

Before the
Pennsylvania Public Utility Commission

**BLOOMING GROVE – WEST DAMASCUS,
KIMBLES TAP 138/69 kV TRANSMISSION
LINE RECONSTRUCTION**

**ATTACHMENTS IN SUPPORT OF THE
Letter of Notification**

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

SUMMARY

This filing is submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for PUC approval to reconstruct approximately 2.25 miles of the single-circuit Blooming Grove-West Damascus 138/69 kV Transmission Line for double-circuit operation. This portion of the Blooming Grove-West Damascus 138/69 kV Transmission Line is located between the Wallenpaupack Hydro Electric Station and the Kimbles 69 - 12 kV Substation. Approximately 0.6 miles of the 2.25 mile transmission line is located on property owned in fee by PPL Generation. The remaining 1.65 miles of transmission line is located within existing maintained PPL Electric right-of-way (ROW). No additional ROW is required to construct this Project. As part of this Project, the existing cellon-treated wood poles will be replaced with single-shaft steel poles on a pole for pole basis. Four additional steel poles will be added in conjunction with the addition of the second circuit, and two load sectionalizing air break switches will be added. The Project is located in Palmyra and Lackawaxen Townships in Pike County, Pennsylvania.

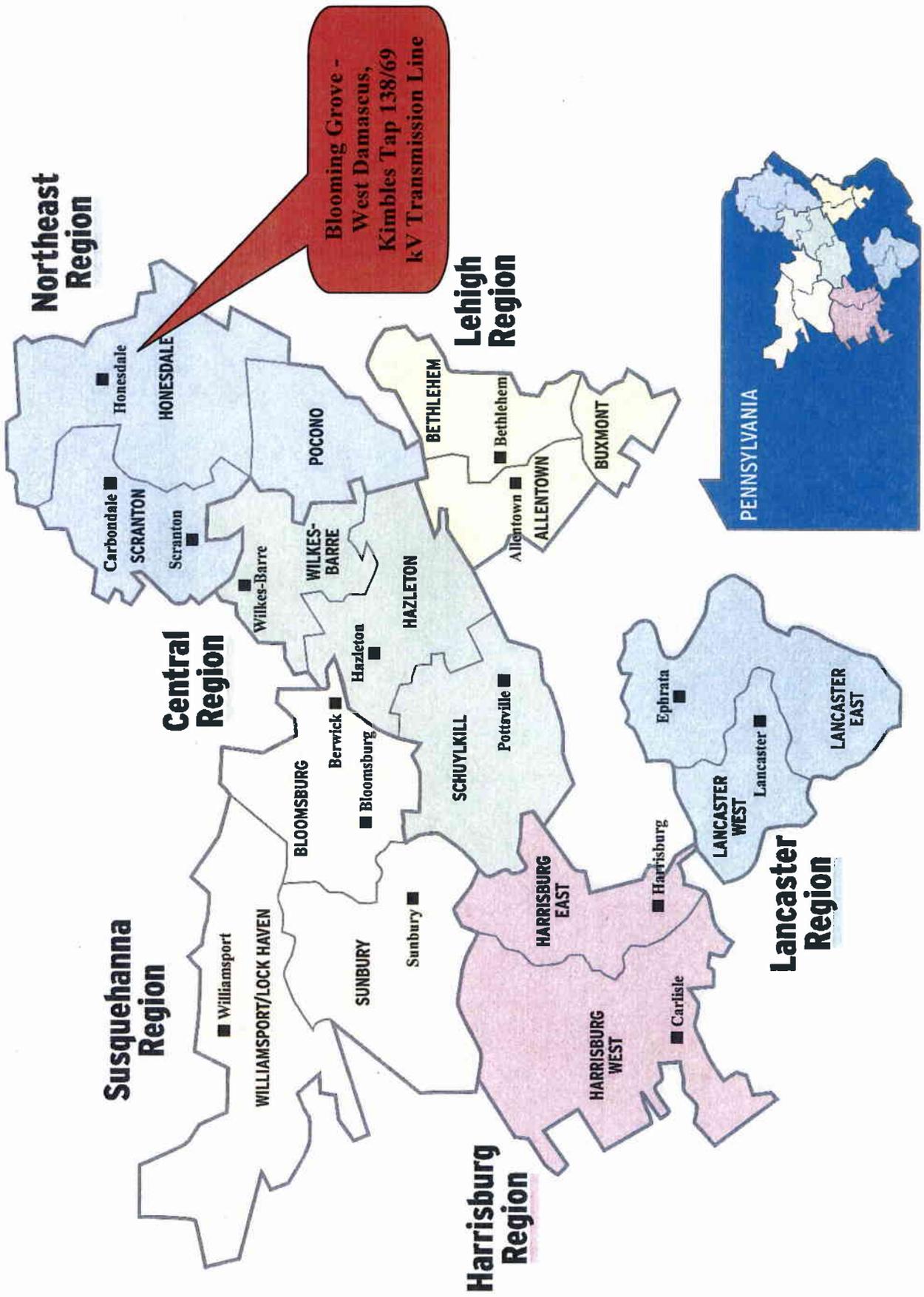
This Project is being undertaken in conjunction with a series of projects in the surrounding area in order to reinforce the local 138/69 kV system. The other Blooming Grove area projects, which are described briefly herein, will be submitted to the PUC for review and approval at an appropriate time in the future.

The estimated cost of this Project is \$2,380,000. Subject to Commission approval, construction will begin as soon as practical to support the Project's November 2013 in-service date. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads that could potentially damage equipment and result in service interruptions to customers. As such, PPL Electric respectfully requests expedited consideration and approval of this letter of notification.

This document, which describes the need for the Project and discusses the engineering and environmental analysis for the proposed construction, consists of the following attachments:

- Attachment 1 Necessity Statement
- Attachment 2 Engineering Description
- Attachment 3 Environmental Assessment
- Attachment 4 PPL Design Criteria and Safety Practices
- Attachment 5 PPL Electric Magnetic Field Management Program
- Attachment 6 List of Owners of Property Within the Right-of-Way
- Attachment 7 List of Involved Governmental Agencies, Municipalities and Other
Public Entities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

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**ATTACHMENT 1
BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV
RECONSTRUCTION
NECESSITY STATEMENT**

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**ATTACHMENT 1
BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV
RECONSTRUCTION
NECESSITY STATEMENT**

A. INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) proposes to rebuild approximately 2.25 miles of the existing Blooming Grove – West Damascus 138/69 kV Tap Line between the Wallenpaupack Hydro Electric Station (HES) and the Kimbles 69 - 12 kV Substation for double-circuit operation. The new line will be designed and constructed for future 138 kV operation but will initially operate at 69 kV until load growth in the area makes it appropriate to increase the operating voltage. As part of the reconstruction, the existing cello-treated wood poles will be replaced with single-shaft steel poles.

The estimated cost to site, design and reconstruct the transmission line is approximately \$2,380,000. This cost includes the proposed transmission line and modifications at Kimbles Substation. Construction will begin as soon as practical following Commission approval in order to meet a required in-service date of November 2013. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads that could potentially damage equipment and result in service interruptions to customers.

A PPL Electric system map showing existing transmission facilities with a design voltage of 35 kV or greater is included in the Attachment “1” map pocket. This filing addresses only the existing and proposed transmission system in this portion of Pike County.

B. EXISTING SYSTEM

From the Blooming Grove Substation to the Wallenpaupack HES, both the Blooming Grove – West Damascus and Blooming Grove – Honesdale 138/69 kV circuits are situated on the same double-circuit 138/69 kV structures. The circuits are insulated for 138 kV operation but are currently operated at 69 kV. From the Wallenpaupack HES to the Kimbles 69 - 12 kV substation, the Blooming Grove – West Damascus 138/69 kV line was designed for future double-circuit 138/69 kV operation but is currently operated as a single-69 kV circuit. The Kimbles 69 – 12 kV Substation, which serves approximately 3,500 customers in Pike County, is supplied from the Blooming Grove – West Damascus 69 kV Line. The Blooming Grove-West Damascus Line, which also supplies the PPL Electric West Damascus and Bohemia Substations, as well as one customer-owned substation, serves approximately 22,000 customers in Pike and Wayne Counties. **Figure 1** shows the functional arrangement of the existing transmission facilities in the area.

C. SYSTEM PLANNING PROCESS AND GUIDELINES

PPL Electric plans its system in accordance with the guidelines found in its Reliability Principles and Practices (RP&P) so that PPL Electric can sustain probable contingencies and disturbances with only minimal customer service interruptions and so that it can adequately serve each customer's needs with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle. System Planning is the process which assures that PPL Electric's regional system can supply electricity to all customer load in a manner that is reliable and economic. In addition, this system is planned so that system reliability can be maintained to prevent large scale, long term, or frequent service interruptions in order to avoid adverse effects and hazards to the public. Specifically, PPL Electric's system is planned and constructed so that:

- It can sustain probable contingencies and disturbances with minimal customer service interruptions;
- It can adequately serve each customer's needs with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle; and
- It is in conformance with PPL Electric's RP&P.

