Xcel Energy

Public Service Company of Colorado

System Impact Study

Load Interconnection Request for a 50 MVA Load Near Collbran

PSCo Transmission Planning
June 2008

Public Service Company of Colorado (PSCo)

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I. Executive Summary

Grand Valley Power (GVP) received a request from a customer for electric service to a gas compressor station approximately two miles east of the Collbran Substation. The station final demand is expected to be 50 MVA and the customer requested that GVP provide service for 7.5 MVA starting in February 2009 and add 7.5 MVA per month until August 2009. GVP does not have sufficient capacity to serve the new load; therefore, GVP requested that Public Service Company of Colorado (PSCo) perform a Load Interconnection System Impact Study and determine how best to serve this proposed load.

A Load Interconnection System Impact Study was performed and it was determined that the 50 MVA load addition could be reliably served by constructing a new substation (Horsethief Substation) approximately two miles east of Collbran and connecting the substation to PSCo's Rifle CU-Collbran-Grand Junction CU 138kV transmission line by looping a short section (approximately one span) of138 kV line using 1-477 conductor in and out of the new substation. The PSCo Rifle CU-Collbran 138kV line would extend on the northwest side of the proposed Horsethief site. The study identified other system enhancements required to reliably serve the new load. The following list summarizes the enhancements required to serve the proposed Horsethief 50 MVA load addition:

1. Horsethief Substation

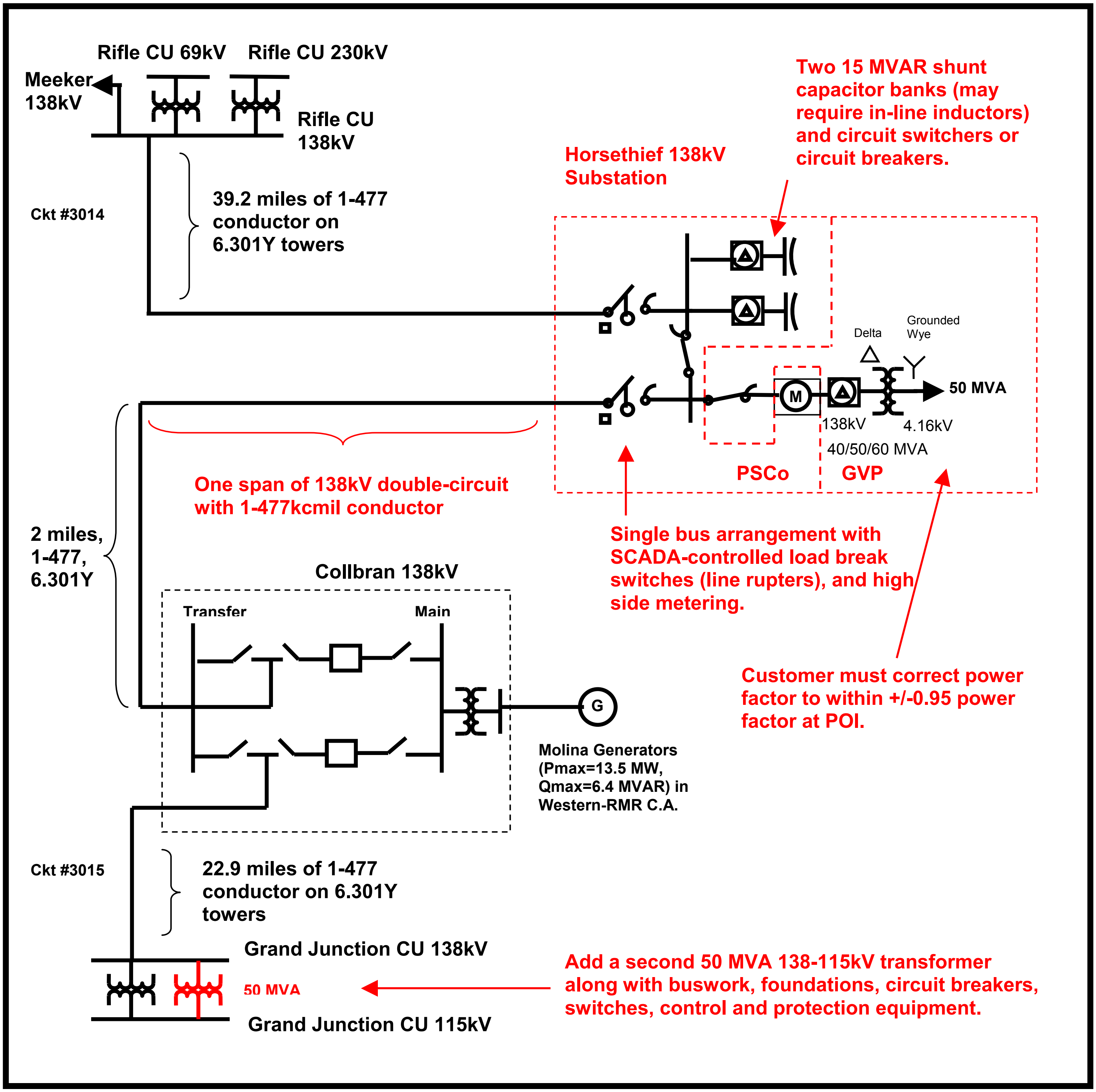
   a. New substation site (Customer supplied)
   b. In-and-out 138kV connection from the Rifle CU-Collbran 138kV transmission line to the 138kV yard of the new substation (assume one span).
   c. 138kV connections including a single bus arrangement with SCADA-controlled load break switches (line rupters), high side metering, and associated switches, buswork, foundations, system control and protection equipment.
   d. Two 15 MVAR shunt capacitor banks with circuit switchers or circuit breakers. (PSCo Engineering needs to select between circuit switchers or circuit breakers and determine the capacitor grounding method. PSCo Engineering needs to determine if the circuit switchers should include in-line inductors).
   e. Customer supplied equipment. This could include transformer(s), fault interrupter(s), associated system control, protection equipment and switches.

2. Grand Junction CU Substation

   a. One 50 MVA 138-115kV transformer and associated buswork, switches, circuit breakers, control and protection equipment.

<u>PSCo Engineering estimated the cost for PSCo's facilities at Horsethief at approximately $4.42 million and determined that a first quarter 2009 in-service date (ISD) is not feasible and that a new ISD will be needed.</u> A conceptual one-line of the project is provided in Figure 1 below.

