**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	)	PROCEEDING NO. 16A-0117E

<u>DIRECT TESTIMONY AND ATTACHMENTS OF BRAD D. COZAD</u>

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

MAY 13, 2016

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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<u>SUMMARY OF THE DIRECT TESTIMONY OF BRAD D. COZAD</u>

Mr. Cozad is the Manager – Transmission Engineering. In this role, he is responsible for overseeing all engineering, design and cost estimates associated with the 345 kilovolt ("kV") Rush Creek Gen-Tie. Mr. Cozad addresses the proposed engineering design and cost estimates of the 345 kV Rush Creek Gen-Tie and associated facilities, including structures, magnetic fields, audible noise, and prudent avoidance measures. He identifies the specific findings regarding magnetic field and audible noise levels for which the Company is seeking a finding of reasonableness with respect to the 345 kV Rush Creek Gen-Tie in this proceeding. The Company's noise modeling resulted in a maximum audible noise level of 44.9 A-weighted

decibels ("dB(A)") at 25 feet outside of the edge of the right of way ("ROW"), which is below the 50 dB(A) threshold established under Rule 3206(f)(III). The Company's magnetic field modeling resulted in a maximum magnetic field level that could be experienced under design conditions at the edge of the transmission ROW, at a location one meter above the ground of 149.3 milligauss ("mG"), which is below the threshold established under Rule 3206(e)(III).

As Mr. Cozad explains, the Company estimates the cost of the 90-mile 345 kV Rush Creek Gen-Tie and Rush Creek Switching Station and network upgrades is $121.4 million. Mr. Cozad also prepared the 230 kV cost estimate, which is $90.2 million.

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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DIRECT TESTIMONY AND ATTACHMENTS OF BRAD D. COZAD

INDEX

SECTION **PAGE**

LIST OF ATTACHMENTS

Attachment BDC-1	345 kV Tangent H-Frame Structure Drawing
Attachment BDC-2	345 kV Three-Pole Guide Deadend Structure Drawing
Attachment BDC-3	345 kV Three-Pole Foundation Deadend Structure Drawing
Attachment BDC-4	345 kV Noise Study
Attachment BDC-5	345 kV Noise at ROW + 25 feet
Attachment BDC-6	345 kV Magnetic Field Study

GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	Meaning
ACSR	Aluminum conductor steel-reinforced
Amp	Amperage
BPA	Bonneville Power Administration
CPCN	Certificate of Public Convenience and Necessity
dBA	A-weighted decibels
EPRI	Electric Power Research Institute
Hz	Hertz
kV	Kilovolt
Leq	Equivalent Sound Pressure Level
mG	Milligauss
MW	Megawatt(s)
NESC	National Electric Safety Code
O&M	Operations and Maintenance
Public Service or Company	Public Service Company of Colorado
ROW	Right of Way
Xcel Energy	Xcel Energy Inc.
XES or Service Company	Xcel Energy Services Inc.

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF COLORADO

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	)	**PROCEEDING NO. 16A-0117E**

<u>DIRECT TESTIMONY AND ATTACHMENTS OF BRAD D. COZAD</u>

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Brad D. Cozad. My business address is 1800 Larimer, Suite 500, Denver, Colorado 80202.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?

A. I am employed by Xcel Energy Services Inc. ("XES") as Manager – Transmission Engineering. XES is a wholly-owned subsidiary of Xcel Energy Inc. ("Xcel Energy"), and provides an array of support services to Public Service Company of Colorado ("Public Service" or "Company") and the other utility operating company subsidiaries of Xcel Energy on a coordinated basis.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THE PROCEEDING?

A. I am testifying on behalf of Public Service.

Q. PLEASE SUMMARIZE YOUR RESPONSIBILITIES AND QUALIFICATIONS.

A. A statement of my qualifications, duties, and responsibilities is included after the conclusion of my testimony.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my testimony is to provide support for the Company's Verified Application for a Certificate of Public Convenience and Necessity ("CPCN") for approximately 90 miles of 345 kilovolt ("kV") electric transmission line connecting the Rush Creek Wind Project to Public Service's Missile Site Substation located in Arapahoe County (the "Rush Creek Gen-Tie" or the "Gen-Tie"). Specifically, I discuss the proposed engineering design of the Rush Creek Gen-Tie and associated facilities, including structures, magnetic fields, audible noise, and prudent avoidance measures. In addition, I identify the specific findings regarding magnetic field and audible noise levels the Company is seeking a finding of reasonableness with respect to the Rush Creek Gen-Tie in this proceeding. As I explain, Public Service's recommended design for the Rush Creek Gen-Tie is expected to result in audible noise under wet conditions at or below the levels deemed reasonable under Commission Rule 3206(f)(II) as measured from the edge of the Gen-Tie right-of-way ("ROW") plus 25 feet. The Company is also requesting that the Commission find as reasonable the magnetic field levels associated with our design for the 345 kV Rush Creek Gen-Tie.

