BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

APPLICATION OF PENNSYLVANIA ELECTRIC COMPANY FOR APPROVAL TO LOCATE AND CONSTRUCT THE BEDFORD NORTH-CENTRAL CITY WEST 115 KILOVOLT TRANSMISSION LINE PROJECT IN CENTRAL CITY BOROUGH AND SHADE TOWNSHIP, SOMERSET COUNTY, AND NAPIER, EAST ST. CLAIR, AND BEDFORD TOWNSHIPS, BEDFORD COUNTY, PENNSYLVANIA	:	**Docket No. A-2016-2565296**

REBUTTAL TESTIMONY OF

JOHN TOTH

ON BEHALF OF

PENNSYLVANIA ELECTRIC COMPANY

REBUTTAL STATEMENT NO. 6-R

Re: Electromagnetic Fields and Interference

Dated: February 20, 2017

INTRODUCTION AND PURPOSE OF TESTIMONY

Q. Please state your name and business address.

A. My name is John T. Toth and my business address is 76 South Main Street, Akron, Ohio 44308.

Q. By whom are you employed and in what capacity?

A. I am employed by FirstEnergy Service Company as a Supervisor in the Transmission Engineering Department. My responsibilities include providing guidance, leadership and supervision to a staff of professionals in the Transmission Engineering Group that are responsible for the examination, design and modification of existing and new transmission facilities in Ohio, Pennsylvania, Maryland, New Jersey, Virginia and West Virginia. In this position, I provide support for the FirstEnergy "operating utilities" efforts to modify, maintain and build transmission facilities, including the modeling of transmission lines and substations in order to determine expected Electric and Magnetic Fields (EMF).

Q. Please describe your professional experience and educational background.

A. I am a graduate of Ohio Diesel Technical Institute. Prior to my returning to school, I worked for seventeen years in various locations as a master mechanic. I am a 2004 graduate of Cleveland State University's Fenn College of Engineering with a Bachelor of Electrical Engineering degree.

In June 2005, I began working for FirstEnergy as an Assistant Engineer in its rotational engineering program. As part of the rotational engineering program, I worked in the following departments: (i) transmission planning; (ii) transmission protection; (iii) substation engineering; and (iv) transmission engineering. I also worked for Cleveland

Electric Illuminating Company's distribution engineering department and the substation maintenance department.

In July 2007, I started working in FirstEnergy's Transmission Engineering Department. While working in FirstEnergy's Transmission Engineering Department, I advanced through the following positions: (i) Associate Engineer (April 2007); (ii) Engineer (May 2008); (iii) Advanced Engineer (July 2010); and (iv) Supervisor Transmission Siting (May 2011). In September 2014, I moved to my current position as Supervisor, Transmission Engineering Design within the Transmission Engineering Department.

My education, experience and qualifications are fully set forth in Appendix A to my testimony.

In my current position, I provide guidance, leadership and supervision to a staff of professionals in the Transmission Engineering Group that are responsible for the examination, design and modification of existing and new transmission facilities in Ohio, Pennsylvania, Maryland, New Jersey, Virginia and West Virginia.

In this position, I provide support for FirstEnergy's efforts to modify, maintain and build transmission facilities, including the modeling of transmission lines and substations in order to calculate and determine expected Electric and Magnetic Fields (EMF) within and adjacent to rights-of-ways and substations.

Q. On whose behalf are you providing this testimony?

A. I am providing this testimony on behalf of Penelec for approval to locate and construct the Bedford North-Central City West 115 kV Transmission Line ("Project").

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to:

- give a brief overview of what electric and magnetic fields are;
- provide a brief description of existing Federal and State Regulations;
- Institute of Electrical and Electronic Engineers ("IEEE") recommended exposure guideline to protect public health;
- explain the expected EMF levels for the project; and
- give a brief overview of radio noise and electromagnetic interference.

ELECTRIC FIELD

Q. WHAT ARE ELECTRIC FIELDS?

A. Electric fields are a vector quantity with both a magnitude and a direction. The directions corresponds to the direction that a positive charge would move within the field. The source of electric field is the electrical charge on the conductors. For example, transmission lines, distribution lines, household wiring and appliances all generate electric fields in their vicinity because of unbalanced electrical charge (voltage) on energized conductors. Voltage and charge on energized conductors in North America are repeated at a rate of 60 times a second (positive to negative to positive). The changing voltage results in electric fields near sources that are also time-varying at a frequency of 60 Hz.