Figure 1 Horsethief Substation Conceptual One-Line



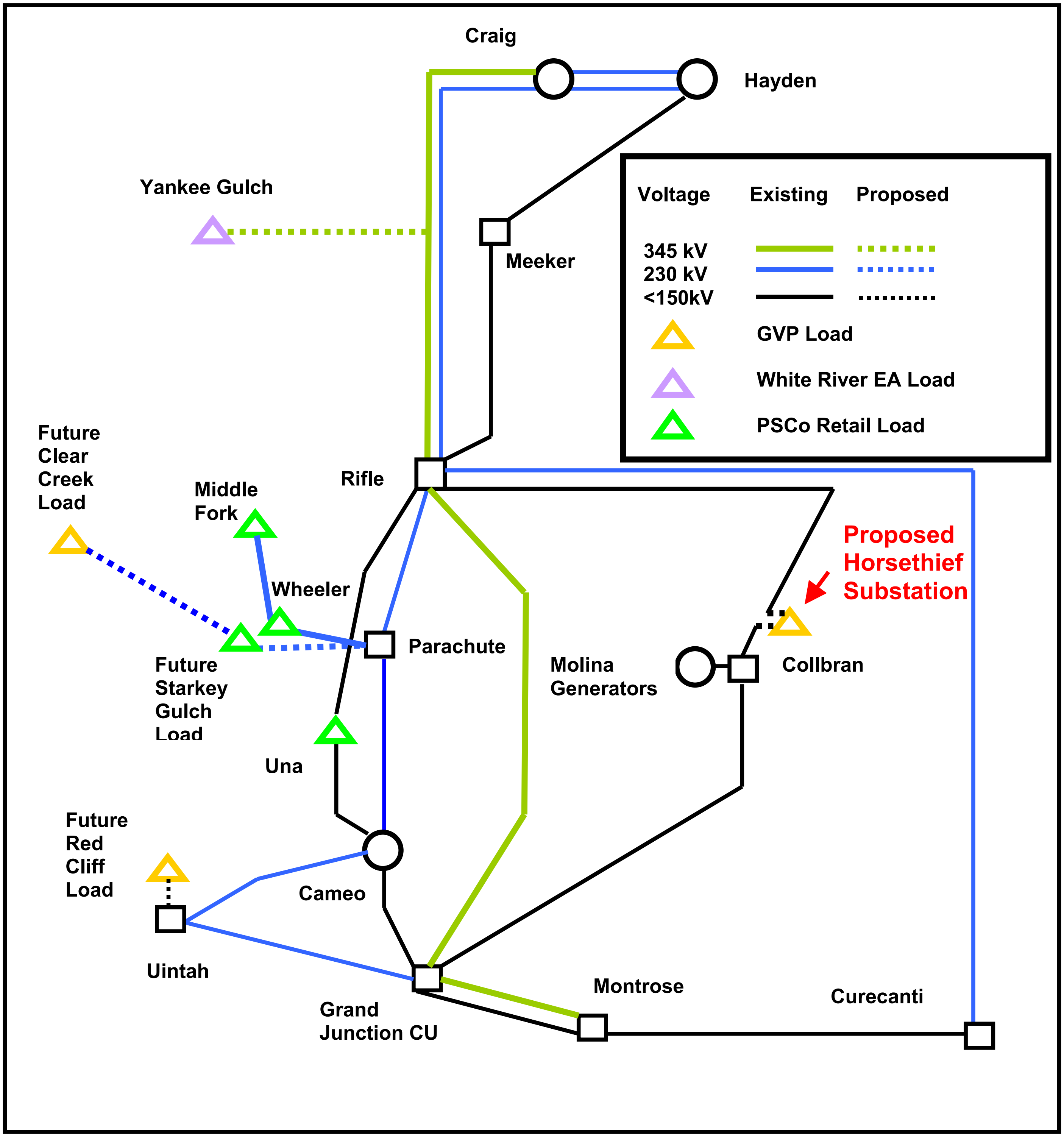
II. Background

Grand Valley Power (GVP) received a request from a customer for electric service to a gas compressor station. The proposed location is approximately two miles east of the Collbran Substation, immediately adjacent to the Rifle CU-Collbran 138 kV line. This location is in the GVP certificated service territory. The customer requested 50 MVA of service. They requested service for 7.5 MVA of load starting in February 2009 and would add 7.5 MVA every month until they reach the 50 MVA level in August 2009. The load is a gas compressor station with a high load factor that would run 24 hours per day.

GVP requested that PSCo perform a Load Interconnection System Impact Study and determine how to reliably serve this proposed load. The study was conducted and it was determined that the 50 MVA load addition could be reliably served by constructing a new substation (called Horsethief) near the Collbran Substation and looping a 138 kV line in and out of a new substation. An advantage of this alternative is that GVP could avoid having to build an additional 138kV line from the Collbran Substation. In addition, there is not sufficient room at the Collbran Substation for a yard expansion to accommodate additional lines.

A map that describes that approximate location of the substation with respect to the bulk transmission system in western Colorado is described in Figure 2 below.

Figure 2 - Location Map of the Horsethief 50 MVA Load Addition



III. Study Results

Load flow studies were conducted for three scenarios – a 2010 on-peak summer condition, a 2015 on-peak summer condition with a high TOT2A north-to-south flow, and a 2017 on-peak winter condition with a high TOT2A south-to-north flow. The load flow studies determined that the proposed 50 MVA load could be reliably served from a new substation called Horsethief Substation (that would tap the Rifle CU-Collbran-Grand Junction CU 138kV line). The new substation should include two 15 MVAR switchable capacitors banks and protective devices. The Grand Junction CU Substation would need to include a second 50 MVA 138-115kV transformer. Detailed results can be found in the Appendix. The study recognized that a 50 MVA load could have a real portion of the load as high as 50 MW if the customer were to maintain a unity power factor. The study took a more conservative approach assuming a 50 MW load with the customer correcting load power factor to a 0.95 lagging power factor (52.6 MVA).

IV. Cost Estimates

PSCo Substation and Transmission Engineering evaluated the preferred alternative. The cost estimates assumed 2008 dollars. The cost estimates are listed in Table 1 and Table 2 below.

Table 1: Horsethief Substation Facilities

Element	Description	Cost ($Million)
PSCo Switchyard	Horsethief Substation • New 138kV substation facilities	$1,455,303
	Collbran-Rifle CU 238kV Line • Transmission Tap of the Collbran-Rifle 138kV transmission line	$ 165,120
Total	Horsethief Substation Facilities	$1,620,423

Table 2: PSCo Transmission System Upgrades – Grand Junction CU Substation

Element	Description	Cost ($Million)
Grand Junction CU Substation	Transmission Facilities • 50 MVA 138-115kV transformer • Protective devices • Installation costs	$2,800,232
Total Cost	Grand Junction CU Substation Facilities	$2,800,232

The anticipated cost of the PSCo facilities for the Horsethief Tap, Horsethief Substation Facilities and Grand Junction CU Substation modifications is approximately $4.42 million. The cost of the customer-owned portion of the project at the Horsethief Substation was not determined.

Scope and Cost Estimate Assumptions

- The estimated costs provided are “scoping level estimates” with an accuracy of +/- 30%.
- All applicable overheads are included. The estimates include AFUDC.
- There is no contingency or escalation added to the estimates.
- All estimates are in 2008 dollars.
- The Customer will purchase, permit, and grade the Horsethief Substation site.
- The Customer will provide station power for PSCo equipment.
- The estimate assumes PSCo will install an electrical equipment enclosure (EEE).
- Horsethief Substation site will be in close proximity (less than ½ mile) to Collbran-Rifle 138kV line.
- The Grand Junction CU transformer In-Service Date (ISD) will lag the ISD of Horsethief Substation (by one year).
- A 1st quarter 2009 ISD is not feasible, and it is assumed that a new date will be set.

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APPENDIX

Methodology

A. Study Cases

1. 2010 Heavy Summer Capital Budget Case

   In February 2008, PSCo developed near term planning cases that reflect the transmission system from 2009 through 2013 for on-peak summer season scenarios. The 2010 heavy summer (on peak) base case was selected. Four zones were monitored for this study - Zone 708, Zone 709, Zone 790 and Zone 791. The demand for each zone in the 2010 heavy summer case is as follows:

   Table 3 Case Summary By Zone

Zone	Demand (MW)	Generation (MW)
708	577.8	94.0
709	156.5	0
790	145.6	2384.0
791	391.1	0

   The path transfer levels are as follows – TOT1A = 238.8 MW east-to-west, TOT2A = 159.1 MW north-to-south, and TOT5 = 739.1 MW west-to-east.

   The case was modified to reflect the addition of the proposed Horsethief 50 MVA load. The Rifle CU-Colbran 138kV line was tapped at a location called "Horsethief" that will be approximately two miles north of Colbran on the Rifle CU-Colbran 138kV line. A 50 MW load with a 90% lagging power factor (24.2 MVAR) was added at the tap location. This represents the large natural gas compressor load addition requiring large induction motors. For large induction motors, a running power factor of approximately 90% lagging is a reasonable assumption. The load addition increased the Rifle CU-Colbran 138kV flow from 16.6 MW – j 4.7 MVAR (11% of its 162 MVA rating) to 49.2 MW + j 10.9 MVAR (32% of its 162 MVA rating) and decreased the 115kV bus voltage at Horsethief from 1.006 p.u. to 0.957 p.u., a 4.8% decrease.

2. 2015 Heavy Summer Case with a High TOT2A Flow and Western Slope Loads and Transmission System Upgrades Added

   PSCo is presently studying the addition of new loads in western Colorado that would be served from the bulk transmission system. The western Colorado system can experience high north-to-south transfers on the TOT2A transfer path. These were represented in a 2015 heavy summer base case. Transmission additions to serve the proposed loads were added. The following table summarizes the zones that comprise the study area.

Table 4 Case Summary By Zone

Zone	Demand (MW)	Generation (MW)
708	1077.7	30.0
709	136.7	0
790	302.9	2388.8
791	653.1	0

The path transfer levels are as follows – TOT1A = 61.3 MW east-to-west, TOT2A = 500.4 MW north-to-south, and TOT5 = 419.5.1 MW west-to-east. Comparing this case with the 2010 heavy summer case, the Zone 708 demand increased by approximately 500 MW due to the natural gas compressor station projects in western Colorado, while the Zone 708 generation decreased by 64 MW due to the proposed retirement of the Cameo generation station. The TOT2A north-to-south transfer flow is 500 MW, a very high transfer condition. Because of the large western Colorado demand and high transfer conditions, this case reflects an extreme operating point of the system.