Q. WHAT ASPECTS OF THE OVERALL RUSH CREEK WIND PROJECT ARE YOU AND YOUR TEAM RESPONSIBLE FOR?

A. My team is responsible for overseeing all engineering, design and cost estimates associated with the Rush Creek Gen-Tie. Mr. Riley Hill relies on the cost information my team developed in presenting the overall cost estimates for the Rush Creek Wind Project.

Q. ARE YOU SPONSORING ANY ATTACHMENTS AS PART OF YOUR DIRECT TESTIMONY?

A. Yes, I am sponsoring Attachments BDC-1 through BDC-5, which were prepared by me or under my direct supervision. Below is a summary of each Attachment:

- Attachment BDC-1 contains a structure drawing of a 345 kV Tangent H Frame
- Attachment BDC-2 contains a structure drawing of a 345 kV Three-Pole Guyed Deadend
- Attachment BDC-3 contains a structure drawing of a 345 kV Three-Pole Foundation Deadend
- Attachment BDC-4 contains the noise studies for the 345 kV Gen-Tie
- Attachment BDC-5 contains the noise study results at the edge of the ROW plus 25 feet
- Attachment BDC-6 contains magnetic field studies for the 345 kV Gen-Tie

II. RUSH CREEK GEN-TIE DESIGN

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I provide an overview of the planned design for the 345 kV Rush Creek Gen-Tie.

Q. PLEASE PROVIDE A BRIEF DESCRIPTION OF THE TRANSMISSION FACILITIES PUBLIC SERVICE PROPOSES TO CONSTRUCT IN CONJUNCTION WITH THE RUSH CREEK WIND PROJECT.

A. The Rush Creek Gen-Tie consists of a 345 kV transmission line that provides an interconnection for the Rush Creek I and Rush Creek II wind generation sites into the Company's existing Missile Site Substation. The Rush Creek Gen-Tie will service the electric production of both Rush Creek I, which is located approximately 40 miles southeast of Public Service's Missile Site Substation, and Rush Creek II, which is located approximately 50 miles east of Rush Creek I. Both facilities will interconnect to the Rush Creek Switching Station and from there connect to the Company's Missile Site Substation. The Missile Site Substation is already designed to accommodate new interconnections at 345 kV, but will need certain transmission network upgrades to accept a new 345 kV transmission line. The Rush Creek Gen-Tie will include all associated equipment such as circuit breakers, switches, and associated protective relaying (i.e., line termination equipment) at the Rush Creek Switching Station and the Missile Site Substation.

Q. DESCRIBE THE CONFIGURATION OF THE TRANSMISSION STRUCTURES FOR THE 345 KV GEN-TIE.

A. The 345 kV Gen-Tie will generally be constructed in a Steel H frame, single-circuit structure. Attachment BDC-1 illustrates this basic structure.

Q. DESCRIBE THE CONDUCTORS THE COMPANY PLANS TO INSTALL.

A. The Company proposes a two-conductor bundled 1272 aluminum conductor steel-reinforced ("ACSR") "Bittern" conductor.

Q. EXPLAIN WHY THE COMPANY PROPOSES TO INSTALL THE STRUCTURES AND CONDUCTORS IT HAS SELECTED.

A. The Company has chosen to use the Steel H Frame configuration for the bulk of the line as it is a cost-effective, reliable method of 345 kV single circuit construction. The Company has used this design on numerous occasions with positive experience. The conductor selection was based on the desired ampacity of the line, to mitigate noise, and because it is a standard conductor size for other 345 kV installations on the Company's system, including the recently built Pawnee-Smoky Hill 345 kV Transmission Line and the Midway-Waterton 345 kV transmission line, as well as the proposed Pawnee-Daniels Park 345 kV project.

Q. WHAT WILL BE THE APPROXIMATE HEIGHT OF THE TRANSMISSION STRUCTURES REQUIRED FOR THE RUSH CREEK GEN-TIE?

A. We anticipate that typical structures for the Gen-Tie will be 90 to 130 feet tall (dependent upon various factors I describe below). Although the final route has not been selected, taller structures are typically utilized when crossing existing distribution and transmission lines or where additional height is required to accommodate existing topography. The Gen-Tie will utilize low corona hardware to minimize audible noise. Overall, Public Service engineers attempted to choose a structure style and configuration that balances electrical, structural, and aesthetic considerations.