The reliable and economical operation of PPL Electric's 138/69 kV transmission system requires planning guidelines for system expansion and reinforcement. The principles upon which these planning guidelines are based recognize that:

- The system expansion should be coordinated to achieve the most economical balance of construction and operating expenditures;
- It should maintain a proper balance between the degree of risk, amount and type of load interrupted, and the cost of providing the needed expansion; and
- System reliability should be maintained to prevent large scale, long term, or frequent service interruptions to avoid adverse effects and hazards to the public.

In accordance with these guidelines and PPL Electric's Reliability Criteria, PPL Electric's non-BES transmission system is planned so that:

1. Normal operation of the system will not load any electric facility beyond its normal continuous rating.
2. The loss of any single transmission line, generating unit connected to the non-BES transmission system, power transformer, substation bus, circuit breaker, or double-circuit line due to the outage of a single tower or pole, does not result in any system electric facility being operated beyond its applicable emergency rating.

3. No customer load should remain interrupted for routine maintenance of non-BES transmission facilities.
4. The loss of any single facility should not result in a voltage drop of more than 5% on the 138/69 kV transmission system.
5. Stability of the electric system should be maintained from a permanent three-phase transmission line fault cleared by normal primary relay action. In addition to this, system stability should also be maintained for a permanent single phase to ground line fault and the failure of the protective devices to operate properly resulting in a failed circuit breaker.
6. No large-scale, long-term or frequent interruption may cause excessive load loss due to their adverse effects on, and hazard to, the public.
7. Excessive load is not interrupted for the loss of a single-circuit 69 kV line or double-circuit 69 kV line.

These principles are incorporated in the PPL Electric Planning RP&P guidelines.

The planning process begins with the development of a computer model of the future system. A specific study year is chosen, and the future system model is developed using the existing system plus any planned modifications to the transmission system scheduled to be completed prior to the study year. Load levels used in the system model are based on the latest forecast prepared annually by PJM, based on recent summer and winter peak load forecasts which take into account ambient temperatures and humidity indices.

Once the system model is complete, comprehensive power flow simulations are performed to determine the ability of the system to comply with the PPL Electric transmission planning reliability criteria. This is accomplished by simulating an outage of each non-BES transmission and bulk electric facility. All conditions where the system is not in conformance with the reliability criteria are identified and system reinforcements are added to bring the system into conformance. Also identified are estimated costs and lead-times to implement the required

reinforcements. Computer simulations of the system with the identified reinforcement alternatives are completed to identify the best overall reinforcement that will meet the needs of the region in a reliable, economic and environmentally acceptable manner.

D. DEFINITION OF THE PROBLEM

By winter 2013, the projected peak load on the Blooming Grove – West Damascus 138/69 kV Line is projected to be 78 MW, and the projected loading on the Blooming Grove – Honesdale 138/69 kV Line is 46 MW. The loading on those lines excludes any generation output from the Wallenpaupack Hydroelectric Plant. A single outage of the Blooming Grove – West Damascus 138/69 kV Line, with the interruption occurring between Blooming Grove and Tafton substations, would initially interrupt 78 MW of load. This is approximately 18 MW above the Transmission RP&P guidelines.

Load transfers from the Blooming Grove to the Peckville Substation are limited because of the resulting low voltage at the end of the Blooming Grove – West Damascus Line, and the segments of small-sized conductor on the Peckville – Varden 69 kV Line that would be overload. In such an outage, the Power Dispatcher would not be able to restore service to customer load served by distribution substations at the Kimbles, Tennessee Gas,¹ Indian Orchard, and Bohemia substations. That load would remain interrupted by the Power Dispatcher to maintain the 69 kV voltage level of the Peckville – Varden 69 kV line within the acceptable lower limit of 62 kV to comply with the RP&P guidelines. As a result, approximately 59 MW would remain interrupted for an extended period of time until the outage is located and switching moves are made to re-sectionalize the line. This load loss would exceed PPL Electric's Planning RP&P Table R-1 guideline for maximum for a single-circuit line outage, which is 30 MW.

¹ Tennessee Gas is a transmission customer.

The RP&P guidelines also recommend that loading on one circuit of a double-circuit line should not exceed 60 MW, so that for the loss of one circuit, the load from the out-of-service circuit can be transferred to the remaining in-service circuit without exceeding its emergency ampacity rating. The Blooming Grove – West Damascus, at 78 MW, exceeds the RP&P guidelines.

E. PROPOSED SOLUTION

This Project is the second in a series of five projects being undertaken in the Blooming Grove area. The other projects, which are explained below, are planned to reinforce the local 138/69 kV system. Individually, this Project does not fully address the RP&P violations identified above. All of the projects in the series, when completed, will fully resolve all of these RP&P violations in the Blooming Grove area.

For the first of the five projects, PPL Electric proposed to transfer the electric service source for the Tafton 69-12 kV Substation from the Blooming Grove – West Damascus 138/69 kV Transmission Line to the Blooming Grove – Honesdale 138/69 kV Transmission Line. The first project was filed with the Commission on May 27, 2011 at Docket A-2011-2269098, and was approved on August 25, 2011. When that project is completed, the projected loading on the Blooming Grove-West Damascus line under peak winter conditions will be approximately 71 MVA; projected loading on the Blooming Grove-Honesdale line will be 48 MVA. That project brought PPL Electric's facilities closer to complying with the RP&P guidelines.

In this, the second Project in the series, to address the issues being experienced on the Blooming Grove – West Damascus transmission line, as described above, PPL Electric, with approval from the PUC, plans to:

- Reconstruct an approximate 2.25 mile section of the Blooming Grove – West Damascus Line between the Wallenpaupack HES and the Kimbles 69 – 12 kV Substation. PPL Electric will design the new line to current 138 kV standards, but will initially operate the line at 69 kV, until load growth in the area makes an increase appropriate.
- At Kimbles 69 – 12 kV Substation, PPL Electric will convert the substation to a double tap-single feed connection (DT/SF).
- Install approximately 2.25 miles of Optical Ground Wire (OPGW) on the reconstructed line segment.

After this Project is completed, the projected loading on the Blooming Grove – West Damascus Line under peak winter conditions will be approximately 67 MVA, and the projected loading on the Blooming Grove – Honesdale line will be 55 MVA. The loading level for the Blooming Grove-West Damascus line will approach RP&P guidelines.

After this Project is completed, for an outage of the Blooming Grove – West Damascus 138/69 kV Line, with the interruption occurring between Blooming Grove and Tafton substations, 67 MW would initially be interrupted. Approximately 51 MW would remain interrupted for an extended period of time until the problem could be located and switching moves made to re-sectionalize the line. This Project would be the second in a series of five projects for local system reinforcements that will enable PPL Electric to meet the RP&P Table R-1 guideline for maximum allowable load loss for a single-circuit line outage.

In the filing for the third project, PPL Electric will seek Commission approval for the reconstruction of a portion of the Peckville – Varden 138/69 kV Line and a portion of the existing Blooming Grove – Honesdale 138/69 kV Line. These line sections will be reconstructed from single circuit 138/69 kV lines to double circuit 138/69 kV lines. These reconstructed line sections will resolve the violation of PPL Electric’s RP&P guidelines, and to reinforce the 138/69 kV systems in Lackawanna and Wayne Counties.

In the filing for the fourth project, PPL Electric will seek Commission approval for the construction of 1.8 miles of new 230 kV line to provide a power source to a new substation, to be named the Paupack 230-69 kV Substation. This new line and substation are also needed to resolve the violation of PPL Electric’s RP&P guidelines and reinforce the 138/69 kV systems in Lackawanna and Wayne Counties.

In the filing for the fifth project, PPL Electric will seek Commission approval for the reconstruction of a portion of the Lakeville 138/69 kV Tap and a portion of the existing Blooming Grove – Honesdale 138/69 kV Line. These line sections will be reconstructed from single circuit 138/69 kV lines to double circuit 138/69 kV lines. These reconstructed lines sections are also needed to resolve the violation of PPL Electric’s RP&P guidelines and reinforce the 69 kV systems in Lackawanna and Wayne Counties.

Figure 2 shows the functional arrangement of the proposed transmission facilities in the area at the completion of the Blooming Grove – West Damascus, Kimbles 138/69 kV reconstruction.

F. FUNCTIONAL ALTERNATIVE

No other economically feasible alternatives were identified to relieve the heavy loading on the Blooming Grove – West Damascus 138/69 kV Line.

Attachment

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ATTACHMENT 2
BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV
TRANSMISSION LINE REBUILD
ENGINEERING DESCRIPTION

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MAP

PROJECT LOCATION MAP AND AERIAL EXHIBIT.....

