Xcel Energy[SM]

PUBLIC SERVICE COMPANY

IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE SAN LUIS VALLEY – CALUMET – COMANCHE TRANSMISSION PROJECT

DIRECT TESTIMONY AND EXHIBITS OF

DANNY J. PEARSON

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE SAN LUIS VALLEY - CALUMET – COMANCHE TRANSMISSION PROJECT	))))))	**DOCKET NO. 09A-____E**

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I. INTRODUCTION AND STATEMENT OF PURPOSE

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Danny J. Pearson. My business address is 550 15th Street, Denver, Colorado 80202.

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

A. I am employed by Xcel Energy Services Inc., the service company subsidiary of Xcel Energy Inc., the parent of Public Service Company of Colorado. My title is Principal Transmission Design Engineer, Transmission Engineering.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS DOCKET?

A. I am testifying on behalf of Public Service Company of Colorado ("Public Service" or the "Company").

Q. HAVE YOU PREPARED A STATEMENT OF YOUR EXPERIENCE AND QUALIFICATIONS?

A. Yes. That statement is included as Attachment A.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to address the transmission line design criteria associated with the proposed Calumet - Comanche 345 kV Segment ("Calumet - Comanche Segment" or "Segment") of the proposed San Luis Valley – Calumet-Comanche Transmission Project, which the Company is proposing to jointly develop with Tri-State Generation & Transmission Association, Inc. ("Tri-State"). I will discuss the structures, right-of-way corridor, electromagnetic fields, audible noise, and prudent avoidance measures. I also identify the specific findings regarding electromagnetic field and audible noise levels that the Company is seeking in this proceeding. In this case the Company is requesting that the Commission find as reasonable the audible noise levels associated with our recommended design for the Calumet - Comanche Segment as described in my testimony. As I explain, Public Service's recommended design for the Calumet - Comanche Segment is expected to result in audible noise under wet conditions that is below 50 dB(A) at the edge of the right-of-way ("ROW"). The Company also seeks a finding consistent with the Commission's ruling in Docket No. 05A-072E and Docket No. 07A-156E establishing a reasonableness level for electromagnetic fields of 150 mG for the Calumet - Comanche Segment.

II. PROJECT DESIGN

Q. PLEASE DESCRIBE THE PROPOSED TRANSMISSION LINE DESIGN FOR THE CALUMET – COMANCHE SEGMENT.

A. As described in the testimony of Mr. Stellern, this Segment will be approximately 45 miles of new transmission that will be constructed in a new right-of-way.

Q. PLEASE DISCUSS THE CONFIGURATION OR STYLE AND HEIGHT OF THE STRUCTURES?

A. Public Service has proposed a structure style and height that strikes a reasonable balance among several factors. For many years the majority of all 345 kV transmission lines were constructed on "lattice" towers. Due to the close proximity to Pueblo and Walsenburg, Public Service ruled out using lattice towers on this right-of-way because of their larger footprint and the terrain in the area being conducive to steel pole construction. Lattice structures are typically considered advantageous in mountainous terrain, such as the terrain described in the testimony of Tri-State's Mr. Mundorff for sections of the associated San Luis Valley – Calumet Segment. Due to the right-of-way configuration on the Calumet – Comanche Segment, Public Service will utilize a standard construction style on steel poles, with three sets of phase wires stacked in a vertical configuration on each side of the pole, as depicted in my Exhibit No. DJP-1. The support structure will be self-weathering steel similar in color to wood poles. Typical structures for this Segment should be 100-150 feet tall.

The line will use low corona hardware to minimize audible noise. Overall, Public Service engineers attempted to choose a structural style and configuration that balances electrical, structural, and aesthetic considerations.

Q. WHY DID PUBLIC SERVICE CHOOSE STEEL AS THE MATERIAL FOR THE SUPPORT STRUCTURES THAT ARE TO BE BUILT FOR THIS SEGMENT?

A. Steel was chosen for the entire Calumet - Comanche Segment because of its structural capability. Wood is an inadequate material choice for a double-circuit line at 345 kV spacing dimensions and with multiple wires per phase. Wood structures would have to be spaced much closer together in order to carry the weight of the wires. If Public Service were required to use wood poles, significantly more poles would be required than if the structures are steel - possibly even twice the number of poles would be needed.