The case was modified to reflect the addition of the proposed Horsethief 50 MVA load. The Rifle CU-Colbran 138kV line was tapped at a location called "Horsethief". A 50 MW load with a 90% lagging power factor (24.2 MVAR) was added at the tap location. The load addition increased the Rifle CU-Colbran 138kV flow from 28.1 MW – j 4.8 MVAR (18% of its 162 MVA rating) to 60.5 MW + j 11.9 MVAR (39% of its 162 MVA rating) and decreased the 115kV bus voltage at Horsethief from 1.000 p.u. to 0.947 p.u., a 5.3% decrease.

3. 2017 Heavy Winter Case – Heavy Winter Demand and High TOT2A South-to-North Import

This case represents the transmission system during an on-peak hour during the winter season in 2017. The following table represents a summary of demand and generation in the four zones of the study area.

Table 5 Case Summary By Zone

Zone	Demand (MW)	Generation (MW)
708	809.2	30.0
709	150.5	0
790	334.3	1855.8
791	412.7	0

The path transfer levels are as follows – TOT1A = 289.6 MW east-to-west, TOT2A = -335.1 MW north-to-south (or 335.1 south-to-north), and TOT5 = 238.2 MW west-to-east. This case represents a high import from south-to-north across TOT2A with high winter demand modeled. Generation is reduced at Craig/Hayden and Nucla as compared to the 2015HS and 2010HS cases.

The case was modified to reflect the addition of the proposed Horsethief 50 MVA load. The Rifle CU-Colbran 138kV line was tapped at a location called "Horsethief, a 50 MW 90% lagging power factor (24.2 MVAR) load was added at the tap location called "Horsethief". The load addition increased the Rifle CU-Colbran 138kV flow from 4.9 MW + j 0.1 MVAR (4% of its 162 MVA rating) to

38.1 MW + j 14.0 MVAR (26% of its 162 MVA rating) and decreased the 115kV bus voltage at Horsethief Tap from 1.014 p.u. to 0.966 p.u., a 4.7% decrease. The case was further modified by adding the proposed western Colorado natural gas compressor loads and associated 230kV transmission upgrades.

B. Study Scope and Assumptions

- This study consisted of powerflow analysis only. Angle or voltage stability studies and short circuit studies were not performed for this study.
- System criteria violations in Zone 708, Zone 709, Zone 790 and Zone 791 were monitored.
- A power transfer of 500 MW across TOT2A from north-to-south was modeled by modifying interchange schedules between Western-RMR and New Mexico. Local generation was used to accomplish the interchange changes. The San Juan and Shiprock phase-shifting transformers were used to achieve the TOT2A schedules.
- Contingencies included only single facility outages. No double-contingency outages were simulated.
- Simultaneous impacts on other paths were not studied.

C. Study Criteria

Category A and Category B events were simulated for the study area. The results are listed in Section V, "Study Results". The following are the NERC performance categories.

1. **Category A – System Normal**
"N-0" System Performance Under Normal (No Contingency) Conditions
(Category A) NERC Standard TPL-001-0

Voltage:	0.95 to 1.05 per unit
Line Loading:	100 percent of continuous rating
Transformer Loading:	100% of highest 65 °C rating

2. **Category B – Loss of generator, line, or transformer (Forced Outage)**
"N-1" System Performance Following Loss of a Single Element
(Category B) NERC Standard TPL-002-0

Voltage:	0.90 to 1.10 per unit
Line Loading:	100 percent of continuous[1] rating.
Transformer Loading:	100% of highest 65 °C rating

3. **Category C – Loss of Bus or a Breaker Failure (Forced Outage)**
"N-2 or More" System Performance Following Loss of Two or More Elements
(Category C) NERC Standard TPL-003-0

[1] The study did not use emergency ratings for PRPA, TSGT, WAPA and PSCo transmission line facilities in Category B contingencies for planning studies.

Voltage and Thermal:	Allowable emergency limits will be considered as determined by the affected parties and the available emergency mitigation plan. Curtailment of firm transfers and load shedding will be considered if necessary.

4. **Category D – Extreme Events (Forced Outages)**
"N-2 or More" System Performance Following Extreme Events (Category D) NERC Standard TPL-004-0

Voltage and Thermal:	Allowable emergency limits as determined by available emergency mitigation plan. Curtailment of firm transfers and load shedding are permissible if necessary.

D. Transfer Path Definitions

Conditions on the transmission system can impact line flows and bus voltages in the study area. Demand and generation dispatch in the study area are two of these conditions. A third condition is the level of bulk power transfers that pass through the study area. Three transfer paths are in the vicinity of the study area – TOT1A, TOT2A, and TOT5. They are defined below. The bulk power transfers that have the most significant impact on this study area are those that cross the TOT2A power transfer path. Load flow studies that are conducted in this study area typically consider demand levels, dispatch scenarios and bulk power transfers across the TOT2A path.

The three transfer paths in the vicinity of the study area are:

TOT1A – A transmission path between northwest Colorado and northeast Utah with a maximum east-to-west rating of 650 MW. The path owners include Western Area Power Administration, Tri-State G&T, Platte River Power Authority, and Utah Associated Municipal Powr Systems.

Transmission Line/Transformer	Metered End
Bears Ears – Bonanza 345 kV	Bears Ears
Hayden – Artesia 138 kV	Hayden
Meeker – Rangely 138 kV	Rangely

TOT2A – A transmission path between southwest Colorado and northwest New Mexico with a maximum north-to-south rating of 690 MW. The path owners include Western Area Power Administration, Tri-State G&T and Public Service Co. of Colorado.

Transmission Line/Transformer	Metered End
-Hesperus-San Juan 345 kV	San Juan
-Durango-Glade Tap 115 kV	Glade Tap
-Lost Canyon-Shiprock 230 kV	Shiprock

TOT5 – A transmission path between western Colorado and eastern Colorado with a maximum west-to-east rating of 1675 MW. The path owners include Western Area Power Administration, Tri-State G&T, Platte River Power Authority, and Public Service Co. of Colorado.

Transmission Line/Transformer	Metered End
Hayden-Archer 230kV	Archer
Craig-Ault 345kV	Craig
Gore Pass-Blue River 230kV	Blue River
Hayden-Gore Pass 138kV	Gore Pass
Gore Pass 230-138kV transformer	Gore Pass 230kV
Gunnison-Poncha 115kV	Poncha
Curecanti-Poncha 230kV	Curecanti
Basalt-Malta 230kV	Basalt
Basalt-Hopkins 115kV	Basalt
Rifle-Hopkins 230kV	Rifle

E. Load Representation

The customer load was modeled for this study as a 50 MVA load at a substation two miles from the Colbran Substation on the Rifle CU-Colbran 138kV line. A 50 MVA load may have a real component of load as high as 50 MW if the load power factor is adjusted to unity. The load power factor that was assumed in the study was a 0.9 lagging power factor without customer correction and 0.95 lagging power factor with customer correction. The customer may be able to achieve unity power factor, but this was not assumed. Power factor is defined as the fraction of power actually used by a customer's electrical equipment compared to the total apparent power supplied, usually expressed as a percentage. A power factor indicates how far a customer's electrical equipment causes the electric current delivered at the customer's site to be out of phase with the voltage. Power factor is expressed as a ratio between watts and volt-amperes and this ratio is generally expressed as a decimal fraction. The study assumed that proposed load addition has a 0.90 lagging power factor without customer correction. The term “lagging” means that the current flowing to customer load at the load bus has a phase angle that lags behind the load bus voltage. Assuming a 50 MW load with a customer corrected .95 lagging power factor (52.6 MVAR) was a conservative assumption for the Horsethief Substation load.

F. Motor Starting Requirements

PSCo requires customers to adhere to a voltage dip requirement during motor starting that restricts voltage dips to 2% or less at any company transmission bus. The voltage dip percentage (%) is defined as:

$$\%\text{Voltage Dip} = (V_{prestart} - V_{start})/V_{prestart} * 100$$

where $V_{prestart}$ is the voltage at the bus before the motor is started and V_{start} is the voltage at the bus at the instant of maximum voltage drop during starting.

