Before the
Pennsylvania Public Utility Commission

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

ATTACHMENTS IN SUPPORT OF THE
Letter of Notification

Application Docket No.____________

Submitted by: PPL Electric Utilities Corporation

ppl™

SUMMARY

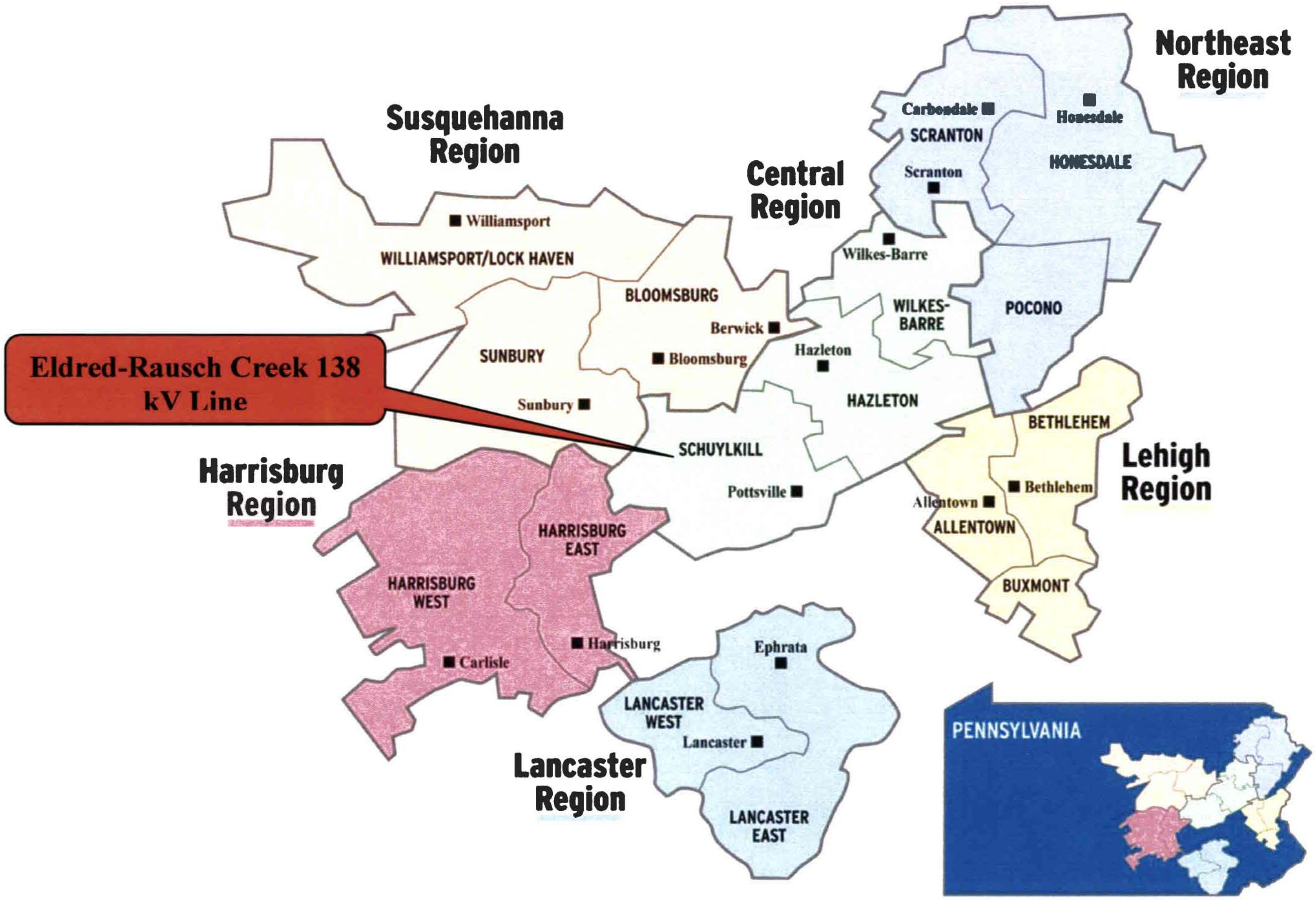
This filing is submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for PUC approval to install a new overhead 138 kV circuit, known as the Eldred – Rausch Creek 138 kV Transmission Line (the "Eldred – Rausch Creek Line"), to connect the Rausch Creek Wind Farm to the existing PPL Electric Eldred Substation. Approximately 6.5 miles of the new 138 kV circuit will be installed on existing transmission structures that presently carry the Eldred – Pine Grove 69 kV Transmission Line. These structures were constructed for double-circuit operation, but currently support only one circuit. In addition, PPL Electric intends to construct a short section (approximately 125 feet) of new overhead 138 kV transmission line to connect to the Rausch Creek Wind Farm generator to the existing transmission structures, and another short section (approximately 500 feet) of new underground 138 kV transmission line from the existing structures for the Eldred – Pine Grove 69 kV Transmission Line into PPL Electric's 230 – 69 kV Eldred Substation. With the exception of the 125-foot connection from the Rausch Creek Wind Farm customer substation to the first existing transmission structure, the entire Project will be contained within existing PPL Electric right-of-way or property owned in fee by PPL Electric. The proposed new circuit will traverse Frailey, Hegins, Barry, and Eldred townships in Schuylkill County, Pennsylvania. The total Project includes the Eldred – Rausch Creek Line and modifications of the Eldred Substation to permit the Eldred – Rausch Creek Line to be connected to and supply it.