Q. WHAT FACTORS DETERMINE INDIVIDUAL POLE HEIGHTS?

A. Individual pole heights are determined by the terrain, span length, and sag of the adjacent wire and the minimum clearances prescribed in the National Electric Safety Code. Public Service uses a "buffer" above minimum clearances to ensure continued safe operations. The buffer is usually about 3-5 feet. The support structures will be higher than the average where the line crosses other electric lines or highly traveled roads. Some structures, particularly those crossing over other electrical circuits, may need to be over 170 feet tall, but the taller towers are the exception and not the norm for this Segment.

Q. HOW WILL THE STRUCTURES FOR THIS SEGMENT BE SPACED?

A. The location of the new proposed alignment has not been determined. Portions of the Calumet - Comanche Segment may parallel existing lines. The new structures will be generally located adjacent to any parallel line structures to minimize visual impacts and avoid a “picket fence” appearance. In areas where we will not parallel existing lines, structures will be placed to provide a safe, reliable, and economical design.

Q. WHAT CONSIDERATIONS INFLUENCED THE CHOICE OF SELF-WEATHERING STEEL AS THE COLOR FOR THE STRUCTURES?

A. Public Service chose self-weathering steel to minimize the metallic appearance of the 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. Colors are a personal preference and a highly debatable issue. Public Service has found that the public generally prefers the self-weathering brown poles to an industrial gray galvanized finish. Public Service rejected the idea of using a painted finish because paint systems wear through and become unsightly over time. They must be repainted periodically, resulting in additional expense and additional outage time for repainting. The Company believes that the maintenance-free, earth tone color provides the least objectionable color.

Q. WHAT WIDTH OF RIGHT-OF-WAY CORRIDOR IS NECESSARY FOR THIS SEGMENT?

A. A corridor width of approximately 200 feet of right-of-way will be procured for this Segment.

III. COLORADO REGULATORY REQUIREMENTS

Q. PLEASE DESCRIBE THE REQUIREMENTS OF 4 CCR 723-3102 (c) OF THE CODE OF COLORADO REGULATIONS.

A. Section 4 CCR 723-3102(c) ("Rule 3102(c)") of the Commission's Rules Governing Electric Utilities requires a utility applying for a Certificate of Public Convenience and Necessity ("CPCN") for transmission facilities to describe its proposed actions and techniques for cost-effectively mitigating noise associated with the proposed facilities. The rule further requires the utility to provide computer generated audible noise studies of the proposed transmission line showing the potential noise levels expressed in dB(A) and measured at the edge of the transmission right of way. Some of the techniques recommended to achieve cost-effective audible noise mitigation are larger conductors, bundled conductors, corona-free hardware, conductor quality, handling and packaging, construction techniques, conductor tensions and design alternatives considering the spatial arrangement of phasing of conductors.

Q. PLEASE DESCRIBE WHAT PUBLIC SERVICE HAS DONE TO MEET THE REQUIREMENTS OF RULE 3102(c)?

A. Public Service has based its preliminary design of this Segment using 2-1272 kcmil ACSR "Bittern" conductor. This conductor was chosen based on the increased capacity it created between the Calumet and Comanche Substations, which is consistent with long-range planning projections. Designing the double-circuits between Calumet and Comanche using the 2-

1272 kcmil ACSR "Bittern" conductor also reduces noise, which supports Public Service's objective to balance a number of issues such as audible noise, electromagnetic fields, and economics. The Company believes choosing 2-1272 kcmil "Bittern" conductor is a prudent and sound approach for this corridor. Public Service also chose to use "non-specular" wire, which reduces reflection, and adds to the aesthetics at a small incremental cost.

