

# Falcon-Midway 115 kV Line Uprate Project Report



**TRI-STATE G&T**

A Touchstone Energy® Cooperative



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## **Background**

The function of this project is to uprate the 26.7 miles of Tri-State's 115 kV line between Midway and Falcon substations from 50° C to 75° C construction. The existing line was constructed in 1974 with 477 ACSR conductor at a spacing that only allows for operation at a maximum of 50° C. Consequently, portions of this line are only rated for a static thermal rating of 95 MVA, which is limited only by the conductor capacity at 50° C construction spacing. Raising, moving, or rebuilding the structures along this line to achieve a 75° C operational rating will raise the overall line rating to 140 MVA, and will provide for an additional 45 MVA of capacity for Tri-State to serve Mountain View Electric Association's (MVEA) customer load.

## **Objective**

According to recent transmission studies, Tri-State's 115 kV Falcon-Midway line was predicted to overload as early as the summer of 2018 for a single contingency line outage of Tri-State's 115 kV Falcon-Fuller line. The magnitude and onset of this overload condition can partially be offset and delayed by a combination of additional var support from capacitor banks installed along the line, or reduced future load forecasts. However, even with those measures, at some point within the next 10 years, this line will have to be either uprated (as proposed by this project), or rebuilt with larger conductor or additional circuits to achieve the greater capacity required for Tri-State to reliably serve MVEA's customer load.

## **Heavy Winter 2008 – Severe Weather**

The 2008 Heavy Winter (HW) – Severe Weather base case was developed from the WECC 2008 HW model. Regional loading was adjusted to more closely match the peak loading of Mountain View's system. Mountain View's 69 kV system was added to the model and loads were defined for each of the substations in Mountain View's system. Loading levels were adjusted according to the Member Coincident Peak (MCP) values in the load forecast developed in greater detail for this region for the purpose of this study. Once contingency analysis was performed upon the 2008 HW case, three new overloads were identified. Of these, the overload which serves as part of the justification for this uprate project is the overload of the Jackson Fuller 230-115 kV transformer which can result from an outage of the 115 kV Midway-Rancho line.

## **2018 Heavy Summer (HS) Load Growth Case**

A heavy summer model was built for 2018 to evaluate a high load-growth scenario for Mountain View's system. A heavy summer model was chosen due to the fact that significant work had already been completed by the Colorado Long Range Transmission Planning Group (CLRTPG) to develop a 2018 HS model with revised topology and load and resource data for systems in Colorado. The customized forecast used for Mountain View for the purposes of this limited regional study illustrates that the summer MCP of Mountain View's system was, at the time this study was performed, expected to be nearly equal to the winter MCP in 2018. Additionally, the number of summer-peaking substations is expected to increase.

The 2018 HS case includes transmission system improvements that were included in the CLRTPG case at that time. Comanche Unit 3, the double-circuit Comanche-Daniels Park

345 kV line, and the Waterton-Midway 345 kV line are all present in that older model. The Lamar Energy Center with Lamar-Boone and Lamar-Burlington 500 kV lines were also modeled in service.

The 2018 HS case had to be modified to correct load levels in the CSU and MVEA areas present in that case. Voltage levels in the WECC power flow cases have, until recently, historically been considered artificially depressed in this area relative to actual historical data, and therefore adjustments were made to the voltage regulation settings at Richard Nixon and Front Range. Transformer taps at Falcon 115-69 kV and Fuller 230-115 kV were modeled with a 2.5% voltage boost. Generation schedules were also adjusted based on information received from CSU.

Two new capacitor banks were also expected to be in service in that model according to information received from CSU. The first capacitor bank is a 25 MVAR at Kettle Creek 115 kV. The second bank is a 50 MVAR bank at El Dorado 230 kV.

