

PAWNEE-SMOKY HILL 345 KV CONDUCTOR COMPARISON

Executive Summary

An analysis was conducted to compare the effects of using bundled 1272 kcmil ACSR “Bittern” versus bundled 1431 kcmil ACSR “Plover” conductor for the Pawnee-Smoky Hill 345 kV line. The thermal rating of the Bittern line is 2867 A (1713 MVA) at 100° C. The thermal rating of the Plover line is 3123 A (1866 MVA) at 100° C. The Pawnee and Smoky Hill 345 kV substation are planned to be rated for 3000 A (1792 MVA).

The difference in power flow between the two conductor sizes was found to be negligible, both for system intact conditions and during contingencies. The maximum injection capability at Pawnee is 800 MW before the limiting element, the Brick Center 230-115 kV autotransformer, becomes overloaded. The highest actual flow on the Pawnee-Smoky Hill 345 kV line was 820 MVA during an outage of the adjacent Pawnee-Daniels Park 345 kV line. Since the actual flows during the critical contingency are less than the 2c1272 kcmil ACSR rating of 1713 MVA during the critical contingency, no additional benefit will be realized by increasing the 345 kV conductor size to 1431 kcmil ACSR.

Introduction

An analysis was conducted to determine the effect of choosing different conductor sizes for the Pawnee-Smoky Hill 345 kV line. Two conductor sizes, 1272 kcmil ACSR “Bittern” and 1431 kcmil ACSR “Plover,” were considered. The line impedance was calculated using a configuration of a single-circuit 345 kV line on double-circuit towers with an average height of 125 feet, with two-conductor, 18-inch, vertical bundles per phase. The thermal rating of the line was calculated at 100° C to be 2867 A (1713 MVA) for Bittern and 3123 A (1866 MVA) for Plover. The location of Missile Site Substation was assumed to be 53 line miles from Pawnee, and 40 line miles from Smoky Hill.

Analysis

Heavy North to South Base Case Model Development

A stressed case was developed from the original benchmark case with heavy north to south flows in order to study the impact of additional injection at Pawnee. Existing generation at Rawhide, Ft. St. Vrain, Ft. Lupton, RMEC, Pawnee, Brush, and Manchief was increased to their maximum levels. Flow across constrained path TOT 3 was increased to 1330 MW. Wind generation at Peetz was scheduled to its maximum output. The generation in Zone 1 was dispatched to the Denver Metro area and south of the metro area by decreasing generation levels at Ray Nixon, Comanche, and LEC, and by scheduling the Lamar DC tie to export.

The following new plant and upgrades are planned to be in-service by 2015 and are therefore present in the base case:

1. Beaver Creek-Erie 230 kV line
 - a. The line is planned by Western and is planned to be in service by <ISD>. The project consists of <desc., conductor, const.>.
2. Brick Center 230-115 kV Autotransformer
3. Pawnee-Smoky Hill 345 kV line
4. Comanche Unit 3
5. Comanche-Daniels Park 345 kV double-circuit line
6. Midway-Waterton 345 kV line
7. Lamar Energy Center (LEC) Unit 1
8. LEC-Boone 500 kV line
9. LEC-Burlington 500 kV line
10. Xcel Energy Line Uprates as a result of model corrections and FAC-9 revisions
11. Western Line Uprates

Base Case Comparison

Under system-intact conditions, and with benchmark generation levels at Pawnee, the difference in flow along the Pawnee-Smoky Hill 345 kV line is approximately 4 MW, as shown in Figure 1 and Figure 2.