Q. WHAT FACTORS DETERMINE INDIVIDUAL STRUCTURE HEIGHTS?

A. Individual structure heights will be determined by the terrain, span length, and sag of the conductor and the minimum clearances prescribed in the National Electric Safety Code ("NESC"). Public Service uses a "buffer" above minimum clearances to ensure continued safe operations. The buffer is usually about 3-5 feet. The support structures may be higher than average where the line crosses other electric lines or highly traveled roads consistent with NESC requirements. Some structures, particularly those crossing over other electrical circuits, may need to be over 130 feet tall or taller, but these taller towers will be the exception and not the norm for the Gen-Tie.

Q. HOW WILL THE STRUCTURES FOR THE GEN-TIE BE SPACED?

A. Although the final route has not been selected, there are existing transmission lines in the area not owned by Public Service. If the final Rush Creek Gen-Tie route parallels or is in close proximity to any existing transmission lines, the new structures will be generally located consistent with any parallel line structures, if cost-effective. In any areas where we construct on a new Right of Way ("ROW") devoid of other existing transmission lines, we will optimize the line design to come up with the most economical design.

Q. WHAT COLOR WILL BE USED FOR THE GEN-TIE TRANSMISSION STRUCTURES?

A. Public Service prefers to use self-weathering steel to minimize the metallic appearance of its steel transmission poles. This steel has a maintenance-free, earth tone color that is similar to wood poles. It starts as a lighter orange-brown and changes to a dark brown over time. Another option is to use industrial gray galvanized finish, where the structures remain a light gray color. Public Service has found that the public also generally prefers the self-weathering brown poles to an industrial gray galvanized finish. We are not proposing to use a painted finish because paint systems wear through and become unsightly over time. Also, they must be repainted periodically, resulting in additional expense and additional outage time for repainting. From the standpoint of both aesthetics and ongoing maintenance, using of an earth tone color is preferable.

Q. WILL THE COMPANY CONSTRUCT THE RUSH CREEK GEN-TIE IN ACCORDANCE WITH INDUSTRY STANDARDS AND GUIDELINES?

A. Yes.

III. RULE REQUIREMENTS FOR AUDIBLE NOISE MODELING

Q. PLEASE PROVIDE AN OVERVIEW OF THIS SECTION OF YOUR TESTIMONY.

A. In this section of my testimony, I discuss the modeling for noise using a proven modeling program accepted by the Commission in prior transmission CPCN filings. Specifically, I present the expected maximum level of noise radiating beyond the property line or ROW at a distance of 25 feet, as required by Commission Rule 3206(f) and explain the cost-effective noise mitigation techniques the Company has employed, as required by Rule 3102(c). I then demonstrate that the recommended 345 kV Gen-Tie is below the maximum threshold for review based on Commission Rule 3206(f)(III), which provides that "the noise level will not be subject to further review if the applicant proposes a noise threshold of 50 A-weighted decibels ("db(A)") or below regardless of the use of the land." Our noise modeling resulted in a 44.9 dB(A) at 25 feet outside of the edge of the ROW.

Q. HAVE YOU PREPARED ANY ATTACHMENTS ILLUSTRATING THE AUDIBLE NOISE EXPECTED TO BE GENERATED FROM THE RUSH CREEK GEN-TIE?

A. Yes. Attachment BDC-4 is the audible noise study that illustrates the projected audible noise generated by the 345 kV Gen-Tie, based on the Bonneville Power Administration ("BPA") Corona and Field Effects Program Version 3.1. Attachment BDC-5 is the numerical representation of audible noise at various distances from the ROW centerline.

Q. HAS THE COMPANY USED THE BPA PROGRAM IN PREVIOUS CPCN APPLICATIONS?

A. Yes. We utilized the BPA program in Proceeding No. 14A-0287E, where Public Service sought a CPCN for the Pawnee-Daniels Park transmission project. Previous to that, Public Service used the Electric Power Research Institute ("EPRI") ENVIRO program, which Rule 3102(c) notes as a utility standard program. Although the ENVIRO program is no longer offered to utilities, the ENVIRO program utilized the BPA noise subroutine. Public Service has used the BPA sound modeling subroutine in the ENVIRO program for many projects brought before the Commission, including the Midway – Daniels Park 230kV Rebuild Project (Proceeding No. 03A-276E, Decision No. C04-0051); the Comanche – Daniels Park 345kV Transmission Project (Proceeding No. 05A-072E, Decision No. C06-0786); the Midway – Waterton 345kV Transmission Project (Proceeding No. 07A-156E, Decision No. C07-0750); the Pawnee – Smoky Hills 345 kV Project (Proceeding No. 07A-421E, Decision No. C09-0048); and the Rifle (UTE) – Parachute 230 kV Project (Proceeding No. 13A-0032E, Decision No. C13- 0256).