The estimated cost of this Project is $13 million which includes $5.5 million for transmission line work and $7.5 million for substation work. All costs will be borne by BP Wind Energy, the owner of Rausch Creek Wind Farm. Subject to Commission approval, construction is scheduled to begin in October 2013 to support the developer's schedule.

The attachments for the Letter of Notification, which describes the need for the Project and discusses the engineering and environmental analysis for the proposed construction, includes the following:

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



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ATTACHMENT 3

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

ENVIRONMENTAL ASSESSMENT

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ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric is requesting PUC approval to install approximately 6.5 miles of new overhead 138 kV circuit to existing transmission structures capable of double-circuit operation, which presently carry the Eldred – Pine Grove 69 kV Transmission Line. In addition, PPL Electric intends to construct a short section of new overhead line that will connect the Rausch Creek Wind Farm to the existing transmission structures, and another short section of new underground line that will extend the new Eldred – Rausch Creek 138 kV Transmission Line into PPL Electric's Eldred Substation. The entire Project is located within Schuylkill County, Pennsylvania. The proposed line begins at the existing PPL Electric Eldred Substation located in Eldred Township, continues south for approximately 6.5 miles through Barry and Hegins townships, and terminates at the proposed Rausch Creek Wind Farm located in Frailey Township. Table 1 identifies the portion of the Project located within each township.

TABLE 1
MUNICIPALITIES CROSSED BY THE PROJECT

Municipality	Length (miles)[1]
Frailey Township	0.1
Hegins Township	2.6
Barry Township	3.6
Eldred Township	0.3

The proposed Project was reviewed with representatives of Schuylkill County and Frailey, Hegins, Barry, and Eldred townships, and neither the County nor the

[1] Rounded to the nearest tenth

townships had any objection. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 7.

B. LAND USE

The Project begins in Eldred Township at the existing Eldred Substation located adjacent to Taylorsville Road and west of Weiser State Forest. The first approximately 500 feet, including 200 feet through Weiser State Forest, will be constructed underground. From this point, the new overhead 138 kV circuit will primarily be constructed on existing transmission structures that presently carry the Eldred – Pine Grove 69 kV Transmission Line within PPL Electric's existing right-of-way.

The existing transmission line turns southeast for approximately 832 feet through Weiser State Forest before turning south and crossing Taylorsville Road and the Eldred – Wheelabrator Frackville Energy 230 kV Transmission Line in Barry Township. The route continues south for approximately 1.1 miles through a forested portion of Barry Township.

At a point approximately 612 feet north of Mabel Road, the existing transmission line turns southwest and traverses through a mix of rural residential, agricultural, and forested land through Barry and Hegins townships for approximately 3.0 miles. The route then turns southeast and traverses forested and agricultural land through Hegins and Frailey townships for approximately 2.1 miles. From this point, PPL Electric has an agreement in principle to acquire approximately 125 feet of new, 100 foot-wide right-of-way from BP Wind Energy, who owns the proposed Rausch Creek Wind Farm in order to connect the new Eldred – Rausch Creek 138 kV Transmission Line to the wind farm generator located north of Interstate 81 (I-81) and approximately 1,200 feet south of Fountain Mountain Road.