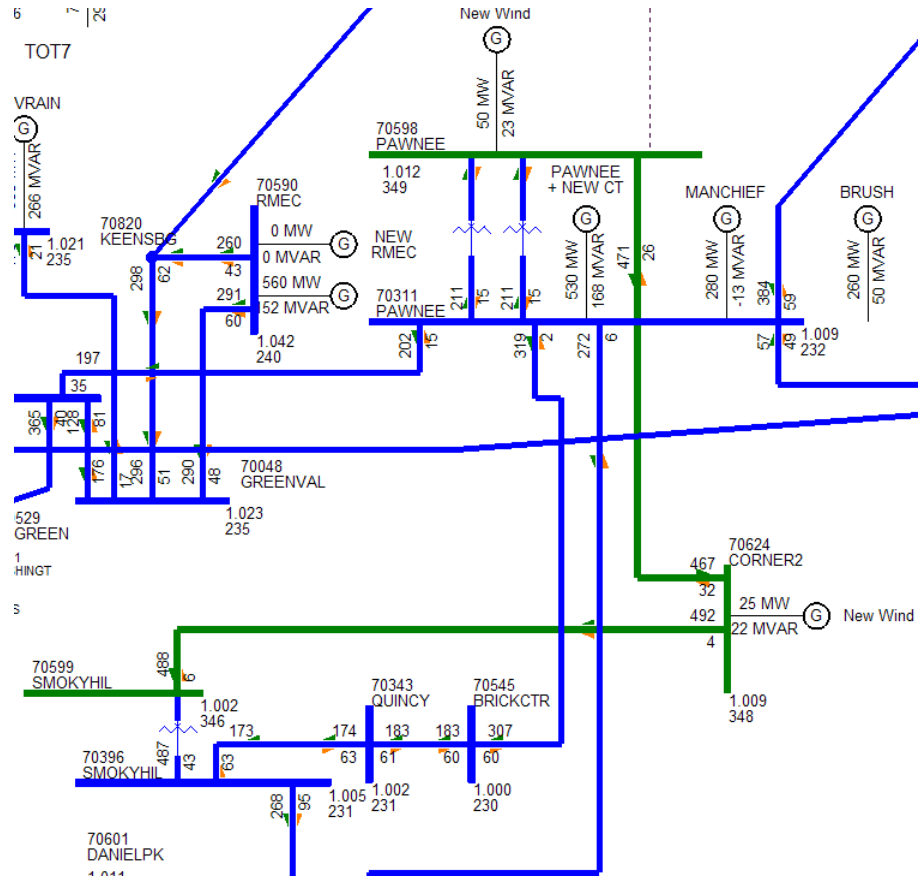


Figure 1 – 1272 kmil ACSR, Base Case System Intact Power Flow

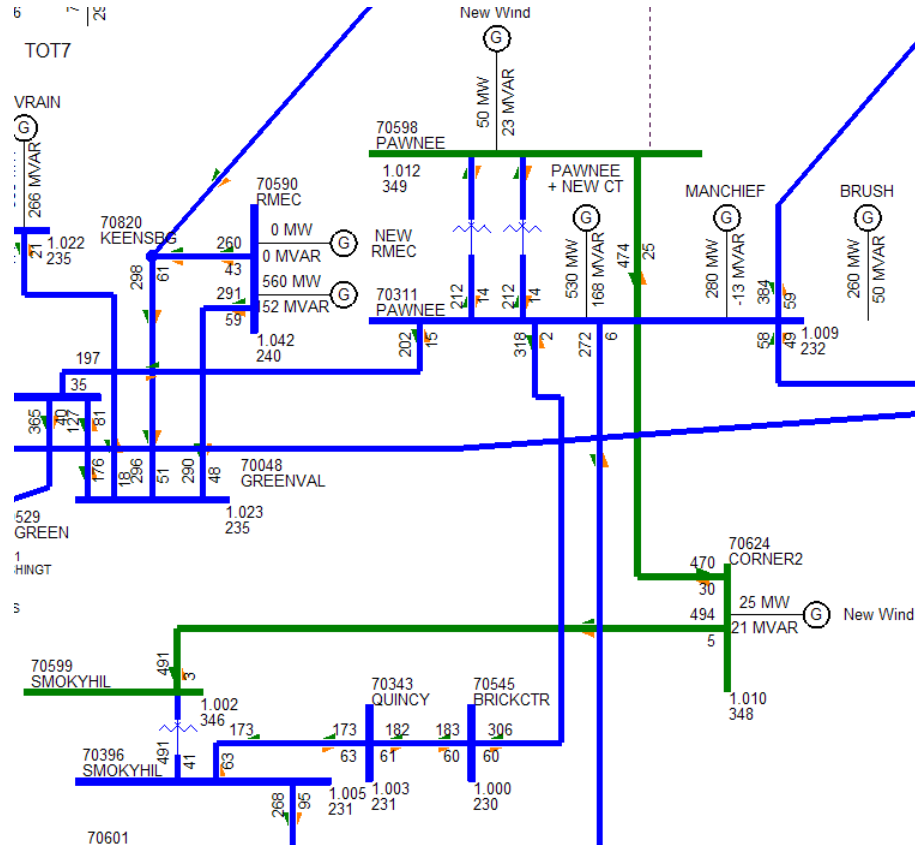


Figure 2 – 1431 kmil ACSR, Base Case System Intact Power Flow

Injection at Pawnee

The injection into the Pawnee 345 kV bus was then increased to 500 MW in order to compare the difference between using 1272 kmil ACSR and 1431 kmil ACSR conductor for the Pawnee-Smoky Hill 345 kV line. Single-contingency analysis was conducted to determine the limiting element with 500 MW injected at Pawnee.

A comparison of the most significantly impacted transmission elements illustrates that there is no improvement to the system by increasing the conductor size from 1272 kmil ACSR to 1431 kmil ACSR. This comparison is shown in Table 1.

Table 1 – Comparison of 1272 kmil ACSR v. 1431 kmil ACSR for Injection-related Overloads

Element	Rating	Base Case %	500 MW 2c1272 %	500 MW 2c1431 %	Percent Diff	Contingency
70545 BRICKCTR 230.00 - 70546 BRICKCTR 115.00 T1	200	100.7	115.3	115.1	-0.2	SINGL1 346 : OPEN LINE FROM BUS 70343 [QUINCY 230.00] TO BUS 70545 [BRICKCTR 230.00] CKT 1
73020 BEAVERCK 115.00 - 73065 GARY 115.00 1	109	95.0	106.3	106.3	0.0	SINGL1 479 : OPEN LINE FROM BUS 70599 [SMOKYHIL 345.00] TO BUS 70624 [MISSILESITE 345.00] CKT 1

73065 GARY 115.00 - 73221 WOODROW 115.00 1	107	< 95	105.3	105.3	0.0	SINGL1 479 : OPEN LINE FROM BUS 70599 [SMOKYHIL 345.00] TO BUS 70624 [MISSILESITE 345.00] CKT 1
73305 EFMORGTP 115.00 - 73379 FMWEST 115.00 1	133	< 95	105.0	104.9	-0.1	SINGL1 546 : OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73464 [ADENA 115.00] CKT 1
