

**ATTACHMENT 5
NORTHEAST-POCONO RELIABILITY PROJECT
DESIGN & ENGINEERING DESCRIPTION**

Table of Contents

1.0	Introduction	1
2.0	Proposed Activity	2
3.0	Design Considerations	14
4.0	Magnetic Field Management Plan	15
5.0	Specific Right of Way Requirements	16
6.0	Construction Techniques and Execution for Typical Single Pole 230 kV and 138 kV Transmission Structures	18

List of Tables

Table 5-1 Design Minimum Conductor Clearances for 1590 Kcmil 45/7 Stranding ACSR Lapwing
Jenkins to West Pocono 230 kV Transmission Line
West Pocono to North Pocono 230 kV Transmission Line
North Pocono to Paupack 230 kV Transmission Line

Table 5-2 Conductor Thermal Rating 1590 Kcmil 45/7 Stranding ACSR Lapwing (284°F) 140°C
Maximum Conductor
Jenkins to West Pocono 230 kV Transmission Line
West Pocono to North Pocono 230 kV Transmission Line
North Pocono to Paupack 230 kV Transmission Line

Table 5-3 Design Minimum Conductor Clearances for 556.5 Kcmil 24/7 Stranding ACSR Parakeet
West Pocono 138/69 kV Transmission Lines
North Pocono 138/69 kV Transmission Lines

Table 5-4 Conductor Thermal Rating 556.5 Kcmil 24/7 Stranding ACSR Parakeet (257°F) 125°C
Maximum Conductor
West Pocono 138/69 kV Transmission Lines
North Pocono 138/69 kV Transmission Lines



List of Figures

- Figure 5-1** Jenkins-West Pocono 230 kV Segment
- Figure 5-2** West Pocono-North Pocono 230 kV Segment
- Figure 5-3** North Pocono-Paupack 230 kV Segment
- Figure 5-4** West Pocono 138/69 kV Connector Lines
- Figure 5-5** North Pocono 138/69 kV Connector Lines
- Figure 5-6** Typical 230 kV ROW Cross-Section: Common ROW near Jenkins Substation
- Figure 5-7** Typical 230 kV ROW Cross-Section: Jenkins to Paupack Substation
- Figure 5-8** Two-pole 230 kV ROW Cross-Section: Near West Pocono and North Pocono Substations
- Figure 5-9** Two-pole 138/69 kV ROW Cross-Section with Upswept Arms: Near West Pocono Substation
- Figure 5-10** Three-Pole 138/69 kV ROW Cross-Section with Upswept Arms: Near North Pocono Substation
- Figure 5-11** Typical 138/69 kV ROW Cross-Section with Upswept Arms: North Pocono Substation Connector Lines
- Figure 5-12** Two-pole 138/69 kV ROW Cross-Section with Straight Arms: Near West Pocono Substation
- Figure 5-13** Three-Pole 138/69 kV ROW Cross-Section with Straight Arms: Near North Pocono Substation
- Figure 5-14** Typical 138/69 kV ROW Cross-Section with Straight Arms: North Pocono Substation Connector Line



1.0 Introduction

PPL Electric Utilities Corporation (“PPL Electric”) seeks approval from the Pennsylvania Public Utility Commission (Commission or PUC) to site and construct transmission line connections associated with two new 230-69 kV transmission substations, the West Pocono 230 – 69 kV Substation and North Pocono 230 – 69 kV Substation.¹ The new Substations will be connected to the existing 230 kV transmission systems by a new 58-mile 230 kV transmission line. The proposed transmission line will have three segments: (1) approximately 15 miles of the line will be constructed from the existing Jenkins 230-69 kV Substation to the new West Pocono 230-69 kV Substation; (2) approximately 21 miles of the line will be constructed from the new West Pocono 230-69 kV Substation to the new North Pocono 230-69 kV Substation; and (3) approximately 22 miles of the line will be constructed from the new North Pocono 230-69 kV Substation to the previously approved Paupack 230-69 kV Substation.² These transmission lines will be designed to current 230 kV standards and operated at 230 kV.

PPL Electric also proposes to construct five new 138/69 kV transmission lines to connect the new North Pocono and West Pocono 230-69 kV Substations to the existing transmission lines. Approximately 5.3 miles of new 138/69 kV transmission lines will be constructed to connect the new North Pocono 230-69 kV Substation to the existing local 69 kV lines. Approximately 6.0 miles of new 138/69 kV transmission lines will be constructed to connect the new West Pocono 230-69 kV Substation to the existing 69 kV lines. These new 138/69 kV connecting lines will be designed and constructed for future 138 kV operation, but initially will operate at 69 kV until load growth in the area makes it appropriate to increase the operating voltage.

Collectively, the proposed North Pocono and West Pocono 230-69 kV Substations, and associated new transmission and connecting lines, make up the proposed Northeast Pocono Reliability Project. As explained in **Attachment 2**, the proposed Northeast Pocono Reliability Project is necessary to resolve projected violations of PPL Electric’s “Reliability Principles & Practices” (“RP&P”)

¹ PPL Electric will file zoning petitions for the West Pocono and North Pocono 230-69 kV Substations, seeking a finding for a finding that the buildings to shelter control equipment at each of the Substations are reasonably necessary for the convenience or welfare of the public and, therefore, exempt from any local zoning ordinance pursuant to 52 Pa. Code § 5.41 and 53 P.S. § 10619.

² On June 11, 2012, PPL Electric submitted a Zoning Petition, at Docket No. P-2012-2309302, for a finding that will exempt the control equipment building at the proposed Paupack 230-69 kV Substation from the Paupack Township Zoning Ordinance. This Zoning Petition was approved by the Commission on September 27, 2012.

guidelines. Further, the new West Pocono 230-69 kV Substation will provide operating flexibility and improved reliability for customers in the northeast Pocono region

The estimated cost to site, design, and construct the Northeast Pocono Reliability Project is approximately \$154 million. This cost includes the siting, design, right of way acquisition, and construction of the proposed new 230 kV transmission lines, the West Pocono and North Pocono 230-69 kV Substations, and the 138/69 kV connecting lines necessary to terminate the existing transmission lines into the new Substations. The required in-service date is November 2017. In order to meet that in-service date, subject to the Commission’s approval, construction is scheduled to commence in the spring of 2014.

All figures and costs are estimates and subject to change based on the routes ultimately approved, actual conditions, and final design and engineering of the proposed transmission lines.

2.0 Proposed Activity

2.1 230 kV Transmission Line Work

PPL Electric proposes to construct approximately 58 miles of new 230 kV overhead transmission line to strengthen the electrical delivery system and improve reliability in the Northeast Pocono region. The 230 kV portion of the Northeast-Pocono Reliability Project is divided into three major segments: the Jenkins-West Pocono Segment, the West Pocono-North Pocono Segment, and the North Pocono-Paupack Segment. The new structures for the 230 kV segments will be self-weathering tubular steel tangent structures equipped with upswept arms³ and installed on concrete caisson foundations. Angle structures, which will consist of one-pole or two-pole structures, will be installed on concrete caisson foundations. Each of these segments is summarized below.