Q. PLEASE ADDRESS THE ACCURACY OF THE TRANSMISSION LINE MODELING PROGRAM THAT YOU USED.

A. The audible noise modeling program we used consists of empirical models that were developed using field-testing as the basis of origin. Although sound modeling is an inexact science, it nonetheless provides good insight or predictions on what corona-generated audible noise activity will likely occur.

BPA and EPRI conducted thousands of field measurements on electric transmission power lines. They then plotted the graphs from those field results and developed equations, algorithms and modeling, which consider the input variables from the field tests. These audible noise modeling programs allow Public Service to predict the audible noise that will be generated from a proposed project by inputting variables such as the conductor and static wire dimensions and spacing, the overall geometry of the project, the elevation of the project, the operating voltage, and the rain rate. The models are statistically based and provide output figures, which are the expected average audible noise levels.

Q. HAS THE COMPANY EVER PERFORMED A FIELD CHECK AGAINST THE MODELING RESULTS TO CONFIRM THE ACCURACY OF THE MODELING?

A. Yes. In the Comanche – Daniels Park 345 kV Transmission Project case (Proceeding No. 05A-072E, Decision No. C06-0786), the Commission ordered the Company to perform field measurement after the project was constructed and operational. There, the Company's field measurements compared the level of noise authorized by the Commission to that of the actual noise in wet conditions under normal operations. The Company conducted two such field measurement investigations, once in the summer of 2011 and again in the spring of 2012. Both field measurements resulted in a finding that the Company's modeling predictions were conservative (meaning the model results are higher than actual noise under wet conditions) compared to actual field measurements. Public Service filed these reports with the Commission in Proceeding No. 05A-072E.

Q. PLEASE PROVIDE A PRACTICAL COMPARISON FOR THE DB(A) SCALE.

A. The following Table BDC-1, is a decibel level reference chart provided in the EPRI Transmission Line Reference Book – 200 kV and Above, Third Edition. This chart provides a reasonable and useable guide to how people experience sound at various decibel levels:

Table BDC-1 Noise Levels in dB(A)

130-140	Threshold of Pain
120-130	Pneumatic chipper
110-120	Loud audible horn (1 mi. distance)
100-110	(no example)
90-100	Inside subway (New York)
80-90	Inside motorbus
70-80	Average traffic on street corner
60-70	Conversational speech
50-60	Typical business office
40-50	Living room, suburban area
30-40	Library
20-30	Bedroom at night
10-20	Broadcasting studio
0-10	Threshold of Hearing

Q. IN YOUR OPINION, IS IT REASONABLE TO USE THE BPA SOUND MODELING CALCULATIONS?

A. Yes. Use of the BPA data is considered industry standard and is the best noise modeling resource I am aware of that is widely available to utilities. It is based upon thousands of field readings in many states and has specific inputs for altitude. Based on this actual testing, the models provide projections of the average level of audible noise expected to emanate from the Rush Creek Gen-Tie. After developing the model algorithms, BPA and EPRI tested the model results against field readings; the results are reported in what is known to transmission engineers as the "Red Book," the EPRI Transmission Line Reference Book – 200 kV and above. That said, our own field testing shows that the actual noise expected in the field will be less than the ENVIRO modeling, so our use of this data may be a conservative approach.

Q. ARE YOU FAMILIAR WITH THE ELEMENTS OR ASSUMPTIONS THAT ARE USED IN THE SOUND MODELING PROGRAM DEPICTED IN YOUR GRAPH?

A. Yes, I am.

Q. PLEASE DESCRIBE THOSE ELEMENTS OR ASSUMPTIONS.

A. The following elements were considered in modeling the projected sound of the Gen-Tie: a) the BPA program, a recognized software program in the utility industry typically used for sound analyses; b) predicted readings for mid-span locations, at conductor low points and without the influence of the transmission structures; c) maximum elevation of 6,000 feet within the study area; d) the operating voltages shown in Attachment BDC-4) "wet" or "rain" conditions; f) audible noise reflection from the ground or other objects is not known (for example, concrete amplifies sound by reflecting sound waves, whereas dirt or grass conditions absorb sound waves or dampen audible noise); and g) a "burn in" period exists for a few months after new construction and the model predicts audible noise after the "burn-in" period.