Electric fields are expressed in units of kilovolts (thousands of volts) per meter (kV/m). The three-dimensional distribution of a transmission line electric field depends on the charge on the conductors, the position of the conductors, and the measurement distance away from the conductors, and the strength of the field is reduced as distance from the conductors' increases. The electric field extends from the energized conductors to other conducting objects such as the ground, towers, vegetation, buildings, vehicles and people. The calculated strength of the electric field at a height of one meter above earth is frequently used to describe the electric field under transmission lines. The more significant factors that determine the electric field strength at the one meter height location are conductor configuration, conductor height above ground, lateral distance from the conductors, and the transmission line voltage.

Methods for measuring transmission line electric fields are described in ANSI/IEEE Standard No. 644-1994. Provided that conditions at the measurement site approximate the situation assumed for calculations, measurements of electric fields closely agree with the calculated values. Measured electric fields are easily shielded by common objects with the resulting measurements usually lower than calculated values.

In long conductor spans with significant sag between attachment points, the greatest field values occur over a small area at midspan, where conductors are closest to the ground. Near transmission structures, the conductor ground clearances increase and the peak electric field strength decreases. Transmission line electric field strengths at and beyond the edge of the right-of-way (ROW) are reduced primarily in relation to the increased lateral distance and are not as sensitive to the conductor height. Buildings, vegetation and other grounded objects all reduce the electric field.

MAGNETIC FIELD

Q. WHAT ARE MAGNETIC FIELDS?

A. Similar to electric fields, magnetic fields are vector quantities characterized by both magnitude and direction. Electrical currents generate magnetic field. Transmission lines, distribution lines, house wiring and appliances carrying a 60 Hz electric current generate a 60 Hz magnetic field in the area surrounding the conductors. The strength of a magnetic field is measured in terms of the magnetic lines of force per unit area or magnetic flux density. The term magnetic field, as used here, is equal with magnetic flux density and is expressed in units of milligauss (mG).

The magnetic field generated by currents on the transmission line extends from the conductors through the air and into the ground. The strength of the magnetic field at a height of one meter is frequently used to describe the magnetic field under the transmission lines. The direction of the magnetic field varies with location, while the electric field is fundamentally vertical near the ground. The most important transmission line factors that determine the magnetic field at one meter height are the conductor height above ground and the magnitude of the electrical currents flowing on the conductor. As the distance from the transmission line increases the magnetic field decreases.

The maximum magnetic field occurs in areas near the centerline of the transmission and at midspan location between structures where the conductors are the lowest. Magnetic field at the edge of the ROW is less reliant on line height. When multiple circuits occupy a common right-of-way, the magnetic field is contingent on the relative electrical phasing of the conductors and the direction of power flow on each circuit.

FEDERAL AND STATE REQUIREMENTS

Q. DOES THE FEDERAL GOVERNMENT HAVE EXPOSURE LIMITS FOR EMF?

A. No, the federal government has not set exposure limits EMF.

Q. ARE YOU AWARE OF ANY REQUIREMENTS OR LIMITS FOR EMF ESTABLISHED BY THE COMMONWEALTH OF PENNSYLVANIA?

A. No.

EXPOSURE GUIDELINES

Q. ARE YOU FAMILIAR WITH ANY ORGANIZATIONS THAT HAVE REVIEWED RESEARCH ON EMF, PERFORMED HUMAN HEALTH RISK ASSESSMENTS AND RECOMMENDED EXPOSURE GUIDELINES TO PROTECT PUBLICK HEALTH?

A. Yes, the International Committee on Electromagnetic Safety, sponsored by the Institute of Electrical and Electronics Engineers ("IEEE"), operates under the IEEE's rules and oversight; this Committee also recommends consensus standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 Gigahertz, which includes power frequency 60-Hz fields. The standard-setting process is open, with a balanced representation from the medical, scientific, engineering, industrial, government, and military communities. Approximately 209 members, including members from outside the United States representing 27 different countries, participate in this Committee.

Q. WHAT ARE THE RECOMMENDATION OF THE IEEE FOR EMF EXPOSURE TO THE GENERAL PUBLIC?

A. The IEEE Committee has reviewed research on EMF and have recommended "basic restrictions," which are limits on internal electric fields to protect against acute established effects that occur at very high EMF exposure levels. These limits on internal electric fields are difficult to measure directly so these organizations have identified screening levels that are below exposures meeting basic restrictions to ensure that limits on internal electric fields are not exceeded. The IEEE Committee has recommended screening values of 9,040 mG for magnetic field exposure, 5 kV/m for electric field exposure (IEEE, 2002) guidelines at 60 Hz.

