

RUSH CREEK WIND 345 KV TRANSMISSION LINE PROJECT
NOISE MODELING

1272 Bittern – 2 Conductor Bundle

Corona Audible Noise For 345 kV Rush Creek Gen-Tie

Corona is the electrical ionization of the air that occurs near the surface of the energized conductor and suspension hardware due to very high electric field strength. Corona may result in audible noise being produced by the transmission lines.

The amount of corona produced by a transmission line is a function of the voltage of the line, the diameter of the conductors, the locations of the conductors in relation to each other, the elevation of the line above sea level, the condition of the conductors and hardware, and the local weather conditions. Power flow does not affect the amount of corona produced by a transmission line, therefore only one set of corona results is predicted for the single circuit Rush Creek 345 kV Gen-Tie. Corona typically becomes more of a design concern for transmission lines at 345 kV and above and is less noticeable from lines that are operated at lower voltages.

The electric field gradient is greatest at the surface of the conductor. Large-diameter or bundle conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. The conductor chosen for the Rush Creek Gen-Tie was selected to have a larger diameter sub-conductor and thus a reduced potential to create audible noise.

Irregularities (such as nicks and scrapes on the conductor surface or sharp edges on suspension hardware) concentrate the electric field at these locations and thus increase the electric field gradient and the resulting corona at these spots. Similarly, foreign objects on the conductor surface, such as dust or insects, can cause irregularities on the surface that are a source for corona.

Corona also increases at higher elevations where the density of the atmosphere is less than at sea level. Audible noise will vary with elevation with the relationship of $A/300$ where A is the elevation of the line above sea level measured in meters (EPRI 2005). Audible noise at 600 meters elevation will be twice the audible noise at 300 meters, all other things being equal. The new Rush Creek 345 kV Gen-Tie was modeled using a maximum elevation of 6,000 feet (1828 meters).

Raindrops, snow, fog, hoarfrost, and condensation accumulated on the conductor surface are also sources of surface irregularities that can increase corona. During fair weather, the number of these condensed water droplets or ice crystals is usually small and the corona effect is also small. However, during wet weather, the number of these sources increases (for instance due to rain drops standing on the conductor) and corona effects are therefore greater. During wet or foul weather conditions, the conductor will produce the greatest amount of corona noise. However, during heavy rain, the noise generated by the falling rain drops hitting the ground will typically be greater than the noise generated by corona and thus will mask the audible noise from the transmission line. Corona produced on a transmission line can be reduced by the design of the transmission line and the selection of hardware and conductors used for the construction of the line. For instance the use of conductor hardware that has rounded rather than sharp edges and no protruding bolts with sharp

edges will reduce corona. The conductors themselves can be made with larger diameters and handled so that they have smooth surfaces without nicks or burrs or scrapes in the conductor strands. The Gen-Tie proposed here is designed to reduce corona generation.

Modeling Methodology

Colorado Public Utilities Commission Rules 3102 and 3206 require that an applicant for a Certificate of Public Convenience and Necessity (“CPCN”) for a construction or extension of transmission facilities model the potential noise levels that the line could produce.

The audible noise from the proposed transmission lines was predicted using the utility-standard Corona and Field Effects Program, Version 3.1, (also known as the “BPA Program”), a program developed by Bonneville Power Administration, U.S. Department of Energy.