With the exception of the first 125-foot segment connecting the wind farm generator to the 138 kV circuit, the proposed Project will be located entirely within the existing right-of-way for the Eldred – Pine Grove 69 kV Transmission Line. Addition of the new 138 kV circuit to the existing structures and the minimal amount of new construction at the Project endpoints is not expected to result in significant land use impacts. Other than the clearing of a minimal amount of trees along the short 125-foot new line segment entering the Rausch Creek Wind Farm generator, and approximately 0.5 acres of potential tree clearing between a new angled structure within Weiser State Forest and the Eldred Substation, no changes to existing land use are expected.

No communication towers, pipelines, or other utilities will be affected by the proposed Project. The closest airport is the Schuylkill County Airport, located approximately 2.8 miles northeast of the Project. PPL Electric will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation to ensure that the proposed construction will not be a hazard to the airport's flight operations. The proposed 138 kV Transmission Line will be installed on existing transmission structures and is not expected to impact airport operations.

C. CULTURAL RESOURCES

PPL Electric reviewed the Pennsylvania Historical and Museum Commission's (PHMC's) Bureau for Historic Preservation (BHP) Cultural Resources Geographic Information System (CRGIS) to identify previously recorded historic resources located in the vicinity of the Project. Based on this review, the Project does not cross any record historic architectural or archeological resources. The closest previously recorded resource is located approximately 538 feet south of the existing transmission line and was determined to be ineligible for the National Register of Historic Places. No other previously recorded resources are located within 0.5 mile of the Project. PPL Electric submitted a letter to the PHMC on February 20, 2013 to request information on any additional archaeological or historic architectural resources located in the Project vicinity. No response has been received to date. Based on the results of the CRGIS database review, PPL Electric does not anticipate the need for further investigation for this Project. However, PPL Electric will complete consultation with the PHMC prior to the start of construction.

D. NATURAL FEATURES

The Project will traverse approximately 0.2 of a mile of Weiser State Forest. Of this, approximately 827 feet will consist of installing a new overhead circuit on the existing Eldred – Pine Grove 69 kV transmission structures and approximately 200 feet will involve construction of a new underground circuit. In both cases, the Project will be located within existing right-of-way. PPL Electric anticipates the need to install one new structure within Weiser State Forest. Minimal tree clearing will occur within the 200-foot segment of new construction through Weiser State Forest in order to accommodate the new 138 kV circuit. Clearing will be limited to the existing 100-foot right-of-way, which is not presently cleared to 100 feet. 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" to mitigate any impacts.

The closest natural area, identified in the natural area inventory (NAI) by The Nature Conservancy,[2] is the referred to as the Good Spring Creek Woods. According to The Nature Conservancy, the area supports a fair-quality example of one plant species of concern, minniebush (*Menziesia pilosa*) and two animal species of concern, the Allegheny woodrat (*Neotoma magister*) and the timber rattlesnake (*Crotalus horridus*). This natural area is located approximately 0.9 mile to the south of the Project site. Based on the distance of the NAI from the

[2] A Natural Areas Inventory of Schuylkill County, Pennsylvania, 2003.

Project, no impacts are anticipated. The Project will not traverse or affect any other unique geological, scenic or natural areas.

The Project crosses two National Hydrography Dataset (NHD) streams: Pine Creek and Deep Creek. No National Wetland Inventory (NWI) wetlands are traversed by the Project. PPL Electric intends to conduct a wetland delineation of the transmission right-of-way, and will acquire all required environmental permits prior to the start of construction and adhere to all of their terms and conditions.

PPL Electric will obtain any required soil erosion and sedimentation control approvals and associated 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.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric conducted an online Pennsylvania Natural Diversity Inventory (PNDI) database review on February 15, 2013. Based on this review, the Pennsylvania Game Commission (PGC), Pennsylvania Fish and Boat Commission (PFBC), the Pennsylvania Department of Conservation and Natural Resources (DCNR), and the U.S. Fish and Wildlife Service (USFWS) reported that the Project will not impact any threatened and endangered species and/or special concern species and resources are located within the Project area.[3] However, Schuylkill County is located within the range of the federally threatened bog turtle (*Clemmys muhlenbergii*). Therefore, PPL Electric will retain a qualified bog turtle surveyor to conduct a Phase I bog turtle survey for any wetlands delineated within the Project boundaries and will submit a Phase I survey report to USFWS.

[3] Pennsylvania Natural Diversity Inventory (PNDI) Search ID: 20130215391337, February 15, 2013.