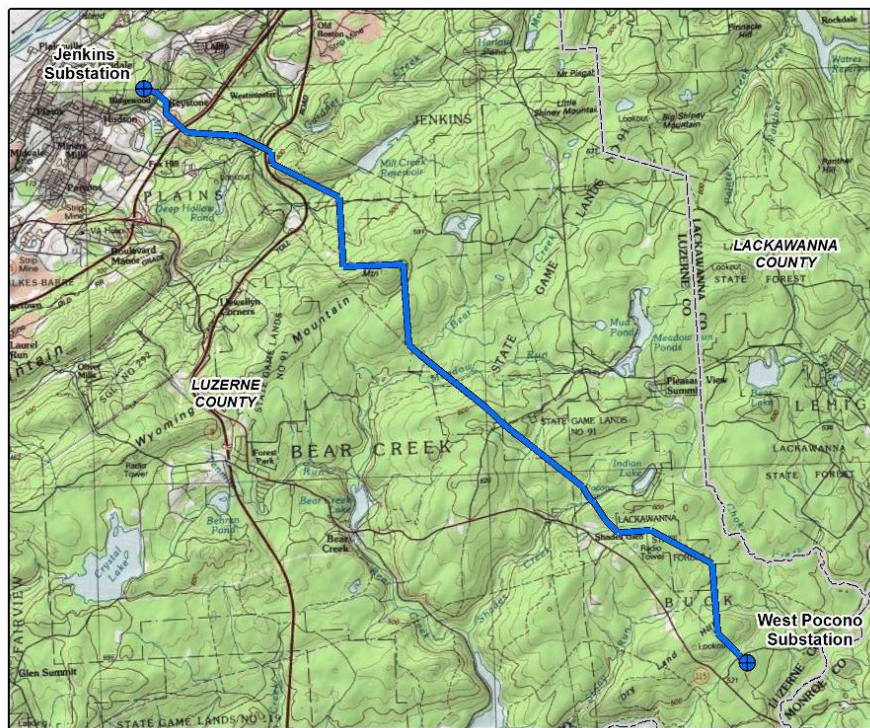
230 kV Transmission Line between Jenkins and West Pocono 230-69 kV Substations

Approximately 15 miles of new 230 kV transmission line will be constructed between the existing Jenkins 230-69 kV Substation and the new West Pocono 230-69 kV Substation (**Figure 5-1**). This segment will be named the Jenkins-West Pocono 230 kV Transmission Line. For the initial 2.5

³ Due to the limitation of steel pole manufacturers’ ability to provide arms with the necessary curved radius, PPL Electric is evaluating the need to utilize straight arms with a vertical rise on all 230kV and 138/69kV lines (**Figures 5-10 to 5-12**).

miles extending southeast from the Jenkins Substation, the new 230 kV line will be co-located in an existing 250-foot wide right-of-way (ROW) with the existing Susquehanna-Jenkins 230 kV Line (see **Figure 5-6**). The remaining section of the Jenkins-West Pocono 230 kV Transmission Line will run in a southeast direction using a new 150-foot ROW (see **Figure 5-7**) except for an approximately 0.40 mile portion that will be co-located with the West Pocono-North Pocono 230 kV Segment in a new 225-foot wide ROW near the West Pocono Substation (see **Figure 5-8**). As further explained in **Attachments 3** and **4**, the new ROW for the Jenkins-West Pocono 230 kV Transmission Line will traverse a predominately wooded area.

FIGURE 5-1: Jenkins-West Pocono 230 kV Segment



The new Jenkins-West Pocono 230 kV Transmission Line will require the installation of approximately 83 structures with an average height of 155 feet. The average spans between the structures will be approximately 1,000 feet. The Jenkins-West Pocono 230 kV Transmission Line will consist of approximately 58 self-weathering tubular steel tangent structures equipped with upswept arms and installed on concrete caisson foundations. There will be approximately 25 angle/dead-end structures, which will consist of one-pole or two-pole steel structures.

The new Jenkins-West Pocono 230 kV Transmission Line will be designed and constructed for 230

kV double circuit capability, but initially only one 230 kV circuit will be installed until load growth in the area makes it appropriate to add the second 230 kV circuit. The 230 kV double-circuit design will utilize six power conductors and two overhead ground wires. The power conductors will be 1590 kcmil⁴ 45/7 ACSR⁵ “Lapwing”⁶ conductors. The overhead ground wires will be 48 count single mode fiber optical ground wires and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault in the line be detected.

The new Jenkins-West Pocono 230 kV Transmission Line will be designed to meet, and generally exceed, National Electrical Safety Code minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 13**. The minimum conductor to ground clearance for the proposed 230 kV line will be 32 feet, which occurs at a maximum conductor temperature of 140° C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 5-1** and **Table 5-2** below.

Construction on the Jenkins-West Pocono portion of the Northeast-Pocono Reliability Project is scheduled to begin in the spring of 2015 to meet the overall project in-service date of November 2017.

230 kV Line between West Pocono and North Pocono 230-69 kV Substations

Approximately 21 miles of new 230 kV transmission line will be constructed from the new West Pocono 230-69 kV Substation to the new North Pocono 230-69 kV Substation (**Figure 5-2**). This segment will be named the new West Pocono-North Pocono 230 kV Transmission Line. This new segment of 230 kV transmission line will run in a northeast direction primarily using a new 150 foot ROW. An approximately 0.40 mile portion adjacent to the West Pocono Substation and an approximately 0.50 mile portion adjacent to the North Pocono Substation will be co-located in a new 225-foot wide ROW with sections of the Jenkins-West Pocono and North Pocono-Paupack 230 kV Segments, respectively (see **Figure 5-8**). As further explained in **Attachments 3** and **4**, the new ROW for the West Pocono-North Pocono 230 kV Transmission Line will traverse a predominately wooded area.

⁴ kcmil stands for thousand circular mils. Kcmil wire size is the equivalent cross sectional area in thousands of circular mils. A circular mil is the area of a circle with a diameter of one thousandth (0.001) of an inch.

⁵ ACSR stands for aluminum conductor steel reinforced.

⁶ Lapwing is the technical term for a 1590 kcmil 45/7 ACSR conductor as defined in the American Society for Testing and Materials.

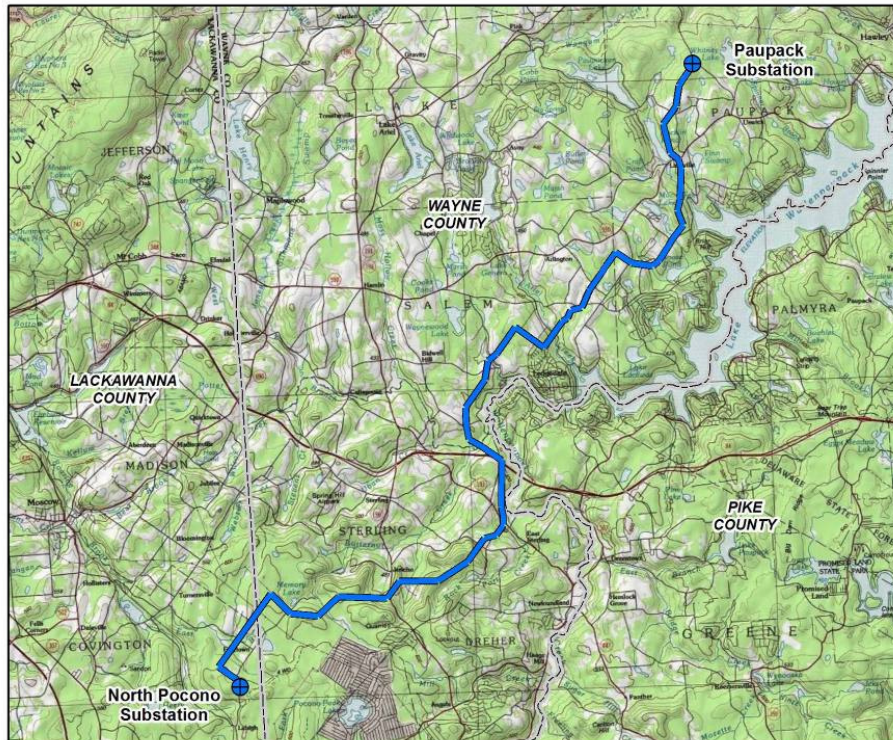
ground clearance for the proposed 230 kV line will be 32 feet, which occurs at a maximum conductor temperature of 140° C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 5-1** and **Table 5-2** below.

Construction on the West Pocono-North Pocono portion of the Northeast Pocono Reliability Project is scheduled to begin in the spring of 2016 to meet the overall project in-service date of November 2017.

230 kV Line between North Pocono and Paupack 230-69 kV Substations

Approximately 22 miles of new 230 kV transmission line will be constructed from the new North Pocono 230-69 kV Substation to the Paupack 230-69 kV Substation (**Figure 5-3**). This segment will be named the North Pocono-Paupack 230 kV Transmission Line. This new segment of 230 kV transmission line will run in a northeast direction using a new 150-foot ROW except for an approximately 0.50 mile portion that will be co-located with the West Pocono-North Pocono 230 kV segment in a new 225-foot wide ROW near the North Pocono Substation. As further explained in **Attachments 3** and **4**, the new ROW for the North Pocono-Paupack 230 kV Transmission Line will traverse a predominately wooded area.