END OF
ATTACHMENT 2

ATTACHMENT 2
BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV
TRANSMISSION LINE REBUILD
ENGINEERING DESCRIPTION

A. DESCRIPTION OF THE PROPOSED LINE

PPL Electric proposes to reconstruct approximately 2.25 miles of the single-circuit of the existing Blooming Grove - West Damascus 138/69 kV Transmission Line between the Wallenpaupack Hydro Electric Station and the Kimbles 69 – 12 kV Substation. No additional right of way is required to construct this Project. Approximately 0.6 miles of the right of way for the 2.25 mile transmission line is located on property owned by affiliates and the remaining 1.65 miles of transmission line right of way is located within existing PPL Electric right of way. The proposed reconstruction will replace 43 deteriorating cellon-treated wood poles with 43 single-shaft steel monopoles and will also add a second circuit to the tap with 4 additional steel poles. Finally, two 138 kV Load Sectionalizing Air Break (LSAB) switches will be installed. The Blooming Grove - West Damascus, Kimbles Tap is located in Palmyra and Lackawaxen Townships in Pike County. Refer to the aerial location map.

The existing cellon wood poles range in height from 75 to 100 feet, with an average height of 90 feet. The replacement steel monopoles will range in height from approximately 75 to 105 feet. The steel monopoles will be direct-embedded, and they will be equipped with 7-foot-long steel upswept conductor support arms for the top and bottom phases and 11 foot-long upswept conductor support arms for the middle phase. (see Figure 2). The replacement steel poles will be placed in approximately the same locations as the existing wood poles. The LSAB switches will be mounted on two 75-foot-tall direct embedded steel poles connected with an x-brace (see Figure 3). The existing conductors will remain,

and three new power conductors will be installed for the additional circuit. Both the existing and new conductors will be 556.5 kcmil 24/7 stranding ACSR. The existing 3/8-inch-diameter high strength steel overhead ground wire will be replaced with one 0.567" optical ground wire.

The proposed line will be designed to, and will generally exceed, minimum National Electrical Safety Code standards. Design specifications and safety rules practiced by PPL Electric Utilities are included in Attachment 4. The minimum conductor to ground clearance for the proposed 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 as follow:

TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 556.5 KCMIL 24/7 STRANDING ACSR*
BLOOMING GROVE - WEST DAMASCUS, KIMBLES TAP 138/69 kV LINE

<u>Condition</u>	<u>Double-Circuit Design Clearance to Ground</u>
Normal load, average weather (16°C ambient temperature)	34.4 feet
Predicted extreme thermal load (125°C conductor temperature)	30.00 feet
Predicted NESC extreme wind load (16°C ambient temperature)	32.5 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -10°C)	32.8 feet

Clearances based on a maximum tension of 7,616 lbs. at 1 inch ice, 4 lbs. wind, -10°C and a ruling span of 450 feet. (NESC Rule 250D)

TABLE 2
CONDUCTOR THERMAL RATING
556.5 KCMIL 24/7 STRANDING ACSR
125°C MAXIMUM CONDUCTOR TEMPERATURE

Ambient Temperature <u>Condition</u>	<u>Wind Speed °C</u>	<u>Ampacity Knots</u>	<u>Amps</u>
Summer Normal	35	0	806
Winter Normal	10	0	929
Summer Emergency	35	1.5	1054
Winter Emergency	10	1.5	1187

B. MAGNETIC FIELD MANAGEMENT

PPL Electric does not believe that the current scientific evidence demonstrates that magnetic fields cause any adverse health effects or pose a health or safety danger to the public. Nevertheless, PPL Electric has determined, as a matter of policy, to design its new and rebuilt transmission lines to reduce magnetic fields when that can be done at low or no cost and consistent with functional requirements. PPL Electric’s Magnetic Field Management Program is included in Attachment 5 and applied to reconstruction and new line projects. In order to lower magnetic field exposures, the program generally prescribes the use of a line design that provides 5 feet higher ground clearances and reverse phasing 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.

For this Project, reverse phasing cannot be utilized to reduce magnetic field levels because we are installing a second circuit to an existing single circuit line. Reverse phasing cannot be accomplished without greatly increasing the cost, as it would require the addition of multiple structures to transpose the phasing and

would also require conductors entering multiple substations to be re-arranged. However, some reduction of the magnetic field will be achieved through the use of taller poles.

C. RIGHT-OF-WAY STATUS

The proposed Project is being completed entirely within existing maintained PPL Electric right-of-way. Of the total length of the Project of 2.25 miles, 0.6 miles of right of way are located on property owned by PPL affiliates, and 1.65 miles are located on land owned by others. PPL Electric has communicated with the owners of the property within the right-of-way to inform them that the existing transmission line will be reconstructed. The Aerial Exhibit at the end of Attachment 2 shows existing property lines and current ownership along the right-of-way. Attachment 6 identifies owners of property within the right-of-way.

FIGURE 1
PROPOSED 138/69 kV DOUBLE CIRCUIT UPSWEPT
STEEL ARMS STRUCTURE



Average Height – 75 – 105 Feet

Length of Arms – 7 Feet upper and lower, 11 feet middle

FIGURE 2
PROPOSED TWO POLE X-BRACED LSAB SWITCH
STRUCTURE



Average Height – 75 Feet
Switch Spacing – 16 Feet
Width of Structure – 16 Feet

Attachment

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ATTACHMENT 3
BLOOMING GROVE – HONESDALE, KIMBLES TAP 138/69 kV
TRANSMISSION LINE REBUILD
ENVIRONMENTAL ASSESSMENT

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ATTACHMENT 3
**BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV
TRANSMISSION LINE REBUILD
ENVIRONMENTAL ASSESSMENT**

A. INTRODUCTION

PPL Electric is requesting PUC approval to reconstruct a portion of the existing Blooming Grove - West Damascus #1 & #2 138/69 kV Transmission Line. PPL Electric intends to convert the approximately 2.25 mile long existing Blooming Grove - West Damascus 138/69 kV Transmission Line from a single circuit line to a double circuit . The proposed transmission line will be designed and constructed for future 138 kV operation but will initially operate at 69 kV until load growth in the area makes it appropriate to increase the operating voltage. The Project begins with the structure located adjacent to the Wallenpaupack Hydro Electric Station (HES) and continues north/northwest to the Kimbles 69 – 12 kV Substation located on Catamount Drive in Hawley, Pennsylvania.

The proposed Project was reviewed with representatives of Palmyra and Lackawaxen Townships and Pike County, and neither the Townships nor the County had any objections. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 7.

B. LAND USE

The Project begins at Wallenpaupack HES, traverses approximately 0.6 miles through undeveloped land owned by PPL affiliates and then runs through approximately 1.65 miles of undeveloped and low density residential property until it terminates at the Kimbles Substation. The corridor crosses the

Lackawaxen River, the Stourbridge Railway² and the abandoned Delaware and Hudson Canal approximately 0.6 miles northwest of the generating station.

The proposed rebuild will be constructed entirely within PPL Electric's existing maintained 100-foot-wide ROW. The Blooming Grove - West Damascus Transmission Line was initially constructed in the late 1970s and predates most of the residential development in the area. Visual impacts to existing homes in the area will be minimal because the transmission line is located within existing right of way, the existing vegetative which provides a buffer between the homes and the transmission line will be rebuilt in place, and the new transmission structures will not significantly increase in height. Further, the rebuilt line will be supported by the same number of structures which will be monopole structures, except that PPL Electric will also add a second circuit to the tap with 4 additional steel poles. Finally and two 138 kV Load Sectionalizing Air Break (LSAB) switches will be installed.. In addition, the structures for the rebuilt line will be in substantially the same locations as the existing structures.

No communication towers, pipelines, or other utilities will be affected by the proposed Project. The closest airport is the Cherry Ridge Airport, located approximately 4.5 miles northwest of the Project. The proposed transmission line reconstruction is not expected to impact airport operations. PPL Electric, however, will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation to ensure that the proposed tap line will not be a hazard to the airport's flight operations.

C. CULTURAL RESOURCES

The Project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC identified that, given the soil type, topographic setting, slope direction, and distance to water, there is a potential for

² Also known as the Morristown & Erie Railway.

archeological resources at the project site (File No. ER 2012-0495-103-A). PPL Electric engaged the services of Dr. Frank Vento of the Quaternary Research Institute to conduct a Phase I Archeological Survey of the project area. The Phase I Survey uncovered no significant archeological artifacts at the subject property. The results of the investigation were submitted to PHMC for its review, along with a recommendation that no further investigation be conducted. PHMC agreed with this finding and issued a clearance letter dated July 6, 2012 which stated that no further archeological work is necessary for this Project.

