Exhibit No.: 14
Issue(s): Design and Engineering
Witness: David Endorf, P.E.
Type of Exhibit: Surrebuttal Testimony
Sponsoring Party: Ameren Transmission Company of Illinois
File No.: EA-2015-0146
Date Testimony Prepared: November 16, 2015

MISSOURI PUBLIC SERVICE COMMISSION

File No. EA-2015-0146

SURREBUTTAL TESTIMONY

OF

DAVID ENDORF, P.E.

ON

BEHALF OF

AMEREN TRANSMISSION COMPANY OF ILLINOIS

St. Louis, Missouri
November, 2015

ATXY Exhibit No. 14
Date 1/25/16 Reporter JL
File No. EA-2015-0146

SURREBUTTAL TESTIMONY

OF

DAVID ENDORF, P.E.

FILE NO. EA-2015-0146

Q. Please state your name and business address.

A. My name is David Endorf, and my business address is 1901 Chouteau Avenue, St. Louis, Missouri 63103.

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

A. I am employed by Ameren Services Company ("Ameren Services") as a Principal Engineer in the Transmission Performance Management and Engineering Department.

Q. Are you the same David Endorf who filed direct testimony in this case?

A. Yes, I am.

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of my surrebuttal testimony is to respond to the rebuttal testimony of Staff, and to issues raised by Neighbors United Against Ameren's Power Line (the "Neighbors") witnesses in their rebuttal testimony, regarding design and engineering considerations related to the Mark Twain Project ("Project").

Q. Certain of the Neighbors witnesses have criticized the route that ATXI selected, and there have been comments that suggest ATXI could have used existing rights-of-way and transmission line corridors. From an engineering perspective how would you respond to this criticism and suggestions?

A. There were multiple factors that ATXI weighed in the multiple routes that were considered for this Project. Several of these are addressed in the surrebuttal testimony of ATXI witnesses Christopher Wood, James Jontry and Jeffrey Hackman. From an engineering perspective, some of the routing factors that I would focus on would be the need to minimize line length, the use of angle structures, impacts to natural resources (such as wetlands, woodlands, and wildlife), impact to landowners and residences, and cost. For example, as testified to by Mr. Jontry, a route that is straight helps to keep the overall cost lower by minimizing the line length and the number of costly angle structures. As Mr. Hackman addresses in his surrebuttal testimony, there are also operational and safety reasons why it is undesirable to construct parallel transmission lines. Moreover, the need for angle structures necessitated by a redesign of the Project not only increases the cost of the line, but the increased number of physical structures along the route impacts the use of the land, and increases the amount of land taken out of production.

Q. What are some of the some of the different types of designs that are used for transmission line structures?

A. Typical structures used for transmission line include lattice towers, wood H-frames, steel H-frames, single pole wood, and steel poles.

Q. What structure design was selected for the Project, and why?

A. The structures used on the Project will consist of single shaft, steel pole structures (also referred to as "monopoles"). This type of structure is self-supported and will not utilize guy wires or anchors. The typical foundation for these steel structures will be a drilled pier that will be approximately 7 to 10 feet in diameter. Monopoles were selected as the type of structure on the Project for a number of reasons. Monopoles consist of steel components which offer

ATXI the ability to utilize a man-made component that provides greater certainty related to quality assurance associated with the materials used, and have been consistently used with great success by Ameren Services and each of its operating companies (including ATXI) on transmission projects in Missouri and Illinois. The use of monopoles also allows for increased spans, and fewer structures. Moreover, as I will testify to later, there have been no outage or safety issues with monopole structures. However, the primary reason for selecting single shaft steel poles for the Project was that the monopoles provide the least impact to property owners along the route. This was a significant issue in the design phase of this Project given the large portion of the route that will go through agricultural lands. Quite simply, this type of construction using a single shaft steel pole and drilled pier foundation will minimize the area impacted on a property, and will allow ongoing activities such as farming and ranching to continue unabated.

Q. The Neighbors witnesses, including Charles Kruse, have provided rebuttal testimony about the negative impacts to farming and land. From a design and engineering perspective, what affect does the use of monopole structures have upon these alleged negative impacts?