FIGURE 5-3: North Pocono-Paupack 230 kV Segment



The new North Pocono-Paupack 230 kV Transmission Line will require the installation of approximately 120 structures with an average height of 150 feet. The average spans between structures will be approximately 1,000 feet. The North Pocono-Paupack 230 kV Transmission Line will consist of approximately 72 self-weathering tubular steel tangent structures equipped with upswept arms and installed on concrete caisson foundations. There will be approximately 48 angle/dead-end structures, which will consist of one-pole or two-pole steel structures.

The new North Pocono-Paupack 230 kV Transmission Line will be designed for 230 kV double-circuit capability, but initially only one 230 kV circuit will be installed until load growth in the area makes it appropriate to add the second 230 kV circuit. The 230 kV double-circuit design will utilize six power conductors and two overhead ground wires. The power conductors will be six 1590 kcmil 45/7 ACSR “Lapwing” conductors. The overhead ground wires will be 48 count single mode fiber optical ground wires and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault in the line be detected.

The new North Pocono-Paupack 230 kV Transmission Line will be designed to meet, and generally exceed, National Electrical Safety Code minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 13**. The minimum conductor to ground clearance for the proposed 230 kV line will be 32 feet, which occurs at a maximum conductor temperature of 140° C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 5-1** and **Table 5-2** below.

Construction on the North Pocono-Paupack portion of the Northeast Pocono Reliability Project is scheduled to begin in the spring of 2014 to meet the overall project in-service date of November 2017.

2.2 Proposed 138/69 kV Transmission Line Work

PPL Electric also proposes to construct approximately 11.3 miles of new 138/69 kV transmission lines to connect the new North Pocono and West Pocono 230-69 kV Substations into the existing local 69 kV transmission lines. These new 138/69 kV connecting lines will, in conjunction with the 230 kV transmission line work, further improve system reliability in the northeast Pocono region. The structures for the new 138/69 kV connecting lines will be self-weathering tubular steel tangent

structures equipped with upswept arms⁷ and will be either direct embedded or installed on concrete caisson foundations as necessary. Angle structures, which will consist of one or two-poles either guyed or on concrete foundations as necessary. The 138/69 kV portion of the Northeast Pocono Reliability Project is divided into two major sections, which are summarized below.

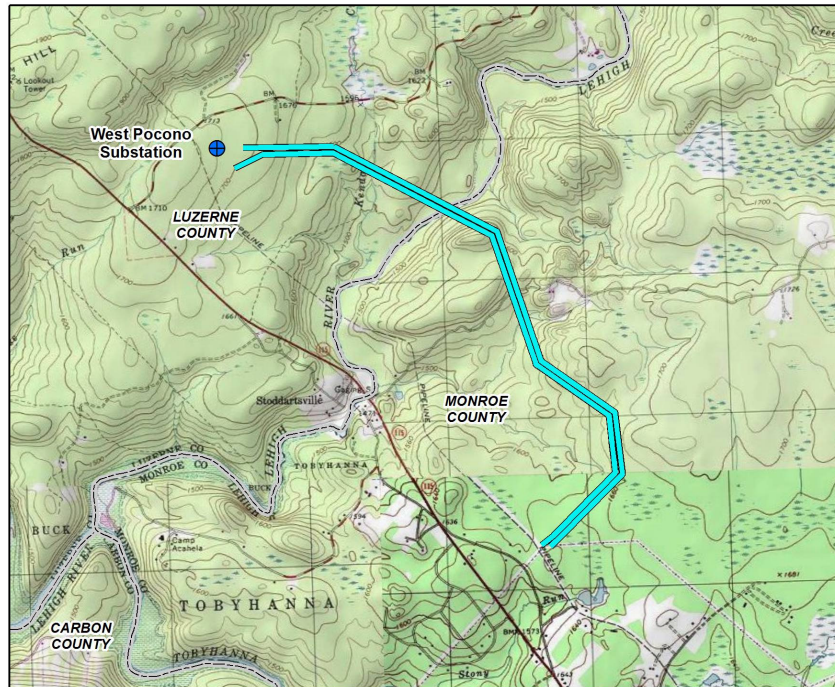
Proposed 138/69 kV lines from the new West Pocono 230-69 kV Substation

Two new double circuit 138/69 kV transmission lines, each approximately 3.0 miles in length, will be constructed to connect the new West Pocono 230-69 kV Substation (collectively the West Pocono 138/69 kV Connecting Lines) with the double-circuit East Palmerton-Wagners #1 & #2 138/69 kV Transmission Line and the Jackson-Wagners #1 & #2 138/69 kV Transmission Lines.⁸ One of the new double-circuit 138/69 kV lines will become the new West Pocono – East Palmerton #1 & #2 Transmission Line and the other new double-circuit 138/69 kV transmission line will become the new West Pocono – Jackson 138/69 kV Transmission Line (**Figure 5-4**). Both double circuit 138/69 kV connecting lines will be constructed using a new 150-foot ROW. Both 138/69 kV connecting lines will share the ROW using a 50-foot centerline separation (see **Figure 5-9**).

⁷ Due to the limitation of steel pole manufacturers' ability to provide arms with the necessary curved radius, PPL Electric is evaluating the need to utilize straight arms with a vertical rise on all 230kV and 138/69kV lines.

⁸ Currently, from the East Palmerton 230-69 kV Substation to the Lake Harmony 69-12 kV Substation, the East Palmerton-Wagners #1 and #2 138/69 kV circuits are built on double-circuit tower structures. From the Lake Harmony 69-12 kV Substation, the East-Palmerton Wagners # 1 circuit proceeds on separate single-circuit tower structures to the Wagners 69-12 kV Substation and then terminates at the Lake Naomi 138/69 kV Tap pole. PPL Electric plans to rebuild the East Palmerton-Wagners #1 & #2 Transmission Line from the Lake Harmony Substation to the Lake Naomi Tap pole for double-circuit operation. Upon completion, this portion of the Palmerton-Wagners Transmission Line (from Lake Harmony to Lake Naomi) will be renamed the Jackson-Wagners #1 & #2 138/69 kV Transmission Line. PPL Electric plans to submit this project for Commission review and approval in mid-2013, and, if approve, this new double-circuit line will be in service prior to the in-service date for the Northeast-Pocono Reliability Project.

FIGURE 5-4: West Pocono 138/69 kV Connector Lines



The new West Pocono 138/69 kV Connecting Lines will require the installation of approximately 48 steel mono-poles with an average height of 105 feet. The average spans between structures will be approximately 650 feet. The West Pocono 138/69 kV Connecting Lines will consist of approximately 34 self-weathering tubular steel tangent structures equipped with upswept arms and that will be either direct embedded or installed on concrete caisson foundations as necessary. There will be approximately 14 angle structures, which will consist of one or two-pole steel mono pole structures.

The new double-circuit West Pocono 138/69 kV Connecting Lines will be designed and constructed for future 138 kV double circuit operation, but initially will be operated at double circuit 69 kV until load growth in the area makes it appropriate to increase the operating voltage. The 138/69 kV double-circuit design will utilize six power conductors and two overhead ground wires. The power conductors will be six 556 kcmil 24/7 ACSR “Parakeet”⁹ conductors. The overhead ground wires will be 48 count single mode fiber optical ground wires and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault in the line be detected.

⁹ Parakeet is the technical term for a 556 kcmil 24/7 ACSR conductor as defined in the American Society for Testing and Materials.