D. NATURAL FEATURES

The corridor crosses the Lackawaxen River and the abandoned Delaware and Hudson Canal approximately 0.6 miles northwest of the generation station. There will be no impact to the river or the canal either by road access or placement of the new poles. The rebuilt transmission line will have minimal incremental impacts to these two features since the proposed poles will be located more than 200 feet from the river bank and situated on elevated terraces approximately 30 to 60 feet above the river channel.

The Project will not affect any other recreational areas or natural landmarks. The nearest natural feature is State Game Lands number 183 which is situated approximately 0.5 miles from the southern terminus of the transmission line.

There are no other natural areas, state or national parks, state forests or scenic geologic features within 2 miles of the project.

PPL Electric conducted a wetland delineation of the line and identified small sections of wetlands, rills and the Lackawaxen River within the right-of-way. Any required permits will be obtained from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers prior to construction. PPL Electric will comply with all conditions placed on the permits.

Some minimal tree clearing may be required, and if so, PPL Electric will apply its “Specification for Initial Clearing and Control of Vegetation On or Adjacent to Electric Line Right-of-Way Through Use of Herbicides, Mechanical and Hand Clearing Techniques” while conducting the clearing activities in order to minimize any possible impacts from its activities.

PPL Electric anticipates that the earth disturbance activities associated with this reconstruction will require a National Pollutant Discharge Elimination System (NPDES) permit and an erosion and sedimentation control (E&S) plan. PPL Electric will obtain any required soil erosion and sedimentation control approvals and associated NPDES permits and will comply with any conditions placed on those permits. PPL Electric will employ its “Specification for Soil Erosion and Sedimentation Control on Transmission Line Rights-of-Way” as appropriate in order to minimize possible impacts from its activities.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has contacted the relevant state and federal agencies, to obtain information regarding endangered and threatened species that could occur in the vicinity of the proposed Project. The Pennsylvania Fish and Boat Commission (PFBC) response stated that, except for occasional transient species of wildlife, no threatened or endangered plant or animal life is known to exist in the project area.³

The Pennsylvania Game Commission (PGC) indicated that there are federally protected bald eagles (*Haliaeetus leucocephalus*) nesting in the vicinity of this Project. As such, Pennsylvania Department of Conservation and Natural Resources (“DCNR”) stated that PPL Electric should not conduct construction or demolition activities in the vicinity of the bald eagle nest during nesting season. The nesting season is from January 14th through August 1st. PPL Electric

³ Pennsylvania Natural Diversity Inventory (PNDI) Search ID: 20111014321393.

intends to comply with the seasonal construction restrictions for the portion of the transmission line that is located near the bald eagle nest. There are no seasonal restrictions for the remaining portions of the project area to the north and south of this area as they fall outside the buffer area for the nesting bald eagles.

The DCNR indicated that the Project may potentially impact *Sedum rosea* (Roseroot Stonecrop) and requested that a survey be conducted by a qualified botanist. PPL Electric hired Mellon Biological Services, LLC to conduct the requested survey. Based on the results of the survey, Mellon Biological Services concluded that no plant species of special concern were found and the only possible habitat for *Sedum rosea* would not be impacted by the proposed reconstruction. DCNR agreed with this finding and issued a clearance letter dated December 22, 2011 which stated that DCNR determined that no impact is likely to occur to species of special concern as a result of the Project.

Attachment

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ATTACHMENT 4

BLOOMING GROVE – WEST DAMASCUS, KIMBLES TAP 138/69 kV TRANSMISSION LINE REBUILD PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

The National Electrical Safety Code (NESC) is a set of rules to safeguard people during the installation, operation, and maintenance of electric power lines. The NESC contains the basic provisions considered necessary for the safety of employees and the public. Although it is not intended as a design specification, its provisions establish minimum design requirements. PPL Electric Utilities Corp. (PPL Electric) has developed design specifications and safety rules which meet or surpass all requirements specified by the NESC.

Engineering Design Criteria and Parameters

The NESC includes loading requirements and clearances for the design, construction, and operation of power lines. The "loads" on conductors and supporting structures are the mechanical forces that develop from the weight of the conductors, the weight of ice on the conductors, plus wind pressure on the conductors and supporting structures. Loading requirements are the loads on the conductors and structures that are anticipated assuming certain ice and wind conditions. Loading requirements always contain "safety factors" to allow for unknown or unanticipated contingencies. The clearances and loading requirements contained in the NESC were developed to ensure public safety and welfare.

PPL Electric transmission line design standards meet or surpass the NESC standards. For example, the relative order of grades of construction for conductors and supporting structures is B, C, and N; Grade B being the highest. According to the NESC standards, construction Grades B, C, or N may be used for transmission lines (except at crossings of railroad tracks and limited access highways where Grade B construction is specified). However, PPL Electric designs all of its transmission lines for Grade B construction. The use of Grade B design and construction specifies enhancements such as larger-minimum crossarm dimensions, larger-minimum conductor size, and increased safety factors.

Another example is the design parameters utilized to account for ice and wind loadings on the overhead ground wire (OHGW) and power conductors. The NESC standard ice and wind design magnitudes for the PPL Electric territory are 0.5 inch thickness of radial ice combined with four pounds per square foot horizontal wind pressure (equivalent to 40-mile per hour wind velocity). The conductor sags and tensions used in line designs are the result of various ice and wind combinations, depending on the elevation at the line location and line design voltage. The conductor sags and tensions used in the design of all PPL Electric transmission lines are at least 0.5-inch ice combined with eight pounds wind pressure (equivalent to 57 miles per hour wind velocity). This means that PPL Electric lines are designed to operate safely and reliably during inclement weather even more severe than assumed by the NESC. In addition, PPL Electric transmission lines are designed with more clearance to the ground than required by the NESC. The tables below compare PPL Electric and NESC ground clearances for lines of various voltages.

138 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
Roads, streets, alleys	21 Ft.	30 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	21 Ft.	30 Ft.
Spaces accessible to pedestrians only	17 Ft.	30 Ft.
Railroad tracks	31 Ft.	35 Ft.

230 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
Roads, streets, alleys	23 Ft.	32 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	23 Ft.	32 Ft.
Spaces accessible to pedestrians only	19 Ft.	32 Ft.
Railroad tracks	31 Ft.	36 Ft.

500 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric Design</u>
Roads, streets, alleys	28 Ft.	53 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	28 Ft.	53 Ft.
Spaces accessible to pedestrians only	24 Ft.	53 Ft.
Railroad tracks	38 Ft.	53 Ft.

A relay protection system is used to protect the public safety and welfare as well as equipment and the transmission system. Relay protection is installed for all transmission lines to automatically de-energize the line in the unlikely event that the line or supporting structure fails and the line contacts the ground.

Periodic Maintenance Program on All Transmission Lines

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use of helicopter patrols, with supplemental foot and structure climbing patrols. A number of helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

Foot and structure climbing patrol programs for a transmission line begin approximately three to five years after the line is energized, unless a helicopter patrol reports a need for earlier action. The frequency of foot patrols varies from once every year to once every several years depending on line type and age.

An assigned foot patroller checks right-of-way conditions, including access roads, bridges, pole washouts, tower footers, vegetation height and clearance to conductors, pole and tower deterioration and, with the use of binoculars, insulators, and condition of hardware. Identified problems are included in a report that is forwarded to the appropriate department for corrective action.

A scheduled line outage is required to perform an overhead patrol because of "hands-on" inspection of hardware. Overhead patrols are conducted on a schedule determined by line age, operating record, and observed general condition. The necessary repairs are also done during the inspection outage.

Personnel Safety Rules

The following are a few of the PPL Electric safety rules that demonstrate the Company's concern for employee safety:

- Work procedures have been developed to allow work to be performed on energized facilities in a safe manner. When lines or apparatus are removed from service to be worked on, the Energy Control Process system is applied. This system provides that a red tag must be physically placed on the control handle of the de-energized equipment. The red tag may be removed only after proper authorization to energize the equipment. Various other tags are used for limited operations and informational purposes. Employees will not apply or remove a tag or change the status of tagged equipment unless authorized.
- Temporary safety grounds are used on de-energized facilities for employee safety during maintenance, construction, or reconstruction work. Safety grounds are wires connecting the de-energized facility to an electrical ground. If the facility should be energized, the safety grounds will divert the current directly to ground and reduce the likelihood of personal injury. The conductor size and attachment clamps of temporary safety grounds must be capable of conducting anticipated fault currents. Rubber gloves, rubber sleeves, and additional rubber protective equipment are used as required when applying or removing temporary safety grounds to or from the lines or apparatus to be grounded. An approved nonconductive working stick of sufficient length to allow workers to maintain the following required minimum clearances is used to test that the line has been de-energized and to apply temporary safety grounds:

<u>Voltage-kV</u>	<u>Minimum Clearance</u>
138	3'-7"
230	5'-3"
500	11'-3"

Before applying grounds, a test is done to confirm that the line is de-energized. The voltage test device is checked before and after use to assure reliability. When ground pins are used to establish proper ground points, they are driven to a depth of not less than four feet as near vertical as possible.

