

Before the
Pennsylvania Public Utility Commission

**SOUTH AKRON-DILLERVILLE
#1 & #2 138 kV REBUILD**

ATTACHMENTS IN SUPPORT OF THE
Letter of Notification

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

SUMMARY

This Letter of Notification is being 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 approval to rebuild an approximately one mile long section of the existing South Akron-Dillerville #1 and #2 138 kV Line from one double circuit line to two separate double circuit (four circuits in total) lines. The top circuit of each line will be designed for and operated at 138 kV while the bottom circuit of each line will be designed for and operated at 69 kV.

This filing is the fifth and final filing in a series of related filings seeking PUC approval for various phases of the conversion of the transmission system that serves central Lancaster County from 69 kV to 138 kV operation.¹ This final phase of the conversion project is required to allow a 69 kV transmission customer, Alcoa, Inc., to continue to be served at the 69 kV. This phase of the Project is located in East Hempfield and Manheim Townships, Lancaster County.

The overall 69 kV to 138 kV conversion Project is required to improve the reliability and operating flexibility of PPL Electric's transmission system in central Lancaster County. The conversion from 69 kV to 138 kV will help meet the increasing demand for electricity in the Lancaster area. Converting the existing 69 kV facilities to 138 kV operation along this corridor is part of PPL Electric's long term plan for providing reliable service to the heavily loaded core service area of the Lancaster Region. Increasing the operating voltage from 69 kV to 138 kV will double the capacity of the existing transmission lines and enable PPL Electric to continue to provide reliable service to its customers without having to establish additional major transmission corridors. This phase will complete the conversion Project to improve reliability and operating flexibility.

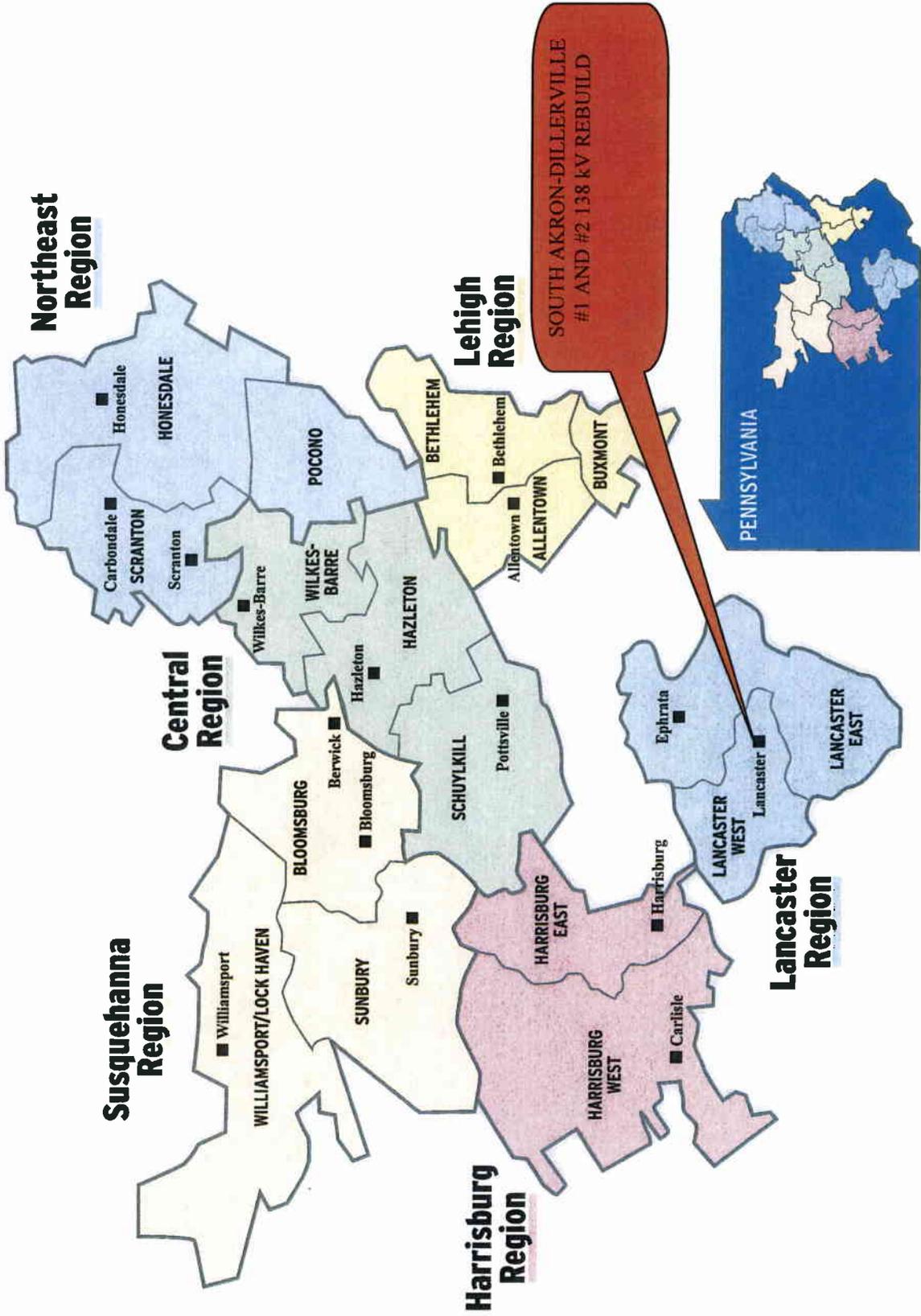
¹ The first phase of the 69 kV to 138 kV conversion was approved by the Commission on June 25, 2009, at Docket No. A-2009-2100767. The second phase of the conversion was approved by the Commission on April 15, 2010, at Docket No. A-2010-2156418. The third phase of the 69 kV to 138 kV conversion was approved by the Commission on October 28, 2011 and docketed at A-2011-2248985. The fourth phase of the 69 kV to 138 kV conversion was approved by the Commission on December 15, 2011 and docketed at A-2011-2266900.