Q. WHAT PHENOMENA PRODUCE AUDIBLE NOISE ON HIGH VOLTAGE TRANSMISSION LINES?

A. Several factors produce audible noise on high voltage transmission lines. The higher the voltage on a transmission circuit, the greater the corona activity on the line. Corona is what creates the hissing or crackling sound that often emanates from transmission lines. Corona is a small electrical discharge, not unlike the static electrical charge that a person may experience when touching a metal object when walking on carpeting. Corona increases substantially in wet weather, when water droplets form on a transmission line because the water droplets alter the voltage gradient at the surface of the conductor resulting in increased corona and thus increase in noise. All high voltage transmission lines experience significant corona during wet weather. In normal, fair weather conditions, corona and its corresponding audible noise are usually at low levels.

Q. WHAT OTHER CONDITIONS AFFECT THE AUDIBLE NOISE LEVEL OF A TRANSMISSION LINE?

A. Corona activity is substantially higher at higher altitudes because of the corresponding decrease in air density. Corona-generated audible noise increases by about 1 dB(A) for every 1000 feet in elevation gain. A transmission line constructed in the Front Range of Colorado area will have corona noise about 5-6 dB(A) higher than a similarly constructed line at sea level. A second source of audible noise on a transmission line is a 120 Hertz ("Hz") synchronous hum created by systems operating at 60 Hz. This 120 Hz hum is generally of little consequence, but it can contribute to audible noise. The audible noise generated by corona causes most concerns.

Q. WHAT ARE THE PROJECTED AUDIBLE NOISE LEVELS ASSOCIATED WITH THE RUSH CREEK GEN-TIE?

A. All studies were based on the planned build out of a two-conductor bundled single circuit 345 kV/1272 ACSR Gen-Tie. Attachments BDC-4 and BDC-5 set forth Public Service's projections as to the audible noise that will be expected from the Rush Creek Gen-Tie under both fair and wet/rainy weather conditions. In fair weather conditions the audible noise-modeling program predicts that the audible noise levels are expected to be be 23.4dB(A).

Q. PLEASE DESCRIBE THE PROCESS YOU USED TO COME UP WITH THE DIFFERENT OPTIONS YOU MODELED FOR THE GEN-TIE?

A. Both segments of the Gen-Tie will have a single circuit steel H-Frame 345 kV transmission line (see Attachment BDC-1). We utilized the loadings based upon Commission Rule 3206(e) and (f) – i.e., average normal loading (25% of bundle capacity), maximum loading (50% of bundle capacity) and maximum rating of the conductor (100% of bundle capacity). We based all modeling on actual proposed average loads and proposed maximum loads. Some of the variables that have an effect on audible noise but do not change the magnetic field values are conductor diameter or different types of conductor, vertical bundle spacing and number of conductors (e.g., two-conductor bundle versus a single conductor versus a three conductor bundle).

Q. WHAT ARE THE RESULTS OF THE NOISE ANALYSES FOR THE GEN-TIE?

A. Our modeling results in a noise level of less than 50 dB(A) at the edge of the ROW plus 25 feet, when wet. Because we have not yet selected our final route, we based our ROW modeling off a 150-foot ROW.

Attachment BDC-4 predicts the L5 average audible noise levels in fair weather and also predicts the L50 average audible noise levels when the lines are wet. The wet/rainy weather models assume the line is saturated with moisture and therefore predicts the average worst-case scenario. As lines begin to dry, from the heat of the current, from the sun and wind, audible noise levels will decrease from the model predictions.

Q. PLEASE EXPLAIN WHAT YOU MEAN BY “L5” AND “L50” WHEN YOU REFER TO THE AVERAGE NOISE LEVELS?

A. Average weighted sound levels are typically measured or presented as equivalent sound pressure level (Leq), which is defined as the average noise level, on an equal energy basis for a stated period, and is commonly used to measure steady-state sound or noise that is usually dominant. Statistical methods are used to capture the dynamics of a changing acoustical environment. Statistical measurements are typically denoted by Lxx, where xx represents the percentile of time the sound level is exceeded. The L5 is a measurement that represents the noise level that is exceeded during 5 percent of the measurement period. Similarly, the L50 represents the noise level exceeded for 50 percent of the measurement period.

