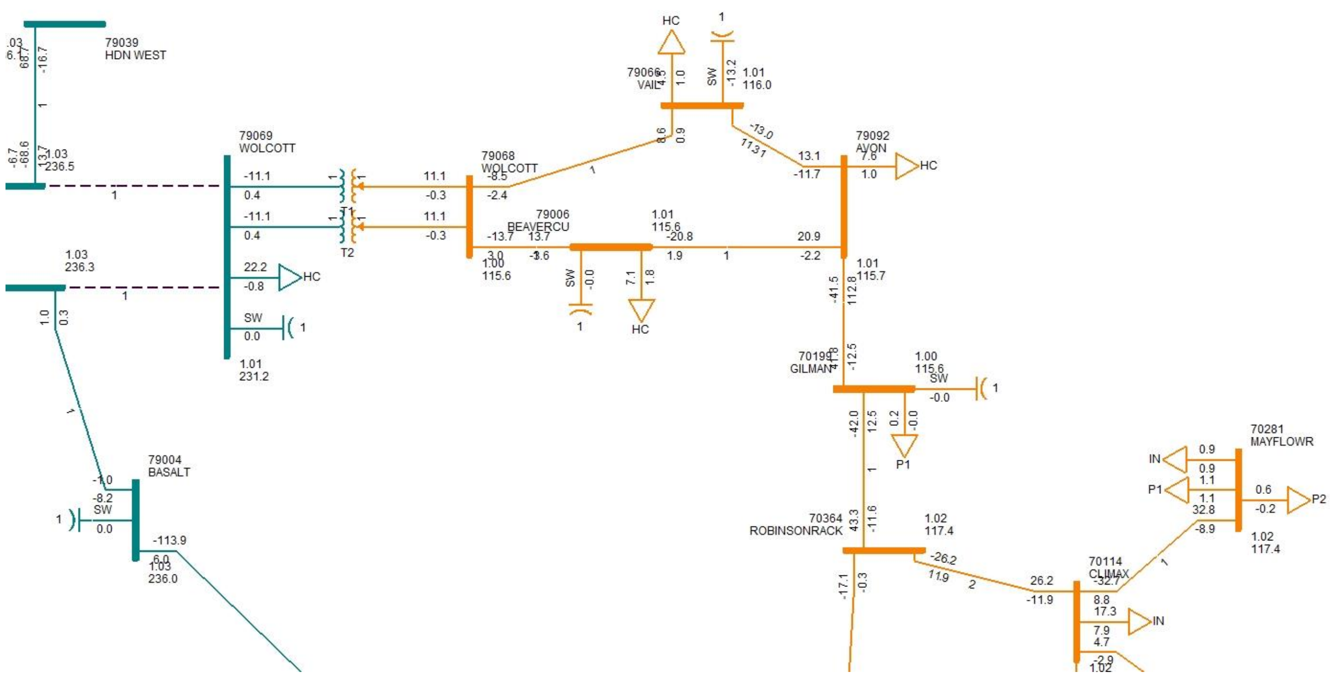
Study Area:



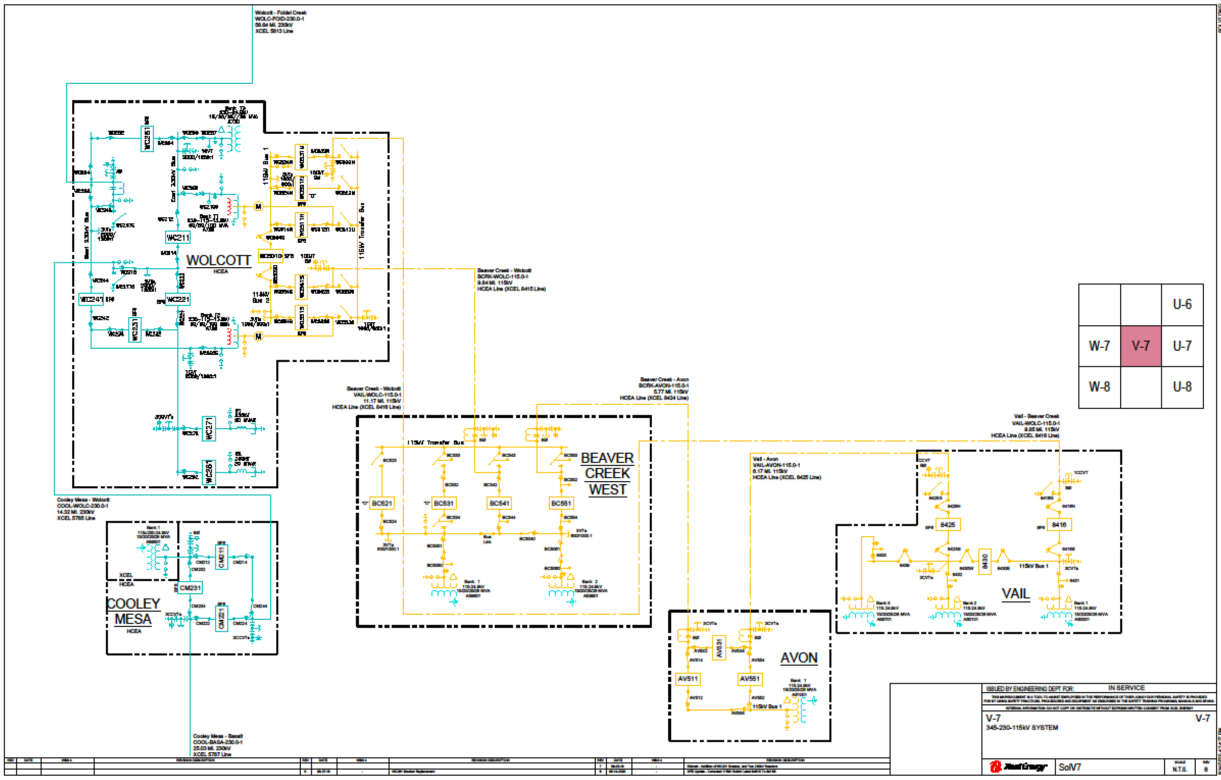
115kV N-2 Slider Diagram



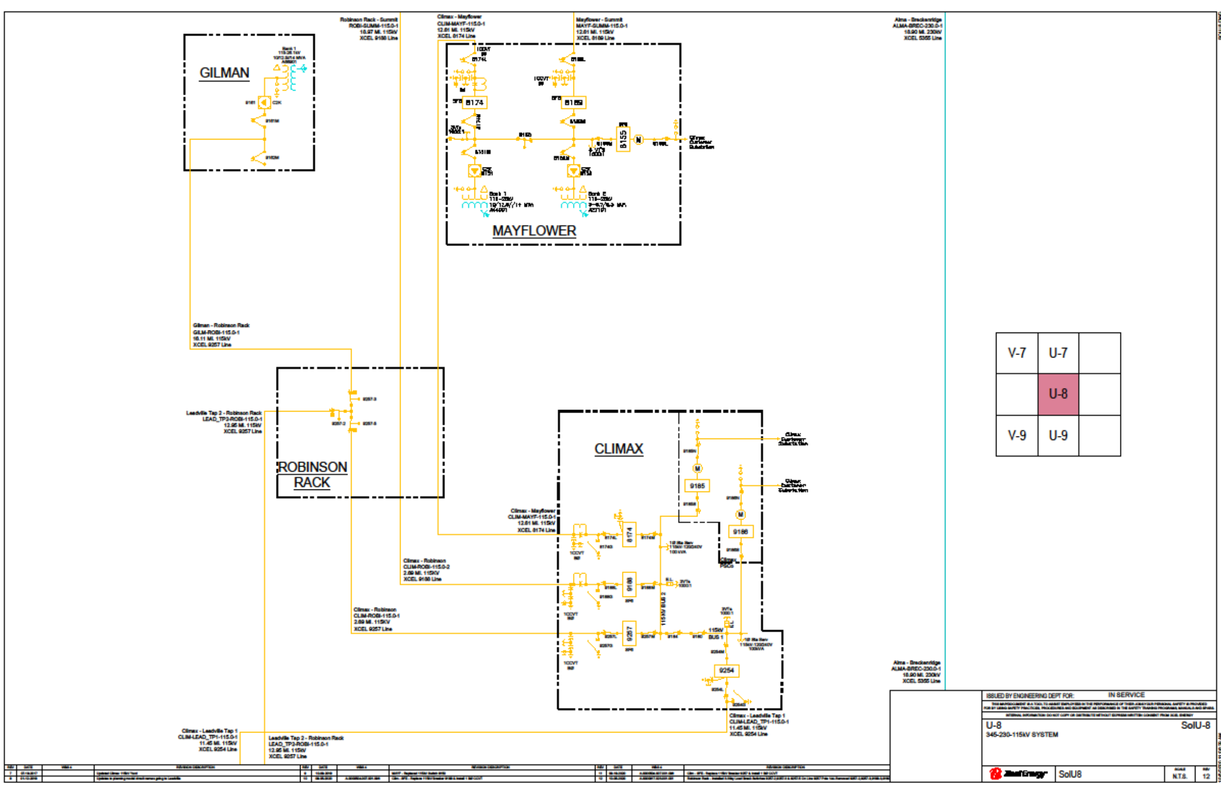
230kV Wolcott N-2 Slider Diagram



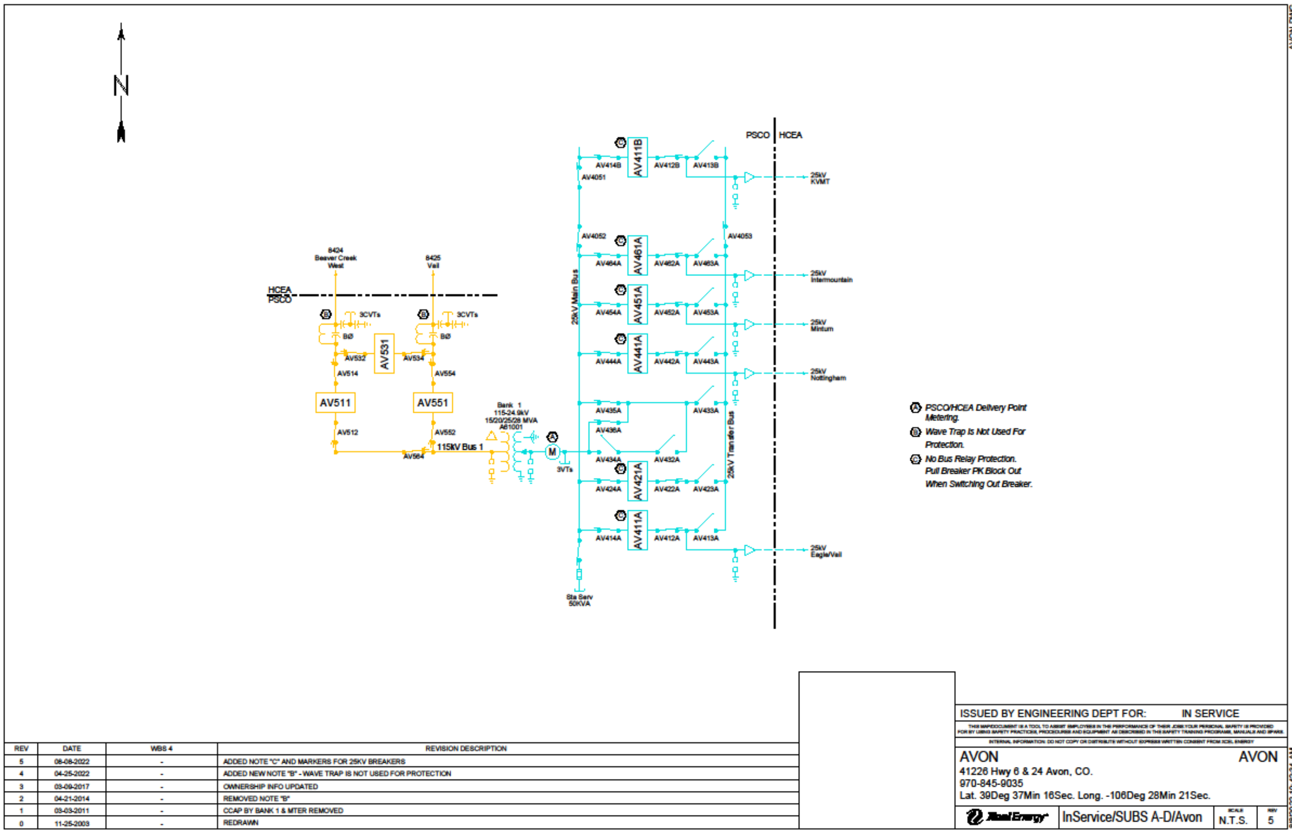
V7 One-Line

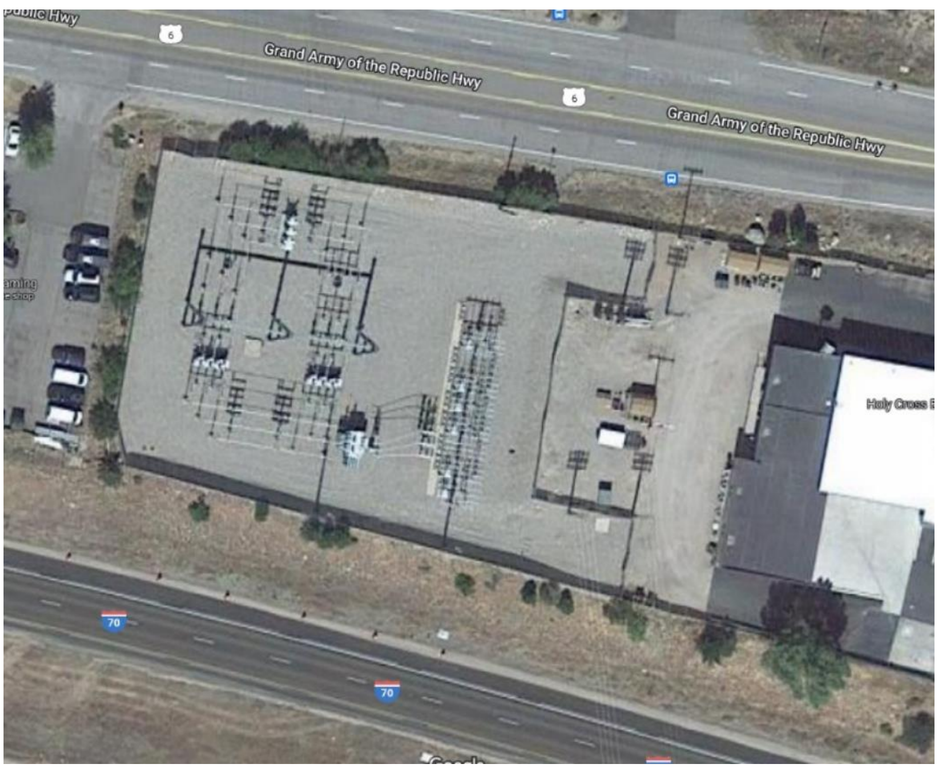


U8 One-Line

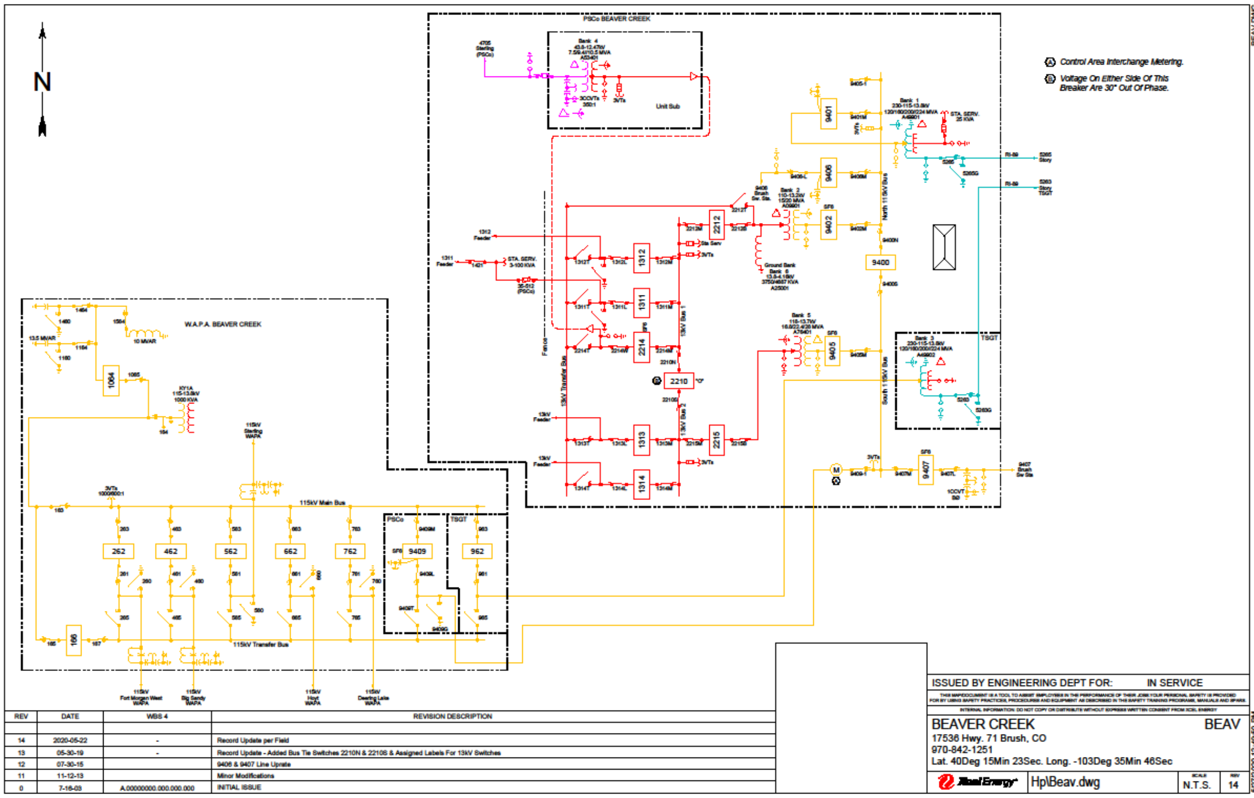


Avon:

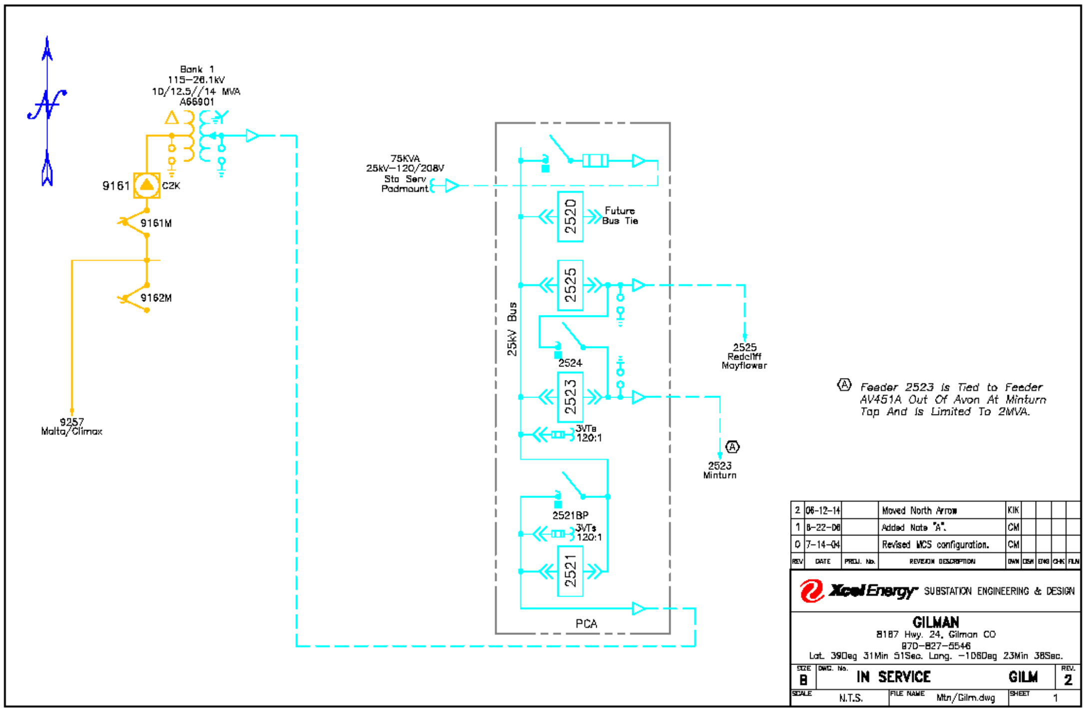

N
PSCO
HCEA
HCEA
PSCO
8424 Beaver Creek West
8425 Vail
AV531
AV511
AV551
115kV Bus 1