This Segment will employ a standard bundled conductor configuration with corona-free hardware that has been used on several other projects. A bundled configuration refers to the use of two wires per phase in a vertical configuration. The two wires per phase configuration has the benefit of increased capacity while at the same time reducing the audible noise that would occur with only one wire per phase. An alternative choice would be to use only one larger conductor per phase. Public Service rejected the single large conductor because it would provide less capacity and would emit greater audible noise.

Industry recognized prudent techniques will be used, which will significantly reduce the effects of corona and thus corona-generated audible noise. The phases will be spaced adequately apart so as not to create an excessive voltage gradient, which, if not taken into account, would generate constant and excessive corona. Attachment hardware of a corona-free nature will be specified and procured. Conductor of high quality will be specified and procured.

The conductor will be handled and packaged properly so as not to damage it. The construction crews will use great care; they will use well maintained equipment and proper construction techniques so as not to damage the conductor. A damaged conductor can emit corona and thus emit higher sound levels than an undamaged conductor. Proper line tensions will be applied so as not to create a loose conductor; as with a damaged conductor, a loose conductor emits higher sound levels than a conductor of proper tension. By using these prudent techniques the transmission line will operate as quietly as possible given the voltage and location. All of these requirements are included in our Construction Specifications, which follow IEEE standard 534, IEEE Guide to the Installation of Overhead Transmission Line Conductors.

There is no overhead construction technique that Public Service can employ to prevent the transmission line from becoming wet. Therefore, during wet periods, the transmission will emit audible noise at levels substantially higher than fair weather levels. However, in Colorado, the wet weather periods are relatively short-lived, as the Commission found in the Comanche – Daniels Park Transmission Line docket.[1]

IV. AUDIBLE NOISE

Q. DID YOU PREPARE EXHIBITS TO ILLUSTRATE THE AUDIBLE NOISE EXPECTED TO BE GENERATED FROM THE TRANSMISSION LINE?

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[1] See Docket No. 05A-072E (Decision No. C06-0786 at ¶ 191, July 3, 2006) ("the characteristics of the noise are such that this level of noise [in wet or droplet conditions] is likely to occur relatively infrequently over the course of a year").

A. Yes. Exhibit Nos. DJP-Case 1 & DJP-Case 2 illustrate the expected audible noise generated by the Calumet - Comanche Segment based on the BPA/EPRI sound-modeling program. DJP-Case 1 is for a D/C (double-circuit) 345 kV line and DJP-Case 2 is for a D/C 345 kV line and a S/C (single-circuit) 230 kV line.

A. BPA/EPRI Noise Model

Q. WHAT METHOD DID YOU USE FOR DEVELOPING EXHIBIT NOS. DJP CASE 1 & DJP-CASE 2?

A. I used a sound-modeling program developed by the Bonneville Power Administration ("BPA") and the Electric Power Research Institute ("EPRI"). This program has also been used to calculate noise for previous CPCN filings, including the Midway – Daniels Park 230 kV Rebuild Project (Docket No. 03A-276E, Decision No. C05-0051); the Comanche – Daniels Park 345 kV Transmission Project (Docket No. 05A-072E, Decision No. C06-0786); the Midway – Waterton 345 kV Transmission Project (Docket No. 07A-156E, Decision No. C07-750); and the Pawnee –Smoky Hill 345 kV Transmission Project (Docket No. 07A-421E, Decision No. C09-0048). The Commission accepted the methodology used in each of those applications.

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

A. The audible noise modeling program used by Public Service consists of empirical models that were developed using field-testing as the basis of origin. Sound modeling is an inexact science, but it does provide good insight or predictions on what corona-generated audible noise activity will likely occur. BPA and EPRI did thousands of field measurements of 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. In developing DJP-Case 1 and DJP-Case 2, I used the same modeling algorithm that was employed in the Midway – Daniels Park Rebuild Project (Docket No. 03A-276E), the Comanche – Daniels Park Transmission Project (Docket No. 05A-072E), the Midway – Waterton Transmission Project (Docket No. 07A-156E), and the Pawnee –Smoky Hill 345 kV Transmission Project (Docket No. 07A-421E, Decision No. C09-0048).