The customer is responsible to verify that motor starting at PSCo busses in the study area adheres to the PSCo motor-starting requirements.

G. Transmission Facility Additions

No transmission line improvements are required with this alternative; however, a transformer addition at the Grand Junction CU Substation will be required. In addition, capacitor bank additions will be required at the proposed Horsethief Substation.

H. Study Case Name Convention

The study required several scenarios for year, season, loading condition, and equipment status. Table 6 describes the naming convention used for the study. The cases are referred by name in the study.

Table 6 Base Case Naming Convention for the Study

Name Segment	Definition
10HS 15HS 17HW	Year and season of study. For example, "10HS" means the case represents the expected conditions in the summer of 2010 under on-peak "heavy summer" demand conditions. "15HS" means the case represents the expected conditions in the summer of 2015 under on-peak "heavy summer" demand conditions. "17HW" means the case represents the expected conditions in the winter of 2017 under on-peak "heavy winter" demand conditions.
Y	Yampa projects added (Upgrade the Craig-RifleWA 230kV line to 345kV, uprate the Craig-Rifle CU 345kV line, and add a Craig 560 MVA 345-230kV transformer #3)
N	New PSCo Retail, Non-PSCo and Tri-State loads and new system proposed in western Colorado
A1 A2	"A1" represents a transmission alternative in western Colorado to serve the proposed loads in western Colorado, namely the addition of the proposed Rifle CU-Clear Creek-Crawford Trail-Yankee Gulch 345kV line and Starkey Gulch-Clear Creek 230kV line. "A2" represents the proposed Clear Creek-Steward Gulch-Story Gulch-Rifle CU 230kV line.
T500	TOT2A north-to-south flow high level at 500 MW. TOT2A is a transfer path between southwest Colorado and northwest New Mexico. The north-to-south flows can vary between 0 MW and 500 MW. "T500" means the TOT (for total) had a north-to-south flow of 500 MW in the case.
H	Horsethief Substation added at a tap on the Meeker-Rifle CU 138kV line two miles north of Colbran
L	Load added at Horsethief Substation - 50 MW (0.90 lagging power factor)
C	Capacitance added on the distribution system of the customer's facility at Horsethief to correct the power factor from 0.90 lagging to 0.95 lagging. Customer may be able to achieve a unity power factor at 50 MVA with 50 MW and 0 MVAR.
M	Molina generating units out-of-service
S	Shunts capacitors added at Horsethief

Outage History

Table 7 below provides a list of outages that have occurred on PSCo transmission lines in the study area over the last two years. The Rifle CU-Colbran 138kV line (Circuit No. 3014) experienced no outages over the last two years while the Colbran-Grand Junction CU 138kV line (Circuit No. 3015) experienced one outage on June 6, 2006.

Table 7 Outage History of Transmission Lines in the Study Area

Ckt ID	Circuit Name	Outage Date/Time	Restore Date/Time	Duration	SGS Catagory
3015	Collbran-Grand Junction 138kV	4/5/06 13:03	4/6/06 18:30	1 days 05 hours 27 minutes	3 (Lines)
5205	RiflePS-Parachute 230kV	3/30/06 18:43	3/30/06 18:45	0 days 00 hours 02 minutes	2 (System Protection)
5205	RiflePS-Parachute 230kV	5/3/06 19:09	5/3/06 19:12	0 days 00 hours 03 minutes	2 (System Protection)
5205	RiflePS-Parachute 230kV	7/6/07 17:08	7/6/07 22:04	0 days 04 hours 56 minutes	10 (Excludable)
5205	RiflePS-Parachute 230kV	8/8/07 7:31	8/8/07 7:31	0 days 00 hours 00 minutes	2 (System Protection)
5509	Parachute-Cameo 230kV	3/22/06 23:43	3/22/06 23:47	0 days 00 hours 04 minutes	2 (System Protection)
5509	Parachute-Cameo 230kV	5/3/06 19:09	5/3/06 19:12	0 days 00 hours 03 minutes	5 (Lightning Only)
5509	Parachute-Cameo 230kV	5/31/06 1:29	5/31/06 1:35	0 days 00 hours 06 minutes	2 (System Protection)
5509	Parachute-Cameo 230kV	7/9/06 20:28	7/9/06 20:32	0 days 00 hours 04 minutes	9 (Other)
5509	Parachute-Cameo 230kV	1/7/08 14:58	1/7/08 15:06	0 days 00 hours 08 minutes	9 (Other)
5555	Uintah-Grand JunctionCu 230kV	1/6/08 3:59	1/8/08 15:25	2 days 11 hours 26 minutes	3 (Lines)
5555	Uintah-Grand JunctionCu 230kV	2/15/08 2:00	2/15/08 2:13	0 days 00 hours 13 minutes	3 (Lines)
5557	Grand Junction CU-GrandJunction 230kV	3/5/07 14:29	3/5/07 15:44	0 days 01 hours 15 minutes	10 (Excludable)
5557	Grand Junction CU-GrandJunction 230kV	1/6/08 3:59	1/6/08 4:04	0 days 00 hours 05 minutes	2 (System Protection)
5557	Grand Junction CU-GrandJunction 230kV	2/15/08 2:00	2/15/08 2:01	0 days 00 hours 01 minutes	2 (System Protection)
5607	Cameo-Uintah 230kV	6/6/07 7:42	6/6/07 7:46	0 days 00 hours 04 minutes	4 (Weather-not lightning)
5607	Cameo-Uintah 230kV	10/22/07 3:26	10/22/07 7:34	0 days 04 hours 08 minutes	2 (System Protection)
5607	Cameo-Uintah 230kV	1/6/08 4:03	1/6/08 4:20	0 days 00 hours 17 minutes	2 (System Protection)
6670	Rifle CU-Cameo 69kV	2/15/06 13:18	2/15/06 13:19	0 days 00 hours 01 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	3/28/06 20:21	3/28/06 21:39	0 days 01 hours 18 minutes	3 (Lines)
6670	Rifle CU-Cameo 69kV	4/17/06 12:41	4/17/06 12:43	0 days 00 hours 02 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	4/17/06 14:01	4/17/06 14:03	0 days 00 hours 02 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	4/17/06 14:08	4/17/06 16:10	0 days 02 hours 02 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	4/17/06 16:20	4/17/06 16:20	0 days 00 hours 00 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	6/22/06 9:59	6/22/06 10:02	0 days 00 hours 03 minutes	8 (External)
6670	Rifle CU-Cameo 69kV	7/6/06 10:08	7/6/06 11:11	0 days 01 hours 03 minutes	1 (Equipment)
6670	Rifle CU-Cameo 69kV	7/23/06 21:27	7/24/06 1:36	0 days 04 hours 09 minutes	5 (Lightning Only)
6670	Rifle CU-Cameo 69kV	8/2/06 17:27	8/2/06 17:27	0 days 00 hours 00 minutes	6 (Unknown)
6670	Rifle CU-Cameo 69kV	10/7/06 10:35	10/9/06 14:35	2 days 04 hours 00 minutes	3 (Lines)
6670	Rifle CU-Cameo 69kV	2/11/07 4:40	2/11/07 4:40	0 days 00 hours 00 minutes	1 (Equipment)
6670	Rifle CU-Cameo 69kV	2/11/07 5:32	2/11/07 5:32	0 days 00 hours 00 minutes	1 (Equipment)
6670	Rifle CU-Cameo 69kV	4/21/07 11:20	4/21/07 12:47	0 days 01 hours 27 minutes	10 (Excludable)
6670	Rifle CU-Cameo 69kV	5/3/07 14:22	5/3/07 14:23	0 days 00 hours 01 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	6/6/07 7:55	6/6/07 7:57	0 days 00 hours 02 minutes	4 (Weather-not lightning)

