Exhibit No.:	
Issue(s):	Project Design
Witness:	David Endorf, P.E.
Sponsoring Party:	Ameren Transmission Company of Illinois
Type of Exhibit:	Direct Testimony
Case No.:	EA-2017-0345
Date Testimony Prepared:	September 15, 2017

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. EA-2017-0345

DIRECT TESTIMONY

OF

DAVID ENDORF, P.E.

ON

BEHALF OF

AMEREN TRANSMISSION COMPANY OF ILLINOIS

St. Louis, Missouri
September 2017

TABLE OF CONTENTS

DIRECT TESTIMONY

OF

DAVID ENDORF, P.E.

CASE NO. EA-2017-0345

I. INTRODUCTION AND WITNESS QUALIFICATIONS

Q. Please state your name, business address and current position.

A. My name is David Endorf. My business address is 1901 Chouteau Avenue, St. Louis, Missouri 63103. I am employed by Ameren Services Company (Ameren Services) as a Principal Engineer in the Transmission Performance Management and Engineering Department.

Q. Please summarize your professional experience and educational background.

A. I have a Bachelor of Science degree in Civil Engineering from Valparaiso University. I have a Master of Science degree in Civil Engineering from the University of Missouri – Rolla. I am a registered Professional Engineer in Missouri and Illinois. I have transmission line experience including project design and management of both small and large projects at voltages ranging from 138,000 volts to 345,000 volts. I currently serve as a member on the American Society of Civil Engineers Standards Committee. I am a member of both the Institute of Electrical and Electronic Engineers and the American Society of Civil Engineers.

Q. What are your duties and responsibilities in your present position?

A. My duties include designing transmission line projects for Ameren operating companies including Ameren Transmission Company of Illinois (ATXI), Ameren Illinois Company d/b/a Ameren Illinois (Ameren Illinois), and Union Electric Company d/b/a Ameren Missouri (Ameren Missouri). These duties include assisting with the selection of line routes that balance cost effectiveness and environmental impacts, and ensuring line design meets National

Electrical Safety Code (NESC) requirements. While the scope of each project varies, they all include the following elements: the design of the transmission structures that are to be used on the transmission line, selection of transmission hardware, development of technical drawings, materials procurement, coordinating the scheduling of outages, coordination of field surveying work and cooperation with other departments within Ameren Services and the other operating companies (real estate, vegetation management, environmental services and other engineering groups), resolution of issues during construction, performance of the final inspection and turning the line over to operations to place in service. One of my current primary responsibilities is serving as an engineer for the Mark Twain Transmission Project (Mark Twain or the Project), which entails designing approximately 96 miles of new 345-kV transmission line that will be co-located with the 161-kV transmission lines of Northeast Missouri Power Electric Cooperative (Northeast Power) and Ameren Missouri, connecting to ATXI's new Zachary Substation.

II. PURPOSE AND SCOPE

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide information regarding the design of the Project in its newly-proposed location.

Q. Are you sponsoring any schedules in support of your direct testimony?

A. Yes. I am sponsoring **Schedule DE-01**, a drawing of a typical tangent steel pole structure for the co-located 345-kV transmission line and 161-kV transmission lines, and **Schedule DE-02**, a drawing of a dead-end double steel pole structure. I am also sponsoring **Schedule DE-03**, a drawing depicting the site design of the Zachary Substation.

III. DESIGN CONSIDERATIONS

Q. Please provide a technical description of the Project.

A. The proposed line will be a 345-kV, overhead transmission line approximately 96 miles long. The route for the line consists of two portions. The first portion runs from ATXI's Maywood Switching Station, located near Palmyra, to the new Zachary Substation near Kirksville. This portion will be primarily co-located with a 161-kV transmission line owned and operated by Northeast Power. The second portion runs from the Zachary Substation north to a connection point at the Iowa state line. This portion will be primarily co-located with a 161-kV transmission line owned and operated by Ameren Missouri. In addition, the Project includes construction of the Zachary Substation, in its new location, immediately adjacent to an existing Ameren Missouri substation just south of Kirksville.