### **System Intact analysis**

During 2018 HS system intact conditions, overloading of the Fuller 230-115 kV transformer occurs at 112% of its 100 MVA rating. The voltage at Rush 69 kV bus is 0.95 pu, which is at minimum criteria of 0.95 pu. In the model, the Falcon 115-69 kV transformer is tapped at 112.125 kV. If this transformer tap can be adjusted to 109.25 kV, the voltage at Rush 69 kV substation would improve by 0.03 pu. A light loading model was created by reducing the 2018 HS load in Zone 757 by 50%. The model indicated that the voltage along Falcon-Rush 69 kV would be 1.06-1.07 pu (0.01-0.02 pu above system intact criteria) if the Falcon 115-69 kV transformer is tapped to 109.25 kV, therefore tapping the Falcon 115-69 kV transformer may not be an acceptable solution.

### **Single Contingency Analysis**

At the time this study was performed, the critical contingencies for MVEA's regional transmission area were the loss of the Fuller 230-115 kV Transformer, and the loss of the Falcon-Fuller 115 kV line. These contingencies cause several worst-case overloads, shown in Table 10, and low-voltage violations. For the outage of the Falcon-Fuller 115 kV line, severely low voltages in the range of 0.80 pu at Lorson Ranch, and 0.50 pu at Rush 69 kV, were identified in the study.

It should be noted that the load at Falcon 115 kV is 20 MW higher than what was originally included in the 2018 HS WECC case. However, even when the 115 kV load at Falcon remained at the WECC value of 11 MW, the load growth attributed to the new delivery subdivisions of Lorson Ranch, Rolling Hills, and Santa Fe still resulted in voltage violations of 0.88 pu at the Rolling Hills 115 kV bus, and 0.79 pu at the Rush 69 kV bus.

**Table 10 – 2018 HS Contingency Analysis Results For Worst Case Overloads**

Element	Rating (MVA)	Loading (MVA)	% Loading	Contingency
73412 MIDWAYBR - 73416 RANCHO 115.00 1	77	147	190.70%	73402 [FALCONMV 115.00] - 73481 [FULLER 115.00] CKT 1
73414 MONUMENT 115.00 - 73415 MONUMENT 69.000 2	28	35	123.30%	73414 [MONUMENT 115.00] - 73415 [MONUMENT 69.000] CKT 1
73416 RANCHO 115.00 - 73458 KANE 115.00 1	95	138	151.50%*	73402 [FALCONMV 115.00] - 73481 [FULLER 115.00] CKT 1
73458 KANE 115.00 - 73940 LORSON 115.00 1	95	118	151.50%*	73402 [FALCONMV 115.00] - 73481 [FULLER 115.00] CKT 1
73477 FULLER 230.00 - 73481 FULLER 115.00 1	100	160	159.90%	73410 [KETTLECK 115.00] - 73576 [FLYHORSE 115.00] CKT 1
73410 KETTLECK 115.00 - 73576 FLYHORSE 115.00 1	139	204	158.50%*	73477 [FULLER 230.00] - 73481 [FULLER 115.00] CKT 1
73940 LORSON 115.00 - 73941 ROLLINGHL 115.00 1	95	88	134.20%*	73402 [FALCONMV 115.00] - 73481 [FULLER 115.00] CKT 1

\* Percent loading is based on the amperage rating of the line. Due to the severely low voltages caused by the Falcon-Fuller 115 kV outage and the Fuller 230-115 kV outage, each element's true MVA rating during the contingency is much lower than the nominal rating shown in the table.