6670	Rifle CU-Cameo 69kV	6/9/07 16:12	6/9/07 16:13	0 days 00 hours 01 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	7/5/07 16:05	7/5/07 16:05	0 days 00 hours 00 minutes	5 (Lightning Only)
6670	Rifle CU-Cameo 69kV	8/20/07 18:43	8/20/07 18:47	0 days 00 hours 04 minutes	6 (Unknown)
6670	Rifle CU-Cameo 69kV	9/12/07 7:25	9/12/07 7:30	0 days 00 hours 05 minutes	1 (Equipment)
6670	Rifle CU-Cameo 69kV	9/14/07 22:34	9/14/07 22:34	0 days 00 hours 00 minutes	5 (Lightning Only)
6670	Rifle CU-Cameo 69kV	10/20/07 17:29	10/20/07 17:30	0 days 00 hours 01 minutes	3 (Lines)
6670	Rifle CU-Cameo 69kV	10/20/07 17:31	10/21/07 19:04	1 days 01 hours 33 minutes	3 (Lines)
6670	Rifle CU-Cameo 69kV	11/30/07 16:50	12/3/07 13:05	2 days 20 hours 15 minutes	4 (Weather-not lightning)
6670	Rifle CU-Cameo 69kV	12/8/07 12:42	12/8/07 12:43	0 days 00 hours 01 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	2/13/06 8:16	2/13/06 8:16	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	3/12/06 6:01	3/12/06 6:02	0 days 00 hours 01 minutes	4 (Weather-not lightning)
7300	Craig-Rifle CU 345kV	10/22/06 7:28	10/22/06 7:28	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	11/20/06 22:56	11/20/06 22:56	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	12/15/06 7:46	12/15/06 7:46	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	12/17/06 7:05	12/17/06 7:05	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	1/6/07 2:51	1/6/07 2:51	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	1/16/07 4:25	1/16/07 4:25	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	1/25/07 20:33	1/25/07 20:34	0 days 00 hours 01 minutes	9 (Other)
7300	Craig-Rifle CU 345kV	1/26/07 3:18	1/26/07 3:19	0 days 00 hours 01 minutes	9 (Other)
7300	Craig-Rifle CU 345kV	2/18/07 8:14	2/18/07 8:14	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	4/22/07 1:37	4/22/07 1:39	0 days 00 hours 02 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	7/20/07 16:20	7/20/07 16:20	0 days 00 hours 00 minutes	5 (Lightning Only)
7300	Craig-Rifle CU 345kV	9/16/07 22:21	9/16/07 22:33	0 days 00 hours 12 minutes	4 (Weather-not lightning)
7300	Craig-Rifle CU 345kV	9/22/07 9:33	9/22/07 9:33	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	9/26/07 2:17	9/26/07 2:17	0 days 00 hours 00 minutes	6 (Unknown)
7300	Craig-Rifle CU 345kV	10/20/07 7:01	10/20/07 7:02	0 days 00 hours 01 minutes	4 (Weather-not lightning)
7300	Craig-Rifle CU 345kV	12/9/07 3:41	12/9/07 3:43	0 days 00 hours 02 minutes	6 (Unknown)
7302	Rifle CU-Grand Junction CU 345kV	3/22/06 23:43	3/22/06 23:46	0 days 00 hours 03 minutes	6 (Unknown)
7302	Rifle CU-Grand Junction CU 345kV	5/3/06 8:44	5/3/06 8:44	0 days 00 hours 00 minutes	6 (Unknown)
7302	Rifle CU-Grand Junction CU 345kV	5/31/06 1:29	5/31/06 1:29	0 days 00 hours 00 minutes	6 (Unknown)
7302	Rifle CU-Grand Junction CU 345kV	7/9/06 20:28	7/9/06 20:28	0 days 00 hours 00 minutes	5 (Lightning Only)

Note: The following are the SGS Statistical Services Cause Code Categories

1. Equipment: Terminal Equipment Failure. Transmission circuit outages caused by failures of breakers, switches, transformers, capacitor banks, busses etc. Any “inside the fence” initiating causes related to equipment failure (exclusive of system protection) should be assigned to this category.
2. System Protection: System Protection or Relay Equipment Failure, mis-operation, incorrect settings or scheme, “over-reaching”, communications, etc. Include relay mis-operations, but where the cause of mis-operation is unknown.
3. Lines: Line Equipment Failure. Transmission circuit outages caused by failed hardware “outside the fence”: Structures, conductors, cable, cable hardware, insulators, static wire, foundation, etc. Some systems include wind, lightning and ice conditions or galloping causing failures that were within design specifications.
4. Weather, other than lightning: Severe weather conditions, usually beyond the design capabilities of the facilities, resulting in outages, exclusively of lightning.
5. Lightning Only: Verified or suspected outages resulting from lightning, ideally when the magnitude of the stroke is verified to exceed design capabilities.

6. Unknown: Diligent attempts to verify cause were unsuccessful. Do not include outages where a failed component or system has been identified, but the source of the failure is unknown (see Category 2: System Protection, above).
7. Vegetation: Vegetation and trees that directly cause an outage. Do not include vegetation incidents that originate off the ROW and not subject to removal under good utility practice.
8. External: Outage causes external to, and outside the control of the transmission system. Examples include foreign utilities, customer equipment, generation, instability or under-frequency, distribution through-faults, vegetation that is not on the ROW and not subject to removal under good utility practices, wildlife or public damage/interference (where reasonable protective measures were in place or not possible) etc.
9. Other: None of the above. Some of these may include operating or workmanship errors, contractor errors, dig-ins, loggers and instances of wildlife or public damage/interference where protective measures were or should have been in place but failed, contamination, etc.
10. Excludable Outages: An excludable outage for a limited number of events or circumstances:
    a) Operational Outage for individual events that are required for safety, voltage control, or stability and initiated by supervisory control.
    b) System Disturbances for events associated with cascading (the initiating event and secondary events should be included with appropriated cause description).
    c) Major Catastrophic Events are the most extreme circumstances a transmission system encounters and should be judiciously limited to “once in ten years” events or situations where reasonable response plans are impossible. Some examples of such occurrences include – Hurricane Andrew (1992), Hurricane Katrina (2005), the NY-Ontario-Quebec ice storm (1998), and California wildfires (2003). Instances of the second (or more) hurricane in a short interval of time (e.g. Florida in 2004).

Category 10 Major Catastrophic Events either impacted many circuits (e.g. >25% of system or region total) in a short time period or a limited number of circuits for an extended period (outage duration measured in weeks as opposed to hours or days). In a few cases, Category 10 may be applied to individual outages such as the destruction of a river crossing or extreme snow depth requiring the forced outage of a line because of insufficient conductor-to-ground clearance.

Reliability Evaluation 2010 through 2017

A. Year 2010 Summer On-Peak Results

The case titled "2010hsp_budget_hshn_RL2.sav" was obtained. The case was developed for the 2009-2013 PSCo Capital Budget studies and reflects a 2010 on-peak "heavy" summer demand scenario. The system flows were low to moderate with TOT1A at 234.0 MW east-to-west, TOT2A at 150.1 MW north-to-south, and TOT5 at 694.7 MW west-to-east. Craig/Hayden generation was high at 1790 MW. Nucla generation was high at 108.0 MW and the Curecanti generation was high at 262.0 MW. The Atlas generating units were off-line. The Molina generating units (Western-RMR) connected to Collbran Substation were providing 9 MW (out of 13.5 MW) of generation. The Collbran load (GVP) was 6.6 MW in the case.

The 2010 HS capital budget case was benchmarked to assess the transmission system reliability prior to adding the proposed 50 MVA load to the system. To do this, a tap on the Rifle CU-Collbran 138kV line was modeled in the load flow case. The line was tapped for the Horsethief Substation approximately two miles from Collbran or 95% of the distance from Rifle CU 138kV to Collbran 138kV (Case: 10HS_H). The following cases were developed"

- a 50 MW load (and 0.90 lagging power factor) at Horsethief (Case: 10HS_HL)
- a 50 MW load (and 0.95 lagging power factor) at Horsethief (Case: 10HS_HLC)
- a 50 MW load (and 0.95 lagging power factor) with the Molina generating units o/s, a reduction of 9 MW of generation at Molina (Case: 10HS_HLCM)
- a 50 MW load (and 0.95 lagging power factor) with the Molina generating units o/s and shunt capacitors added at Horsethief (Case: 10HS_HLCMS).

Outages were simulated and the results are listed in the tables that follow.