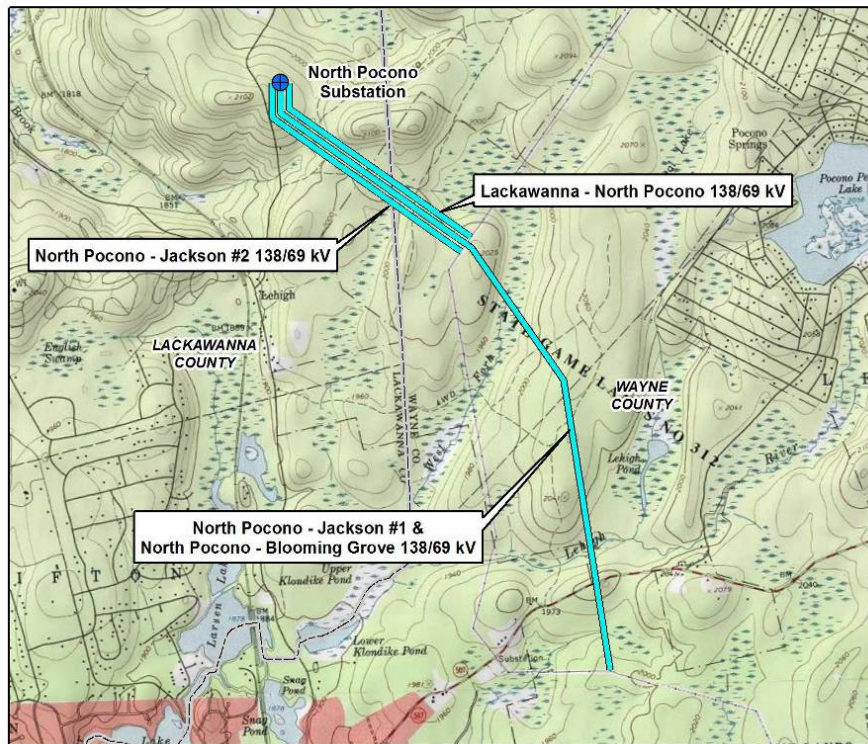
The new West Pocono 138/69 kV Connecting Lines will be designed to meet, and generally exceed, National Electrical Safety Code minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 13**. The minimum conductor to ground clearance for the proposed 138/69 kV line will be 30 feet, which occurs at a maximum conductor temperature of 125 °C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 5-3** and **Table 5-4** below.

Construction on the West Pocono 138/69 kV Connecting Lines portion of the Northeast Pocono Reliability Project is scheduled to begin in the spring of 2015 to meet the overall project in-service date of November 2017.

Proposed 138/69 kV lines from the new North Pocono Substation

Three new 138/69 kV transmission lines, collectively approximately 5.3 miles, will be constructed to connect the new North Pocono 230-69 kV Substation (collectively, North Pocono 138/69 kV Connecting Lines) to the existing Blooming Grove-Jackson and Peckville-Jackson 138/69 kV Transmission Lines (**Figure 5-5**).

FIGURE 5-5: North Pocono 138/69 kV Connector Lines



The new North Pocono 138/69 kV Connecting Lines will each be designed and constructed for future 138 kV double-circuit operation, but initially will be operated at 69 kV until load growth in the area makes it appropriate to increase the operating voltage. The 138/69 kV double-circuit design will utilize six power conductors and two overhead ground wires. The power conductors will be six 556 kcmil 24/7 ACSR “Parakeet” conductors. The overhead ground wires will be 48 count single mode fiber optical ground wires and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault in the line be detected.

The new North Pocono 138/69 kV Connecting Lines will be designed to meet, and generally exceed, National Electrical Safety Code minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 13**. The minimum conductor to ground clearance for the proposed 138/69 kV line will be 30 feet, which occurs at a maximum conductor temperature of 125 °C. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 5-3** and **Table 5-4** below.

Construction on the North Pocono 138/69 kV Connecting Lines portion of the Northeast-Pocono Reliability Project is scheduled to begin in the spring of 2014 to meet the overall project in-service date of November 2017. A description of each of the three new double-circuit 138/69 kV connecting lines is provided below.

Proposed Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Lines:

Two new 138/69 kV transmission lines, each approximately 1.1 miles in length, will connect the North Pocono 230-69 kV Substation to the single-circuit Peckville-Jackson 138/69 kV Transmission Line. One single-circuit line will be renamed the Lackawanna-North Pocono 138/69 kV Transmission Line and the other single-circuit line will be renamed the North Pocono-Jackson #2 138/69 kV Transmission Line.

The new Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Lines initially will have only one circuit installed until load growth in the area makes it appropriate to add the second circuit. The new Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Lines will be constructed within a new, shared 200-foot ROW, using a 50-foot centerline separation that will extend from the North Pocono 230-69 kV Substation to the existing Peckville-Jackson 138/69 kV Line (see **Figure 5-10**).

The new single-circuit Lackawanna-North Pocono 138/69 kV Transmission Line will extend approximately 1.1 miles from the North Pocono 230-69 kV Substation to break into the existing Peckville-Jackson 138/69 kV Transmission Line, and then will proceed northwest to the existing Lackawanna Substation.¹⁰ The new Lackawanna-North Pocono 138/69 kV Transmission Line will require the installation of approximately 10 structures with an average height of 110 feet. The spans between structures will be approximately 650 feet. The Lackawanna-North Pocono 138/69 kV Transmission Line will consist of approximately 7 self-weathering tubular steel tangent structures equipped with upswept arms and that will be either direct embedded or installed on concrete caisson foundations as necessary. There will be approximately 3 angle structures, which will consist of one-pole or two pole steel structures and that will be either direct embedded and guyed or installed on concrete caisson foundations as necessary.

The new single-circuit North-Pocono-Jackson #2 138/69 kV Transmission Lines will extend approximately 1.1 miles from the North Pocono 230-69 kV Substation to break into the existing Peckville-Jackson 138/69 kV Transmission Line and proceed south to the existing Gouldsboro Substation, and then proceed southeast from the Gouldsboro Substation to the existing Jackson Substation. The new North Pocono-Jackson #2 138/69 kV Transmission Lines will require the installation of approximately 12 structures with an average height of 110 feet and an average span of 650 feet. The North Pocono-Jackson #2 138/69 kV Transmission Line will consist of approximately 7 self-weathering tubular steel tangent structures equipped with upswept arms and that will be either direct embedded or installed on concrete caisson foundations as necessary. There will be approximately 5 angle/dead-end structures, which will consist of one-pole or two-pole steel structures and that will be either direct embedded and guyed or installed on concrete caisson foundations as necessary.

The Proposed North Pocono-Jackson #1 & North Pocono-Blooming Grove 138/69 kV Transmission Line:

The third 138/69 kV transmission line will be approximately 3.1 miles and will connect the North Pocono 230-69 kV Substation to the existing Blooming Grove-Jackson and Peckville-Jackson #1 138/69 kV Transmission Lines near the Gouldsboro Substation. One circuit on

¹⁰ The Peckville Substation is scheduled to be decommissioned on September 2015 and, as a result, the new Lackawanna-North Pocono 138/69 kV Transmission Line will ultimately terminate at the Lackawanna Substation.

this double-circuit connecting line will be named the North Pocono-Jackson #1 138/69 kV circuit and the other circuit will be named the North Pocono-Blooming Grove 138/69 kV circuit. The new North Pocono Jackson #1 138/69 kV circuit will break into the one of the circuits on the existing double-circuit Blooming Grove-Jackson and Peckville-Jackson 138/69 kV Transmission Line, and then proceed southeast to the Jackson Substation.¹¹ The new North Pocono-Blooming Grove 138/69 kV circuit will tie into the existing single-circuit Blooming Grove-Jackson 138/69 kV Transmission Line, and then proceed northeast to the Blooming Grove Substation.¹²

The new double circuit transmission line will be constructed in the middle of the new 200 foot ROW shared by the new single-circuit Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Lines. Thereafter, the ROW for the North Pocono-Jackson #1 and North Pocono-Blooming Grove 138/69 kV Transmission Line will continue south on a new 100-foot ROW where it will intersect the existing Peckville-Jackson #1 and Blooming Grove-Jackson 138/69 kV Transmission Lines near the Goldsboro 69 kV Substation (see **Figure 5-11**).

The new North Pocono-Jackson #1 & North Pocono-Blooming Grove 138/69 kV Transmission Line will require the installation of approximately 25 structures with an average height of 110 feet. The spans between structures will be approximately 650 feet. The North Pocono-Jackson #1 & North Pocono-Blooming Grove 138/69 kV Transmission Line will consist of approximately 18 self-weathering tubular steel tangent structures equipped with upswept arms and that will be either direct embedded or installed on concrete caisson foundations as necessary. There will be approximately 7 angle/dead-end structures, which will consist of one-pole or two-pole steel structures and that will be either direct embedded and guyed or installed on concrete caisson foundations as necessary.