73194 SWOODROW 115.00 - 73221 WOODROW 115.00 1	107	< 95	104.1	104.1	0.0	SINGL1 479 : OPEN LINE FROM BUS 70599 [SMOKYHIL 345.00] TO BUS 70624 [MISSILESITE 345.00] CKT 1
73097 KIOWA CK 115.00 - 73213 WIGGINS 115.00 1	50	151.1	159.5	159.4	-0.1	SINGL1 543 : OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1
73125 LSCHANCE 115.00 - 73194 SWOODROW 115.00 1	106	< 95	103.3	103.3	0.0	SINGL1 479 : OPEN LINE FROM BUS 70599 [SMOKYHIL 345.00] TO BUS 70624 [MISSILESITE 345.00] CKT 1
70112 CLARK 230.00 - 70241 JORDAN 230.00 1	394	< 95	103.2	103.3	0.1	SINGL1 91 : OPEN LINE FROM BUS 70067 [BUCKLY12 230.00] TO BUS 70396 [SMOKYHIL 230.00] CKT 1
70396 SMOKYHIL 230.00 - 70599 SMOKYHIL 345.00 T1	750	< 95	102.4	102.9	0.5	SINGL1 328 : OPEN LINE FROM BUS 70311 [PAWNEE 230.00] TO BUS 70545 [BRICKCTR 230.00] CKT 1
70273 MALTA 115.00 - 70274 MALTA 230.00 T1	100	101.7	109.1	109.1	0.0	SINGL1 188 : OPEN LINE FROM BUS 70155 [DILLON 115.00] TO BUS 70156 [DILLON 230.00] CKT T2
70397 B.CK PS 115.00 - 73020 BEAVERCK 115.00 1	379	< 95	102.2	102.5	0.3	SINGL1 790 : OPEN LINE FROM BUS 73192 [STORY 230.00] TO BUS 73537 [BEAVERCK 230.00] CKT 1
73088 HOYT 115.00 - 73103 L.MEADOW 115.00 1	75	122.7	129.1	129.1	0.0	SINGL1 543 : OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1

Double-circuit 345 kV Pawnee to Daniels Park

Next, an analysis was completed with two 345 kV circuits from Pawnee to Daniels Park. The first circuit interconnects the Pawnee, Missile Site, Smoky Hill, and Daniels Park substations. The second circuit interconnects directly from Pawnee-Daniels Park. The configuration is illustrated in Figure 3. Injection at Pawnee was increased in 100 MW increments to determine the maximum injection that could be realized with the system configuration of Figure 3.