Table 8 Case:10HS_H Horsethief Substation Added with No Load at Horsethief

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		CRAIG_______230.0-RIFLE_WA____230.0-1				1.000
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	36.1	72.1	
GRANDJCT 138.00		GRANDJCT____345.0-RIFLE_CU____345.0-1				0.982
HORSETHF 138.00		BONANZA_____345.0-BEARS_______345.0-1				1.000
HORSETHF 138.00		BASE CASE				1.006
RIFLE CU 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.988
RIFLE CU 69.000-RIFLE CU 138.00	T2	CAMEO_______69.00-DEBEQUE_____69.00-1	25.0	26.1	104.4	

Table 8 shows the reliability of the system prior to the addition of the Horsethief 50 MVA load. Bus voltages at the substations in the area are within criteria. The contingency overload of the Rifle CU 138-69kV transformer is within the PSCo emergency rating of 115% for load-serving transformers.

A 50 MW (0.9 lagging power factor) load was added at the proposed Horsethief Substation. Outages were simulated and the results listed in Table 9 below.

Table 9 Case:10HS_HL Load added at Horsethief (50 MVA at a 0.90 lagging power factor)

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.835**
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	55.9	111.9	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.871**
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.831**
RIFLE CU 138.00		RIFLE_CU____138.0-RIFLE_CU____230.0-T3				0.958
RIFLE CU 69.000-RIFLE CU 138.00	T2	CAMEO_______69.00-DEBEQUE_____69.00-1	25.0	23.6	94.5	

Table 9 shows that after adding a 50MVA (0.9 lagging power factor) load at Horsethief, the system in not reliable. The contingency voltages at the Horsethief 138kV, Collbran 138kV and Grand Junction CU 138kV busses are below the 0.9 p.u. voltage criteria. To mitigate these contingency violations, the Horsethief load power factor was corrected to 0.95 lagging to represent the customer correcting the load power factor using distribution capacitors. Outages were simulated and the results are listed in Table 10.

Table 10 Case:10HS_HLC Capacitance added at Horsethief to correct Power Factor to 0.95

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.881**
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	51.7	103.3	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.907
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.878**
RIFLE CU 138.00		RIFLE_CU____138.0-RIFLE_CU____230.0-T3				0.968
RIFLE CU 69.000-RIFLE CU 138.00	T2	CAMEO_______69.00-DEBEQUE_____69.00-1	25.0	23.8	95.2	

Table 10 demonstrates that even if the customer corrected the power factor at the Horsethief 138kV bus to 0.95 lagging, contingency voltages at Horsethief 138kV and Collbran 138kV would still be below the 0.9 p.u. contingency voltage criteria. Therefore, additional voltage support would be needed at Horsethief beyond the customer's distribution system additions to correct the load power factor to 0.95 lagging.

The study area includes the Molina Generating Station that connects to the Collbran Substation and has a significant impact on the system at Collbran. The Molina generating units are part of the Collbran Project that includes the Vega Dam and Reservoir, the Upper and Lower Molina power plants, the East Fork Diversion Dam, the Bonham Dam and Reservoir, about thirty-seven miles of canal, and about eighteen miles of pipeline and penstock. The Upper Molina power plant is located on the east bank of Cottonwood Creek and contains a single 8.64 MW generating unit. The Lower Molina power plant is located on the south bank of Plateau Creek near Molina, Colorado and contains a single unit with an installed capacity of 4.85 MW. The two power plants have a combined capacity of 13.5 MW and a reactive capacity of 6.4 MVAR. Western Area Power Administration (Western) manages the power produced by the power plants. The unit output is limited by water availability and the schedules Western maintains with its customers. The power from the Molina generating station helps offset the demand at Collbran Substation, reduces the line flow on the transmission system, and provides voltage support for loads in the study area.

To study the impact of placing the Molina generating units off-line, the “10HS_HLC” case was obtained and the Molina generating units were represented out-of-service. Facility outages in the study are were simulated and the results are listed in Table 11.

Table 11 Case:10HS_HLCM Molina Generating Units Out-Of-Service with 50 MW at Horsethief and Capacitance Added to Correct the Load Power Factor to 0.95

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.826**
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	64.5	128.9	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.863**
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				**0.822**
RIFLE CU 138.00		RIFLE_CU____138.0-RIFLE_CU____230.0-T3				0.956
RIFLE CU 69.000-RIFLE CU 138.00	T2	CAMEO_______69.00-DEBEQUE_____69.00-1	25.0	23.4	93.5	

Table 11 shows the impact of taking the Molina generating units off-line. Contingency voltages would be very low at Horsethief (0.822 p.u.), Collbran 138kV (0.826 p.u.) and Grand Junction CU (0.863 p.u.) for an outage after sectionalizing of the Rifle CU-Horsethief 138kV line.

Because PSCo has no control over the operation of the Monlina units, capacitors would be needed if these units were out-of-service when the Rifle CU-Horsethief 138kV transmission line were out-of-service. The “10HS_HLCM” case was obtained and a switchable capacitor bank (two 15 MVAR capactor banks) added at the Horsethief 138kV bus. Outages of transmission facilities were conducted and the results listed in Table 12.

Table 12 Case:10HS_HLCMS Molina gen o/s, 2-15 MVAR shunt capacitor banks at Horsethief, Horsethief at 0.95 lagging power factor

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.973
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	58.3	**116.5**	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.979
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.973
RIFLE CU 138.00		CLIFTON_____230.0-GRANDJCT____230.0-1				1.000
RIFLE CU 69.000-RIFLE CU 138.00	T2	CAMEO_______69.00-DEBEQUE_____69.00-1	25.0	24.0	96.0	

Table 12 summarizes the branch flows and bus voltages in the vicinity of Horsethief Substation for Case 10HS_HLCMS. Adding 2-15 MVAR of capacitor banks mitigates the potential contingency voltage problems at Horsethief, Collbran and Grand Junction CU. However, it should be noted that the contingency overload of the Grand Junction CU 138-115kV transformer is 116.5%, just over the 115% emergency overload. The contingency that causes this is the outage after sectionalizing of the Rifle CU-Horsethief 138kV line. This outage leaves the Horsethief 50MVA load and the Collbran 138kV load connected to the system by way of a radial line from the Grand Junction CU Substation. Without the Molina generation to offset some of this load, the capacity of the Grand Junction CU 138-115kV transformer (50 MVA) would be exceeded as it would need to serve the Horsethief load, the Collbran load, line and transformer losses and any reactive power flowing on the line. To mitigate this potential problem, PSCo Transmission Planning recommends the addition of a second Grand Junction CU 138-115kV transformer.

The study results show that the system is reliable after the addition of the Horsethief 50 MVA load provided capacitors are added at Horsethief and a transformer is added at Grand Junction CU. The capacitor addition was split into 15 MVAR increments to mitigate the full load running voltage increase or drop as capacitors are switched on and off line. With the Horsethief 138kV power factor corrected to 0.95 lagging by the customer and with the Molina units off-line, the system intact voltage at Horsethief 138kV would be 0.957 p.u. Adding one 15 MVAR bank would increase the system intact voltage to 0.981 p.u. Adding the second 15 MVAR bank would increase the system intact voltage to 1.006 p.u. The voltage change is approximately 2.5% for each bank addition under post-transient voltage conditions. PSCo needs to study the transient conditions due to switching these capacitor banks. Switching the capacitor banks on and off at Horsethief with circuit switchers may require in-line inductors. Table 13 summarizes the flows on the Rifle CU-Horsethief-Collbran 138kV line for the 2010 summer on-peak “heavy” scenario.