Bank 1
25kV Main Bus
25kV Transfer Bus
AV411B
AV461A
AV451A
AV441A
AV421A
AV411A
25kV KVMT
25kV Intermountain
25kV Minturn
25kV Nottingham
25kV Eagle/Vail
Sta Serv 50KVA
PSCO/HCEA Delivery Point Metering.
Wave Trap Is Not Used For Protection.
No Bus Relay Protection. Pull Breaker PK Block Out When Switching Out Breaker.
AVON.DWG
ISSUED BY ENGINEERING DEPT FOR: IN SERVICE
REV DATE WBS 4 REVISION DESCRIPTION
5 08-08-2022 - ADDED NOTE "C" AND MARKERS FOR 25KV BREAKERS
4 04-25-2022 - ADDED NEW NOTE "B" - WAVE TRAP IS NOT USED FOR PROTECTION
3 03-09-2017 - OWNERSHIP INFO UPDATED
2 04-21-2014 - REMOVED NOTE "B"
1 03-03-2011 - CCAP BY BANK 1 & MTER REMOVED
0 11-25-2003 - REDRAWN
AVON
AVON
41226 Hwy 6 & 24 Avon, CO.
970-845-9035
Lat. 39Deg 37Min 16Sec. Long. -106Deg 28Min 21Sec.
Xcel Energy
InService/SUBS A-D/Avon
N.T.S.
5
8/8/2022 10:42:34 AM