¹¹ The new North Pocono-Jackson #1 and new North Pocono-Jackson #2 lines meet on the existing double-circuit Blooming Grove-Jackson and Peckville-Jackson 138/69 kV Transmission Line and continue on the same existing double-circuit line to the Jackson Substation. This double-circuit line will be renamed the North-Pocono-Jackson #1 & #2 138/69 kV Transmission Line after the Northeast-Pocono Reliability Project has been completed.

¹² The existing Blooming Grove-Jackson is built on single-circuit tower structures from the Gouldsboro Substation to the Blooming Grove Substation. This circuit will be renamed the North Pocono-Blooming Grove 138/69 kV Transmission Line after the Northeast-Pocono Reliability Project has been completed.

3.0 Design Considerations

The proposed new line constructions described above will be designed according to, and generally exceed, all National Electric Safety Code minimum standards. Design specifications and safety rules practiced by PPL Electric are described in **Attachment 13**.

Table 5-1 shows the design minimum conductor clearances and **Table 5-2** lists the conductor thermal ratings of the proposed new Jenkins-West Pocono, West Pocono-North Pocono, and North Pocono-Paupack 230 kV Transmission Lines.

TABLE 5-1 DESIGN MINIMUM CONDUCTOR CLEARANCES FOR 1590 KCMIL 45/7 STRANDING ACSR “LAPWING”	
<u>Condition</u>	<u>Double-Line Design Clearance-to-Ground</u>
Normal load; average weather (16°C ambient temperature)	41.6 feet
Predicted extreme thermal load (140°C conductor temperature)	32.0 feet
Predicted PPL Extreme wind load (100 mph, 16°C)	38.8 feet
Predicted extreme weather conditions (1 inch ice, 8 lbs. wind, -18°C)	39.4 feet
*Clearances based on a maximum tension of 21,900 pounds at 1 inch ice, 0° F, 8# wind and a ruling span of 1000 feet.	

TABLE 5-2 CONDUCTOR THERMAL RATING 1590 KCMIL 45/7 STRANDING ACSR “LAPWING” (284°F) 140°C MAXIMUM CONDUCTOR			
Condition	Ambient Temperature _____ °C _____	Wind Speed _____ ft/sec _____	Ampacity _____ Amps _____
Summer Normal	35	0	1788
Winter Normal	10	0	2010
Summer Emergency	35	2.533	2172
Winter Emergency	10	2.533	2399

Table 5-3 shows the design minimum conductor clearances and **Table 5-4** lists the conductor thermal ratings of the proposed new North Pocono and West Pocono 138/69 kV Connecting Lines.

TABLE 5-3 DESIGN MINIMUM CONDUCTOR CLEARANCES FOR 556.5 KCMIL 24/7 STRANDING ACSR “PARAKEET”	
<u>Condition</u>	<u>Double-Line Design Clearance-to-Ground</u>
Normal load; average weather (16°C ambient temperature)	35.8 feet
Predicted extreme thermal load (125°C conductor temperature)	30.0 feet
Predicted PPL Extreme wind load (100 mph, 16°C)	32.8 feet
Predicted extreme weather conditions (1/2 inch ice, 8 lbs. wind, -18°C)	35.0 feet
*Clearances based on a maximum tension of 7,000 pounds at 1/2 inch ice, 0° F, 8# wind And a ruling span of 650 feet.	

TABLE 5-4 CONDUCTOR THERMAL RATING 556.5 KCMIL 24/7 STRANDING ACSR (257°F) 125°C MAXIMUM CONDUCTOR			
Condition	Ambient Temperature °C	Wind Speed Ft/sec	Ampacity Amps
Summer Normal	35	0	806
Winter Normal	10	0	929
Summer Emergency	35	2.533	1054
Winter Emergency	10	2.533	1187

4.0 Magnetic Field Management Plan

PPL Electric’s Magnetic Field Management Program is included in **Attachment 11** and is applied to new and reconstructed transmission line projects. In order to lower magnetic field exposures, the program generally prescribes the use of a line design that provides ground clearances of five feet higher than the required minimum NESC ground clearance and reverse phasing of new double

circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications will be considered, provided those modifications can be made at low or no cost and will not interfere with the operation of the line.

Consistent with its Magnetic Field Management Program, PPL Electric will construct the proposed 230 kV and 138/69 kV transmission lines for ground clearances that are a minimum of five feet higher than the required NESC minimum ground clearance for 230 kV and 138/69 kV lines. The new Jenkins-West Pocono, West Pocono-North Pocono, and North Pocono-Paupack 230 kV Transmission Lines initially will be built as single circuits on one side of the structure or in a staggered delta configuration. Therefore, reverse phasing cannot be accomplished on the proposed new 230 kV transmission lines. The new double circuit 138/69 kV lines connected to the new West Pocono and North Pocono 230-69 kV Substations will be designed to be reverse phased. The new 138/69kV initial single/future double circuit lines connected to North Pocono 230-69 kV Substation will not be reverse phased. Since each of these lines are to be constructed as single circuit; reverse phasing at this time is not feasible. In the future, when a second circuit is added to these lines, PPL Electric will select the best circuit/phase arrangement to reduce the magnetic field where it is feasible to do so at low or no cost to the extent practical.

5.0 Specific Right of Way Requirements

Description of the Right of Way Requirement's

PPL Electric's standard ROW width for a double-circuit 230 kV transmission line is 150 feet. Standard right of way width for a double-circuit 138/69 kV transmission line is 100 feet, 50 feet either side of the proposed centerline of transmission line. ROW widths for proposed 138/69 kV lines out of West Pocono and North Pocono Substations are based on the number of new lines being proposed and the 50 feet from centerline of proposed transmission lines. ROW width is determined by structure type, design tensions, span length, and conductor "blowout" (the distance the wires are moved by a crosswind).

Cross sections of the proposed ROWs required for the Northeast Pocono Project are illustrated in **Figures 5-6** through **5-14**. The aerial maps of the selected line routes (see **Attachment 4 Map Pocket**) show the location of the proposed route, identify the properties that are traversed by the

selected routes, and show ROW widths. Additionally, a list of all persons owning property within the proposed ROWs is included in **Attachment 6**.

Status of Right of Way Negotiations

PPL Electric has attempted to negotiate new easements with 126 property owners across 177 parcels of land. To date, agreements have been secured from 89 property owners. PPL Electric will continue to negotiate with the 37 unsigned property owners.

The new Jenkins-West Pocono 230 kV Transmission Line will run in a southeast direction using existing 250-foot and new 150-foot and 225-foot rights-of-way. At the time of this filing, PPL Electric requires rights-of-way and easements from 5 property owners for the Jenkins-West Pocono segment.

The new West Pocono-North Pocono 230 kV Transmission Line will run in a northeast direction using new 150-foot and 225-foot rights-of-way. At the time of this filing, PPL Electric requires rights-of-way and easements from 12 property owners for the West Pocono-North Pocono segment.

The new North Pocono-Paupack 230 kV Transmission Line will run in a northeast direction using both existing and new 150-foot and 225-foot rights-of-way. At the time of this filing, PPL Electric requires rights-of-way and easements from 15 property owners for the North Pocono-Paupack segment.

The two new double-circuit 138/69 kV transmission lines to connect the new West Pocono 230-69 kV Substation to the existing 138/69 kV system will be constructed using a new, single 150-foot right-of-way. At the time of this filing, PPL Electric requires rights-of-way and easements from 5 property owners for the West Pocono 138/69 kV connecting lines.

The new Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Line will connect the North Pocono 230-69 kV Substation with the existing single-circuit Peckville-Jackson 138/69 kV Transmission Line using a new, shared 200-foot right-of-way with a 50-foot centerline separation. At the time of this filing, PPL Electric requires license

agreements from Pennsylvania State Game Commission and Lackawanna State Forest for the new Lackawanna-North Pocono 138/69 kV Transmission Line.

The new North Pocono-Jackson #1 and North Pocono-Blooming Grove 138/69 kV Transmission Lines will connect the North Pocono 230-69 kV Substation with the existing double-circuit Blooming Grove-Jackson and Peckville-Jackson 138/69 kV Transmission Line using the middle of the new 200 foot right-of-way shared with the new single-circuit Lackawanna-North Pocono and North Pocono-Jackson #2 138/69 kV Transmission Lines described above. Thereafter, the right-of-way for the North Pocono-Jackson #1 and North Pocono-Blooming Grove 138/69 kV Transmission Line will continue south on a new 100-foot right-of-way. At the time of this filing, PPL Electric requires license agreements from Pennsylvania State Game Commission and Lackawanna State Forest for these Lines.