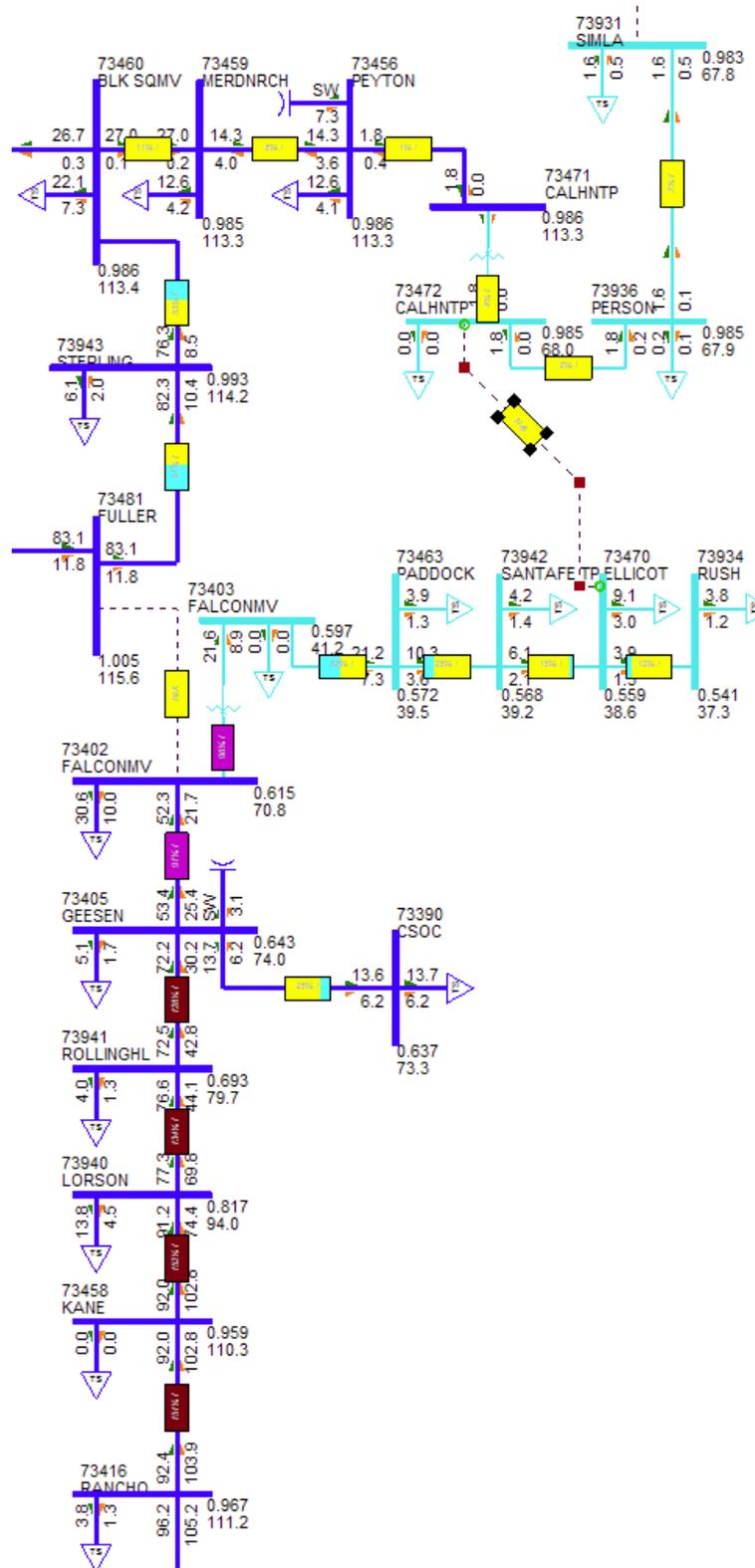


Figure 7 – 2018 