Q. PLEASE EXPLAIN THE VERTICAL DOTTED LINES ON ATTACHMENT BDC-4.

A. The vertical dotted lines are based off a ROW width of 150 feet. On the Noise Chart for the Wet – L50 data, the red dotted line are the edge of the existing/proposed ROW plus 25 feet, as required by Rule 3206(f).

Q. WHAT IS THE LEGAL STANDARD THAT APPLIES TO NOISE LEVELS FOR THE RUSH CREEK GEN-TIE?

A. Section 25-12-103(12), C.R.S., provides that the Commission can determine whether the projected audible noise levels for electric transmission lines are reasonable when reviewing CPCN applications without regard to the audible noise levels otherwise set forth in the state statute. The requirements of this statute are also reflected in Commission Rule 3206(f).

Q. HOW CAN THE COMMISSION DETERMINE WHETHER THE PROJECTED AUDIBLE NOISE LEVELS OF THE GEN-TIE ARE REASONABLE?

A. Section 25-12-103, C.R.S. sets forth audible noise levels for various "zones" that the General Assembly has found to be acceptable for uses other than electric transmission lines. They are as follows in Table BDC-2 (measured from 25 feet or more from the property line of the audible noise generator):

Table BDC-2 Statutory Noise Limits

Zone	**7:00 a.m. to next 7:00 p.m.**	**7:00 p.m. to next 7:00 a.m.**
Residential	55 dB(A)	50 dB(A)
Commercial	60 dB(A)	55 dB(A)
Light Industrial	70 dB(A)	65 dB(A)
Industrial	80 dB(A)	75 dB(A)

Public Service projects the entire Gen-Tie, including the Rush Creek I Switching Station will all have audible noise levels of 44.9 dB(A), which is below the most restrictive level set forth in statute, (i.e. 50 dB(A)). Accordingly, predicted audible noise will be compliant with Rule 3206(f)(II) levels.

Q. CAN YOU DESCRIBE THE REQUIREMENTS OF COMMISSION RULE 3102(c)?

A. Yes. When an electric utility applies for a CPCN to construct or extend transmission facilities, Commission Rule 3102(c) requires it to "describe its actions and techniques relating to cost-effective noise mitigation with respect to the planning, siting, construction, and operation of the proposed transmission construction or extension." The Commission lists eight steps and techniques a utility may employ to reduce noise.

Q. WHAT HAS PUBLIC SERVICE DONE TO MEET THE REQUIREMENTS OF COMMISSION RULE 3102(C) WITH RESPECT TO THE RUSH CREEK GEN-TIE?

A. Public Service will employ each of the eight techniques to varying extents to cost-effectively mitigate noise. Specifically, we have chosen large conductors that are of high-quality and bundled, will phase the conductors in the most cost-effective manner taking into account noise mitigation, utilize corona-free attachment hardware, carefully handle the conductor, utilize industry-standard construction techniques, and utilize a line tension that maximizes our ability to cost-effectively mitigate noise.

IV. MAGNETIC FIELD MODELING AND MITIGATION

Q. PLEASE PROVIDE AN OVERVIEW OF THIS SECTION OF YOUR TESTIMONY.

A. In this section of my testimony, I explain the magnetic field modeling the Company conducted, as required by Rule 3206(e), which requires a CPCN application to include “the expected maximum level of magnetic fields that could be experienced under design conditions at the edge of the transmission right-of-way or substation boundary, at a location one meter above the ground.” I describe our actions and techniques relating to prudent avoidance as required by Rule 3102(d). I also present our modeling results, which show that the magnetic fields from the 345 kV Gen-Tie are expected to be below 150 mG. Commission Rule 3206(e)(III) provides that magnetic field levels below 150 mG are “deemed reasonable by rule,” therefore, I request the Commission find the magnetic fields emitted from the 345 kV Gen-Tie to be reasonable.

Q. PLEASE PROVIDE AN OVERVIEW OF ELECTROMAGNETIC FIELDS, MAGNETIC FIELDS AND ELECTRIC FIELDS.

A. The term electromagnetic field refers to electric and magnetic fields that are coupled, as in high-frequency radiating fields. When the frequency of these fields is sufficiently low, electromagnetic fields should be separated into electric fields or E Fields (related to voltage) and magnetic fields or B Fields (related to current). In my testimony I will be talking about magnetic fields only, as required by the Commission’s rules.

Q. CAN YOU DESCRIBE THE REQUIREMENTS OF COMMISSION RULE 3102(d)?

A. Yes. When an electric utility applies for a CPCN to construct or extend transmission facilities, Commission Rule 3102(d) requires it to "describe its actions and techniques relating to prudent avoidance with respect to planning, siting, construction, and operation of the proposed construction or extension."