Although negotiations continue with these property owners, PPL Electric is separately filing 37 Condemnation Applications, pursuant to 15 Pa.C.S. §1511(c), for a finding and determination that the service to be furnished through its proposed exercise of the power of eminent domain to acquire the above-mentioned tracts of land for the proposed Northeast Pocono Reliability Project is necessary or proper for the service, accommodation, convenience, or safety of the public.

In addition, a portion of the selected route crosses lands of the Pennsylvania Game Commission and Lackawanna State Forest. PPL Electric has met with local State Foresters to review and identify routes through state lands that would have the least amount of impacts as possible and balance the amount of transmission line across state lands, private lands and commercial lands within the study area. PPL Electric will seek license agreements from the applicable state agencies to occupy their lands.

6.0 Construction Techniques and Execution for Typical Single Pole 230 kV and 138 kV Transmission Structures

The following is a summary, non-technical explanation of the typical construction activity that is associated with new transmission line construction for single poles, which are either directly embedded into the ground or installed on a concrete foundation. This is not to be misconstrued as

all encompassing and may vary based on specific site/service conditions at each project. Actual construction steps may not necessarily occur in this particular order:

- The project manager will review the construction plans with PPL Electric personnel that will be constructing the line, including all permits and conditions that apply (such as erosion and sediment control, wetland encroachments, and storm water management), as well as any agreements made with specific property owners for work done on their lands.
- Professional land surveyors will stake the locations of all poles to be constructed, as well as the edge of ROWs and locate any wetland or streams previously sited during field work.
- All wetlands/waters are delineated in the field, located by land surveyors, and specifically shown to the construction manager prior to work commencing.
- During the installation of access roads, poles, and hanging of the wire, approved “best management practices” are implemented to assure that the soil will be stabilized and not erode during storm events while the Project is under construction. Any temporary wetland encroachments (usually roads) will be removed according to the permit conditions. Whenever practical, PPL Electric will utilize timber matting in wetland areas to minimize disturbance to the wetland vegetation and topography.
- Construction roads will be constructed, approximately 14 to 16 feet in width, with a stone surface to support the equipment that will be transporting materials to the pole sites. Those vehicles are usually cranes, concrete trucks (if foundations are involved), boom trucks, and pickups. The roads will be built as provided for in the construction drawings as per the erosion and sediment control plan, the NPDES permit plan, and/or the wetland encroachment permit plan. The plan may require these roads to be temporary in nature, returning to vegetative cover when the work is complete. Landowners may wish to have the roads remain intact for shared use between PPL Electric for line inspection and maintenance and property owner use. Much of the routine maintenance to the line, once built, will be by helicopter or 4 wheel drive pickup truck.
- The direct embedded poles will be installed by the use of auger and then a crane. After the hole is drilled, usually 4 to 6 feet in diameter, the bottom section of pole is placed directly into the hole and backfilled with native soil or engineered material, then the remaining sections are installed along with any cross arms. A pole that is at an angle in the line, or for another specialized reason, may be required to have a concrete foundation. These

foundations are seldom more than 12 feet in diameter and are filled with reinforced concrete. The top of the foundation may extend an average of 1 foot above the ground.

- Once the poles are in place along the line route, the wires will be installed using bucket trucks to attach the wires to each pole and equipment and manpower will be used to pull the wires along from pole to pole. Helicopter stringing/pulling may be utilized in restricted access or environmental sensitive areas.
- The project manager will oversee the stabilization of the site including the successful establishment of vegetation on all previously disturbed areas during construction.

Typical examples of the proposed structures are depicted in **Figures 5-6 to 5-14**.

FIGURE 5-6: Typical 230 kV ROW Cross-Section: Common ROW near Jenkins Substation

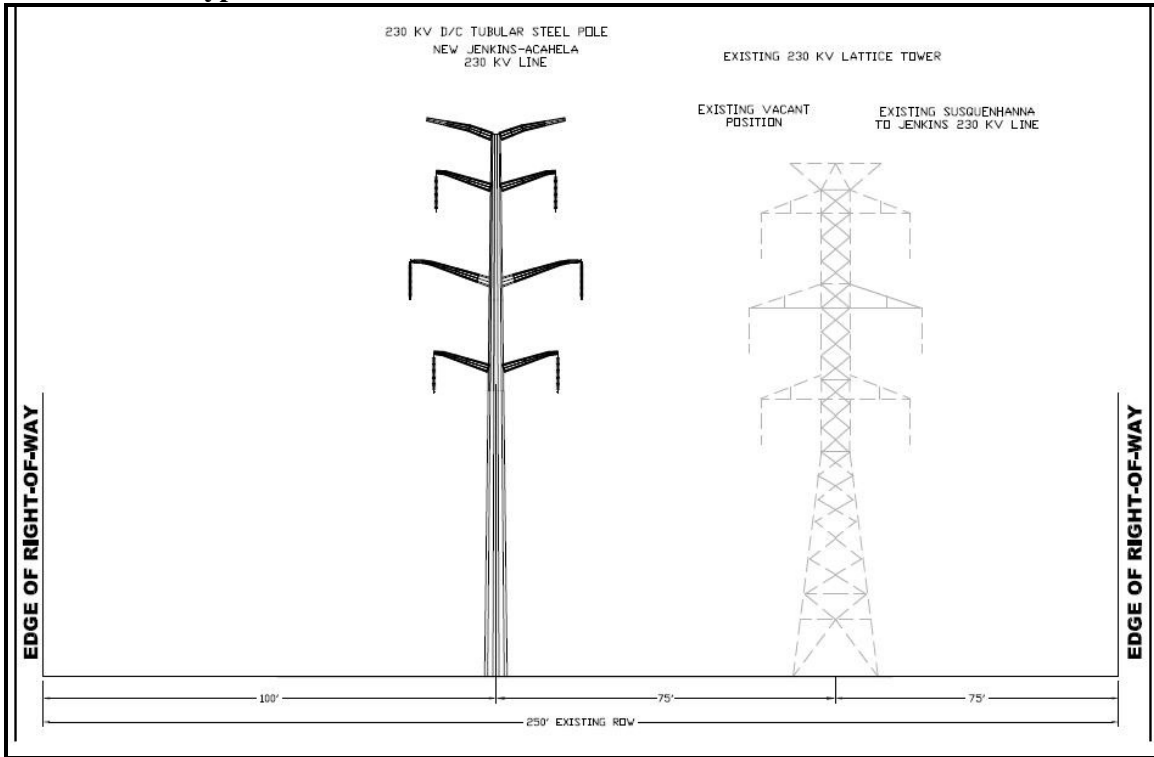


FIGURE 5-7: Typical 230 kV ROW Cross-Section: Jenkins to Paupack Substation

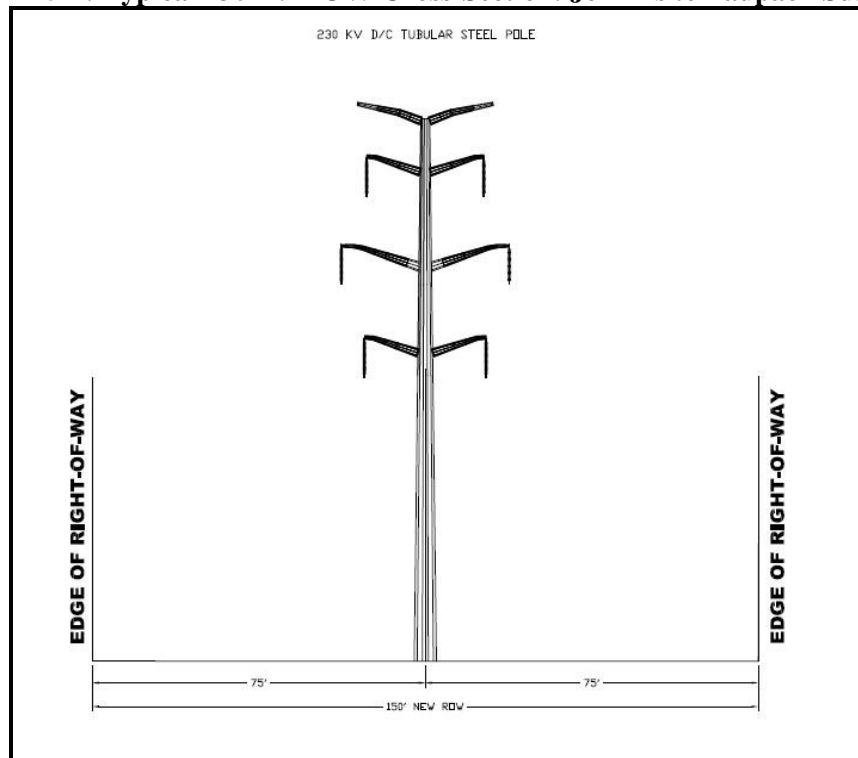


FIGURE 5-8: Two-pole 230 kV ROW Cross-Section: Near West Pocono and North Pocono Substations