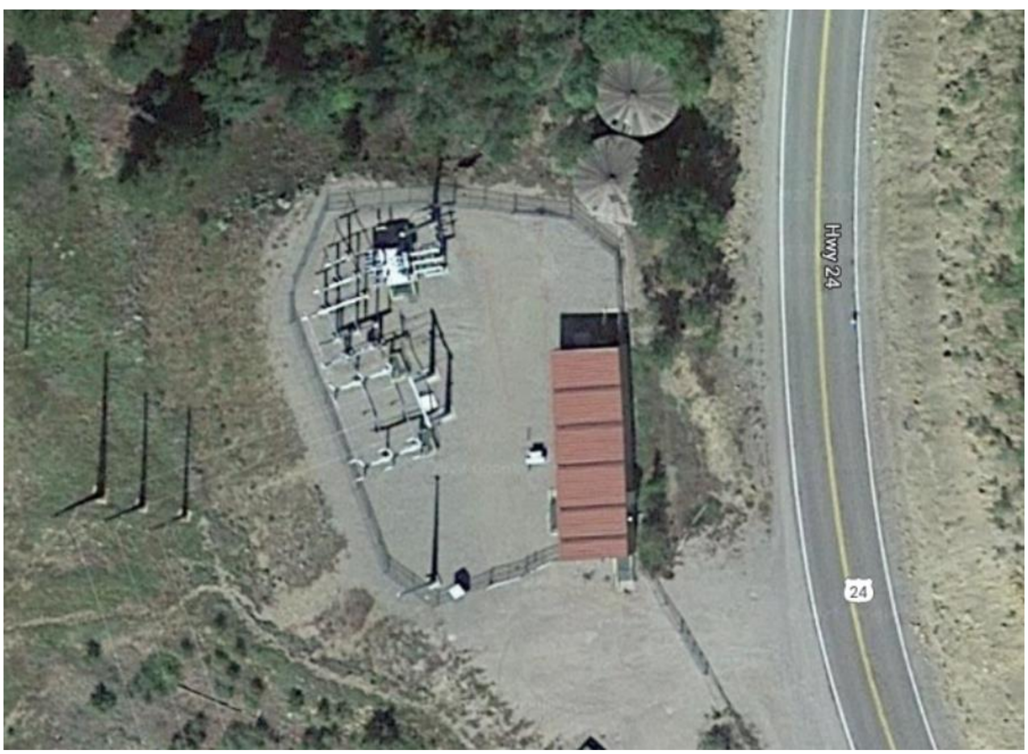

Grand Army of the Republic Hwy
Grand Army of the Republic Hwy
6
6
70
70

Beaver Creek West:

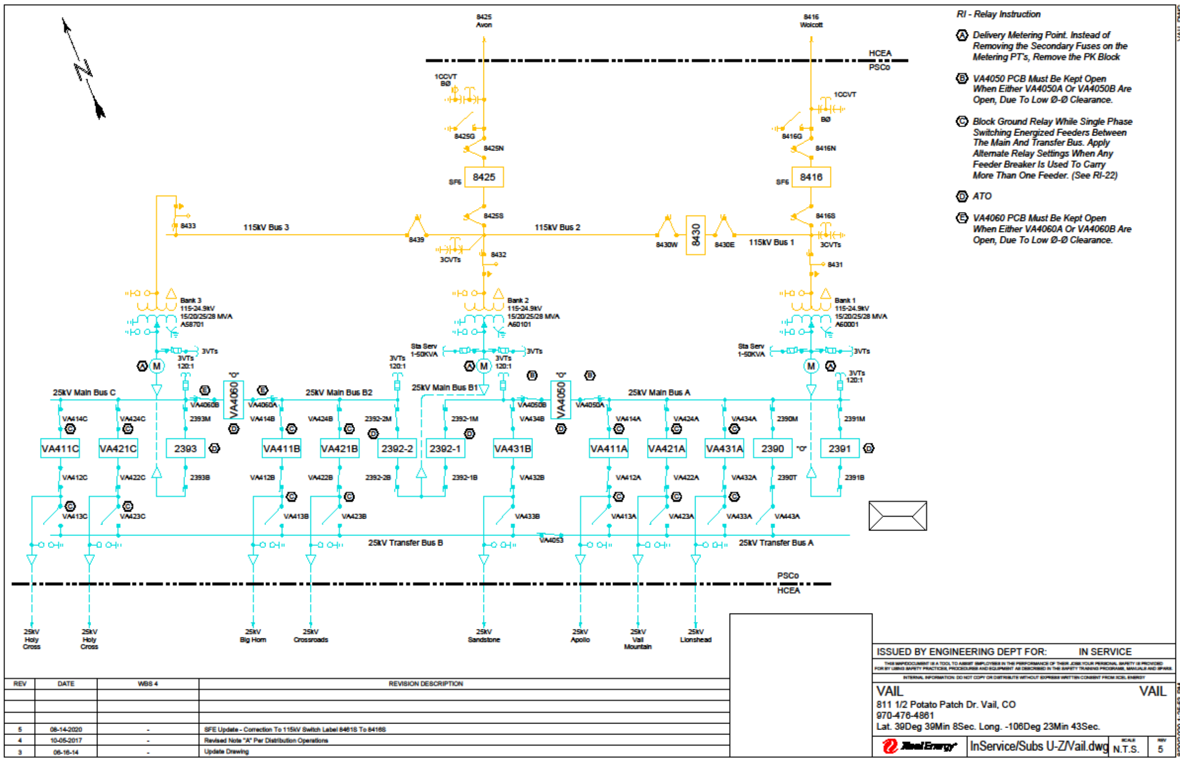


Gilman:


Bank 1
115–26.1kV
10/12.5//14 MVA
A66901
9161
C2K
9161M
9162M
9257
Malta/Climax
75KVA
25kV–120/208V
Sta Serv
Padmount
2520
Future
Bus Tie
2525
25kV Bus
2524
2523
3VTs
120:1
2521BP
3VTs
120:1
2521
PCA
2525
Redcliff
Mayflower
A
2523
Minturn
A Feeder 2523 Is Tied to Feeder AV451A Out Of Avon At Minturn Tap And Is Limited To 2MVA.
2 06-12-14 Moved North Arrow KIK
1 8-22-08 Added Note "A". CM
0 7-14-04 Revised MCS configuration. CM
REV DATE PROJ. No. REVISION DESCRIPTION DWN DSN ENG CHK FLN
Xcel Energy SUBSTATION ENGINEERING & DESIGN
GILMAN
8187 Hwy. 24, Gilman CO
970-827-5546
Lat. 39Deg 31Min 51Sec. Long. -106Deg 23Min 38Sec.
SIZE B
DWG. No. IN SERVICE GILM
REV. 2
SCALE N.T.S.
FILE NAME Mtn/Gilm.dwg
SHEET 1