Table 13 – Rifle CU-Horsethief-Collbran Line Flows - 2010 On-Peak Summer Conditions

Case	Description	Colbran Load (MW)	Horsthf Load (MW)	Molina-U Pgen (Pmax=8.6)	Molina-L Pgen (Pmax=4.9)	**System Status**	Horsthf Volt (p.u.)	Rifle CU-Horsethief 138kV Flow	Horsethief-Collbran 138kV Flow
10HS_H	From 2010HS Budget Case - Add Horsethf Tap with no load	6.6	0.0	6.0	3.0	**System Intact**	1.006	16.6-j4.7 (11% of 162 MVA rating)	16.5-j1.0 (10% of 162 MVA rating)
10HS_HL	From 2010HS_T - Add Horsethf 50 MW load (0.9 PF)	6.6	50.0	6.0	3.0	**System Intact**	0.957	49.2+j10.9 (32% of 162 MVA rating)	-1.9-j13.9 (9% of 162 MVA rating)
10HS_HLC	From 2010HS_TL - Customer correct PF at POI to 0.95 lagging.	6.6	50.0	6.0	3.0	**System Intact**	0.970	49.3+j5.6 (31% of 162 MVA rating)	-1.8-j11.1 (7% of 162 MVA rating)
10HS_HLCM	From 2010HS_TLC - Molina units O/S	6.6	50.0	0.0	0.0	**System Intact**	0.957	55.0+j10.2 (35% of 162 MVA rating)	3.6-j7.9 (6% of 162 MVA rating)
10HS_HLCM	From 2010HS_TLC - Molina units O/S	6.6	50.0	0.0	0.0	**Outage: Horsthf-Rifle CU 138kV**	0.822	0 + j0	-50.0 – j16.5 (40% of 162 MVA rating)
10HS_HLCMS	From 2010HS_TLM - Add 2-15 MVAR of caps at Horsethf 138kV	6.6	50.0	0.0	0.0	**System Intact**	1.006	55.5 – j10.1 (35% of 162 MVA rating)	4.1 + j2.7 (3% of 162 MVA rating)
10HS_HLCMS	From 2010HS_TLM - Add 2-15 MVAR of caps at Horsethf 138kV	6.6	50.0	0.0	0.0	**Outage: Horsthf-Rifle CU 138kV**	0.973	0 + j0	-50.0 +j12.0 (33% of 162 MVA rating

B. Year 2015 On-Peak Summer Heavy Transfers Results

Heavy transfers through the study area can affect the amount of load that can be reliably served at the proposed Horsethief Substation. Specifically, as north-to-south flows are increased across the transfer path TOT2A (see Section D of the Appendix) in southwest Colorado, the flows from the Craig/Hayden area to the Rifle and Grand Junction CU areas increase. As this occurs, flows on the Rifle CU-Collbran-Grand Junction CU 138kV transmission line increase. Outages of parallel transmission lines may result in even higher flows on the Rifle CU-Collbran-Grand Junction CU 138kV transmission line reducing the capacity available in the line for load-serving.

To study the impacts on the Horsethief Substation of high north-to-south transfers across the study area and connected system, a far term study case was selected. The study case selected was the 2015 heavy summer case that was developed to study alternatives to serve future loads in western Colorado. PSCo is conducting a System Impact Study to determine the transmission upgrades needed to serve new loads in western Colorado over the long term. Several alternatives have been developed to serve the loads. The model for one of these alternatives, Alternative 1 was obtained. It represents a possible demand scenario in the year 2015. This alternative consists of a Rifle CU-Clear Creek-Crawford Trail-Yankee Gulch 345kV line and Starkey Gulch-Clear Creek 230kV line. This alternative could represent the future system in the summer of 2015. Other alternatives being studied would impact the Rifle CU-Collbran-Grand Junction CU 138kV system in much the same way.

The 2015 heavy summer case that was developed to study this alternative included transmission enhancements between Craig and Rifle and was dispatched to create a 500 MW north-to-south flow across TOT2A. The Horsethief Substation was modeled as a tap on the Rifle CU-Collbran 138kV line and a 50 MVA load with a 0.95 lagging power factor was modeled. Outages were simulated and the results are listed in Table 14.

Table 14 Case:15HS_T500_A1_NYHLC Case 2015HS with W.Slope loads and Yampa Project with TOT2A at 500 MW and the Horsethief Load with 0.95 Power Factor

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		RIFLE_CU____138.0-HORSETHF____138.0-1				**0.875**
COLBRAN 138.00		BASE CASE				0.961
GRANDJCT 115.00-GRANDJCT 138.00	T2	RIFLE_CU____138.0-HORSETHF____138.0-1	50.0	48.2	96.4	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	36.3	72.6	
GRANDJCT 138.00		RIFLE_CU____138.0-HORSETHF____138.0-1				**0.899**
GRANDJCT 138.00		BASE CASE				0.963
HORSETHF 138.00		RIFLE_CU____138.0-HORSETHF____138.0-1				**0.872**
HORSETHF 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.921
HORSETHF 138.00		BASE CASE				0.960
MEEKER 138.00-RIFLE CU 138.00	1	CRAIG_______345.0-MEEKER______345.0-1	124.0	99.9	80.6	
RIFLE CU 138.00		RIFLE_CU____138.0-RIFLE_CU____230.0-T3				0.949
RIFLE CU 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.952
RIFLE CU 138.00-HORSETHF 138.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	162.0	83.9	51.8	
RIFLE CU 138.00-HORSETHF 138.00	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	162.0	84.0	51.8	
RIFLE CU 138.00-RIFLE CU 230.00	T3	MEEKER______138.0-RIFLE_CU____138.0-1	168.0	85.5	50.9	
RIFLE CU 69.000-RIFLE CU 138.00	T2	PARACHUT____230.0-WALCRKTP____230.0-1	25.0	35.2	140.7	

Table 14 demonstrates that additional shunt capacitors would be needed at Horsethief Substation to support the heavy transfers, even with the Molina generation on-line. It should be noted that the overload of the Grand Junction CU 50 MVA 138-115kV transformer does not appear in the table because the Molina generators were in-service in the case and were offsetting the Horsethief and Collbran loads. Two 15 MVAR capacitor banks were added at the Horsethief Substation and outages were simulated. The results are listed in Table 15.

Table 15 Case:15HS_T500_A1_NYHLCS Case 2015HS with W.Slope loads and Yampa Project with TOT2A at 500 MW and Horsethief with 0.95 PF and 2-15 MVAR Shunt Caps at Horsethief

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.969
COLBRAN 138.00		BASE CASE				1.001
GRANDJCT 115.00-GRANDJCT 138.00	T2	RIFLE_CU____138.0-HORSETHF____138.0-1	50.0	48.0	96.1	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	37.0	73.9	
GRANDJCT 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.965
HORSETHF 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.969
HORSETHF 138.00		BASE CASE				1.001
MEEKER 138.00-RIFLE CU 138.00	1	CRAIG_______345.0-MEEKER______345.0-1	124.0	100.9	81.3	
RIFLE CU 138.00		CRAIG_______345.0-MEEKER______345.0-1				0.966
RIFLE CU 138.00		BASE CASE				1.006
RIFLE CU 138.00-HORSETHF 138.00	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	162.0	85.3	52.7	
RIFLE CU 138.00-HORSETHF 138.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	162.0	84.4	52.1	
RIFLE CU 138.00-RIFLE CU 230.00	T3	MEEKER______138.0-RIFLE_CU____138.0-1	168.0	85.9	51.1	
RIFLE CU 69.000-RIFLE CU 138.00	T2	PARACHUT____230.0-WALCRKTP____230.0-1	25.0	35.1	140.5	

Table 15 demonstrates that the capacitors at Horsethief provide reactive power to support the heavy transfers. In addition, the Rifle CU-Collbran-Grand Junction CU 138kV line has sufficient capacity to serve the 50 MVA load along with heavy transfers. The contingency overload of the RifleCU 138-69kV transformer that occurs for high TOT2A north-to-south transformers is being studied by PSCo to determine a project to mitigate this contingency overload.

C. Year 2017 On-Peak Winter Results

In many portions of western Colorado, the electrical demand at certain substations can be higher in the winter than in the summer. To verify that the Horsethief Substation and load would be reliable during winter conditions, a 2017 heavy winter case was obtained. The 2017 heavy winter case reflects 6.7 MW of demand at Colbran 138kV and 9 MW of generation at Molina (connected to the Colbran Substation). The case represents a very high south-to-north flow across the TOT2A transfer path with the TOT2A flow at 402 MW south-to-north. This reflects a high import condition into southwest Colorado from Arizona/New Mexico (which has more generation available in winter due to the reduced demand) to Colorado for on-peak winter demand conditions that could occur whenever winter demand is high in Colorado.

The 50 MVA Horsethief Substation was represented as a tap on the Rifle CU-Collbran 138kV line. The proposed western Colorado loads were added along with a 230kV transmission upgrade to serve the loads (Alternative 2 or “A2”). Outages of transmission facilities in the study area were simulated and the results listed in Table 16.