Attachment

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ATTACHMENT 4

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

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

	Vertical Clearance to Ground	
Surface Underneath Conductors	NESC Standard	PPL Electric Design
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

Surface Underneath Conductors	Vertical Clearance to Ground: NESC Standard	Vertical Clearance to Ground: PPL Electric Design
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

Surface Underneath Conductors	Vertical Clearance to Ground: NESC Standard	Vertical Clearance to Ground: PPL Electric Design
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:

Voltage-kV	Minimum Clearance
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.

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ATTACHMENT 5

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

PPL ELECTRIC MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

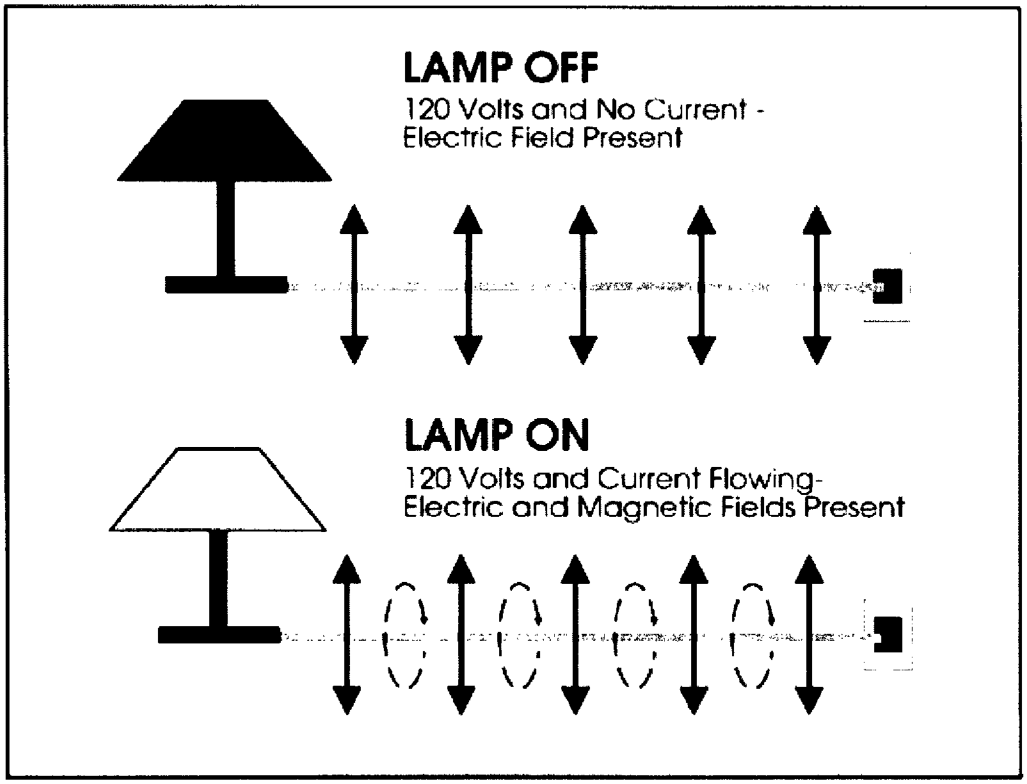

LAMP OFF
120 Volts and No Current - Electric Field Present
LAMP ON
120 Volts and Current Flowing- Electric and Magnetic Fields Present

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.

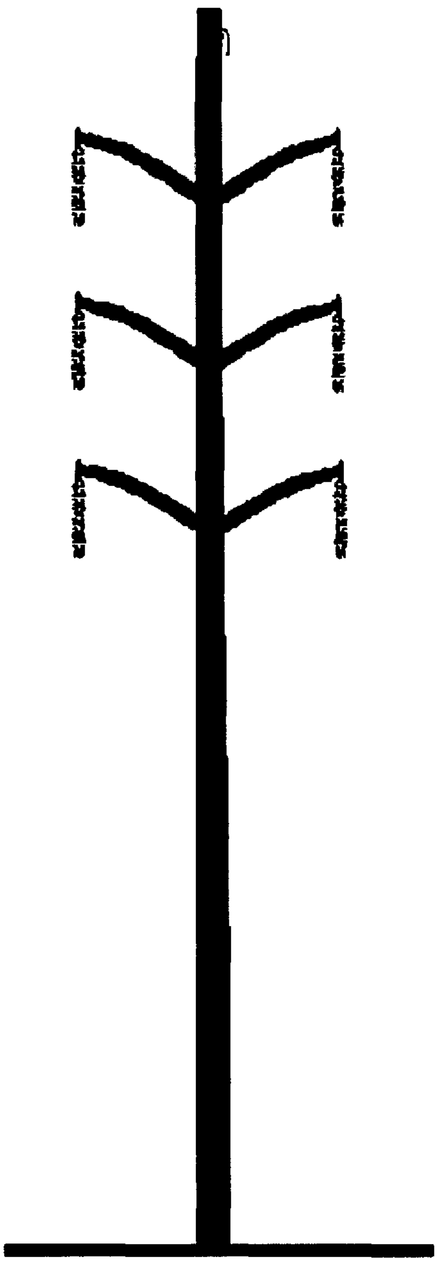
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These 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.