A. As I previously mentioned, the use of monopoles provides a significant amount of mitigation against any claim of negative impact with farming and ranching, or other uses. As ATXI witness Doug Brown states in his surrebuttal testimony, because the typical steel monopole has a drilled pier concrete foundation approximately 7 to 10 feet in diameter, agricultural activities, such as crop farming, can be performed up to an area approximately 10 feet by 10 feet around each structure. The design of the structure, including the use of a single pole and absence of guy wires, will result in fewer contact points with the land which will afford

better maneuverability around the structure. Moreover, the transmission line is designed to meet or exceed the National Electric Safety Code (NESC). For example, there is an NESC requirement which addresses a minimum wire height above ground. Prior to construction ATXI works with property owners to ensure that the transmission line layout provides adequate clearance over areas where terracing will be installed. In addition, span length between structures is significant. For a 345kV transmission line (similar to what will be constructed for that portion of the Project approximately 95 miles in length) the average span is 850 feet. For a 161kV transmission line (similar to what will be constructed for that portion of the Project approximately 2.2 miles in length) the distance between structures averages 600 feet. The reduced number of structures (estimated at 580 structures along the 345kV route and 20 structures along the 161kV route) further mitigates any impact to farming, ranching and other activities associated with the Project. As further summarized in Mr. Brown's testimony, the cumulative impact of the design and engineering plans as proposed for the Project by ATXI will result in a reduction of the total acreage of agricultural ground taken out of production of less than one acre.

Q. In the testimony of Neighbor's witness Boyd Harris he mentioned concerns over stray voltage associated with the Project. Could you briefly describe what stray voltage is, and identify any concerns you would have from a design and engineering perspective related to stray voltage on the Project?

A. Stray voltage is a small amount of voltage (usually less than 10 volts) measured between two points that can simultaneously be contacted. Some current flows through the earth at each point where the electrical system is grounded and a small voltage develops. Stray voltage is typically associated with single phase distribution, and distribution systems are

grounded to earth to ensure safety and reliability. The Project involves a transmission line rather than a distribution line, and will be designed to ensure that stray voltage is not an issue. ATXI witness Dr. William Bailey's surrebuttal testimony provides additional support for ATXI's position that there is no stray voltage issue associated with this Project. The transmission line will effectively be grounded, because it will connect to substations at the ends and will not connect to any customers' electrical system. The design will ensure that normal current flows are not carried through other objects. Finally, during construction of the transmission line, ATXI will ground any permanent metal objects within the right-of way. To my knowledge, none of the Ameren Service Company operating companies have experienced a stray voltage claim associated with a transmission line.[1]

Q. Another concern that was raised by Neighbor's witness Charles Kruse relates to storm recovery. Please respond to the concern over the possibility that a storm will topple over ATXI structures and the resulting damage.

A. The steel monopole structures are designed to meet or exceed the requirements of the National Electric Safety Code (NESC). The structures are designed for an extreme wind load of almost 100 miles per hour. They are designed to withstand the loads imposed by 1 inch of radial ice on the wires, along with a 40 mile per hour wind. If for some reason one of the conductors broke and fell to the ground, the line is protected with relays that will open breakers to take the line out of service. Based upon the design of the monopole structures, and the safeguards that are designed into the ATXI system, I strongly disagree with the assertions by Mr. Kruse that in the unlikely event a storm topples over a structure, that agriculture will experience

[1] A line in excess of 100kV.

substantial damage, that the loss to livestock or crops would be significant, or that the potential for significant losses would be high.

Q. In your experience are you aware of a steel monopole failure in any of the projects performed by an Ameren Services operating company, including ATXI, as a result of a storm?

A. No.

Q. Are you aware of a steel monopole failure in any projects elsewhere in the Midwest?

A. No.

Q. Mr. Kruse also suggests in his rebuttal testimony that ATXI's transmission line will interfere with irrigation equipment, particularly center pivot irrigation systems. How does ATXI design and construct its transmission lines to address irrigation systems?

A. The approach used by ATXI is the same as is used by all Ameren Services operating companies. For center pivot irrigation systems, ATXI attempts to avoid or minimize the impacts associated with known fields which use center pivot irrigation. As indicated by Mr. Wood, and Mr. Brown, the route ATXI ultimately selected for this Project was chosen in part because it avoided any known fields which use center pivot irrigation. In the unlikely event that during this Project a planned center pivot irrigation systems is encountered that would be directly impacted by the routing, ATXI will seek to coordinate with landowners on structure placement to either avoid or minimize any conflicts with existing pivotal irrigation systems (including the placement of structures inside the arc of a soon-to-be constructed center pivot irrigation system). In addition, if a landowner has demonstrable, specific plans for the installation of a pivotal

irrigation system in the near future, ATXI will take those plans into consideration during negotiations.

Q. What about other types of irrigation systems?

A. The approach would be similar for any conflict between ATXI's transmission line and any other type of irrigation systems such as wheel-lines, flood and traveling guns. I would note that these types of irrigation systems do not pose an inherent hazard when located near transmission lines. While water stream from gun-type irrigation systems must maintain adequate clearance from transmission line structures or wires, ATXI again would work with the affected landowner to minimize any impact.

Q. Another concern we have heard is the impact of transmission lines on electric fences. Specifically that transmission lines will adversely impact electric fence chargers and cause them to fail. What is the potential impact, and what can ATXI do to address this potential issue?