ATXI will construct the proposed double-circuit, 345-kV/161-kV transmission line using single-shaft, self-supported steel poles on concrete foundations for nearly all of the route. Pole heights will range from approximately 100 feet to 160 feet above ground, and these steel monopole structures will be set on top of a concrete pier foundation that will be about seven (7) to ten (10) feet in diameter. Where the transmission line turns a large angle (generally greater than 15 degrees) or where a dead-end structure[1] is otherwise required, a double-pole configuration using self-supported steel poles approximately 100 to 160 feet above ground and twenty (20) to forty (40) feet apart from each other will be used. Only about five percent (5%) of the structures on the Project will be double-pole, dead-end structures. **Schedule DE-01** shows a drawing of a typical tangent steel monopole structure for the 345-kV transmission line and **Schedule DE-02** shows a typical dead-end, double steel pole structure. The average span will be approximately 900 feet. The transmission line will require a 150-foot wide easement. As

[1] Compared to tangent structures, a dead-end structure is designed to be stronger. Typically, insulators on a dead-end structure are in series with the conductors (horizontal) to bring wind, weight, and line angle loads directly to the structure. Dead-end structures can be designed for various line angles and unbalanced loads.

described by ATXI witness Douglas (Doug) Brown, the Northeast Power line is already located on a 150-foot easement, meaning that additional easement area will generally not be required. The Ameren Missouri 161-kV line segment of the line, however, is located on a 100-foot easement. As a result, ATXI will need to acquire an additional 50 feet in easement area[2] for that line segment. To be clear, ATXI will obtain its own easements for the entirety of the 96-mile line.

Each phase for the 345-kV line will be bundled Cardinal ACSS conductor. Each phase for the 161-kV line will be Grackle ACSS conductor. The arrangement of the conductor phasing on the structures will be done to reduce electric and magnetic fields. Both shield wires for the double circuit 345-kv/161-kV line will be fiber optic ground wires. The structure types will consist of tangents, running angles, and dead-ends. The entire line will be designed to meet or exceed the requirements of the NESC and, accordingly, the requirements at 4 CSR 240-18.010.

Q. Did co-location of the transmission line result in any particular changes to the design from the original single-circuit line?

A. Yes. The poles are approximately twenty (20) feet taller in order to accommodate the vertical configuration of 161-kV on one side of the pole and 345-kV on the other side of the pole.

Q. Will ATXI place any guy wires or anchors in the right-of-way?

A. No. All proposed structures will be self-supporting steel poles with concrete foundations and will not require any guy wires. The majority of the new line will involve replacing existing 161-kV transmission lines that currently use wood H-frame structures. At line

[2] Meaning that ATXI will obtain easement rights to a 150-foot corridor for both the Northeast Power segment and the Ameren Missouri segment.

angles (those generally over 1 degree), both of the existing 161-kV lines utilize guy wires attached to anchors. The new transmission line minimizes impact to landowners and existing farmland due to the reduced number of poles and the elimination of guy wires and anchors.

Q. Please provide a general description of the proposed Zachary Substation and related facilities.

A. The substation, designed by the Ameren Services Substation Design Team, will be located adjacent to the existing Ameren Missouri Adair Substation near Kirksville, and will consist of a 345-kV and a 161-kV switchyard connected by a power transformer. The substation will include two relay control enclosures, six circuit breakers, voltage and current sensing transformers, and a shunt reactor for voltage stability. The substation yard will be fully enclosed by chain-link fencing and only accessible by authorized personnel. **Schedule DE-03** depicts the substation design for the Zachary Substation.

IV. RIGHT-OF-WAY WIDTH

Q. You have stated that a 150-foot right-of-way easement will be required to construct the 345-kV portion of the Project. Please describe why a 150-foot easement is required.