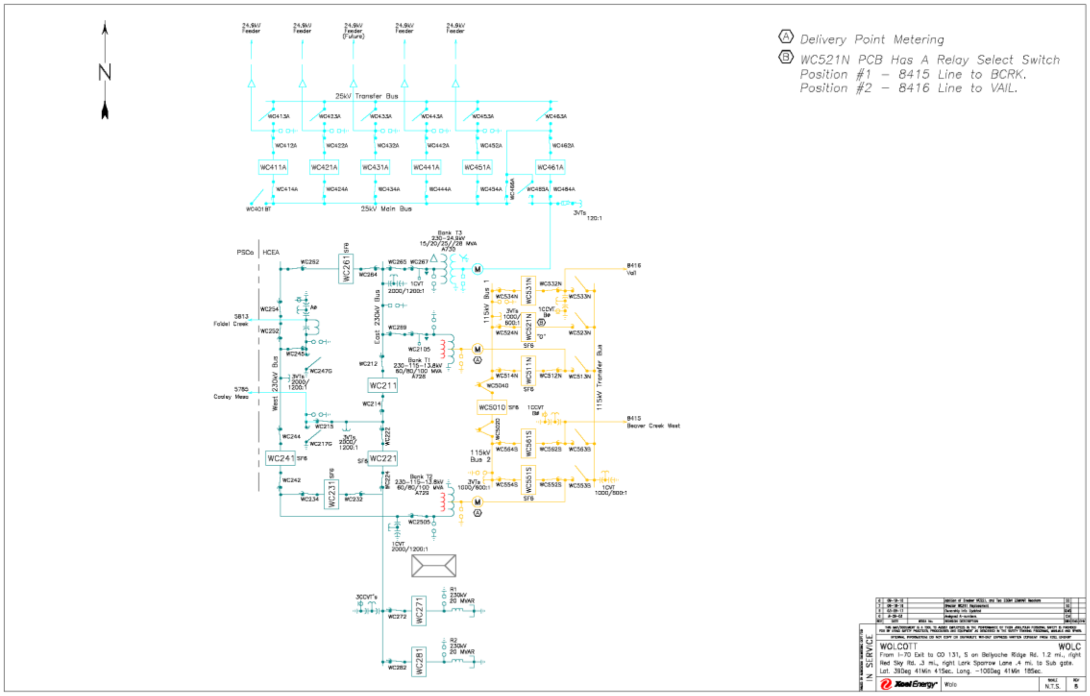

Hwy 24
24

Vail:



8425
Avon
8416
Wolcott
HCEA
PSCo
115kV Bus 3
115kV Bus 2
115kV Bus 1
8425
8416
8430
Bank 3
115-24.9kV
15/20/25/28 MVA
Bank 2
115-24.9kV
15/20/25/28 MVA
A60101
Bank 1
115-24.9kV
15/20/25/28 MVA
A60001
25kV Main Bus C
25kV Main Bus B2
25kV Main Bus B1
25kV Main Bus A
VA4060
VA4050
VA411C
VA421C
2393
VA411B
VA421B
2392-2
2392-1
VA431B
VA411A
VA421A
VA431A
2390
2391
25kV Transfer Bus B
25kV Transfer Bus A
25kV Holy Cross
25kV Big Horn
25kV Crossroads
25kV Sandstone
25kV Apollo
25kV Vail Mountain
25kV Lionshead
RI - Relay Instruction
A Delivery Metering Point. Instead of Removing the Secondary Fuses on the Metering PT's, Remove the PK Block
B VA4050 PCB Must Be Kept Open When Either VA4050A Or VA4050B Are Open, Due To Low Ø-Ø Clearance.
C Block Ground Relay While Single Phase Switching Energized Feeders Between The Main And Transfer Bus. Apply Alternate Relay Settings When Any Feeder Breaker Is Used To Carry More Than One Feeder. (See RI-22)
D ATO
E VA4060 PCB Must Be Kept Open When Either VA4060A Or VA4060B Are Open, Due To Low Ø-Ø Clearance.
VAILDWG
REV
DATE
WBS 4
REVISION DESCRIPTION
5
08-14-2020
SFE Update - Correction To 115kV Switch Label 8461S To 8416S
4
10-05-2017
Revised Note "A" Per Distribution Operations
3
06-16-14
Update Drawing
ISSUED BY ENGINEERING DEPT FOR: IN SERVICE
VAIL
VAIL
811 1/2 Potato Patch Dr. Vail, CO
970-476-4861
Lat. 39Deg 39Min 8Sec. Long. -106Deg 23Min 43Sec.
Xcel Energy
InService/Subs U-Z/Vail.dwg
N.T.S.
5
8/20/2020 1:25:53 PM

Wolcott:


N
Delivery Point Metering
WC521N PCB Has A Relay Select Switch
Position #1 – 8415 Line to BCRK.
Position #2 – 8416 Line to VAIL.
25kV Transfer Bus
25kV Main Bus
WOLCOTT
WOLC


Sporting Clay Rd
Sporting Clay Rd
Sporting Clay Rd
Sporting Clay Rd

Forecasted Load Totals

To determine the appropriate total and incremental step sizes required within the study area multiple load forecasts were used to attempt to decrease forecasting error. Loads within the study area were extrapolated to 2042 from PI data, base case values, and PSCo load forecasts for PSCo owned substations. HCE provided load forecasts were used for Beaver Creek West, Avon, and Vail substations. Base case 2033 (33HW1 and 33HS1) winter and summer peaking values were used for generation and loads at substations outside of the study area and were not forecasted beyond 2033. The substations and their load values are stated in the load specific tables 2 through 5 below.