HS Falcon-Fuller 115 kV Outage

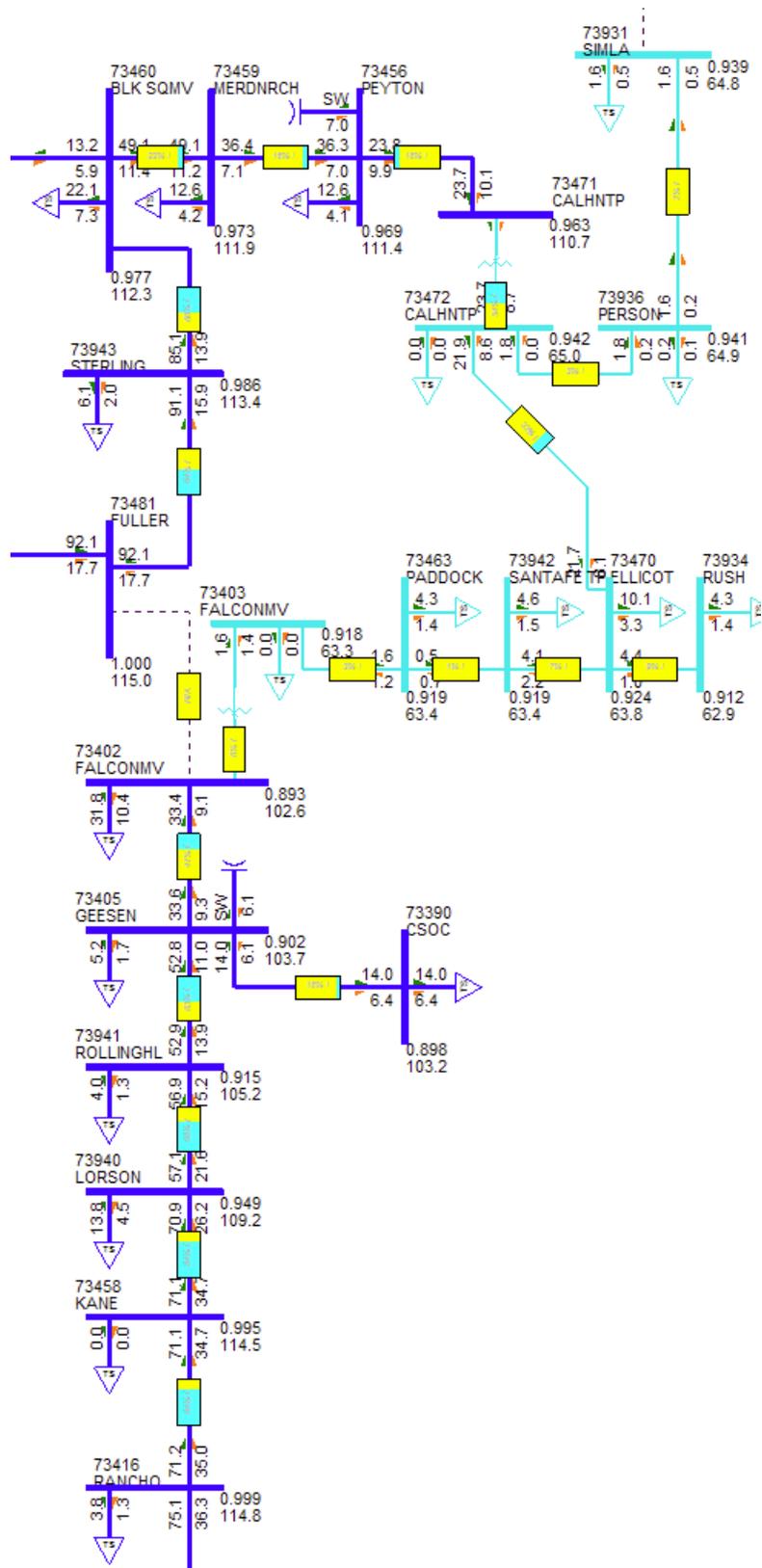