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

A. The following is a decibel level reference chart provided in the EPRI Transmission Line Reference Book – 345 kV and Above. This chart provides a reasonable and useable guide to how people experience sound at various decibel levels:

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, ARE THE SOUND MODELING CALCULATIONS THAT YOU HAVE PROVIDED ACCURATE?

A. Yes. The sound modeling that I have presented is based upon thousands of field readings in many states and has specific inputs for altitude. The models provide accurate projections of the average level of audible noise expected to emanate from this Segment. 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 – 345 kV and Above. In reviewing this report, I find that modeling versus field verification is usually plus or minus 2 to 3 dB(A).

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

A. I am.

Q. PLEASE DESCRIBE THOSE ELEMENTS OR ASSUMPTIONS.

A. The following elements were considered in the sound modeling of the Calumet – Comanche Segment: a) the ENVIRO program calculating the Bonneville Power algorithm, a recognized software program in the utility industry typically used for sound analyses, was used; b) readings were predicted for mid-span locations, at conductor low points, without the influence of the transmission structures; c) maximum elevation of 6000 feet between Calumet and Comanche; d) the operating voltages are shown on the exhibits; e) "wet" or "rain" signifies when water droplets are formed on the line, which is represented by the L50 curve (a common statistical indicator); 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 the transmission circuit, the greater the corona activity on the line. Corona is what creates the hissing, crackling or random popping sound. 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. 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?

A. Corona activity is substantially increased at higher altitudes because of the corresponding decrease in air density. A rough rule of thumb is that corona-generated audible noise increases by about 1 dB(A) for every 1000 feet in elevation gain. A transmission line constructed in the Colorado Front Range area will have corona noise about 6 dB(A) higher than a similarly constructed line at sea level.

The second source of audible noise on a transmission line is a 120 Hz synchronous hum created by systems operating at 60 Hz. This 120 Hz hum is generally of little consequence, but it can be a contributor to audible noise. The audible noise generated by corona causes most concerns.

Q. WHAT ARE THE PROJECTED AUDIBLE NOISE LEVELS ASSOCIATED WITH THIS SEGMENT?

A. Exhibit Nos. DJP–Case 1 and DJP-Case 2 set forth Public Service's projections as to the audible noise that will be expected from the Calumet - Comanche Segment under both fair and wet/rainy weather conditions. When there is moisture on the line, whether due to rain, snow or fog, the audible noise-modeling program predicts that the audible noise levels can be as high as 25 dB(A) greater than under fair weather conditions until the line dries. Over 70 different options were modeled to come up with the cases I am submitting here.

Q. PLEASE DESCRIBE THE PROCESS YOU USED TO COME UP WITH THE 70 DIFFERENT OPTIONS YOU MODELED FOR THIS SEGMENT?

A. Not knowing the final alignment of this Segment, I modeled this Segment assuming that it could parallel an existing 230 kV line or be constructed as a stand-alone line. The existing 230 kV line was modeled to come up with the existing electromagnetic field and audible noise values.

The phasing arrangement for the lines was the basis for a majority of the different options considered. With the phasing for the existing lines held constant, every combination of phasing for the new double-circuit line was run. For the stand-alone line, every combination of phasing was run also. Some of the variables that have an effect on audible noise but do not change the electromagnetic field values are: A) Vertical bundle spacers with 18" or 12" spacing (18" is our standard); B) Conductor diameter or different types and number of conductors (2 conductor bundle of 954 kcmil ACSR "Cardinal," 2 conductor bundle of 1272 kcmil ACSR "Bittern," and a 3 conductor bundle of 636 kcmil ACSR "Grosbeak").

Q. WHAT PROCEDURE DID YOU UTILIZE TO REDUCE THE 70 DIFFERENT OPTIONS YOU MODELED FOR THIS SEGMENT DOWN TO THE CASES YOU ARE PRESENTING WITH YOUR TESTIMONY?