The guidelines incorporate large safety factors to account for uncertainty and variation in exposure conditions. Exposures above the IEEE Committee screening guidelines are permitted if it can be shown that their basic restrictions on internal electric fields and current densities are not exceeded.

Q. WILL THE LEVELS OF EMF ASSOCIATED WITH THE OPERATION OF THE NEW TRANSMISSION LINE BE BELOW THE IEEE COMMITTEE GUIDELINES?

A. Yes, both the calculated electric fields and magnetic fields, even directly under the conductors, will be well below the lowest guideline limit.

ESTIMATED EMF PROJECT LEVELS

Q. WHAT IS THE EXPECTED ELECTRIC FIELD LEVEL FOR THE PROJECT?

A. The electric field under the lowest conductor, at mid-span, is expected to be 1.77 kV/m and the electric field at the edge of the ROW is expected to be 0.22 kV/m for the section of ROW where both the Bedford North-Central City West and the Bedford North-New Baltimore 115 kV transmission lines share the ROW. The electric field under the lowest conductor, at mid-span, is expected to be 1.25 kV/m and the electric field at the edge of the ROW is expected to be 0.02/0.21 kV/m for the section of ROW where only the Bedford North-Central City West is within the ROW.

Q. WHAT IS THE EXPECTED MAGNETIC FIELD LEVEL FOR THE PROJECT?

A. The load on the transmission line varies both on a daily and seasonal basis and I have developed an estimate of the magnetic field strengths based on the anticipated normal maximum load on the transmission line. The magnetic field under the lowest conductor, at mid-span, is expected to be 47.18 mG for the section of ROW where both the Bedford North-Central City West and the Bedford North-New Baltimore 115 kV transmission lines share the ROW and the magnetic field at the edge of the ROW is expected to be 19.97/25.33 mG for this section. The magnetic field under the lowest conductor, at mid-span, is expected to be 41.14 mG for the section of ROW where only the Bedford North-Central City West is within the ROW and 10.10/21.2 at the edge of the ROW. The actual magnetic field strengths will most often be lower than these values.

Q. WHAT SOFTWARE DID YOU USE TO MODEL THE TRANSMISSION LINE?

A. The model was prepared utilizing the Electric Power Research Institute's EMF Workstation 2015 software program.

Q. WHAT TYPE OF APPROACH DID YOU USE MODELING THE TRANSMISSION LINE?

A. A conservative approach is used to create the model. As I indicated previously, the model is based on the maximum normal line loading. Additionally, the height of the conductors are modeled on the minimum National Electric Safety Code clearance above ground plus FirstEnergy's construction tolerance rather than the conductor's higher height. This conservative approach gives the anticipated maximum electric and magnetic field levels, measured values are expected to be below these levels.

Q. ARE TRANSMISSION LINES COMMON SOURCES OF EMF?

A. Transmission lines are not common sources of EMF exposure. Distribution lines, service drops to buildings, household wiring and electric devices and appliances are more common and the main sources of EMF exposure in homes, schools, workplaces and other locations in our communities. The operation of all these sources produces EMF that oscillates at a frequency of 60 Hz.

Q. WHAT ARE TYPICAL MAGNETIC FIELD LEVELS IN A HOUSE?

A. Magnetic field levels found in the living areas of homes away from appliances typically range from less than 1 mG to approximately 4 mG. Magnetic fields near appliances can exceed 1,000 mG. Some examples include the following from the National Institute of Environmental Health Sciences:

- Clothes dryer, 10 mG
- Microwave oven, 100 – 300 mG
- Toaster, 5 – 20 mG
- Power Drill, 100 – 200 mG
- Can Opener, 500 – 1500 mG
- Hair Dryer, 1 – 700 mG

RADIO NOISE / ELECTROMAGNETIC INTERFERENCE

Q. WILL THE PROJECT CAUSE INTERFERENCE WITH WI-FI AND CELL PHONE RECEPTION?

A. No, in order to protect sensitive radio service such as aircraft navigation and emergency beacons, the Federal Communications Commission ("FCC") established Part 15 of Title 47 of the Code of Federal Regulations. These rules are directed at equipment that does not deliberately generate radio frequency energy. Part 15 affects a larger variety of electronic devices than does any other FCC regulation, imposing RF emissions limits on radios, personal electronics, and includes the electric power transmission and distribution system.

Q. Have you sponsored direct testimony in this proceeding?

A. No.

Q. Are you sponsoring any exhibits in your rebuttal testimony?

A. No.

Q. Does this complete your rebuttal testimony?

A. Yes it does. However, I would like to reserve the right to supplement my testimony if anything changes with respect to the status of the application.