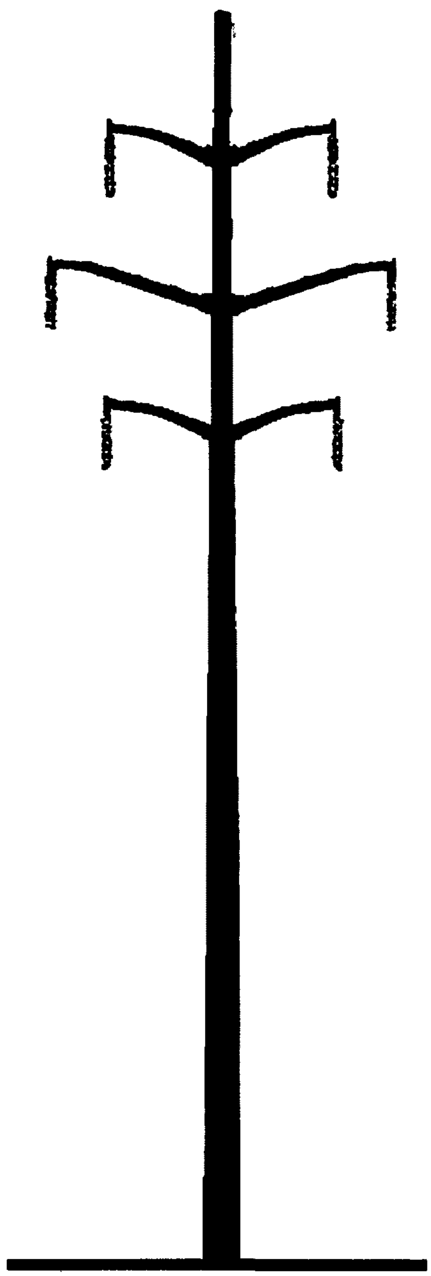
Short-Span Construction



- **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:**

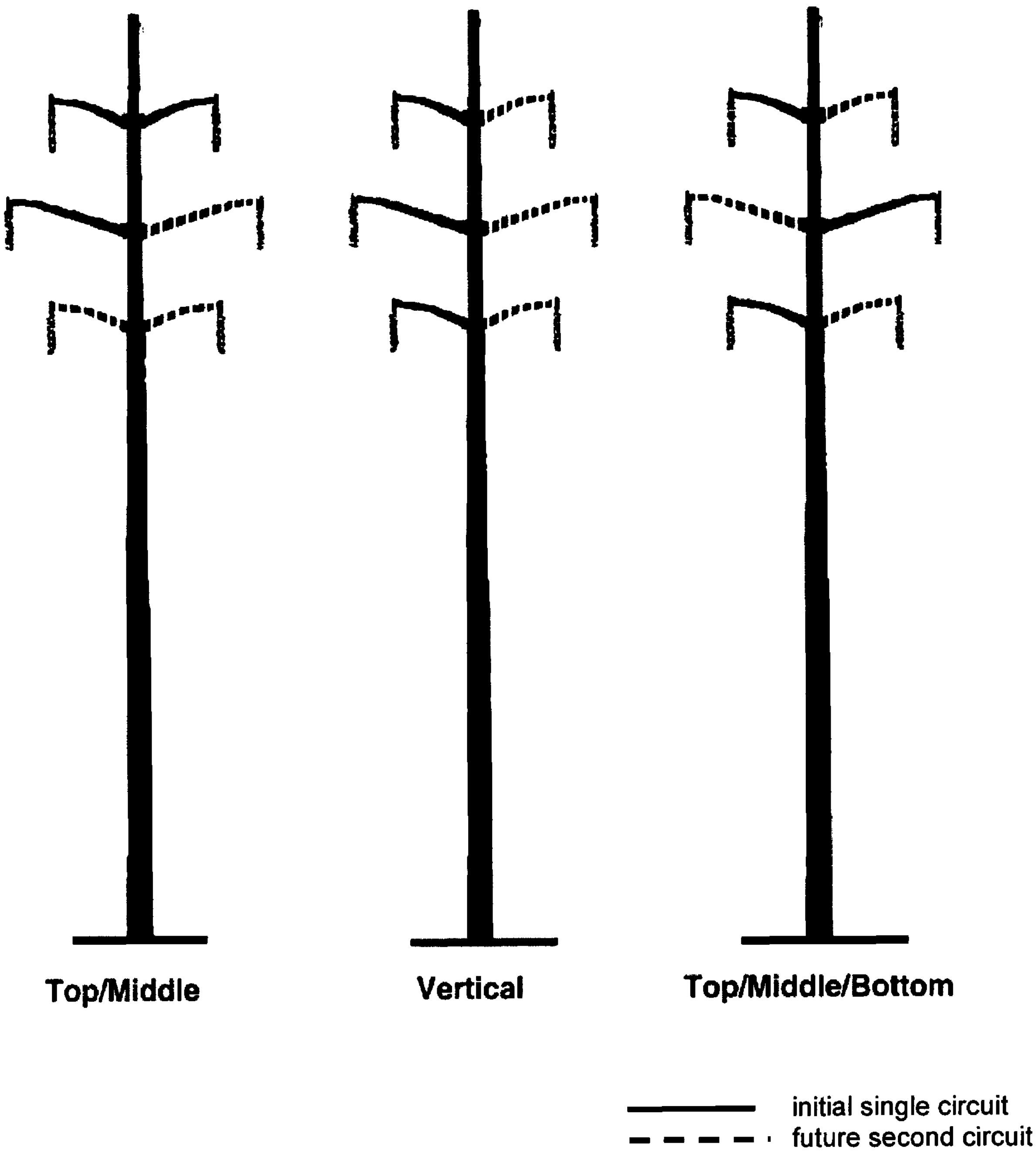
  1 3/8" HS steel overhead ground wire - 17.3 feet sag
  6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
  Average span - 600 feet