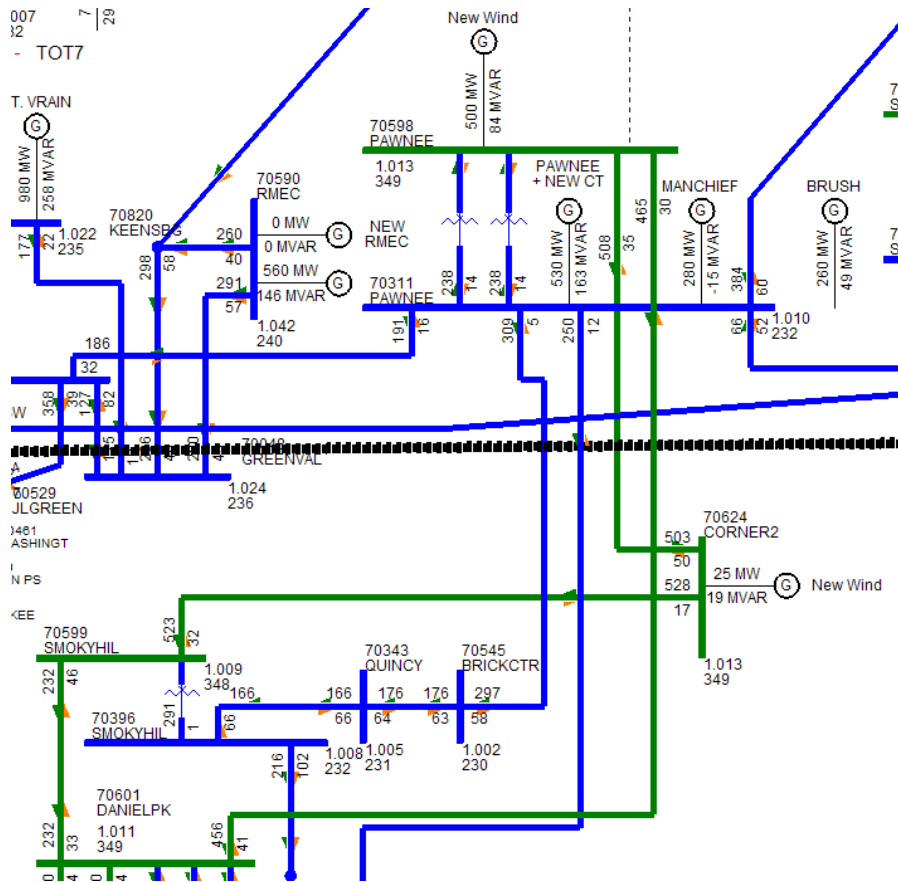


Figure 3 - Double-circuit Pawnee-Daniels 345 kV

Approximately 800 MW can be injected into the Pawnee 345 kV bus with both 345 kV circuits from Pawnee to Daniels Park in service. The limiting element is the Brick Center 230-115 kV autotransformer during an outage of the Brick Center-Quincy 230 kV line. The use of 1431 kcmil ACSR did not significantly increase the maximum injection at Pawnee.

The maximum power flow on the 345 kV system was 820 MW on the Missile Site-Smoky Hill 435 kV line during an outage of the Pawnee-Daniels 345 kV line. Both the Bittern and Plover conductors have sufficient capacity for this contingency, with ratings of 1713 MVA and 1866 MVA, respectively.

Conclusion

The difference in power flow is negligible for the two conductor sizes studied. The maximum injection that can be realized at Pawnee without causing overloads on the surrounding system is approximately 800 MW for the dispatch scenario that was studied. During contingency conditions, the maximum flow on the 345 kV system between Pawnee and Daniels Park was significantly lower than the conductor ratings of either the 2c1272 kcmil ACSR “Bittern” or the 2c1431 kcmil ACSR “Plover.”