- Poles or structures are inspected and examined for structural integrity before climbing. If there is any reason to believe that a pole is unsafe, it is stabilized before work is performed. Appropriate safety gear in the form of body belts, safety straps, hard hats, gloves, etc., is worn by linemen during line work activity.

Attachment

5



**MAGNETIC
FIELD
MANAGEMENT
PPL Electric Utilities
Corporation**

DECEMBER 2004

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INTRODUCTION

At PPL Electric Utilities Corp. (PPL EU), magnetic field management means investigating and implementing methods at low or no cost to reduce magnetic fields in new or rebuilt transmission and distribution lines. This document explains PPL EU's Magnetic Field Management Program, which is part of PPL EU's larger Electric and Magnetic Fields (EMF) policy.

PPL EU's View

Some people are worried that electric and magnetic fields are harming their health. Others think the scientific research does not show a problem at all, and still others believe there's just too much scientific uncertainty to draw any conclusions.

Here's what we do know now. Various panels of scientists that have reviewed the EMF research generally have drawn two main conclusions. First, the large body of evidence does not demonstrate that EMF are harmful. Second, additional research is recommended to explore questions raised in some studies.

Given these conclusions, PPL EU is taking a reasoned approach in responding to the EMF issue. PPL EU's approach to the EMF issue consists of five elements:

- Providing EMF information to customers and employees
- Providing magnetic field measurements
- Establishing and implementing a magnetic field management program to reduce magnetic fields in new or rebuilt facilities when it can be done at no, or low, cost
- Integrating EMF in the public involvement process that PPL EU undertakes in the siting of transmission lines
- Have supported additional research

6

EMF Are All Around Us

Electric and magnetic fields occur in nature and in all living things. The earth, for instance, has a magnetic field, which makes the needle on a compass point north.

Electric fields and magnetic fields of a different type also surround every wire that carries electricity. In everyday life, these EMF arise from several basic sources, including power lines, electrical appliances, home and building wiring, other utility lines and cables, and currents flowing on water pipes. Though they often occur together, EMF are made up of two separate components:

Electric Fields

Electric fields are produced by the voltage—or electrical pressure—on a wire. The higher the voltage, the higher the electric field. As long as a wire is energized—has voltage present—an electric field is present (see Figure 1). In other words, an appliance, or an electric power line, doesn't actually have to be turned on to create an electric field. It just has to be plugged in. Electric fields diminish with distance and can be blocked or partially shielded by objects such as trees and houses.

Magnetic Fields

Magnetic fields are created by the current or flow of electricity through a wire. Generally speaking, the higher the current, the higher the magnetic field. Because they only occur when current is flowing, magnetic fields are present only when the power is turned on (see Figure 1). Magnetic fields also diminish with distance, but—unlike electric fields—are not blocked by common objects. In recent years, public and scientific interest has turned toward the magnetic field component of EMF because of some scientific studies regarding these fields.

Figure 1

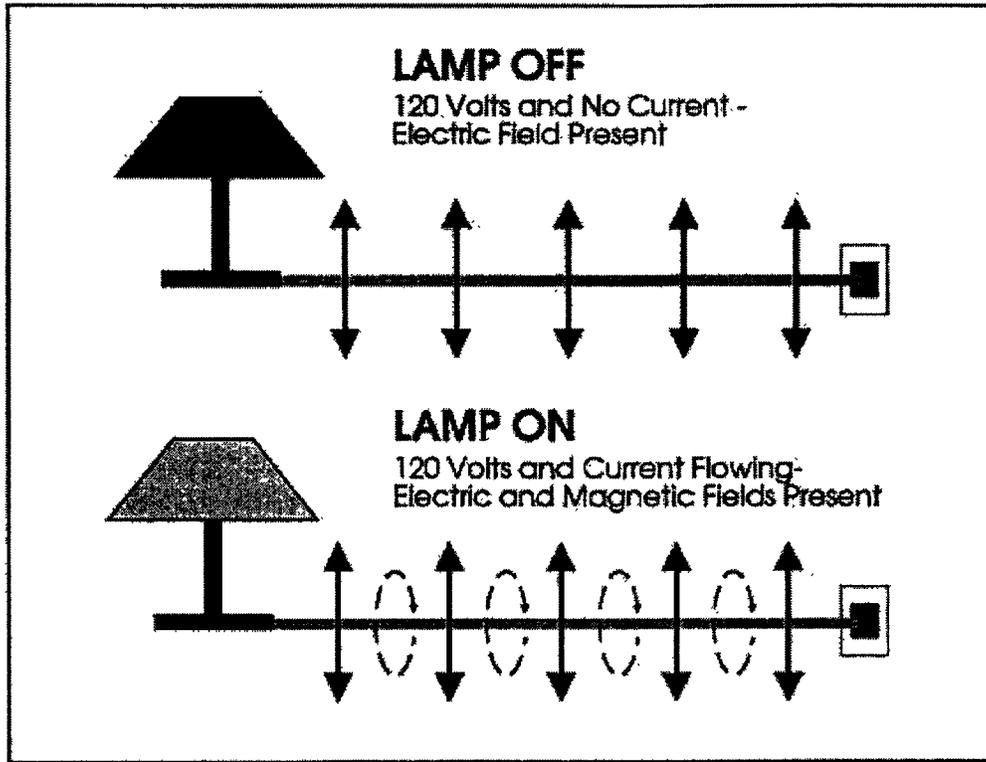


Figure 2

Magnetic field strengths decrease with distance Magnetic fields are measured in milligauss		Source: "EMF in Your Environment", U.S. Environmental Protection Agency 1992		
		At 6 inches	At 1 foot	At 2 feet
Clothes dryer		2 to 10	* to 3	*
Microwave oven		100 to 300	1 to 200	1 to 30
Toaster		5 to 20	* to 7	*
Power drill		100 to 200	20 to 40	3 to 6
Can opener		500 to 1500	40 to 300	3 to 30
Mixer		30 to 600	5 to 100	* to 10
Hair dryer		1 to 700	* to 70	* to 10
Color television		Data not available	* to 20	* to 8

FIGURE 2 * The magnetic field measurement at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

Measuring Magnetic Fields

Magnetic fields usually are measured in a unit called a milligauss. Magnetic field levels found in the living areas of homes typically range from less than 1 milligauss to about 4 milligauss according to the U.S. Environmental Protection Agency. They can be higher in some cases. The levels next to appliances can exceed 1,000 milligauss (1 gauss). Figures 2 and 3 show how the strength of the field falls off as you move away from the source, just as the heat of a campfire grows weaker as you walk away from it. For overhead power lines, the strength of the magnetic fields is dependent upon a number of factors that will be explained later. Those factors produce a magnetic field that drops off rapidly as you move away from the power line.

Figure 3

Sample Magnetic Field Levels in Milligauss				
Type of Overhead Power Line	Distance from the line			
	Under the line	50 ft.	100 ft.	200 ft.
220 kV and 500 kV	5-400	5-250	1-75	0.5-20
69 kV and 138 kV	3-80	0.5-2.5	0.1-10	0.1-3
12 kV and below	0.4-20	0.1-1	-	-

The magnetic field values provided in this table represent a general range of values associated with the types of overhead power lines listed and are provided for illustration. There will be circumstances in which there will be magnetic field levels above or below the range of values provided due to variations in such factors as height of the wires, current flow and so on.

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

One element of our response to EMF concerns expressed by some of our customers is PPL EU's Magnetic Field Management Program. The program was initiated in March 1991 because PPL EU believes it makes good sense, as a matter of policy, to respond to the concerns expressed by some of our customers and to reduce magnetic fields in new and rebuilt facilities where it can be done with either no-cost or low-cost design changes.

This document updates the original program which has been revised several times since 1991. These guidelines were developed by PPL EU's EMF Working Group.

VARIABLES THAT AFFECT MAGNETIC FIELDS

Magnetic fields from transmission and distribution lines are a function of a number of design variables. The following parameters affect the magnetic field levels produced by transmission and distribution lines:

- Current
- Height of conductors above ground
- Configuration of conductors
- Distance from the line

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

At power frequencies (i.e., 60 hertz), the magnetic field level is a function of the current or flow of electricity through a wire. Keeping all other parameters the same, the magnetic field is proportional to the current. Hence, if the current increases by 25 percent, the resulting magnetic field level will increase by 25 percent.

The overall load current on any line varies with the demand for power. It's usually highest during daytime hours and lowest at night. There also are weekly, monthly, seasonal and yearly variations.