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

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLLIGAUSS 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

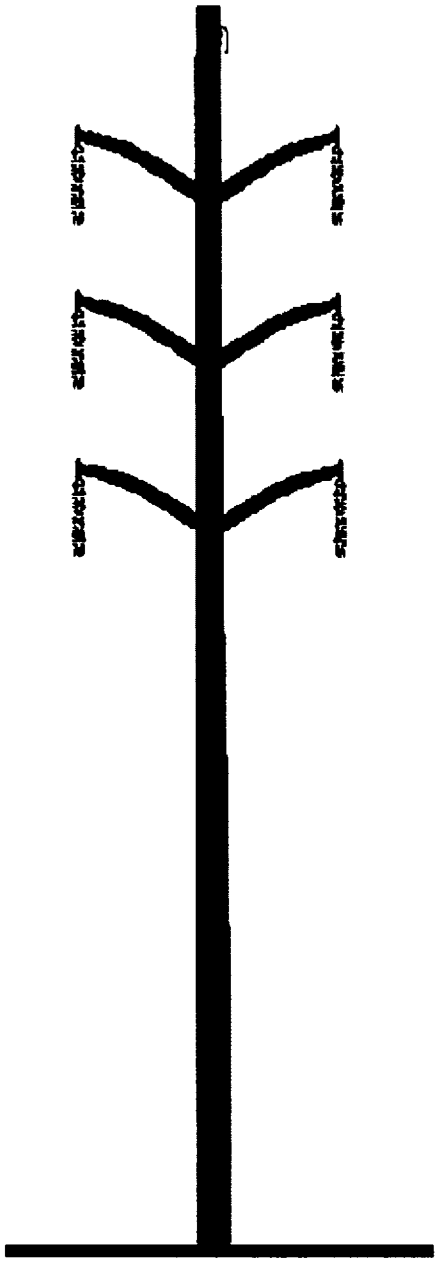


138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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.