A. After all the runs were completed, the audible noise and the electromagnetic field data was entered into a spreadsheet and saved as two different files (one was titled "Magnetic Field" and the other as "AN" (audible noise)). Each data file was then sorted several different ways. For the "Magnetic Field" file, the data was sorted, with the primary sort being on electromagnetic field values and the secondary sort being for audible noise values.

The same process for the "AN" file was followed with the audible noise values being the primary sort and the electromagnetic field values being the secondary sort. The 70 different cases were then reduced to the different cases based upon the lowest audible noise values (50 dB(A) or less).

These cases were then reviewed to see if any of the lowest electromagnetic field cases matched any of the lowest AN cases. A majority of the cases run for this segment resulted in audible noise less than 50 dB(A) at the edge of ROW. The lowest magnetic field values resulted in audible noise level of over 50 dB(a) at the edge of ROW.

Q. PLEASE EXPLAIN THE INFORMATION THAT IS SET FORTH ON YOUR EXHIBIT NOS. DJP-CASE 1 AND DJP-CASE 2.

A. Exhibit Nos. DJP-Case 1 and DJP-Case 2 show the audible noise modeling associated with the two different possible construction scenarios for the Calumet – Comanche Segment. Exhibit Nos. DJP- Case 1a and DJP-Case 2a predict the L5 average audible noise levels in fair weather and Exhibit Nos. DJP-Case 1b and DJP-Case 2b predict the average L50 audible noise levels when the lines are wet. The wet/rainy weather models assume that the line is saturated with moisture, and therefore predict the average worst-case scenario. As the lines begin to dry from the heat of the current, and from the sun and wind, audible noise levels will decrease from the model predictions.

Q. PLEASE EXPLAIN THE VERTICAL DOTTED LINES ON EXHIBIT NOS. DJP- CASE 1 AND DJP-CASE 2.

A. The vertical dotted lines are the edge of Public Service's proposed right-of-way. I show the edge of the right-of-way because this is the location that the Commission rules specify is to be used to measure audible noise limits for transmission lines.

Q. WHAT IS THE LEGAL STANDARD THAT APPLIES TO NOISE LEVELS FOR THIS SEGMENT?

A. Colorado State statute, C.R.S. § 25-12-103(12), provides that the Commission can determine whether the projected audible noise levels for electric transmission lines are reasonable when reviewing applications for certificates of public convenience and necessity without regard to the audible noise levels otherwise set forth in the state statute.

Q. HOW CAN THE COMMISSION DETERMINE WHETHER THE PROJECTED AUDIBLE NOISE LEVELS OF THIS SEGMENT ARE REASONABLE?

A. Colorado Revised Statutes § 25-12-103 sets forth audible noise levels for various "zones" that the General Assembly found acceptable for uses other than electric transmission lines. They are as follows (measured from 25 feet or more from the property line of the audible noise generator):

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)

However, in passing the new law allowing for Commission determination of reasonable noise levels for electric transmission lines (§ 25-12-103(12) described above), the General Assembly stated that it was a matter of statewide interest and concern that the State of Colorado have an adequate, reliable, and cost-effective electricity infrastructure to serve the needs of the people of Colorado for their homes, businesses and industries. The general assembly found that electric transmission facilities are linear and may pass through several local jurisdictions and zoning districts. Therefore, the General Assembly left it up to the Commission to determine whether the predicted audible noise levels from proposed transmission facilities were reasonable.

Public Service is proposing in this application that the Commission accept the preferred alternative of DJP-Case 1 and DJP-Case 2. As can be seen in Exhibit Nos. DJP-Case 1a and DJP-Case 2a, when the line is not wet, the predicted audible noise levels are well below the most stringent limits set for residential zone use. When the lines are saturated with moisture, as shown in Exhibit Nos. DJP-Case 1b and DJP-Case 2b, the audible noise will be below the most stringent limits (50 dB(A)) set for residential zone use.