Appendix A
Resume: Education and Experience of John T. Toth

Education:

2004	Bachelor of Electrical Engineering, Cleveland State University's Fenn College of Engineering, Cleveland, Ohio
1983	Ohio Diesel Technical Institute, Cleveland, Ohio

Experience:

1981 – 1998	Master Mechanic – Various Employers
2005 – 2007	Assistant Engineer, Rotational Engineer Program – FirstEnergy Service Company
2007 – 2008	Associate Engineer, Transmission Engineering Group – FirstEnergy Service Company
2008 – 2010	Advanced Engineer, Transmission Engineering Group – FirstEnergy Service Company
2011 – 2014	Transmission Siting Supervisor, Transmission Engineering Group – FirstEnergy Service Company
2014 – Present	Supervisor Transmission Engineering Design, Transmission Engineering Group – FirstEnergy Service Company

Prepared and presented testimony in the following siting related cases:

<u>Ohio Power Siting Board Case:</u>

Docket No. 08-0123-EL-BTX, Chamberlin – Shalersville Transmission Line Project

<u>Pa P.U.C. Case:</u>

Docket No. A-2011-2247862, Bedford North – Osterberg East 115 kV HV Transmission Line Project

Docket No. A-2015-2513898, Pierce Brook – Lewis Run 230 kV Transmission Line Project

Docket No. A-2016-2529650, East Towanda – South Troy 230/115 kV Transmission Line Project

Docket No. A-2017-2586434, Campbell-Keister Transmission Line Project

<u>NJ B.P.U. Cases:</u>

Docket No. EO14030281, Oceanview 230 kV Transmission Project.

Docket No. EO15030383, Montville – Whippany 230 kV Transmission Line Project

Supervised the development and preparation of the following filings

Pennsylvania Public Utility Commission

Letter of Notification:

Pennsylvania Electric Company

A-2009-2103919
A-2009-2112928
A-2009-2112958
A-2009-213-3063
A-2011-221-9842
A-2011-2225736
A-2011-224-2416
A-2011-224-7862
A-2011-2264762
A-2011-2264773
A-2012-2286421
A-2012-2296742
A-2012-2307985
A-2013-2381170

Pennsylvania Power Company

A-2013-2370205

Metropolitan Edison Company

A-2010-2208888
A-2011-2240477
A-2011-2240484
A-20112271978
A-2012-2317843
A-2012-2329304

West Penn Power Company

A-2012-2281399
A-2013-2348946
A-2013-2360874
A-2013-2375569

Trans-Allegheny Interstate Line Company

A-2013-2345844
A-2013-2348538

Ohio Power Siting Board:

Letters of Notification:

11-2885-EL-BLN
11-2892-EL-BLN
11-3246-EL-BLN
11-3247-EL-BLN
11-5836-EL-BLN
11-5844-EL-BLN
11-6063-EL-BLN
12-0774-EL-BLN
12-1138-EL-BLN
12-1430-EL-BLN
12-1637-EL-BLN
12-1726-EL-BLN
12-2397-EL-BLN
12-2461-EL-BLN
12-2462-EL-BLN
12-2475-EL-BLN
12-2476-EL-BLN
12-2666-EL-BLN
12-2912-EL-BLN

12-2938-EL-BLN
12-3031-EL-BLN
12-3126-EL-BLN
12-3157-EL-BLN
12-3158-EL-BLN
12-3159-EL-BLN
12-3233-EL-BLN
13-0108-EL-BLN
13-0191-EL-BLN
13-0224-EL-BLN
13-0341-EL-BLN
13-0493-EL-BLN
13-1153-EL-BLN
13-1247-EL-BLN
13-1248-EL-BLN
13-1749-EL-BLN
13-1800-EL-BLN
13-2163-EL-BLN

Construction Notice:

11-4375-EL-BNR	12-2380-EL-BNR
11-4376-EL-BNR	12-2524-EL-BNR
11-4387-EL-BNR	12-3301-EL-BNR
11-5582-EL-BNR	13-1243-EL-BNR
11-5871-EL-BNR	13-1611-EL-BNR
11-6031-EL-BNR	13-1797-EL-BNR
12-0880-EL-BNR	13-1835-EL-BNR
12-1662-EL-BNR	13-1934-EL-BNR
12-2208-EL-BNR	13-2234-EL-BNR
12-2223-EL-BNR	13-2350-EL-BNR