The total estimated cost of the proposed Project is \$3.7 million. Subject to the PUC's approval, construction is scheduled to begin in February, 2013 to support the in-service date of November, 2013.

This document, which describes the need for the Project and discusses the engineering and siting 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 Electric 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
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PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

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**ATTACHMENT 1
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
NECESSITY STATEMENT**

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**ATTACHMENT 1
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
NECESSITY STATEMENT**

A. INTRODUCTION

With Commission approval, PPL Electric plans to rebuild a portion of the existing double circuit South Akron-Dillerville #1 and #2 138 kV Line to two separate double circuit lines (four circuits in total). The top circuit of each line will be designed and operated at 138 kV while the bottom circuit of each line will be designed and operated at 69 kV. This is the final phase of the Project to convert the transmission system that serves central Lancaster County from 69 kV to 138 kV. The conversion of the transmission system from 69 to 138 kV operation is being accomplished in stages to enable PPL Electric to continue to provide service during the conversion process without interruptions. This is the fifth and final phase of the overall conversion Project.

PPL Electric proposes to rebuild a portion of the existing South Akron-Dillerville #1 and #2 138 kV Line from one double circuit line to two individual double circuit lines. This phase of the Project will permit PPL Electric to continue to serve Alcoa from the South Manheim Substation at 69 kV¹ while completing the 138 kV transmission line conversion between the South Akron and Dillerville Substations.

The proposed upgrade is part of an integrated Project which is required to resolve violations to PPL Electric's Reliability Principles and Practices (RP&P). PPL Electric relies on the standards set forth in the RP&P for guidance in determining when it is appropriate to reinforce its transmission and distribution systems. The 138 kV conversion will also increase reliability of service and improve operating flexibility in the core of the Lancaster Region. Finally, the 138 kV conversion will increase capacity to help meet the increasing demand for electrical power in the area.

¹ Conversion of the service to Alcoa, Inc., to 138 kV would necessitate at least the installation of a new transformer at the Alcoa customer-owned facilities (Please see Functional Alternatives section). .