A. Based on the proposed line design, a 150-foot wide easement is necessary to provide adequate clearance from the 345-kV transmission line conductors to the edge of the right-of-way for operational and maintenance purposes.

Q. Given the proposed line design, is the 150-foot easement the minimum easement required?

A. Yes. Based on the proposed design, the 150-foot easement will provide adequate NESC clearances from the conductor to a building on the edge of the right-of-way (Rule

234C.1). The 150-foot easement is the minimum easement that will provide the necessary clearance to trees or vegetation at the edge of the right-of-way. Maintenance of this clearance is necessary for the safe operation of the line.

Q. Do the existing Northeast Power and Ameren Missouri 161-kV lines already have sufficient right-of-way for the Mark Twain transmission line?

A. The Northeast Power line is located on a 150-foot right-of-way for the entire portion of the route that will be co-located with the Mark Twain transmission line. Ameren Missouri's 161-kV transmission line, however, is located on 100 feet of right-of-way.

Q. Will ATXI rely on the easements granted to Northeast Power and Ameren Missouri by landowners in order to construct Mark Twain?

A. No. As indicated above, and as ATXI witness Doug Brown will address in his direct testimony, ATXI will acquire its own permanent easements and not rely on the easements granted to Northeast Power or Ameren Missouri. Finally, ATXI is in the process of acquiring the property for the re-located, proposed Zachary Substation.

Q. In addition to the permanent utility easements, will ATXI require temporary construction or access easements to construct the Project?

A. Generally, the permanent easement obtained by ATXI will provide sufficient area for construction of the transmission line. During the installation of the wires, the construction contractor may need to set up equipment outside the permanent right-of-way, especially near hard-angle structures. ATXI witness Doug Brown will address this in his direct testimony.

Q. Does ATXI anticipate installing its transmission structures along the centerline of the easements?

A. For the co-located line with Northeast Power, the line will be offset from the easement centerline by approximately six (6) to ten (10) feet. This is being done to minimize outages and help facilitate construction of the line. On the co-located line with Ameren Missouri, ATXI intends to offset the centerline of the transmission line from the centerline of the easement approximately fifteen (15) feet after the additional fifty (50) feet of easement is acquired. This is also being done to minimize outages and facilitate the construction of the line.

V. CONCLUSION

Q. What is the status of the final technical design for the Project?

A. Now that the final route has been selected, the technical design of the Project has begun. We anticipate having a final design for the Project complete by fall 2017. When complete, ATXI will file the plans and specifications for the Project with the Missouri Public Service Commission as required by 4 CSR 240-3.105(1)(B)2.

Q. Does this conclude your direct 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 a Certificate of Public Convenience and Necessity Authorizing it to Construct, Install, Own, Operate, Maintain and Otherwise Control and Manage a 345-kV Electric Transmission Line from Palmyra, Missouri, to the Iowa Border and an Associated Substation Near Kirksville, Missouri.	))))))))	File No. EA-2017-0345

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 the City of St. Louis, Missouri, and I am employed by Ameren Services Company as a Principal Engineer in the Transmission Performance Management and Engineering Department.

2. Attached hereto and made a part hereof for all purposes is my Direct Testimony on behalf of Ameren Transmission Company of Illinois consisting of 7 pages, and Schedule(s) DE-01, DE-02, and DE-03, 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.