A. If there is an electric fence on the right-of-way, it may pick up an induced charge from the presence of the 345kV line. ATXI would install an electric fence filter on the electric fence to filter out the induced 60 hertz charge to ground and allow the fence to operate properly. The cost of the fence filter and the installation would be paid for by ATXI.

Q. Another concern we have heard relative to 345kV transmission lines is something called the corona effect. What is the corona effect, and if it exists how does ATXI address the issue?

A. Corona effect is an audible buzz or interference in AM radio signals that can be present around high voltage lines. ATXI is using bundled conductor and conductor hardware

designed to minimize corona noise. In addition, as Mr. Brown testifies, the agreed upon standards and procedures in Schedule DBR-SR2 include a provision to address interference issues.

Q. Have you reviewed Staff's proposed conditions, which were in Staff witness Dan Beck's rebuttal testimony, at pages 16-17?

A. Yes.

Q. Please identify any condition that involves design, engineering or construction activities and provide a response on behalf of ATXI.

A. While ATXI witness Maureen Borkowski's surrebuttal testimony addresses each of the recommended conditions, I will focus my surrebuttal testimony on the first condition which requires ATXI to file the plans and specifications for the construction of the Project with the Commission as required by 4 CSR 240-3.105(1)(B)2. In satisfaction of that condition I am submitting, as Schedule DE-SR1[2] a series of files that reflect the Project plans and specifications as follows:

Maywood-Zachary Plan and Profile Drawings
- MYWD-ZACH-4588 P&P_11-13-15_pg 1-10
- MYWD-ZACH-4588 P&P_11-13-15_pg 11-20
- MYWD-ZACH-4588 P&P_11-13-15_pg 21-30
- MYWD-ZACH-4588 P&P_11-13-15_pg 31-40
- MYWD-ZACH-4588 P&P_11-13-15_pg 41-50
- MYWD-ZACH-4588 P&P_11-13-15_pg 51-63

MYWD-ZACH-4588 Structure Outline and Assembly Drawings (653104 thru 653120)
MYWD-ZACH-4588 Hardware Assembly Drawings (653121 thru 653125)

Zachary-Ottumwa Plan and Profile Drawings
- ZACH-OTMW-4542 P&P_11-13-15_pg 1-10
- ZACH-OTMW-4542 P&P_11-13-15_pg 11-20
- ZACH-OTMW-4542 P&P_11-13-15_pg 21-30

[2] Due to the size of the files that reflect the Project plans and specifications, ATXI will submit said plans and specifications to the Commission's Data Center separately.

ZACH-OTMW-4542 P&P_11-13-15_pg 31-38
ZACH-OTMW-4542 Structure Outline and Assembly Drawings (653127 thru 653143)
ZACH-OTMW-4542 Hardware Assembly Drawings (653144 thru 653148)

Zachary-Adair Plan and Profile Drawings
ZACH-ADIR-7671 P&P_11-13-15
ZACH-ADIR-7671 Structure Outline Drawings (SK-T150709, 001 and 002)

ZACHARY SUBSTATION
ZACH_CIVIL_ELECTRICAL_CONST_SPECS_11-16-15
ZACH_SUB_GRADING_11-16-15
ZACH_SUB_CONDUIT_11-16-15
ZACH_SUB_ENCLOSURES_11-16-15
ZACH_SUB_FOUNDATIONS_11-16-15
ZACH_SUB_GROUNDING_11-16-15
ZACH_SUB_LAYOUT_11-16-15
ZACH_SUB_ONELINE_11-16-15
ZACH_SUB_PANELS_11-16-15
ZACH_SUB_SCHEMES_11-16-15
ZACH_SUB_STEEL_11-16-15

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Ameren Transmission Company of Illinois for Other Relief or, in the Alternative, a Certificate of Public Convenience and Necessity Authorizing it to Construct, Install, Own, Operate, Maintain and Otherwise Control and Manage a 345,000-volt Electric Transmission Line from Palmyra, Missouri, to the Iowa Border and an Associated Substation Near Kirksville, Missouri.	)))))))	File No. EA-2015-0146

AFFIDAVIT OF DAVID ENDORF

STATE OF MISSOURI)
) **ss**
CITY OF ST. LOUIS)

David Endorf, being first duly sworn on his oath, states:

1. My name is David Endorf. I work in St. Louis, Missouri, and I am employed by Ameren Services Company.

2. Attached hereto and made a part hereof for all purposes is my Surrebuttal Testimony on behalf of Ameren Transmission Company of Illinois consisting of 9 pages, and Schedule(s) DE-SR1 all of which have been prepared in written form for introduction into evidence in the above-referenced docket.

3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct.

David Endorf

Subscribed and sworn to before me this 16th day of November, 2015.

Notary Public

My commission expires:

Debra K. Patterson - Notary Public
Notary Seal, State of
Missouri - St. Louis County
Commission #12482292
My Commission Expires 10/31/2016