B. EXISTING SYSTEM (See Figure 1)

PPL Electric has submitted four previous Letters of Notification to obtain Commission approval of the first four phases of the Project to convert the 69 kV facilities along the South Akron – Dillerville transmission corridor to 138 kV.

In the first phase of the integrated 138 kV conversion Project, the Dillerville distribution supply substation was converted from a 69-12 kV facility to a 138-12 kV facility. In addition, new 138 kV ties were created between the Dillerville Taps and the West Hempfield – Prince #1 and #2 138 kV Line. The load normally served by the Dillerville 138-12 kV Substation was temporarily transferred to the West Hempfield – Dillerville #1 and #2 138 kV Ties which are supplied from West Hempfield 230-138 kV Substation via the West Hempfield – Prince #1 and #2 138 kV Line. The first phase of the 138 kV conversion was the subject of the *Letter of Notification of PPL Electric Utilities Corporation Filed Pursuant to 52 Pa. Code Chapter 57.72 with Respect to the West Hempfield-Dillerville #1 and #2 138 kV Ties and the Dillerville #1 and #2 138/69 kV Taps in the City of Lancaster, Lancaster County, PA*, which was approved by the PUC at Docket No. A-2009-2100767 on June 25, 2009. The system modifications have been completed, and the facilities are in service.

In the second phase of the 138 kV conversion Project, the existing Roseville 138/69 kV Tap and the Neffsville #1 and #2 69 kV Taps were upgraded for 138 kV operation. The Roseville and Neffsville #1 and #2 Taps remain energized at 69 kV but will be transferred to the 138 kV system when the third phase of the 138 kV conversion plan has been completed. The second phase of the 138 kV conversion was approved by the PUC in the *Letter of Notification of PPL Electric Utilities Corporation, Filed Pursuant to 52 Pa. Code Chapter 57.72, with Respect to the Roseville 138/69 kV Tap in Manheim Township, Lancaster County, PA*, at Docket No. A-2010-2156418, on April 15, 2010. The system modifications approved by the PUC in this proceeding have been completed, and the facilities are in service.

In the third phase of the integrated 138 kV conversion, the existing South Akron – South Manheim #1 and #2 69 kV Line and the Dillerville #1 and #2 69 kV Taps are being upgraded for

138 kV operation. In addition, PPL Electric will construct a new 1,360 foot double circuit line to connect the South Akron – South Manheim Transmission Line to the 138 kV yard at the South Akron 230-138-69 kV Substation. The 69 kV and 138 kV systems will be resectionalized and the South Akron – South Manheim #1 and #2 69 kV Line and the Dillerville #1 and #2 69 kV Taps will be redesignated as the South Akron – Dillerville #1 and #2 138 kV Line. The third phase of the 138 kV conversion was approved by the PUC in the *Letter of Notification of PPL Electric Utilities Corporation, filed pursuant to 52 Pa. Code Chapter 57.72 with respect to the South Akron - Dillerville #1 and #2 138 kV Line in the City of Lancaster, Lancaster County, PA*, at Docket No. A-2011-2248985, on October 28, 2011. PPL Electric began construction of the system modifications approved by the PUC in this proceeding in early 2012

As part of the fourth phase of the 138 kV conversion, the East Petersburg #1 and #2 69 kV Taps and the Park City #1 and #2 69 kV Taps, currently insulated and operated at 69 kV, will be reinsulated to meet 138 kV standards. No extra physical work is required since the Taps were originally constructed for 138 kV operation. In addition, the 69-12 kV transformers will be replaced by 138-12 kV transformers in East Petersburg Distribution Substation. The fourth phase of the 138 kV conversion was approved by the PUC in the *Letter of Notification of PPL Electric Utilities Corporation, filed pursuant to 52 Pa. Code Chapter 57.72 with respect to the East Petersburg # 1 and # 2 138 kV tap and Park City # 1 and # 2 138 kV tap in the City of Lancaster, Lancaster County, PA*, at Docket No. A-2011-2266900, on December 15, 2011. Construction of these system modifications approved by the PUC in this proceeding is expected to begin in the summer of 2012