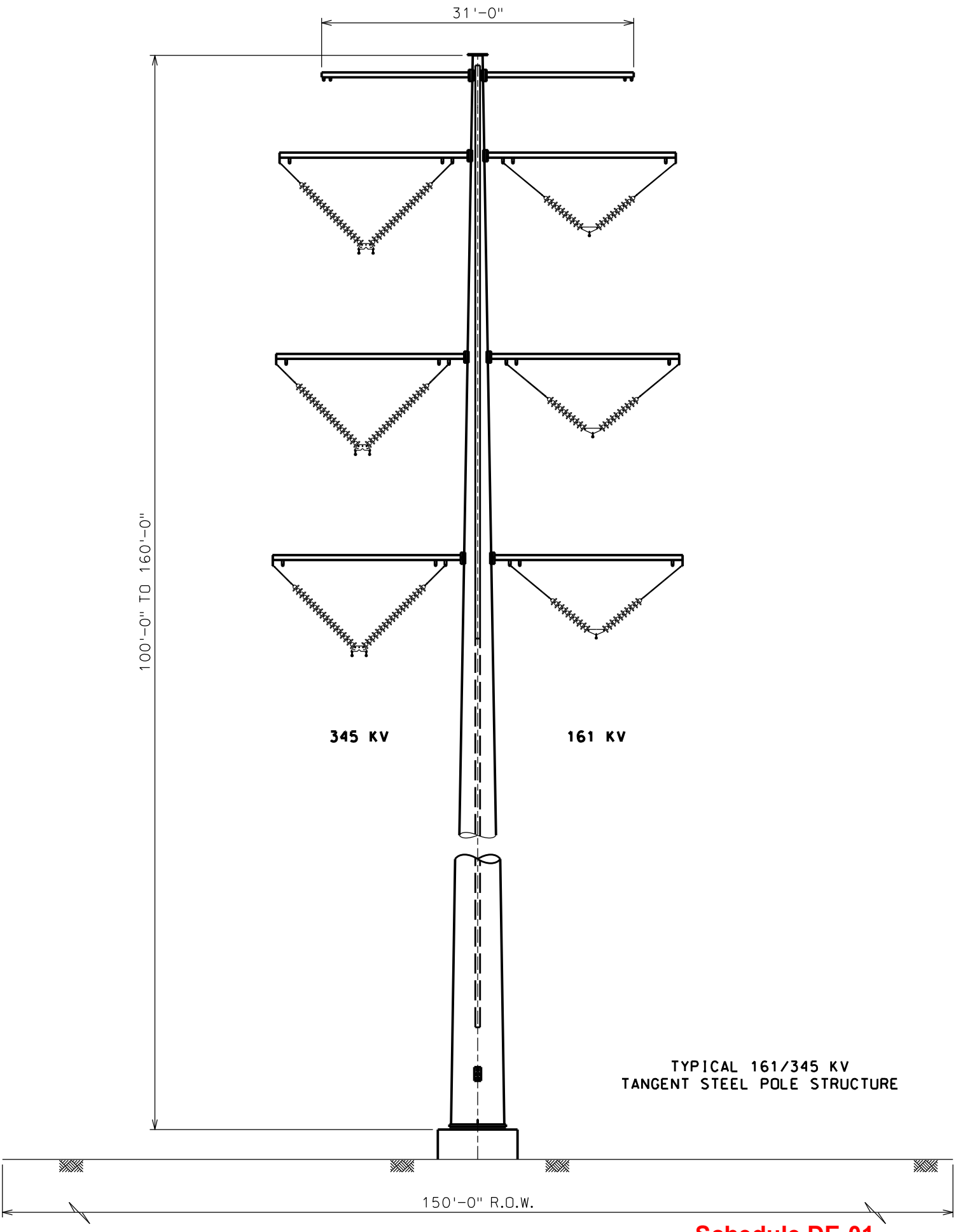
David Endorf

Subscribed and sworn to before me this 12th day of September, 2017.