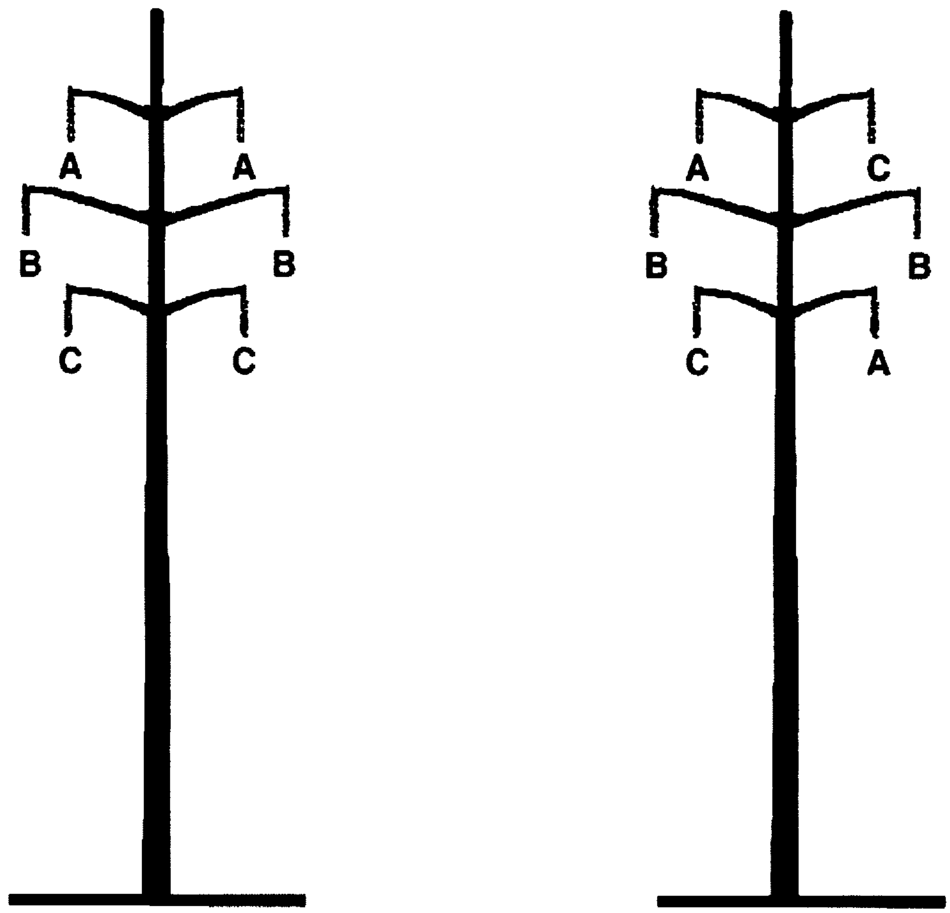
Compact Design Structure



- **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: ⟶ ⟶ ⟶ ⟶ 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**

CHART VIII

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.

CHART IX

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.

CHART X

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

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY

Property Owner/Address	Parcel Number
PPL Electric Utilities PPL – Real Estate Taxes (GENTW2) 2 North Ninth Street Allentown, PA 18101	1
Weiser District Office P.O. Box 99 Cressona, PA 17929	2
RJ Hoffman & Sons 1144 Buckwheat Valley Road Mount Pleasant Mills, PA 17853	3
Earl Header 1001 Deep Creek Road Ashland, PA 17921	4
David Bruch 1688 Buckaroo Cove Auburn, PA 17922	5
Earl Header 1001 Deep Creek Road Ashland, PA 17921	6
Nancy Harner 73 Maplewood Road Ashland, PA 17921	7
Carl & Doris Wetzel 64 Mabel Road Ashland, PA 17921	8
Carl & Michelle Wetzel 68 Mabel Road Ashland, PA 17921	9
Charles & Edith Header 82 Mabel Road Ashland, PA 17921	10

Property Owner/Address	Parcel Number
Virden & Myrna Header 1001 Deep Creek Road Ashland, PA 17921	11
Roger & Anna Neumeister 943 Deep Creek Road Ashland, PA 17921	12
Roger & Anna Neumeister 943 Deep Creek Road Ashland, PA 17921	13
Paul & Betty Fetter 874 Deep Creek Road Ashland, PA 17921	14
Victor & Rose Grandinetti 872 Deep Creek Road Ashland, PA 17921	15
Barry Township 868 Deep Creek Road Ashland, PA 17921	16
E U B Church 858 Deep Creek Road Ashland, PA 17921	17
Terry Klinger 867 Deep Creek Road Ashland, PA 17921	18
Ann Schaeffer 161 Narragansett Trail Medford Lakes, NJ 08055	19
Frank Neumeister 28 Frank Lane Ashland, PA 17921	20
Cathy Klock 499 Main Street Lavella, PA 17943	21
Steven T. Flory 740 Deep Creek Road Hegins, PA 17938	22