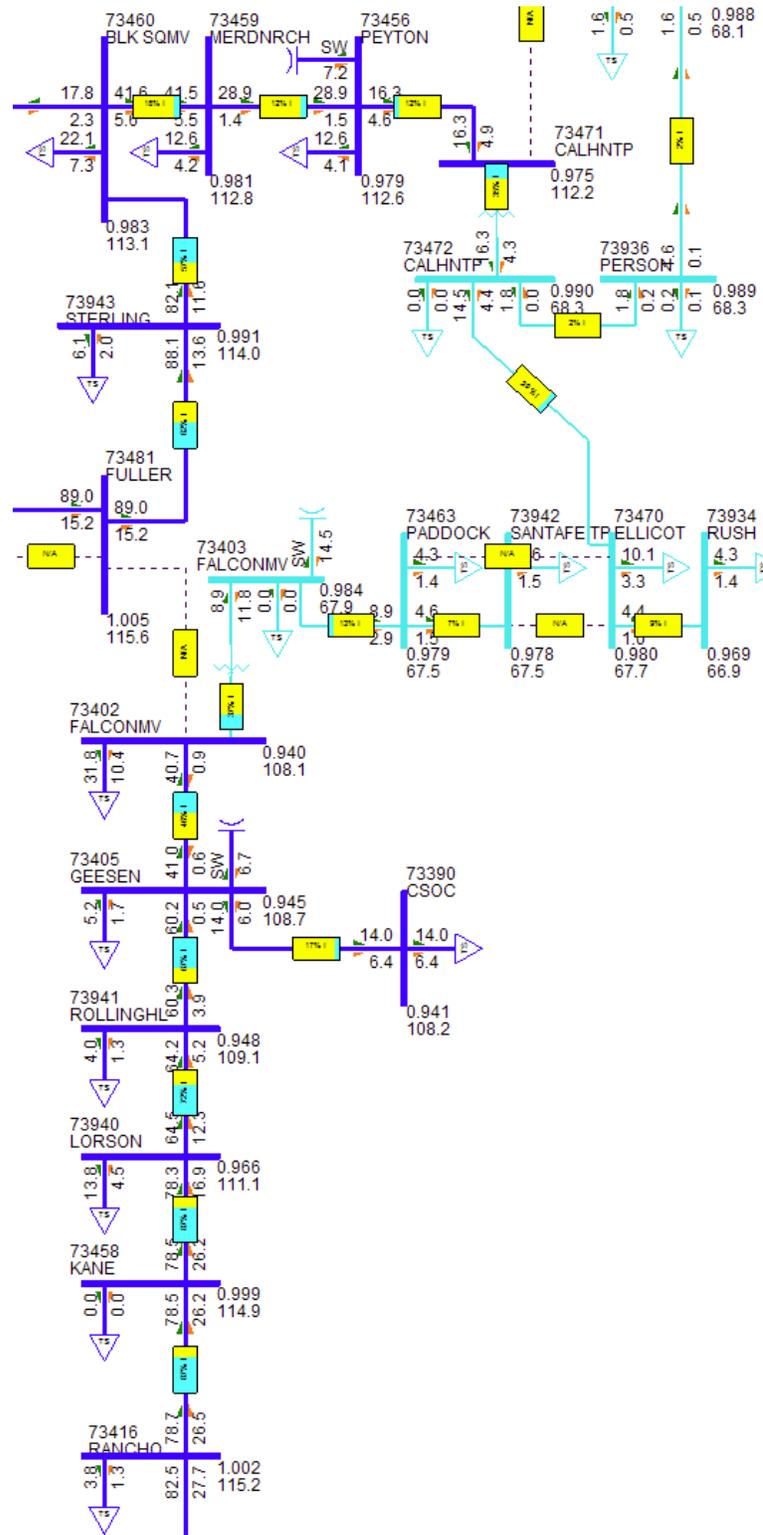