Cathleen A. Dehne
Notary Public

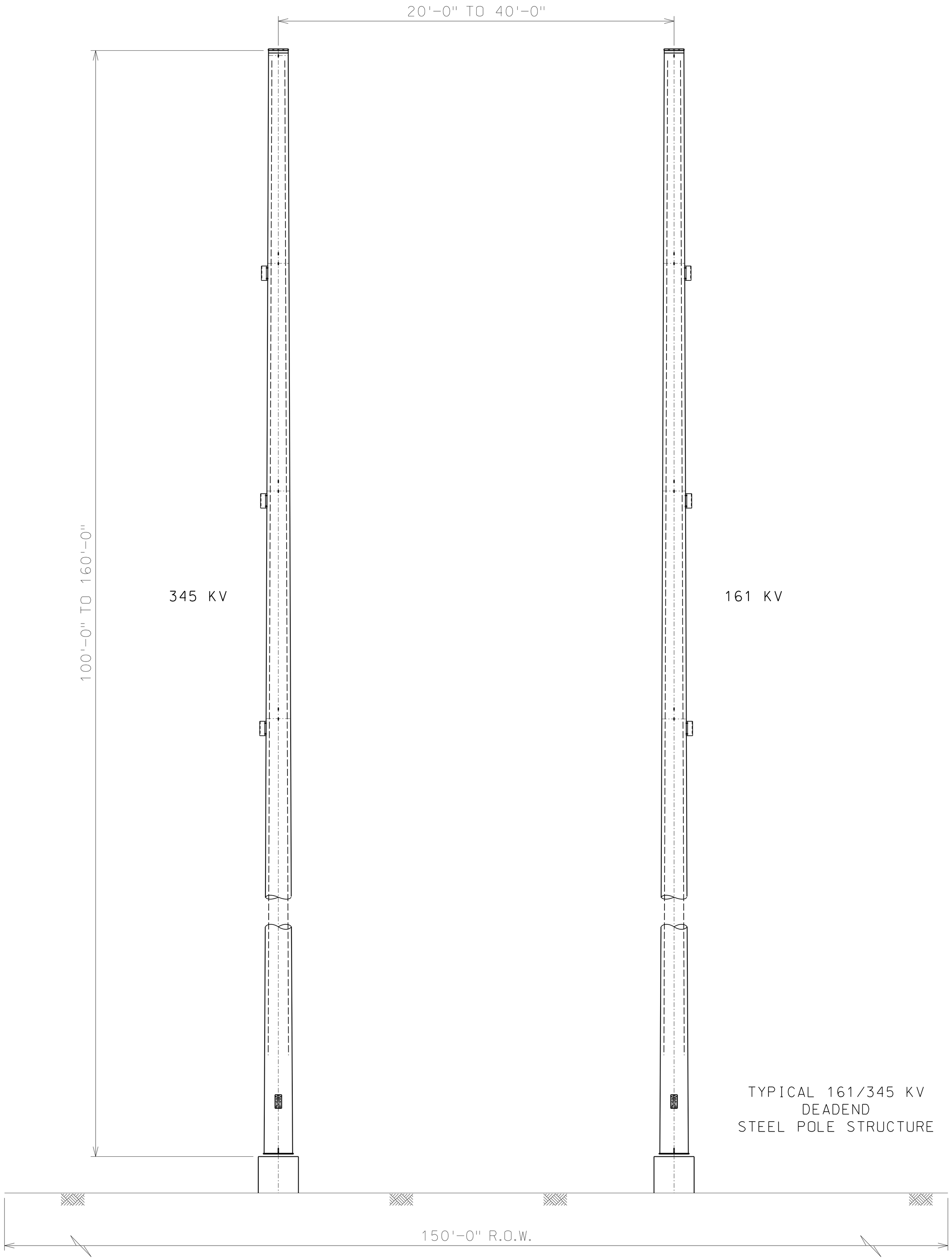
My commission expires: March 7, 2017

CATHLEEN A DEHNE
Notary Public - Notary Seal
St. Louis City - State of Missouri
Commission Number 17119727
My Commission Expires Mar 7, 2021



TYPICAL 161/345 KV
TANGENT STEEL POLE STRUCTURE

Schedule DE-01



Schedule DE-02

TO OTTUMWA

TO MAYWOOD

TO ADAIR

1435'-0"

729'-0"

EQUIPMENT PLAN

ZACHARY SUBSTATION

NORTH

Schedule DE-03