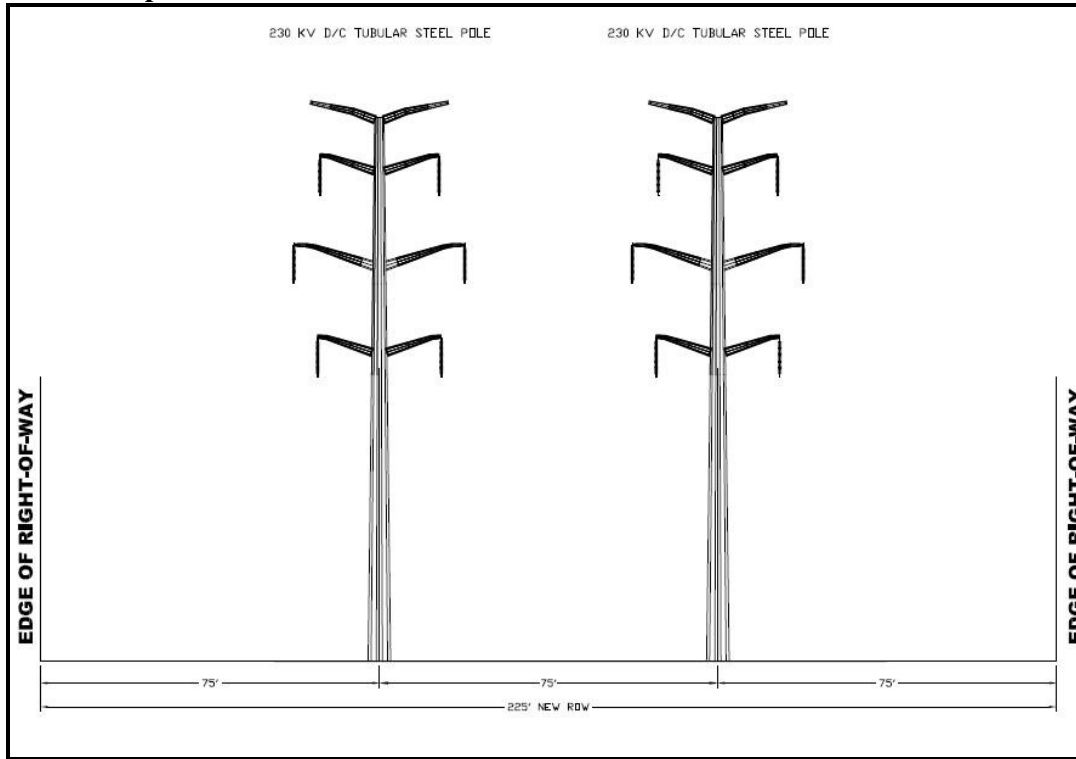
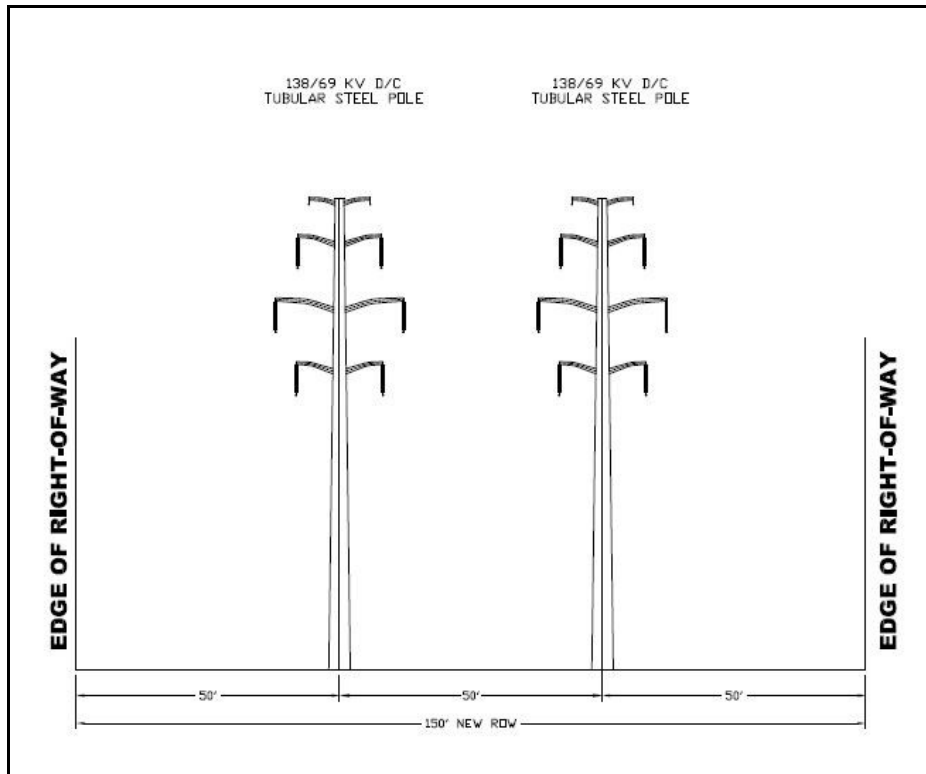
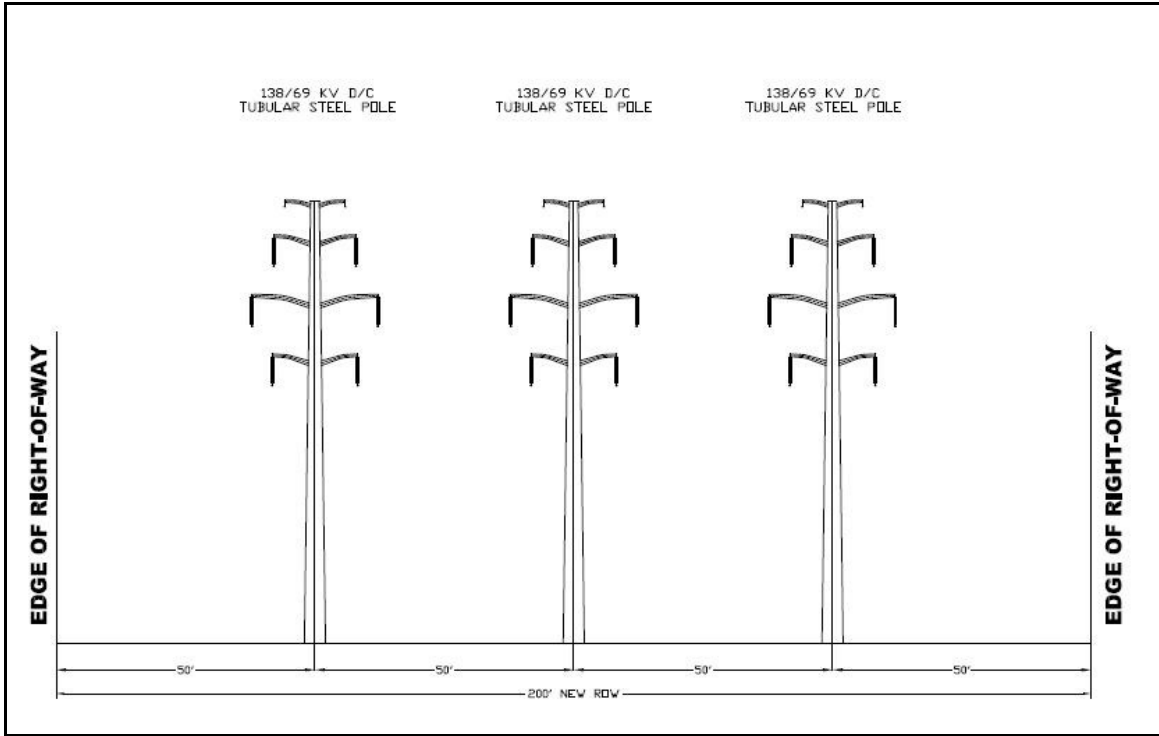