The difference in the currents between each phase in a multiphase line also can affect the magnetic field. This difference is called phase unbalance. For a constant load, a statistical analysis of this phase unbalance can be made to determine its effect on the magnetic field. Close to the line, there is very little effect. However, the phase unbalance slows the rate at which the magnetic field decreases with distance from the line.

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

In the transmission and distribution of power, utilities like PPL EU presently use both three-phase and single-phase lines. Each phase on a three-phase power line has either a single conductor or a bundle of two or more conductors. In a three-phase system, the ground-level magnetic field is a result of the fields produced by the currents in each of the phases. Placing the three phases as close together as possible (compaction) creates some field cancellation, and the ground-level magnetic field is reduced. However, appropriate phase separation is required for the reliable operation of the line. In addition, the arrangement of the phases can create some; field cancellation and reduction of the ground-level magnetic field.

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

Magnetic field strength diminishes with the vertical and lateral distances from the magnetic field source. Increasing the height of the conductors above ground is useful for magnetic field reduction at ground level, but may result in increased structure costs and increased aesthetic impact of the structures. Another possible method of increasing the distance to the magnetic field source is to increase the right-of-way requirements. By keeping buildings off increased rights of way, thereby requiring the public to live and work further away from lines, exposure to magnetic fields produced by the lines can be reduced. Increases in right of way are not always practical and may increase costs significantly, however.

SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

Under its Magnetic Field Management Program, PPL EU has changed the way it builds and rebuilds some of its transmission and distribution lines. These design changes reduce magnetic field levels (assuming balanced circuit loadings and phase currents) by up to 69 percent in most of the company's new transmission lines. These guidelines now are being applied to new and reconstructed transmission facilities, based on this program.

The distribution component of the program focuses on 12 kV lines, the company's standard distribution voltage. It concentrates on the three-phase, primary 12 kV lines, since these are the most heavily loaded facilities and often are located in densely populated areas. The guidelines in this program are being applied to these three-phase, primary 12 kV lines.

A maximum 3-5 percent change in estimated cost was used as the limit for the guidelines since this value is consistent with low cost, is within estimating accuracy and is likely to have little impact on overall line costs.

The magnetic field calculations used in this document for the design of PPL EU's overall magnetic field management plan assume balanced load conditions among the phases and a fixed level of current, not necessarily representative of specific transmission or distribution lines. These levels were calculated using the Electric Power Research Institute's ENVIRO computer program. Under actual operating conditions, the magnetic field levels that result may vary due to such things as actual load per circuit, overall current on each phase conductor and the electrical configuration and operation of each line.

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

The guidelines for magnetic field management are noted below, with discussion points for each.

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

1. **Balance transmission circuit loads and phase currents as much as possible.**
 - PPL EU should continue to make every effort to balance loadings between the two circuits of a double circuit line when planning new or rebuilt facilities to maximize the effects of reverse phasing.
 - PPL EU should continue the practice of balancing single-phase loads across the three phases of the distribution system. (Unbalanced phase currents on the distribution system are reflected through to the transmission system.)
 - Unbalanced phase currents result in higher magnetic fields that do not drop off as quickly with distance as do the fields resulting from balanced phase currents.
 - For a 5 percent phase current unbalance, the magnetic field 50 feet from the centerline of a single circuit 138 kV line could be more than twice the value than if the same line had balanced phase circuits.
 - Balanced phase currents on each three-phase distribution circuit also reduce magnetic fields from the distribution circuits themselves. In addition, they reduce magnetic fields on the transmission system from which the distribution system circuits are supplied and connected through substations.
 - Apart from magnetic field considerations, balanced phase currents on each three-phase distribution circuit also reduce line losses and improve the system voltage.

2. Continue with the present practice of using long-span construction as the PPL EU 138/69 kV standard

- Structure designs for short-span and long-span construction are illustrated on Charts I and II, respectively.
 - Short-span design does not significantly reduce magnetic fields when compared to long-span design even though it is more compact than long-span design. Comparison of the magnetic field values from Chart III indicates essentially the same values. Therefore, short-span design should not be used solely to reduce magnetic fields.
 - PPL EU will continue to use long-span construction for 138/69 kV double-circuit lines and for single-circuit/future-double-circuit lines.
 - For single-circuit/future-double-circuit lines, PPL EU will continue to install two conductors on the top positions and one in the middle position as shown in Chart IV.
 - This arrangement minimizes magnetic fields as shown in Chart V by placing the three initial conductors higher on the structure, which increases the ground clearances, and by placing the conductors in a triangular configuration.

3. Compact design structures are not a low-cost alternative and should be used for magnetic field reduction only in special applications.

Chart VI illustrates the compact design structure.

- The compact design increases the initial installation costs by 79 percent when compared to the long-span design but reduces the magnetic field from 9 mG to 3 mG (about 67 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.

4. Reverse phase new or rebuilt double-circuit transmission lines for all voltage levels.

- Reverse phasing was adopted by PPL EU in March 1991 for double-circuit 138/69 kV transmission lines and in April 1992 for all other double circuit transmission lines. Reverse phasing is shown in Chart VII. Reverse phasing will reduce the magnetic fields when the current flow on both circuits is in the same

direction. Calculated values contained here are based on balanced and equal phase currents on both circuits.

- Reverse phasing reduces the magnetic field of a double circuit 138 kV single pole transmission line from 29 mG to 9 mG (about 69 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.
- Reverse phasing reduces the magnetic field of a double circuit 230 kV single pole transmission line from 49 mG to 16 mG (about 67 percent) at the edge of the 150-foot-wide right of way as shown on Chart VIII.
- Reverse phasing reduces the magnetic field of a double-circuit 500 kV single pole transmission line from 37 mG to 21 mG (about 43 percent) at the edge of the 200-foot-wide right of way as shown on Chart IX.
- When new or rebuilt double-circuit lines require tapping existing double-circuit lines, PPL EU will review the existing lines to determine if reverse phasing can be provided at low cost.
- Computer modeling is required to develop the optimum phasing and overall conductor arrangements for lines added to, or rebuilt in, multiple-line corridors.
 - Merely adding a reverse-phase double-circuit line to an existing transmission line corridor or reverse phasing a rebuilt line in the multiple-line corridor will not necessarily produce lower magnetic field levels at the edge of the corridor right of way.
 - The corridor must be computer modeled with all the lines, existing phase conductor locations and currents. Then, magnetic field calculations must be made varying the phase arrangements of the new or reconstructed line to determine the appropriate phasing arrangement.
 - Current flow direction on a line also must be considered. For example, a reverse-phased line should have the current flowing in the same direction on both circuits. If the current flow is in the opposite direction for one circuit, reverse phasing will not produce the lowest magnetic field and another phase arrangement that produces lower fields may need to be utilized.

5. Increase the minimum ground clearance for all new transmission lines.

138/69 kV Transmission Lines

- Increasing the minimum line design ground clearance from 25 feet to 30 feet may add up to about 5 percent to the installed cost of a new double-circuit single pole 138/69 kV line. For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. With long-span reverse-phase design, the magnetic field is reduced from 9 mG to 7 mG (about 22 percent) at the edge of a 100-foot-wide right of way as shown in Chart X.
 - In the actual design of transmission lines to include higher minimum ground clearances, there may be limited segments (such as highway crossings, severe slopes and transmission line crossing locations) where National Electrical Safety Code (NESC) minimum ground clearances may need to be used. The NESC minimum ground clearances are less than the increased ground clearance discussed previously.

230 kV Transmission Lines

- Increasing the minimum line design ground clearances from 27 feet to 32 feet may add up to about 5 percent to the cost of a single-circuit single-pole line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 30 mG to 28 mG (about 7 percent) at the edge of a 150-foot-wide right of way.
- Increasing clearances from 27 feet to 32 feet could theoretically add up to about 2.8 percent to the cost of a double-circuit single-pole line (current standard) and reduce the magnetic field of a reverse-phase line from 16 mG to 15 mG (about 6 percent) at the edge of a 150-foot-wide right of way. Chart XI is a summary of this data.
- Studies are required for each new 230 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such

studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced phase spacing (a "Delta" configuration on a single-circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

500 kV Transmission Lines

- Increasing ground clearances from 33 feet to 53 feet may add up to about 4.5 percent to the cost of a single-circuit "H-frame" line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 42 mG to 35 mG (about 17 percent) at the edge of a 200-foot-wide right of way.
- Increasing ground clearances from 33 feet to 53 feet could theoretically add up to 2.8 percent to the cost of a double-circuit "H-frame" line (current standard) and reduces the magnetic field of a reverse-phase line from 21 mG to 16 mG (about 24 percent) at the edge of a 200-foot-wide right of way. Chart XII is a summary of this data.
- Studies are required for each new 500 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced-phase spacing (a "Delta" configuration on a single circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

When reconductoring or adding additional circuits to existing transmission lines, PPL EU will evaluate low-cost or no-cost options for magnetic field management on a case-by-case basis.