Q. WHAT IS PRUDENT AVOIDANCE?

A. As set out in Commission Rule 3102(d), prudent avoidance "means the striking of a reasonable balance between the potential health effects of exposure to magnetic fields and the cost and impacts of mitigation of such exposure, by taking steps to reduce the exposure at a reasonable and modest cost." The rule lists the following five examples of prudent avoidance steps and techniques: 1) design alternatives to all phasing of conductors; 2) routing of lines to limit exposure; 3) use of higher structures; 4) the widening of corridors; and 5) the burying of lines.

Q. WHAT HAS PUBLIC SERVICE HAS DONE TO MEET THE REQUIREMENTS OF COMMISSION RULE 3102(d) WITH RESPECT TO THE RUSH CREEK GEN-TIE?

A. Public Service has been using "prudent avoidance" techniques for many years. However, not all of the prudent avoidance concepts listed in Rule 3102(d) can be implemented on this project because of either physical limitations or it is not cost effective. On many transmission projects only one or two of the techniques can be reasonably applied.

For the Rush Creek Gen-Tie, the 150 foot ROW and the chosen maximum conductor rating are prudent avoidance measures, which are sufficient to meet the threshold of less than 150 mG established by Rule 3102(d). Therefore, we do not find it necessary to apply any additional prudent avoidance techniques to the Gen-Tie design and construction.

Q. WHY IS PUBLIC SERVICE NOT PROPOSING TO UNDERGROUND THE GEN-TIE?

A. As I stated above, the 150 foot ROW is sufficient to meet the limitation set forth in Rule 3102(d). Undergrounding entails significantly higher costs as well as environmental and technological impacts associated with burying the transmission line. Also, underground transmission lines do not eliminate magnetic fields; the lines simply have a different, albeit more concentrated magnetic field profile; more of a spoke versus more of a bell curve. In addition, placing a high voltage transmission line underground requires electrically insulating each of the three phases (wires) and dissipating the heat through the cable insulation layers and soil to ambient earth. To construct the Gen-Tie underground with the same ampacity as the two-conductor bundled overhead circuit we have proposed, we would have to install multiple underground conductor cables for each phase thereby increasing the cost. In the Company’s experience, the cost of constructing a high voltage line underground can range as much as between 10 and 30 times as expensive as overhead construction depending on the configuration.

The Company also has not constructed a 345 kV transmission line underground for the distance required here.

Underground lines also present challenges during outages. Faults that occur in underground installations are typically more difficult to locate and repair than overhead lines. And, the increased difficulty and duration for repairs can cause significantly longer power outages than with overhead power lines.

Q. WHAT ARE THE MAGNETIC FIELD LEVELS ASSOCIATED WITH THE RUSH CREEK 345 KV GEN-TIE?

A. The Magnetic Field curves shown in Attachment BDC-6 provide an accurate representation of magnetic field levels projected for the 345 kV Gen-Tie. Magnetic fields are directly proportional to the electric current flowing in the conductor. The loads used to calculate the transmission line magnetic fields are based upon Rule 3206(e). Public Service conducts modeling runs based upon three conditions: Average Normal loading (25% of phase conductor(s) capacity), Maximum normal loading (50% of phase conductor(s) capacity) and maximum rating of the conductor (100% of phase conductor(s) capacity). As our study indicates, the projected maximum magnetic field level that could be experienced under design conditions at the edge of the transmission ROW is one, one meter above the ground, is 149.3 mG. However, for the vast majority of time, the Rush Creek Gen-Tie will operate at steady state "Average" Normal loading.

Q. PLEASE DESCRIBE WHAT YOU HAVE DEPICTED ON ATTACHMENT BDC-6.

A. Attachment BDC-6 shows the modeling results for the same cases as were presented for audible noise.

Q. HOW DID YOU CALCULATE THE VALUES AT THE EDGE OF THE ROW IF THE COMPANY HAS NOT YET SELECTED A ROUTE?

A. As I stated above regarding noise, the same hold true for magnetic fields. As Mr. John Lupo testifies, we will acquire a 150 foot wide ROW, and we will center the transmission line in the ROW in order to predict what the magnetic fields will be at the edge of the right of way.

Q. WHAT WOULD YOU EXPECT THE MAXIMUM POSSIBLE LINE FLOWS AND MAGNETIC FIELD VALUES TO BE BASED ON THE MAXIMUM OPERATIONS OF THE GEN-TIE?