An approximately one-mile section of the existing South Akron-Dillerville # 1 and # 2 138 kV Line is the subject of this filing. This will be the fifth and final phase of the 138 kV conversion for this section of Lancaster County. As mentioned above, the existing South Akron – South Manheim #1 and #2 Line and the Dillerville Taps will be resectionalized and redesignated the South Akron – Dillerville #1 and #2 138 kV Line after the third phase is completed. Since the conversion of the overall South Akron-Dillerville #1 and #2 138 kV Line was submitted and approved in a previous application this filing only pertains to the approximately one mile long section being modified to two separate double circuit lines.

See Figure 1 on page 9 for the existing transmission system configuration.

C. DEFINITION OF THE PROBLEM

The multiphase Lancaster 138 kV conversion Project began in 2009 to address reliability concerns in the core Lancaster area which are summarized next. Under PPL Electric's RP&P, the maximum amount of load that can be interrupted due to a double-circuit line outage is 45 MW after all allowable switching moves have been made. Without the conversion to 138 kV operation, the loss of the Dillerville #1 and #2 69 kV Taps would interrupt approximately 60 MW of load during periods of high demand. Due to limited transmission and distribution switching capability, the load would remain interrupted until repairs could be made. Such a service interruption would affect approximately 1,400 customers supplied from the PPL Electric distribution system, as well as two large transmission customers. If there were an outage of the double-circuit Dillerville #1 and #2 69 kV Taps, no other 69 kV ties would be available to serve the large transmission customers. Transmission service to these customers would remain interrupted until line repairs could be made.

In addition, if the West Hempfield – Dillerville #1 and #2 138 kV Ties experienced an outage, no other 138 kV Ties would be available to supply the Dillerville 138-12 kV Substation. PPL Electric's ability to transfer the load served by the Dillerville 138-12 kV Substation to other nearby distribution substations is limited during peak loading conditions because they are already heavily loaded. Under such circumstances, service to approximately 1,400 customers would remain interrupted until repairs could be completed.

Finally, electric lines which carry different voltage levels (i.e. 69 kV, 138 kV, etc.) cannot be directly connected to each other. Therefore the 69 kV transmission customer, Alcoa, needs to either be connected to the 138 kV circuit or be connected to a different 69 kV source. Alcoa, a 69 kV customer is not obligated to convert to 138 kV. PPL Electric is responsible for any upgrades required to keep this customer supplied per the electric service contract.

D. PROPOSED SOLUTION (See Figure 2)

In this fifth phase of the integrated 138 kV conversion Project, PPL Electric proposes to rebuild a portion of the existing South Akron-Dillerville # 1 and # 2 138 kV Line as two separate double circuit lines (four circuits in total), from the existing Dillerville Tap points up to the Alcoa customer tap at the Howmet Substation. These pole structures will be designed to PPL Electric's 138 kV standards for the top circuits and 69 kV standards for the bottom circuits. The top circuit of each line will be operated at 138 kV, and the bottom circuit of each line will be operated at 69 kV.

The 138 kV circuits will be part of the South Akron - Dillerville #1 and #2 138 kV Line and supplied from the South Akron 230-138 kV Regional Substation. The 69 kV circuits will supply the Alcoa facilities from the South Manheim 230-69 kV Regional Substation. See Figure 2 on page 10 for the proposed transmission system configuration.

After the completion of the 138 kV conversion, the Dillerville 138-12 kV Substation and the customer-owned Park City Substation will be transferred to the South Akron – Dillerville #1 and #2 138 kV Line, which will be supplied from the South Akron 230-138 kV Substation. The final arrangement of the South Akron – Dillerville #1 and #2 138 kV Line will provide sufficient transfer capabilities to bring PPL Electric into compliance with its RP&P guidelines. In the event of an outage after the conversion, the load on the South Akron – Dillerville #1 and #2 Line will be able to be transferred to the West Hempfield – Prince #1 and #2 138 kV Line via the West Hempfield – Dillerville #1 and #2 138 kV Ties. In addition, this configuration allows the customer, Alcoa, to continue to be supplied at the 69 kV voltage level.