V. ELECTROMAGNETIC FIELD MITIGATION

Q. CAN YOU DESCRIBE THE REQUIREMENTS OF SECTION 4 CCR 723-3102(d) OF THE CODE OF COLORADO REGULATIONS?

A. Yes. When applying for a CPCN, Rule 3102(d) of the Commission's Rules Governing Electric Utilities requires a utility to describe the actions and techniques applied when they were planning, siting, constructing and operating the line, relating to prudent avoidance of electromagnetic fields.

A. Prudent Avoidance

Q. WHAT IS PRUDENT AVOIDANCE?

A. Prudent Avoidance "means the striking of a reasonable balance between the potential health effects of exposure to electromagnetic fields and the cost and impacts of mitigation of such exposure, by taking steps to reduce the exposure at a reasonable and modest cost". See Rule 3102(d) of the Commission's Rules Regulating Electric Utilities.

Q. PLEASE DESCRIBE WHAT PUBLIC SERVICE HAS DONE TO MEET THE REQUIREMENTS OF SECTION 3102(d) OF THE CODE OF COLORADO REGULATIONS.

A. Public Service has been using "prudent avoidance" concepts for many years. Of course, not all of the prudent avoidance concepts listed in Section 3102(d) can be implemented on every project because it is not cost effective to do so. On many transmission projects only one or two of the techniques can be reasonably applied.

In this case Public Service proposes to use two basic avoidance techniques. First, Public Service has studied and will use the technique of reverse phasing (referenced in the Commission rule as "design alternatives considering the arrangement of phasing of conductors"). The reverse phasing application will reduce the electromagnetic fields created by this Segment.

The second minimization avoidance technique Public Service can reasonably employ for this Segment is the use of higher structures. The structures that we will use are about five feet higher than the minimums required for ground clearance by the National Electric Safety Code. This small height increase will provide an additional EMF reduction along with increased safety clearances.

Burial of the line, which is listed as an avoidance technique in Section 3102(d), is also not available at a reasonable or modest cost.

B. Underground Versus Overhead Transmission Lines

Q. WAS UNDERGROUND CONSTRUCTION CONSIDERED IN THE PROPOSED DESIGN OF THIS SEGMENT?

A. An underground construction alternative was not specifically considered given that the magnetic fields and audible noise resulting from the proposed overhead design are well within typical exposure guidelines. The magnetic field exposure levels estimated for this Segment are consistent with those this Commission and other states' regulatory bodies have previously found to be reasonable. The audible noise levels (L50 wet) are 50 dB(A) or less at the edge of the right of way. In light of the minimal benefits that might be obtained from burial of the 345 kV circuits in terms of magnetic field or EMF exposure and audible noise, this alternative was not considered to be a reasonable cost.

C. Projected Electromagnetic Field Levels

Q. WHAT ARE THE ELECTROMAGNETIC FIELD LEVELS ASSOCIATED WITH THIS SEGMENT?

A. The Electromagnetic Field curves shown in Exhibit Nos. DJP- Case 1e and DJP-Case 2e provide an accurate representation of EMF levels, using the preliminary design of what can be expected during daily peaks in the near future. EMF levels are directly proportional to the electric current flowing in the conductor. The load used to calculate EMF for a transmission line is developed from projected system normal peak conditions. Higher currents could occur under certain system operating conditions, however, for the vast majority of time, the Project operations will be at steady state.

Q. PLEASE DESCRIBE WHAT YOU HAVE DEPICTED ON EXHIBIT NOS. DJP- CASE 1 AND DJP-CASE 2.

A. Exhibit Nos. DJP-Case 1e and DJP-Case 2e show the EMF model results for the same Cases as were presented for audible noise. The EMF from the existing facilities is shown by the thick solid blue lines on DJP-Case 2e graph. The vertical dotted lines show the edge of Public Service's proposed right-of-way for DJP-Case 1; and the edge of the existing Tri-State ROW and the edge of the Public Service's proposed right-of-way for DJP-Case 2. As I stated previously, over 70 different options were modeled to come up with the cases I am presenting here.