When reconductoring existing transmission lines or adding additional circuits, low-cost alternatives may not exist; however, the following steps will be taken:

- For a single-circuit line, the use of a Delta arrangement or other modifications on the existing structure, with reduced-phase spacing, will be evaluated.
- For double-circuit lines, application of reverse phasing may reduce the magnetic field under the line and within the right of way and will be evaluated.
- For single- and double-circuit lines, evaluate using higher conductor tensions that can increase the minimum line design ground clearance.

DISTRIBUTION LINES

At the 12 kV distribution level, new main three-phase lines will continue to be constructed with five feet of additional ground clearance.

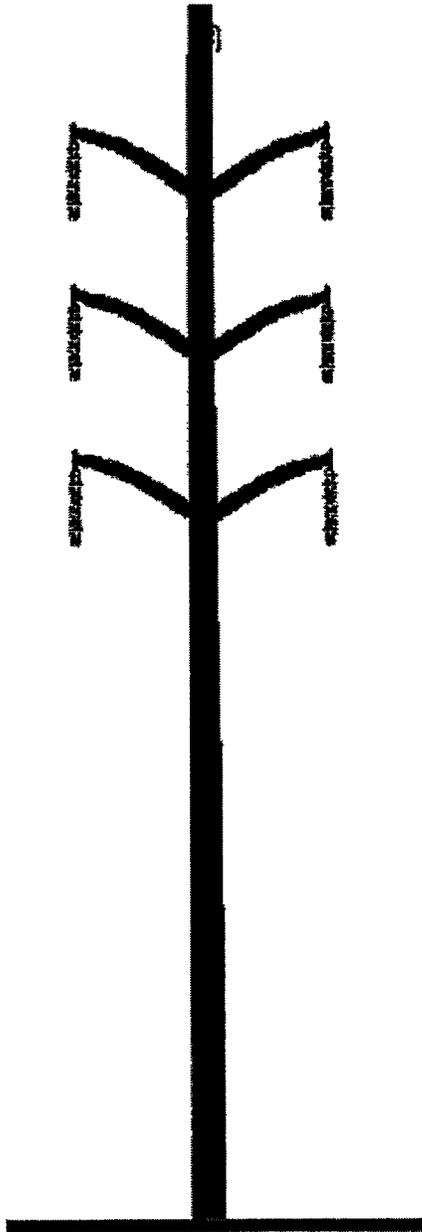
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These values are based on increasing pole heights from 45 feet to 50 feet and a typical operating current of 300 amps per phase.
- Chart XIII is a summary of this data. Increasing ground clearance by five feet could theoretically add about 5 percent to the cost of a typical distribution line.

UNDERGROUND TRANSMISSION LINES

Underground transmission lines are required due to environmental or land use factors or restrictions on available clearances, PPL EU will evaluate options for magnetic field management techniques on a case-by-case basis.

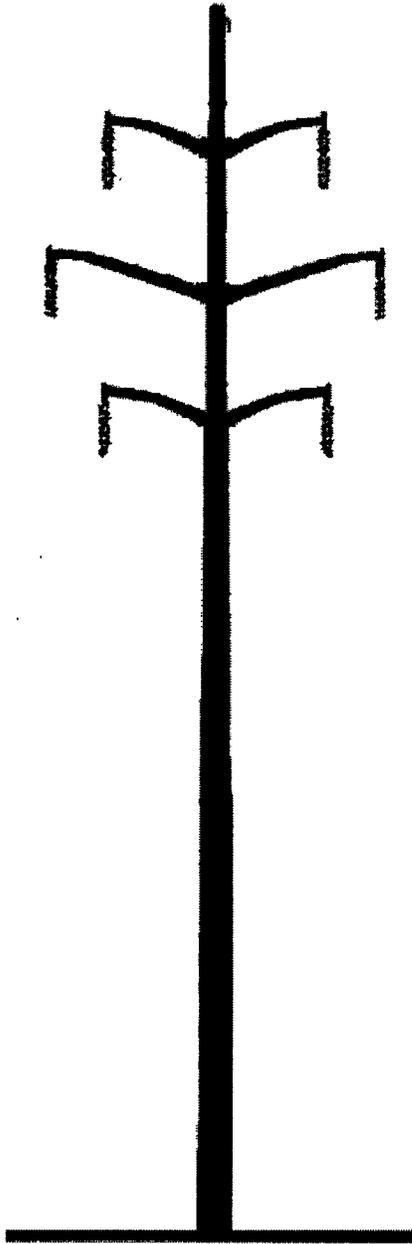
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will be evaluated.

Short-Span Construction



- **More compact design**
- **Should not be used solely to reduce magnetic fields**
- **Typical conductor data:**
 - 1 3/8" HS steel overhead ground wire - 7.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 10.0 feet sag
 - Average span - 400 feet

Long-Span Construction Remains PPL EU 138 kV Standard



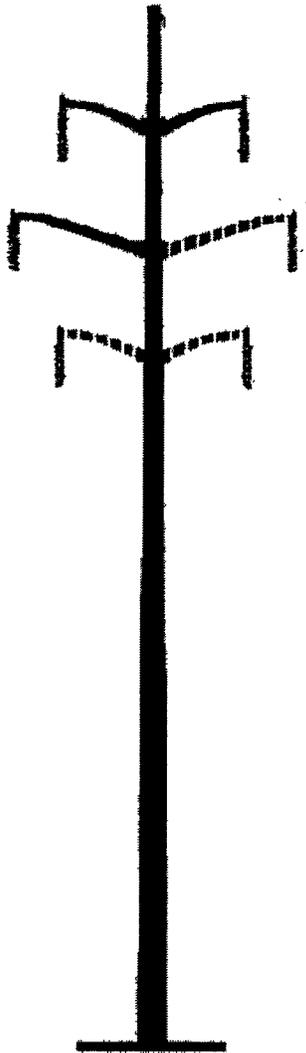
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

**138/69 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

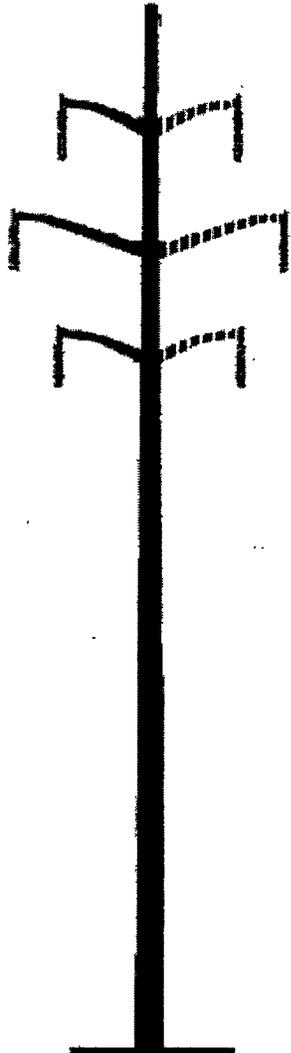
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

The edge of right of way is 50 feet from the line centerline.
 The 400 ampere phase current is balanced between phases.
 Calculations are based on a minimum ground clearance of 25 feet.
 LONG SPAN, SHORT SPAN and COMPACT are double-circuit lines.

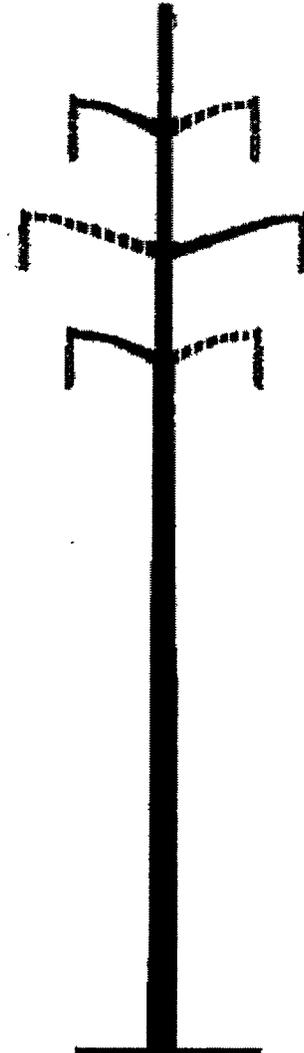
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