Table 1

	Scenario Total Load			
	Ideal Range (MVAR)		P (MW)	Q (MVAR)
33HS1 - w/o line upgrades	5	15	173.49	3.27
33HS1 - w/ line upgrades	5	15	173.49	3.27
33HS1 - 2042 PI Data	15	25	128.94	26.70
33HS1 - 2042 PI Data w/ HCE Forecast	15	25	161.29	6.49
33HS1 - 2042 Load Forecast	5	15	189.57	7.67
33HS1 - 60% 2042 PI Data	0	0	77.36	16.02
33HS1 - 60% 2042 PI Data w/ HCE Forecast	0	0	96.77	3.89
33HS1 - 60% 2042 Load Forecast	0	0	113.80	3.42
33HW1 - w/o line upgrades	55	65	233.61	11.78
33HW1 - w/ line upgrades	55	65	233.61	11.78
33HW1 - 2042 PI Data	25	35	256.80	7.34
33HW1 - 2042 PI Data w/ HCE Forecast	60	70	324.29	-12.78
33HW1 - 2042 Load Forecast from 33HW1	65	75	250.78	11.35
33HW1 - 60% 2042 PI Data	0	10	154.32	4.46
33HW1 - 60% 2042 PI Data w/ HCE Forecas	0	0	194.57	-7.67
33HW1 - 60% 2042 Load Forecast from 33H	20	30	150.47	6.81

Table 2

				Base Case Loads			
				33HW1		33HS1	
Bus No.	Bus Name	kV	ID	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)
79006	BEAVERCI	115	HC	43.08	4.53	22.24	-6.30
79092	AVON	115	HC	22.13	-1.27	11.26	-1.56
79066	VAIL	115	HC	42.18	-5.91	21.42	-10.26
70199	GILMAN	115	P1	1.44	0.21	1.47	0.42
70281	MAYFLOW	115	P1	6.74	-2.30	6.89	-4.36
70281	MAYFLOW	115	P2	1.38	-0.16	1.41	-0.13
70281	MAYFLOW	115	IN	21.34	3.14	12.12	3.14
70114	CLIMAX	115	IN	29.06	13.28	29.06	13.28
70257	LEADVIL1	115	P1	1.48	-0.36	1.51	-0.86
70258	LEADVIL2	115	P2	3.13	-0.65	3.20	3.36
70418	SUMMIT1	115	P1	9.11	1.32	9.29	1.34
70155	DILLON	115	P1	5.87	0.20	5.99	1.14
70156	DILLON	230	P3	9.79	0.90	10.00	6.94
70156	DILLON	230	P4	0.67	0.45	0.68	0.25
70064	BRECKRD(	230	P1	6.93	-0.03	7.07	-1.03
70064	BRECKRD(	230	P2	8.23	1.81	8.40	0.36
70064	BRECKRD(	230	P3	8.37	0.19	8.54	-0.85
70057	PTARMGN	230	P1	8.56	-3.49	8.73	-2.27
70032	ALMA	230	P1	4.14	-0.09	4.22	0.68
			HCE	107.39	-2.64	54.91	-18.12
			PSCo	126.22	14.43	118.58	21.39
			Total	233.61	11.78	173.49	3.27

Table 3

				2042 Load Forecast from PI Data							
				Winter		60% Winter		Summer		60% Summer	
Bus No.	Bus Name	kV	ID	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)
79006	BEAVERCI	115	HC	19.61	2.84	11.77	1.71	11.87	2.92	7.12	1.75
79092	AVON	115	HC	22.17	1.79	13.30	1.08	12.66	1.69	7.60	1.02
79066	VAIL	115	HC	12.87	1.51	7.72	0.90	7.46	1.63	4.48	0.98
70199	GILMAN	115	P1	0.61	-0.05	0.37	-0.03	0.35	-0.07	0.21	-0.04
70281	MAYFLOW	115	P1	14.19	-3.55	8.51	-2.13	1.76	1.76	1.06	1.06
70281	MAYFLOW	115	P2	1.80	-0.36	1.08	-0.22	0.95	-0.36	0.57	-0.22
70281	MAYFLOW	115	IN	11.40	-2.85	6.91	-1.73	1.43	1.43	0.86	0.86
70114	CLIMAX	115	IN	28.77	13.15	17.43	7.97	28.77	13.15	17.26	7.89
70257	LEADVIL1	115	P1	3.64	-0.47	2.19	-0.28	2.01	-0.38	1.20	-0.23
70258	LEADVIL2	115	P2	7.55	2.13	4.53	1.28	4.57	2.39	2.74	1.43
70418	SUMMIT1	115	P1	20.09	-2.44	12.05	-1.46	10.95	-2.16	6.57	-1.30
70155	DILLON	115	P1	6.40	-0.31	3.84	-0.19	4.96	-0.59	2.98	-0.35
70156	DILLON	230	P3	27.74	1.98	16.64	1.19	4.80	-2.63	2.88	-1.58
70156	DILLON	230	P4	1.21	-0.79	0.73	-0.48	1.25	-0.81	0.75	-0.48
70064	BRECKRD(	230	P1	12.72	0.73	7.63	0.44	5.13	1.02	3.08	0.61
70064	BRECKRD(	230	P2	12.41	-2.03	7.45	-1.22	3.39	-0.32	2.03	-0.19
70064	BRECKRD(	230	P3	26.76	0.58	16.06	0.35	13.26	2.40	7.96	1.44
70057	PTARMGN	230	P1	17.55	-5.05	10.53	-3.03	9.00	4.87	5.40	2.92
70032	ALMA	230	P1	9.30	0.52	5.58	0.31	4.40	0.76	2.64	0.46
			HCE	54.66	6.14	32.79	3.69	31.99	6.24	19.20	3.74
			PSCo	202.15	1.19	121.53	0.78	96.95	20.46	58.17	12.28
			Total	256.80	7.34	154.32	4.46	128.94	26.70	77.36	16.02