Property Owner/Address	Parcel Number
Pamela Merwin 51 Middle Road Hegins, PA 17938	23
Bernard Joyce 19 Middle Road Hegins, PA 17938	24
Edward & Florence Waizenegger 20 Middle Road Hegins, PA 17938	25
Edward Waizenegger 1825 Grace Avenue Lebanon, PA 17046	26
Jesse Waizenegger 114 Weishample Road Hegins, PA 17938	27
Robert & Carla Carl 943 Deep Creek Road Ashland, PA 17921	28
Robert & Carla Carl 943 Deep Creek Road Ashland, PA 17921	29
Robert & Trudy Molnar 91 Weishample Road Hegins, PA 17938	30
Lester & Lucille Ludwig 818 Deep Creek Road Ashland, PA 17921	31
Frederic & Deborah Richter 648 Deep Creek Road PO Box 37 Hegins, PA 17938	32
Kenneth Witmer 200 Hill Road Hegins, PA 17938	33
Albert & Alice Leninger 129 Hill Road Hegins, PA 17938	34

Property Owner/Address	Parcel Number
Mark Klinger 183 Hill Road Hegins, PA 17938	35
Francis & Sue Ann Braconaro 145 Hill Road Hegins, PA 17938	36
Ralph Schnoke 281 Main Street Joliett Tremont, PA 17981	37
Ricky Deeter & Christine Wynn 168 Hill Road Hegins, PA 17938	38
Amber Gemberling 162 Hill Road Hegins, PA 17938	39
Alfred & Ann Beruck 154 Hill Road Hegins, PA 17938	40
Michael & Jaime Deeter 111 Division Street Valley View, PA 17983	41
Gerald and Cathy Stutzman 134 Hill Road Hegins, PA 17938	42
Randall & Cindy Bloch 91 Hill Road Hegins, PA 17938	43
Bryan M Hoover PO Box 5 Cressona, PA 17929	44
Tommy L. Bressler 934 East Main Street Hegins, PA 17938	45
Kerry Otto 963 East Mountain Road Hegins, PA 17938	46

Property Owner/Address	Parcel Number
Pamela J. Reed 1666 East Main Street Hegins, PA 17938	47
Christine Bowman PO Box 268 Valley View, PA 17983	48
Molly J. Otto 200 Fountain Road Hegins, PA 17938	49
Molly J. Otto 200 Fountain Road Hegins, PA 17938	50
Russell C. Ernfield 134 Forest Drive Darlington, PA 16115	51
Richard & Kitty Sitlinger 55 Dell Road Hegins, PA 17938	52
Maynard & Patricia Geist 285 East Mountain Road Hegins, PA 17938	53
PPL Electric Utilities PPL – Real Estate Taxes (GENTW2) 2 North Ninth Street Allentown, PA 18101	54
Rausch Creek Land LP 978 Gap Street Valley View, PA 17983	55

Attachment

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ATTACHMENT 7

ELDRED – RAUSCH CREEK 138 KV TRANSMISSION LINE

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

1. 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. McLearen, Chief

2. 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: William J. Cressler

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

4. Schuylkill County Planning and Zoning Commission
   401 North Second Street
   Pottsville, PA 17901
   Attn: Susan A. Smith, Planning Director

5. Schuylkill County Board of Commissioners
   401 North Second Street
   Pottsville, PA 17901
   Attn: Frank J. Staudenmeier, Chairman

6. Barry Township
   868 Deep Creek Road
   Ashland, PA 17921
   Attn: Jeffrey Hinkel, Chairman

7. Eldred Township Planning Commission
P.O. Box 430
Kunkletown, PA 18058
Attn: Helen Mackes, Chairperson

8. Eldred Township
1399 Creek Road
Pitman PA 17964
Attn: Samuel R. Zimmerman, Chairman

9. Frailey Township
23 Maryland Street
Donaldson, PA 17981
Attn: Donald Allar, Chairman

10. Hegins Township Planning Commission
P.O. Box 630
421 South Gap Street
Valley View, PA 17983
Attn: Mr. Rick Lettich, Chairman

11. Hegins Township
P.O. Box 630
421 South Gap Street
Valley View, PA 17983
Attn: Chad Richards, Chairman