A. The line will be rated to carry 2740 amps at full thermal ampacity for the two-conductor bundle. The Rush Creek I and II generation sites at maximum output will only use approximately 37% of the line capacity. Ms. Mirzayi testifies that the benefit of 345 kV is to allow other future uses of this line such as additional interconnection, however any future interconnection would be limited by the 2740 amperage (‘Amp”) rating. This value is shown on Magnetic Field Curves Attachment BDC-6.

Q. HAS THE COMMISSION RULED ON MAGNETIC FIELD REASONABLENESS IN THE PAST?

A. Yes. The projected magnetic fields associated with the Rush Creek Gen-Tie fall below 150 mG, which is deemed reasonable by Commission Rule 3206(e)(III).

V. GEN-TIE COST ESTIMATES

Q. DID YOUR TEAM PREPARE THE COST ESTIMATES FOR THE DESIGNING AND CONSTRUCTING THE 345 KV RUSH CREEK GEN-TIE?

A. Yes. My team prepared the design and construction cost estimates set forth in Mr. Riley Hill's testimony. The Company estimates the total cost for the 345 kV Gen-Tie and switchyard work to be $121.4 million. Of this $121.4 million, $20.6 million are Substation costs. We developed the cost estimates for the Rush Creek Gen-Tie using an industry-recognized cost-management software program called "Hard Dollar". The program utilizes a database that pulls cost data from similar projects the Company and others (when available) have constructed, which we can apply to the specifications of a proposed project. Table BDC-3 below breaks out the cost estimates by category for the Rush Creek Gen-Tie, including substation costs.

Table BDC-3 Rush Creek 345 kV Gen-Tie Capital Cost Estimates

Line Item	***Cost Category***	***Amount***
1	Substation Costs including Land, Switching and Communications	$20.6 million
2	Transmission Costs including Land	$100.8 million

Q. DO YOU BELIEVE THIS ESTIMATE IS REASONABLE?

A. Yes.

Q. WHAT WAS THE COST ESTIMATE YOU PROVIDED TO MR. RILEY HILL FOR THE 230 KV GEN-TIE?

A. Table BDC-4 below is the cost estimate for the 230 kV alternative provided.

Table BDC-4 Rush Creek 230 kV Gen-Tie Capital Cost Estimates

Line Item	***Cost Category***	***Amount***
1	Substation Costs including Land, Switching and Communications	$14.8 million
2	Transmission Costs including Land	$75.4 million

Q. DO YOU BELIEVE THIS ESTIMATE IS REASONABLE?

A. Yes.

Q. HAS COMPANY ESTIMATED OPERATIONS AND MAINTENANCE COSTS FOR THE GEN-TIE?

A. Yes, the Company developed yearly O&M budget for the 345 kV Gen-Tie, which on average nominal dollar basis, is $110,618 per year over the 25-year life of the Rush Creek I and II generation facilities. This estimate is based off known O&M costs for other lines and assumed times and rates of pay for patrolmen to monitor the line. This estimate also includes our projected O&M for the Rush Creek Switching Station, which is also based off historic substation O&M costs.

Q. BASED ON YOUR EXPERIENCE AS A TRANMISSION MANAGER, DO YOU BELIEVE THE GEN-TIE O&M ESTIMATE IS REASONABLE?

A. Yes.

VI. RECOMMENDATIONS AND CONCLUSION

Q. WHAT FINDINGS IS THE COMPANY ASKING THE COMMISSION TO MAKE IN THIS PROCEEDING?

A. The Company is requesting that the Commission approve the recommended 345 kV design of the Rush Creek Gen-Tie as described in my testimony. We request that the Commission find our cost estimates associated with the design, construction, and operation and maintenance of the line reasonable. The Company requests the Commission find that our projected noise level of 44.9 dB(A) for the Gen-Tie is reasonable. The Company also requests the Commission find our projected maximum magnetic field level of 149.3 mG for the Gen-Tie is reasonable.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

Statement of Qualifications

Brad D. Cozad

I graduated from University of Missouri-Rolla with a BS degree in Civil Engineering in 1996 and a MS in Engineering Management In 1999. I worked in the Transmission and Distribution realm for 10 years with a consulting firm, Black & Veatch. In 2003, I received my Professional Engineer's license in the state of Colorado. I began my employment with Xcel Energy as a Project Manager in 2008 and took the position of Manager – Transmission Engineering in 2010. I currently manage a design team for Xcel Energy that provides the engineering services needed to construct new transmission lines as well as the engineering expertise required to maintain existing transmission facilities.