Figure 8 – 2018 HS Falcon-Fuller 115 kV Outage with Calhan-Ellicott 69 kV Inservice

The Calhan-Ellicott 69 kV line may be able to be operated as normally closed in the near term to provide additional voltage support to the 69 kV system east of Falcon. However, in the 2018 HS model, an overload of 132% of the Falcon 115-69 kV transformer's 42 MVA rating occurred during an outage of the Black Squirrel-Meridian Ranch 115 kV line.

Presently, the Calhan-Ellicott 69 kV line is operated normally open, energized at one end. The line is maintained by Mountain View and operational at all times. If it is determined that the line cannot be operated as normally closed, then significant reactive power resources must be applied to the 69 kV system. One option is to close the Calhan-Ellicott 69 kV line and open the Ellicott-Santa Fe 69 kV line in order to serve Ellicott and Rush from Calhan. Adequate voltage can be maintained during the Falcon-Fuller 115 kV outage by tapping the Calhan 115-69 kV transformer at 112.125 kV, and adding a 15 MVAR capacitor bank at Falcon 69 kV. Additionally, overloads on the 115 kV system from Geesen to Rancho are mitigated in this scenario, which is shown in Figure 9.

A second option is to install capacitor banks at several locations. The installation of a 7.5 MVAR capacitor bank at Falcon 69 kV bus, a second 7.5 MVAR bank at Geesen for a total of 15 MVAR at Geesen, and a 15 MVAR bank at Ellicott would be required to support voltage greater than 0.95 pu at Rush during the Falcon-Fuller 115 kV outage. Figure 10 shows the voltage support supplied by these capacitor banks during the Falcon-Fuller 115 kV outage.



**Figure 9 – 2018 HS Falcon-Fuller 115 kV Outage with Ellicott and Rush Fed From Calhan, Calhan 115-69 kV transformer tapped at 112.125 kV, and 15 MVAR Capacitor Bank at Falcon**