This Segment proposed by Public Service is shown in the Electromagnetic Field graphs, DJP-Case 1e and DJP-Case 2e.

Q. WHY DID YOU MODEL DIFFERENT CONFIGURATIONS FOR ELECTROMAGNETIC FIELD?

A. Public Service examined various configurations for the Calumet - Comanche Segment to determine the configuration that has a reasonable balance for lowering both electromagnetic fields and audible noise. This Segment proposed by Public Service's Application is represented as Electromagnetic Field Curves Exhibit Nos. DJP-Case 1e and DJP-Case 2e.

Q. YOUR ELECTROMAGNETIC FIELD MODELING IS BASED UPON TYPICAL 2015 LOAD FLOWS. COULD THE POWER FLOWS AND RESULTING ELECTROMAGNETIC FIELD VALUES ON THE LINE BE HIGHER?

A. Yes. Although we believe the models represent typical flows and electromagnetic field values for many years to come, the lines have the potential to carry higher flows, and therefore higher EMF values.

Q. WHAT WOULD YOU EXPECT THE MAXIMUM POSSIBLE LINE FLOWS AND ELECTROMAGNETIC FIELD VALUES TO BE?

A. Each of the lines will be constructed to carry approximately 2900 amps. As a general rule, Public Service operators would only allow enough power to flow on each line so that, if one of the lines is lost (N-1), the remaining line will only carry its rated power of 2900 amps. Therefore, the highest continuous loading for each line under system intact conditions would be half of that, or 1450 amps. Although we do not expect to ever see these types of flows, we modeled each of our proposed Cases (DJP-Case 1 and DJP-Case 2) using this maximum potential loading scenario. Again, it should be noted that these loadings are not likely. Due to the nature of the regional transmission system, we would not expect to transfer that much power between the Calumet - Comanche Substations.

Q. WHAT WOULD YOU EXPECT THE MAXIMUM POSSIBLE LINE FLOWS AND ELECTROMAGNETIC FIELD VALUES TO BE FOR AN OUTAGE (N-1) SITUATION?

A. Each of the new 345 kV lines will be constructed to carry approximately 2900 amps. The highest loading for each line under system outage condition (N-1) would be 2900 amps for the 345 kV lines and an estimated 1450 amps for Tri State's existing 230kV line. Although we do not expect to ever see these types of flows, we modeled each of our proposed Cases (DJP-Case 1 and DJP-Case 2) using this maximum potential loading scenario. Again, it should be noted that these loadings are not likely.

Q. HAVE ANY STATES OR AGENCIES IN THE UNITED STATES ESTABLISHED ELECTROMAGNETIC FIELD EXPOSURE LIMITS?

A. Yes. Two states, Florida and New York, have set electromagnetic field exposure limit values, as measured at the edge of right-of-way. In Florida, a range from 150 to 250 milli-Gauss (mG) exists for transmission lines ranging in voltage from 69 to 500 kV, and in New York an electromagnetic field value of 200 mG is the limit for any transmission line regardless of voltage. In addition, the American Conference of Governmental Industrial Hygienists[2] has set a not-to-exceed value of 10,000 mG for occupational exposure, and 1,000 mG for those workers with pacemakers. The International Commission on Non-Ionizing Radiation Protection[3] has set exposure limits of 4,200 mG for occupational exposure and 833 mG for the general public.

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2 The American Conference of Governmental Industrial Hygienists is a professional organization that facilitates the exchange of technical information about worker health protection. It is not a governmental regulatory agency.

3 The International Commission on Non-Ionizing Radiation Protection is an organization of 15,000 scientists from 40 nations who specialize in radiation protection.

VI. ALTERNATIVE CHOICES FOR ELECTROMAGNETIC FIELD AND NOISE

Q. PLEASE EXPLAIN THE DIFFERENCES IN CASES.

A. All the cases run for this Segment utilizes a typical two conductor bundle with 1272 kcmil ACSR "Bittern" with 18" vertical bundle spacing. This configuration for our proposed DJP-Case 1 and DJP-Case 2 provides an electromagnetic field value of less than 27 mG and has wet/rainy L50 audible noise levels less than 50 dB(A) at the edge of right-of-way.