Xcel Energy

Table 16 Case:17HW-NY-A2-HL Case 2017 Heavy Winter, Horsethief Load (0.9 lagging power factor)

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.852
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.830
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	55.3	110.7	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.866
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.826
MOLINA-L 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.854
MOLINA-U 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.855

Table 16 shows that adding the Horsethief 50 MW load assuming a 0.9 lagging power factor results in criteria violations at busses for outages of transmission facilities in the study area. The contingency voltages at the Horsethief 138kV, Collbran 138kV and Grand Junction CU 138kV busses are below the 0.9 p.u. voltage criteria. The contingency overload of the Grand Junction CU 138-115kV transformer is within the 115% emergency rating for load-following transformers.

To mitigate these contingency violations, the Horsethief load power factor was corrected to 0.95 lagging to represent the customer correcting the load power factor using distribution capacitors. Outages were simulated and the results are listed in Table 17.

Table 17 Case:17HW-NY-A2-HLC Case 2017 Heavy Winter, Horsethief Load (0.95 lagging power factor)

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.895
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.875
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	51.1	102.1	
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.872
MOLINA-L 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.897
MOLINA-U 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.898

Table 17 demonstrates that if the customer corrected the power factor at Horsethief 138kV to 0.95 lagging, contingency voltages at Horsethief 138kV and Collbran 138kV would still be below the 0.9 p.u. contingency voltage criteria. Therefore, additional voltage support would be needed at Horsethief beyond the customer's distribution system additions to correct the load power factor to 0.95 lagging.

Switchable shunt capacitor banks were added at the Horsethief Substation. Contingencies were simulated and the results listed in Table 18.

Table 18 Case: 17HW-NY-A2-HLCS Case 2017 Heavy Winter, Horsethief Load (0.95 lagging power factor), 2-15 MVAR Capacitor Banks at Horsethief

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	50.1	100.2	

The case demonstrates that two 15 MVAR switchable capacitor banks mitigate the undervoltage criteria violations.

To study the impact of placing the Molina generating units off-line, the “10HS_HLC” case was obtained and the Molina generating units were represented out-of-service. Facility outages in the study are were simulated and the results are listed in Table 19.

Table 19 Case:17HW-NY-A2-HLCM Case 2017 Heavy Winter, Horsethief Load (0.95 lagging power factor), Molina Generating Station Off-Line

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
COLBRAN 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.822
COLBRAN 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.821
GRANDJCT 115.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.897
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	63.9	127.7	
GRANDJCT 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.858
HORSETHF 138.00		HORSETHF____138.0-RIFLE_CU____138.0-1				0.818

Table 19 shows the impact of taking the Molina generating units off-line. Contingency voltages would be very low at Horsethief (0.818 p.u.), Collbran 138kV (0.821 p.u.) and Grand Junction CU (0.858 p.u.) for an outage after sectionalizing of the Rifle CU-Horsethief 138kV line. In addition, the Grand Junction CU 50 MVA 138-115kV transformer contingency flow reaches 127.7% of its 50 MVA rating for an outage of the Rifle CU-Horsethief 138kV transmission line.

The Molina generating station has a significant impact on the facilities in the study area. The power from the generating station offsets the demand at the Collbran and Horsethief substations, reduces the line flows on the Rifle CU-Collbran-Grand Junction CU 138kV transmission system, and provides voltage support for the loads served from the Collbran Substation. Because the Molina facility is a hydroelectric plant with limited capability and not under the control of PSCo but under the dispatch control of Western-RMR, a second 50 MVA 138-115kV transformer would be needed at Grand Junction CU. Because PSCo has no control over the operation of the Molina Generating Station units, capacitors would be needed if these units were out-of-service when the Rifle CU-Horsethief 138kV transmission line was out-of-service. The “10HS_HLCM” case was obtained and a switchable capacitor bank (two 15 MVAR capactor banks) added at the Horsethief 138kV bus.

Outages of transmission facilities were conducted and the results listed in Table 20.

Table 20 Case: 17HW-NY-A2-HLCMS Case 2017 Heavy Winter, Horsethief Load (0.95 lagging power factor), Molina Generating Station Off-Line, 2-15 MVAR Capacitor Banks at Horsethief

Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
GRANDJCT 115.00-GRANDJCT 138.00	T2	HORSETHF____138.0-RIFLE_CU____138.0-1	50.0	57.7	115.3	

Table 20 shows that the Grand Junction CU 50 MVA 138-115kV transformer contingency flow would exceed the 115% emergency rating for load-following transformers for an outage after sectionalizing of the Rifle CU-Horsethief 138kV transmission line.

When the Molina generators are on-line, the generator output would offset the Horsethief and Collbran demand by the amount of the generation schedule; however, when off-line, the Horsethief and Collbran loads must receive all of their power requirements from the Grand Junction CU-Collbran-Horsethief 138kV line. Although the line has sufficient capacity (162 MVA) to serve the demand, the Grand Junction CU 138-115kV transformer in series with this line has a maximum capacity of 50 MVA under continuous loading conditions and 57.5 MVA (115% of the maximum rating) under emergency conditions. Due to the very high load factor of the

Horsethief units, the amount of demand at Horsethief and Collbran is expected to be above 50 MVA 24 hours per day with only the Collbran load expected to decrease during off-peak hours. The emergency rating of the Grand Junction CU 138-115kV transformer assumes that the load on the transformer would not exceed the continous rating for extended periods of time and that the load experienced by the transformer would drop off during off-peak hours. Since the Horsethief load is not expected to drop off during off-peak hours, if the Molina generators were not available to offset load and the Rifle CU-Horsethief 138kV line were out-of-service, corrective action would be needed to unload the transformers including load reduction at Horsethief. For this reason, PSCo transmission planning recommends the addition of a second Grand Junction CU 138-115kV transformer.

D. Summary of Proposed System Enhancements

The preferred alternative to serve the 50 MVA load addition (at a new substation called Horsethief Substation) is to connect the substation to the Rifle CU-Collbran-Grand Junction CU 138kV transmission line by looping a short section (approximately one span) of138 kV line using 1-477 conductor in and out of the new substation. The PSCo Rifle CU-Collbran 138kV line would extend on the northwest side of the new site. The transmission portion of this project consists of constructing the 138kV facilities required to supply a new 138-4.16kV (4.16kV was the assumed transformer secondary) 60 MVA transformer and associated equipment at the Horsethief Substation.

Two 15 MVAR 138kV switchable capacitor banks and associated circuit switchers would be added at the substation. This assumes the customer has corrected its power factor to within +/- 0.95 at the point-of-interconnection. The Horsethief capacitors were sized to reduce the full load running voltage drop (post transient) to approximate 2.5% as each capacitor is energized. Energizing and de-energizing capacitor banks can result in negative effects to the utility and customer including overvoltages on the capacitor bus due to switching transients. These overvoltages may be high enough to cause arrestor operation or even equipment failure. An additional study to determine the effects of capacitor switching at Horsethief Substation may be required.

The study determined that no transmission line upgrades would be required to serve the Horsethief load; however, a transformer upgrade is required at Grand Junction CU, specifically a second Grand Junction CU 50 MVA 138-115kV transformer. An outage after sectionalizing of the Rifle CU-Horsethief 138kV line leaves the proposed Horsethief 50 MVA load (that will have a very high load factor), the Grand Valley Power (GVP) load at Collbran Substation (approximately 7 MW), and the Molina generating station served from the Grand Junction CU-Collbran-Horsethief 138kV radial transmission line. If the Molina generating station were off-line or otherwise unavailable at sufficient generation levels, the contingency flow across the Grand Junction CU 138-115kV transformer could exceed its emergency rating; therefore, a second 50 MVA Grand Junction CU 138-115kV transformer would be needed.

The following list summarizes the enhancements required to serve the proposed Horsethief 50 MVA load addition:

1. Horsethief Substation

   b. New substation site (Customer supplied).
   c. In-and-out 138kV connection to the 138kV yard of the new substation (assume one span).
   d. 138kV connections including a single bus arrangement with SCADA-controlled load break switches (line rupters),high side metering, and associated switches, buswork, foundations, system control and protection equipment.
   e. Two 15 MVAR shunt capacitor banks with circuit switchers or circuit breakers. PSCo Engineering needs to select between circuit switchers or circuit breakers and determine the capacitor grounding method. PSCo Engineering needs to determine if the circuit switchers should include in-line inductors.
   f. Customer-supplied equipment. This could include a transformer(s), fault interrupter(s), system control, protection equipment and switches.

2. Grand Junction CU Substation

   a. One 50 MVA 138-115kV transformer and associated buswork, switches, circuit breakers, control and protection equipment.