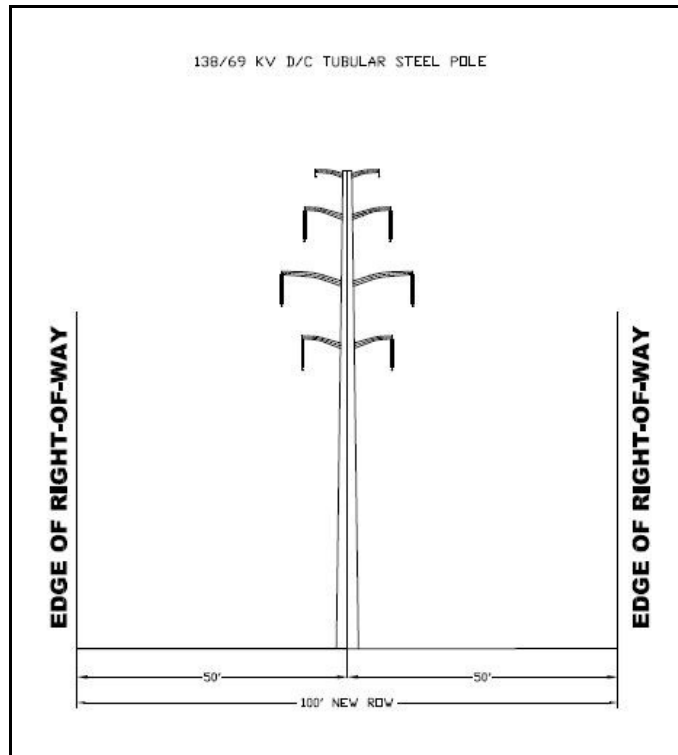
FIGURE 5-9: Two-pole 138/69 kV ROW Cross-Section with Upswept Arms: Near West Pocono Substation



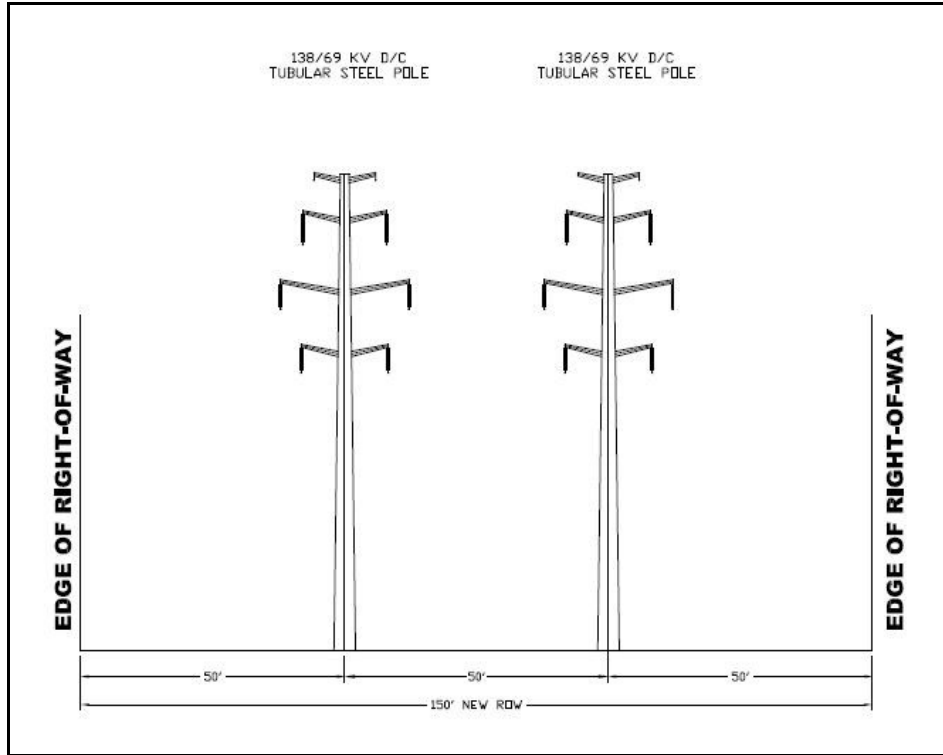
**FIGURE 5-10: Three-Pole 138/69 kV ROW Cross-Section with Upswept Arms:
Near North Pocono Substation**



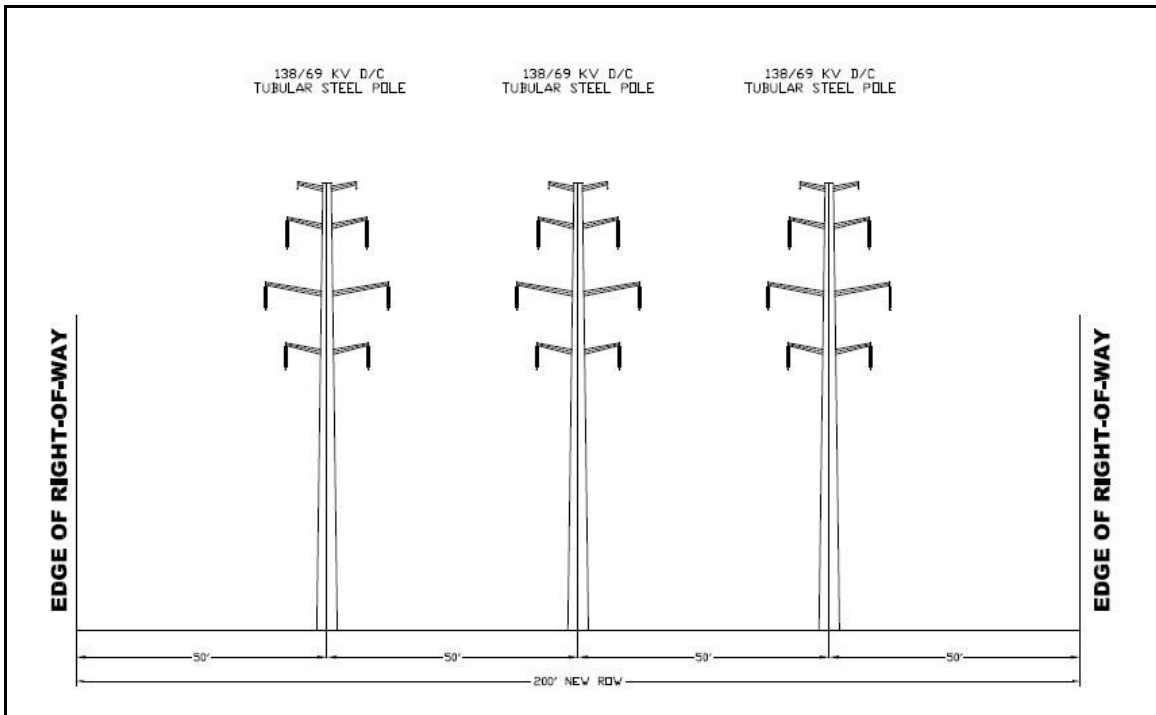
**FIGURE 5-11: Typical 138/69 kV ROW Cross-Section with Upswept Arms:
North Pocono Substation Connector Line**



**FIGURE 5-12: Two-pole 138/69 kV ROW Cross-Section with Straight Arms:
Near West Pocono Substation**



**FIGURE 5-13: Three-Pole 138/69 kV ROW Cross-Section with Straight Arms:
Near North Pocono Substation**



**FIGURE 5-14: Typical 138/69 kV ROW Cross-Section with Straight Arms:
North Pocono Substation Connector Line**