Q. HOW DO THE AUDIBLE NOISE VALUES THAT YOU PRESENT ON YOUR EXHIBIT NOS. DJP-CASE 1 AND DJP-CASE 2 FOR THIS SEGMENT COMPARE WITH THE AUDIBLE NOISE LEVELS ASSOCIATED WITH OTHER HIGH VOLTAGE LINES ON PUBLIC SERVICE SYSTEM?

A. Public Service uses similar techniques as those described here to mitigate audible noise when it constructs all of its high voltage transmission lines. However, as I indicated earlier, audible noise levels from a particular facility are dependent upon numerous factors, such as voltage level, altitude, surrounding structures, line configuration and ground cover. Therefore, it would not be appropriate to use the audible noise levels in Exhibit Nos. DJP-Case 1 and DJP-Case 2 as the expected audible noise levels from any other line. However, in constructing the Calumet – Comanche Segment, Public Service is using good utility practices to employ reasonably prudent techniques to minimize audible noise impacts.

VII. RECOMMENDATIONS

Q. GIVEN ALL YOUR STUDIES, WHY DOES PUBLIC SERVICE BELIEVE THAT CASE 1 AND CASE 2 ARE THE MOST REASONABLE DESIGNS TO PURSUE?

A. Cases 1 and 2 represent a reasonable balance between electromagnetic fields, audible noise impacts and costs. The lines are generally very quiet, emitting audible noise far below the most restrictive zone standard unless wet. Without burying the lines, Public Service cannot prevent the lines from becoming wet from time to time. When the lines are wet, the audible noise levels will be temporarily higher.

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

A. The Company is requesting that the Commission approve the recommended design of the Calumet - Comanche Segment as described in my testimony. The Company also seeks a finding consistent with the Commission's ruling in Docket No. 05A-072E and Docket No. 07A-156E establishing a reasonableness level of 150 mG for this Segment.

Q. WHY DOES THE COMPANY BELIEVE IT IS APPROPRIATE TO ESTABLISH THE SAME ELECTROMAGNETIC FIELD REASONABLENESS LEVEL FOR THIS SEGMENT AS IT DID FOR THE COMANCHE – DANIELS PARK TRANSMISSION PROJECT AND THE MIDWAY – WATERTON TRANSMISSION PROJECT?

These projects are very similar in design. All of these lines are designed to accommodate a double-circuit 345 kV capacity. In addition, just as in the case of the Comanche – Daniels Park and Midway – Waterton Transmission Projects, while the estimated electromagnetic field levels under typical projected peak power flows are significantly below 150 mG at the edge of right of way, the Company's Alternate Loading Cases 1 Maximum Loading & 2 Maximum Loading show that electromagnetic field levels could increase to as high as 50 mG at the edge of right of way at maximum loadings (one half of the lines' rated capacity). Given these modeling results and the electromagnetic field limits that have been prescribed in other jurisdictions and for the Comanche - Daniels Park and Midway – Waterton Transmission Projects, the Company seeks the same reasonableness finding as the Commission made in those cases.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Attachment A

Statement of Qualifications

DANNY PEARSON

I graduated from the University of Nebraska with a BS degree in Electrical Engineering in 1976. Subsequently, I began my employment with Public Service Company of Colorado as a Staff Engineer. I am licensed as a Professional Engineer and Professional Land Surveyor in the State of Colorado. I have held positions of increasing responsibility in the Transmission Engineering Department throughout my career. In 1984-1985, I was acting Supervisor, Transmission Engineering. From 1990 to 1992 I was Supervisor of Transmission Engineering. I currently am a Principal Transmission Design Engineer in Transmission Engineering Department, providing the engineering services needed to construct new Public Service transmission lines as well as the engineering expertise required to maintain existing transmission facilities.

In the past ten years, I have been responsible for the design, construction and Project Management of over 400 miles of energized 345kV transmission lines.