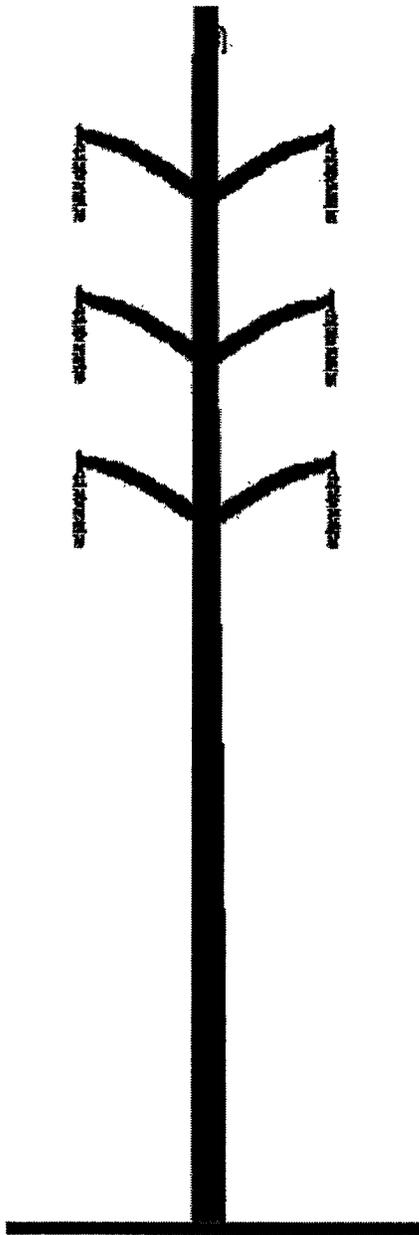
——— initial single circuit
- - - - - future second circuit

**138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
TOP/MIDDLE/BOTTOM	20
VERTICAL	17
TOP/MIDDLE	12

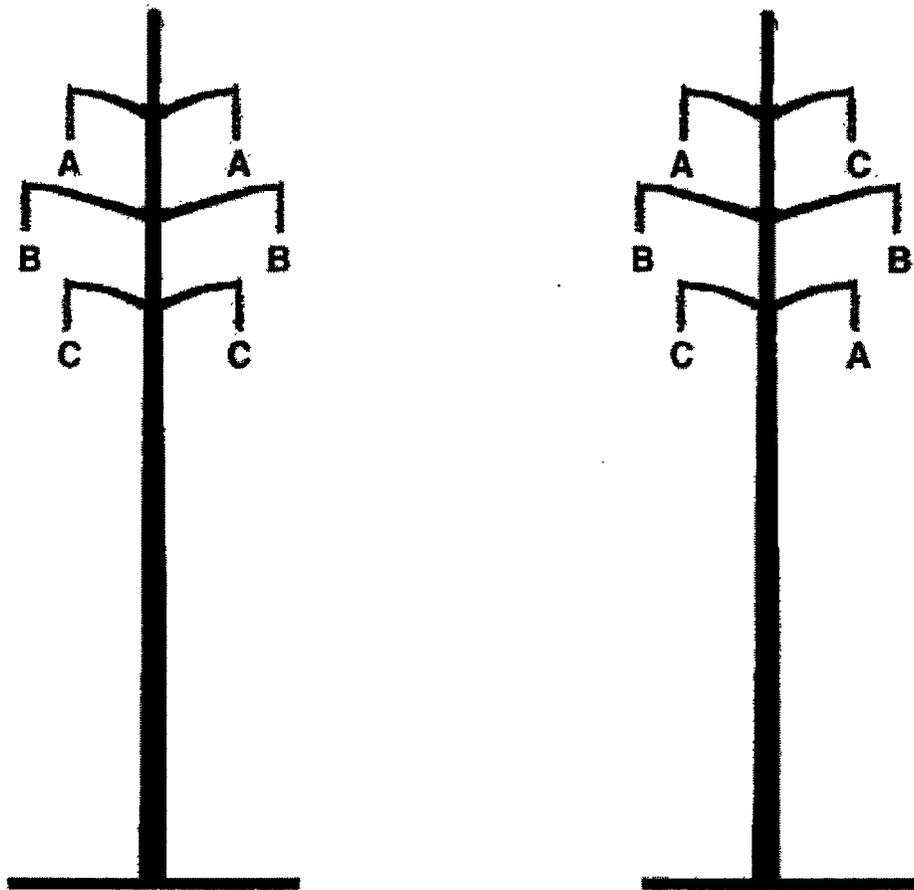
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

Compact Design Structure



- **Minimize magnetic fields due to compact design**
- **Not a low-cost alternative**
- **Typical conductor data:**
 - 1 3/8" HS steel overhead ground wire - 9.0 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 9.0 feet sag
 - Average span - 300 feet

Reverse Phasing of Double-Circuit Transmission Lines



From: $\longrightarrow \longrightarrow \longrightarrow \longrightarrow$ To:

Reverse phasing also can be one of the following phase arrangements:

A	B		B	A		B	C		C	A		C	B
C	C	or	C	C	or	A	A	or	B	B	or	A	A
B	A		A	B		C	B		A	C		B	C

**230 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	49
DOUBLE CIRCUIT POLE (REVERSE-PHASE)	16

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 27 feet.

**500 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 1100 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	37
DOUBLE CIRCUIT POLE (REVERSE PHASE)	21

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 33 feet.

**INCREASED 138/69 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	25	12
SINGLE CIRCUIT TOP/MIDDLE	30	10
LONG SPAN	25	29
LONG SPAN	30	26
LONG SPAN (REVERSE PHASE)	25	9
LONG SPAN (REVERSE PHASE)	30	7

The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.

**INCREASED 230 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	27	30
SINGLE CIRCUIT TOP/MIDDLE	32	28
DOUBLE CIRCUIT POLE	27	49
DOUBLE CIRCUIT POLE	32	46
DOUBLE CIRCUIT POLE (REVERSE PHASE)	27	16
DOUBLE CIRCUIT POLE (REVERSE PHASE)	32	15

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.

**INCREASED 500 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 1,100 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT "H" STRUCTURE	33	42
SINGLE CIRCUIT "H" STRUCTURE	53	35
DOUBLE CIRCUIT POLE	33	37
DOUBLE CIRCUIT POLE	53	31
DOUBLE CIRCUIT POLE (REVERSE PHASE)	33	21
DOUBLE CIRCUIT POLE (REVERSE PHASE)	53	16

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.

**12 kV DISTRIBUTION LINES
CALCULATED MAGNETIC FIELDS AT 300 AMPERES**

TYPE CONSTRUCTION	POLE HEIGHT FEET	MAGNETIC FIELD IN MILLIGAUSS*	
		AT CENTERLINE	AT 30 FEET FROM CENTERLINE
STANDARD CROSSARM	45	14	7
STANDARD CROSSARM	50	11	6

* Field level under the line at mid-span based on 300 amps, balanced loading, one meter above ground level.

Attachment

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ATTACHMENT 6
BLOOMING GROVE - WEST DAMASCUS, KIMBLES TAP 138/69 KV
TRANSMISSION LINE REBUILD
LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY

<u>Property Owner/Address</u>	<u>Parcel Number</u>
PPL Holtwood, LLC C/O PPL Real Est. Taxes 2 North Ninth Street Allentown, PA 18101	1
Douglas Lietzke and Lura C. Palmer 88 Mine Road Oley, PA 19547	2
Christopher G. Lanning 152 E. 94th Street Apt. 11A New York, NY 10128-2579	3
Wayne Tigie HC 1 Box 32 Paupack, PA 18451	4
Richard W. Hiris 1130 Towpath Road Hawley, PA 18428	5
Kenneth J. Vanwyk Route 590 VG Hawley, PA 18428	6
PPL C/O PPL Real Estate Taxes 2 North Ninth Street Allentown, PA 18101	7
PPL C/O PPL Real Estate Taxes 2 North Ninth Street Allentown, PA 18101	8
Ignatius and Joan Scalavino 29 McGregor Ave Roslyn Heights, NY 11577	9

Attachment

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ATTACHMENT 7

BLOOMING GROVE - WEST DAMASCUS, KIMBLES TAP 138/69 KV

TRANSMISSION LINE REBUILD

**LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND
OTHER PUBLIC ENTITIES RECEIVING APPLICATIONS**

Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0053
Attn: Mr. Douglas C. McLearn, Chief

Pennsylvania Department of Transportation
Honorable Barry Schoch, P.E., Secretary
c/o Office of Chief Counsel
Commonwealth Keystone Building
400 North Street, 9th Floor
Harrisburg, PA 17120
Attn: Andrew Gordon

Department of Environmental Protection
P.O. Box 2063
Market Street State Office Building
Harrisburg, PA 17105-2063
Attn: Office of Field Operations

Pike County Board of Commissioners
506 Broad Street
Milford, PA 18337
Attn: Mr. Rich Caridi, Chairman

Pike County Planning Commission
837 Route 6, Unit 4
Shohola, PA 18458
Attn: Ms. Sally Corrigan, Planning Director

Blooming Grove Township
488 Route 739
Blooming Grove, PA 18428-9039
Attn: Ms. Jo-Anna Donahue, Secretary

Blooming Grove Township Planning Commission
488 Route 739
Blooming Grove, PA 18428-9039
Attn: Mr. Levi Travis, Sr., Chairman