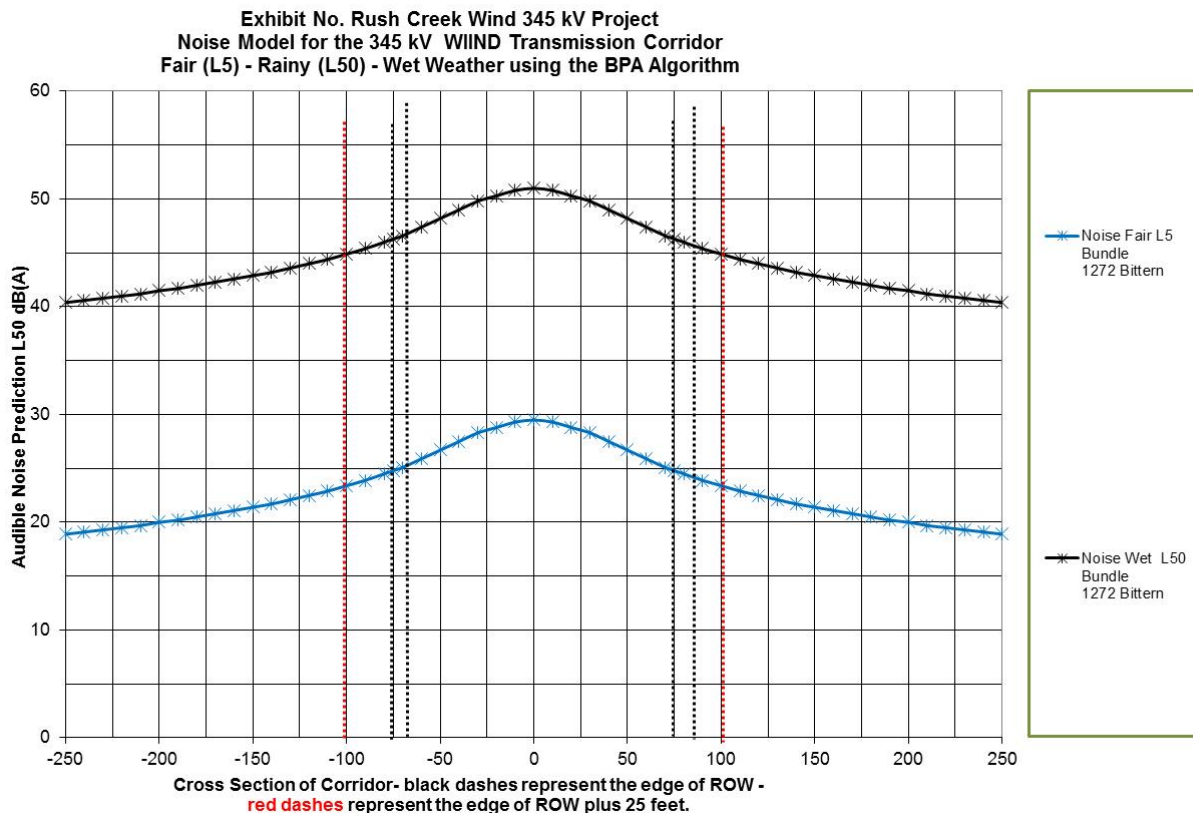
The data presented in Tables A-1 and A-2 of Appendix A were input into the Corona and Field Effects Program to calculate the corona audible noise, with the addition of elevation of the line above sea level. The new Rush Creek Wind 345 kV Gen-Tie was modeled with an elevation of 6,000 feet (1828 meters), which is approximately the average elevation along the corridor. Because the equations that predict audible noise were created from empirical measurements, the accuracy of the model is as good as the measurements that produced the original equations. In addition, the model is as good as the accuracy of the parameters input to the model (e.g. the actual elevation of the transmission line at a particular location rather than the average elevation of the entire project). Given these potential uncertainties, the resulting field plots are within a few percent of the true value for the conditions modeled. Actual testing of the Comanche – Daniels Park Corridor (3 – 345 kV transmission lines and 1 – 230 kV transmission line) showed that the modeled audible noise values were 3 dB(A) to 5 dB(A) higher than actual noise levels measured in the field.

Modeling Results

Figure 2 shows the audible noise modeled for the new Rush Creek 345 kV Gen-Tie. It also shows two conditions, fair and rain. This is to show the range in corona effects due to changing weather.

Rush Creek Wind 345 kV Corridor – Audible Noise

Figure 2, Audible noise for the Rush Creek 345 kV Gen-Tie.



The audible noise at both the right and left right of way (“ROW”) edge is 24.8 dB(A) (23.4 dB(A) at edge of ROW plus 25 feet) in fair weather and 46.3 dB(A) (44.9 dB(A) at edge of ROW plus 25 feet) in wet weather. The maximum noise that occurs within the ROW is 29.5 dB(A) in fair weather and 51 dB(A) in wet weather.

APPENDIX A

BPA Modeling Inputs

Table A-1 – Projected Electrical Power Flows, Conductor Size and Type, and Operating Voltage				
Line	Phase (top to bottom)	Case #1 Normal Loading (25% Conductor Capacity) Amps	Case #2 Maximum Loading (50% Conductor Capacity) Amps	Case #3 N-1 Loading (100% Conductor Capacity) Amps
New Rush Creek 345 kV Gen-Tie				
Rush Creek Gen-Tie	Shield Wire/OPGW	0	0	0
	A	685	1370	2740
	B	685	1370	2740
	C	685	1370	2740

Shield Wire = 3/8" EHS Steel, 7 Strand. Diameter = 0.360 inches. Weight/Foot = 0.273 lbs.

OPGW = 48 Fibers

Conductor (All 3 phases) = 2 - 1272 kcmil 45/7 Bittern ACSR. Diameter = 1.345 inches. Weight/Foot = 1.434 lbs.

Operating Voltage = 345 kV

Case #3 = 100% Conductor Capacity = 100 Degrees C Thermal Limit = 2740Amps per bundle (1370 Amps per conductor)

Table A-2 – Conductor Height and Horizontal Location, Conductor Sag, and Conductor Phasing				
Line	Phase (top to bottom)	Horizontal Location (ft)	Height (ft)	Sag (ft)
New Rush Creek 345 kV Gen-Tie				
Rush Creek Gen-Tie	Shield Wire/OPGW	13.5	52	14
	A	-27	30	29
	B	0	30	29
	C	27	30	29

Minimum Ground Clearance at Maximum Sag = 30 Feet.