Table 4

				2042 Load Forecast from PI data with HCE Forecast							
				Winter		60% Winter		Summer		60% Summer	
Bus No.	Bus Name	kV	ID	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)
79006	BEAVERCL	115	HC	48.99	-3.88	29.39	-2.33	26.15	-3.88	15.69	-2.33
79092	AVON	115	HC	25.31	-3.26	15.19	-1.96	13.21	-3.26	7.93	-1.96
79066	VAIL	115	HC	47.84	-6.83	28.70	-4.10	24.98	-6.83	14.99	-4.10
70199	GILMAN	115	P1	-0.61	-0.05	-0.37	-0.03	-0.35	-0.07	-0.21	-0.04
70281	MAYFLOW	115	P1	-14.19	-3.55	-8.51	-2.13	-1.76	1.76	-1.06	1.06
70281	MAYFLOW	115	P2	-1.80	-0.36	-1.08	-0.22	-0.95	-0.36	-0.57	-0.22
70281	MAYFLOW	115	IN	-11.40	-2.85	-6.84	-1.71	-1.43	1.43	-0.86	0.86
70114	CLIMAX	115	IN	-28.77	13.15	-17.26	7.89	-28.77	13.15	-17.26	7.89
70257	LEADVIL1	115	P1	-3.64	-0.47	-2.19	-0.28	-2.01	-0.38	-1.20	-0.23
70258	LEADVIL2	115	P2	-7.55	2.13	-4.53	1.28	-4.57	2.39	-2.74	1.43
70418	SUMMIT1	115	P1	-20.09	-2.44	-12.05	-1.46	-10.95	-2.16	-6.57	-1.30
70155	DILLON	115	P1	-6.40	-0.31	-3.84	-0.19	-4.96	-0.59	-2.98	-0.35
70156	DILLON	230	P3	-27.74	1.98	-16.64	1.19	-4.80	-2.63	-2.88	-1.58
70156	DILLON	230	P4	-1.21	-0.79	-0.73	-0.48	-1.25	-0.81	-0.75	-0.48
70064	BRECKRDG	230	P1	-12.72	0.73	-7.63	0.44	-5.13	1.02	-3.08	0.61
70064	BRECKRDG	230	P2	-12.41	-2.03	-7.45	-1.22	-3.39	-0.32	-2.03	-0.19
70064	BRECKRDG	230	P3	-26.76	0.58	-16.06	0.35	-13.26	2.40	-7.96	1.44
70057	PTARMGN	230	P1	-17.55	-5.05	-10.53	-3.03	-9.00	4.87	-5.40	2.92
70032	ALMA	230	P1	-9.30	0.52	-5.58	0.31	-4.40	0.76	-2.64	0.46
			HCE	122.14	-13.98	73.28	-8.39	64.34	-13.98	38.60	-8.39
			PSCo	202.15	1.19	121.29	0.72	96.95	20.46	58.17	12.28
			Total	324.29	-12.78	194.57	-7.67	161.29	6.49	96.77	3.89

Table 5

				2042 Forecast from 33HW1				2042 Forecast from Load Tool			
				Winter		60% Winter		Summer		60% Summer	
Bus No.	Bus Name	kV	ID	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)	P (MW)	Q (MVAR)
79006	BEAVERCL	115	HC	47.11	4.95	28.27	2.97	26.15	-3.88	15.69	-2.33
79092	AVON	115	HC	24.20	-1.38	14.52	-0.83	13.21	-3.26	7.93	-1.96
79066	VAIL	115	HC	46.13	-6.46	27.68	-3.88	24.98	-6.83	14.99	-4.10
70199	GILMAN	115	P1	1.58	0.23	0.95	0.14	1.61	0.46	0.97	0.26
70281	MAYFLOW	115	P1	7.37	-2.52	4.42	-1.51	7.53	-4.78	4.51	-3.04
70281	MAYFLOW	115	P2	1.51	-0.17	0.90	-0.10	1.54	-0.14	0.92	-0.09
70281	MAYFLOW	115	IN	21.34	3.14	12.80	1.88	12.00	3.11	7.20	1.86
70114	CLIMAX	115	IN	29.06	13.28	17.43	7.97	28.77	13.15	17.26	7.89
70257	LEADVIL1	115	P1	1.61	-0.39	0.97	-0.23	1.65	-0.94	0.99	-0.57
70258	LEADVIL2	115	P2	3.43	-0.71	2.06	-0.42	3.50	3.67	2.10	2.16
70418	SUMMIT1	115	P1	9.96	1.44	5.98	0.87	10.16	1.46	6.09	0.71
70155	DILLON	115	P1	6.42	0.22	3.85	0.13	6.55	1.24	3.93	0.68
70156	DILLON	230	P3	10.70	0.99	6.42	0.59	10.93	7.58	6.55	4.29
70156	DILLON	230	P4	0.73	0.49	0.44	0.30	0.75	0.27	0.45	0.16
70064	BRECKRDG	230	P1	7.58	-0.03	4.55	-0.02	7.74	-1.13	4.64	-0.76
70064	BRECKRDG	230	P2	9.00	1.97	5.40	1.18	9.19	0.39	5.51	0.14
70064	BRECKRDG	230	P3	9.15	0.21	5.49	0.12	9.15	-0.94	5.60	-0.70
70057	PTARMGN	230	P1	9.36	-3.81	5.62	-2.29	9.55	-2.49	5.73	-1.62
70032	ALMA	230	P1	4.53	-0.10	2.72	-0.06	4.62	0.74	2.77	0.43
			HCE	117.45	-2.89	70.47	-1.74	64.34	-13.98	38.60	-8.39
			PSCo	133.33	14.24	80.00	8.54	125.23	21.65	75.20	11.81
			Total	250.78	11.35	150.47	6.81	189.57	7.67	113.80	3.42