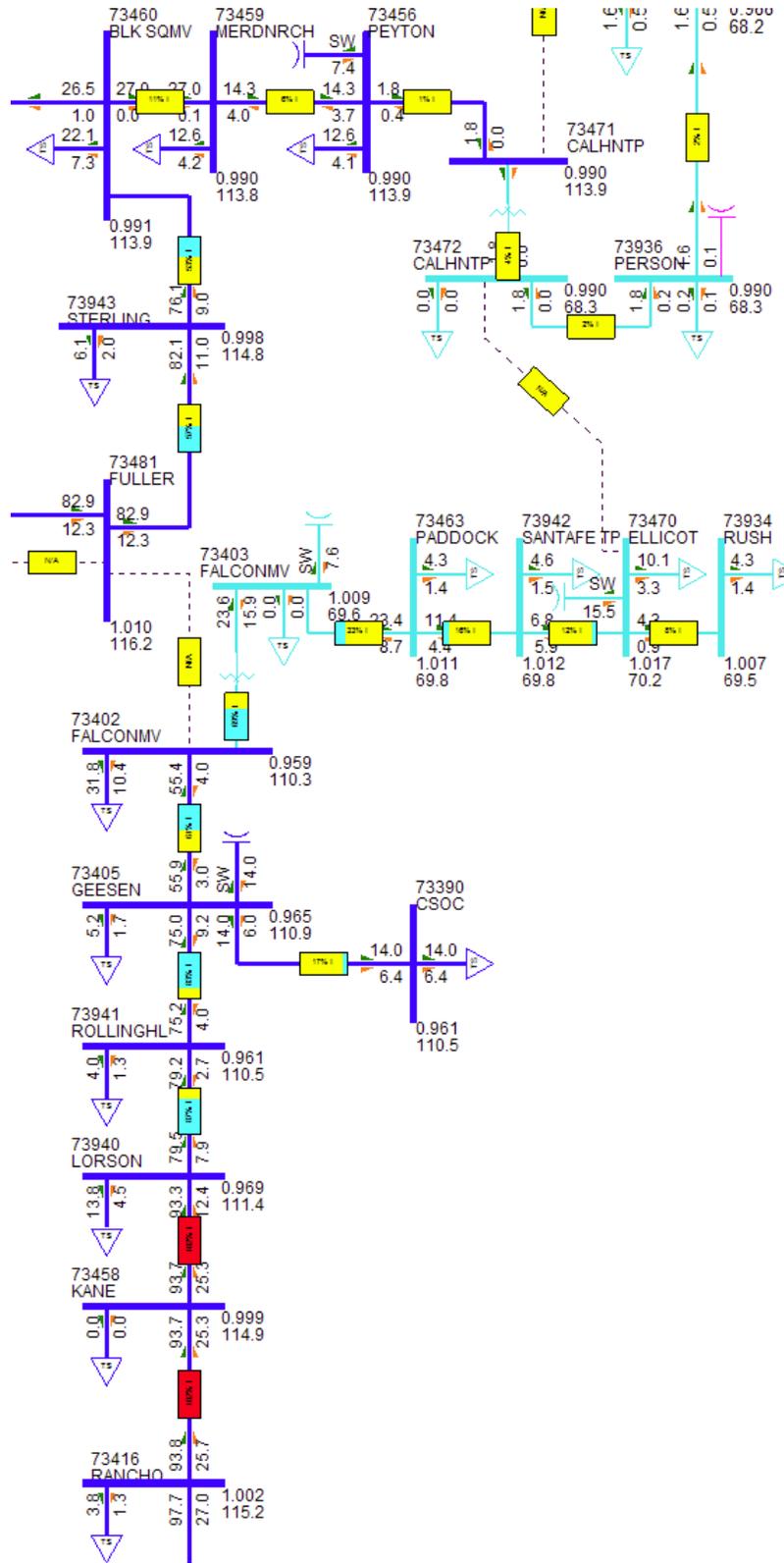


Figure 10 – 2018 HS Falcon-Fuller 115 kV Outage with Capacitor Banks at Geesen, Falcon, and Ellicott

**Falcon – Midway 115 kV Line Uprate: Thermal upgrade to 75°C**

The uprate of the Falcon-Midway 115 kV line is needed by 2018 to mitigate overloads on this line during the Falcon-Fuller 115 kV line outage. The portion of the line from Midway to Rancho is currently rated 77 MVA. In the 2018 HS case, the Falcon-Fuller 115 kV outage overloads the Midway-Rancho 115 kV line to 192% of its 77 MVA rating, and voltages are extremely low along Falcon-Midway 115 kV, and Falcon-Rush 69 kV. The Falcon-Midway 115 kV line did not exhibit any overloading in the 2008 HW or the 2013 HW cases during the Falcon-Fuller 115 kV outage. Table 12 illustrates the progression of loading on the Midway-Rancho 115 kV line for 2008, 2013, and 2018. Most of the overloading of Falcon-Midway can be alleviated by adding additional reactive power support of 7.5 MVAR at Geesen for a total of 15 MVAR at Geesen, 7.5 MVAR at Falcon, and 15 MVAR at Ellicott, and interconnecting Calhan-Ellicott 69 kV.

**Table 12 – Loading of Midway-Rancho 115 kV Line During Falcon-Fuller 115 kV Outage**

Element	Rating	Contingency: Falcon-Fuller 115 kV				
		2008 HW % Loading	2013 HW % Loading	2018 HS % Loading	2018 HS with VAR support	2018 HS w/ Caps and Calhan-Ellicott 69 kV
Midway-Rancho 115 kV	77 MVA	66%	98%	192% (1)	132% (2)	102%

**Conclusion**

The transmission system power flow analyses conducted for the Mountain View 10-year long range plan show that several key transmission elements will not be able to support the anticipated load growth of Mountain View’s system. By 2018, low voltage conditions develop on the 69 kV systems of Falcon-Rush and Calhan-Simla under certain single contingency conditions. The Fuller 230-115 kV transformer begins to exceed its 100 MVA rating during contingencies in 2008, and by 2018, this transformer will exceed 100 MVA for system intact conditions due to load growth.