The total estimated cost for this fifth proposed phase to complete the conversion of the transmission system serving the core of the Lancaster region from 69 kV to 138 kV operation is \$3.7 million. Subject to the PUC's approval, the proposed transmission line construction is scheduled to begin in February, 2013 in order to meet a scheduled in-service date of November, 2013.

The 138 kV conversion is PPL Electric's long range plan for serving the heavily loaded core of the Lancaster region. This conversion will expand the existing 138 kV system and allow more operating flexibility between the West Hempfield and South Akron Substations.

Raising the operating voltage from 69 kV to 138 kV will double the capability of the existing transmission lines. In combination with the other stages of the conversion plan, this phase of the Project will allow PPL Electric to improve reliability and operating flexibility while meeting the increasing demand for electricity and avoids establishing additional major transmission corridors. In addition, the total combined additional transformer capacity in the 138kV conversion Project will be 120 MVA, which will almost double the local transformer capacity available to supply the increasing electrical demand in this highly developed area of Lancaster County.

E. FUNCTIONAL ALTERNATIVES

Three alternatives were considered to provide the necessary reinforcements and complete the 138 kV conversion. Each alternative was based on its ability to restore load in the Region in accordance with PPL Electric's RP&P in a long range economic manner. Each alternative is identified and described below:

Alternative 1 (Preferred Option): Rebuilding a portion of the existing South Akron - Dillerville # 1 and # 2 138 kV Line from the Dillerville Tap points up to customer Alcoa's (Howmet) tap.

This alternative involves rebuilding approximately one mile of the existing South Akron-Dillerville # 1 and # 2 138 kV Line as two separate double circuit lines. This configuration will allow the customer, Alcoa, to continue to be supplied from the South Manheim Regional Substation at 69 kV while closing the loop of the 138 kV conversion by tying East Petersburg distribution substation to customer-owned Park City substation and completing the South Akron – Dillerville #1 and # 2 138 kV Lines.

The construction of this alternative eliminates the single contingency violation and improves reliability by providing two ways of supplying the South Akron-Dillerville #1 and # 2 Lines (either South Akron or West Hempfield regional substations) and keeping the customer, Alcoa, served with the same level of reliability at the same voltage. This option would utilize existing transmission line rights-of-way.

Alternative 2: Upgrade the customer's equipment in order to provide the customer 138 kV transmission service.

This alternative would involve upgrading the customer's substation equipment and replacing all of the 69-12 kV customer's transformers with new 138-12 kV transformers. In addition, the existing South Akron-Dillerville #1 and #2 138 kV Line would be operated at 138 kV, and Alcoa would be supplied from this line.

Although this alternative would eliminate the contingency violations outlined above, space constraints at the customer's facilities prevented PPL Electric from exercising this option. The space where the current transformers are located is limited and not able to accommodate 138-12 kV transformers. In addition, no other practical area is available to accommodate the 138-12 kV transformers, thus eliminating this alternative.

Alternative 3: Build a new 138-69 kV substation to supply Alcoa while completing the 138 kV conversion.

This alternative would involve building a new 138-69 kV substation on Alcoa's property. The new substation would be supplied by tapping the South Akron – Dillerville # 1 and # 2 138 kV double circuit Line. Alcoa's existing substation could then be supplied at 69 kV from this new substation. With this arrangement, Alcoa's substation equipment would not need to be modified.

Although Alternative 3 also eliminates the contingency violations outlined above, it is estimated to cost \$7.2 million. Therefore, this alternative is more expensive to build compared to the preferred alternative, and it provides no additional benefit to the system.

Attachment

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**ATTACHMENT 2
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV LINE REBUILD
ENGINEERING DESCRIPTION**

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ATTACHMENT 2
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV LINE REBUILD
ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to rebuild an approximately one mile long section of the existing South Akron – Dillerville #1 and #2 138 kV Line from a one monopole double circuit line to two separate monopole double circuit (four circuits in total) lines. Each monopole along this section will have one South Akron-Dillerville 138 kV circuit on top and one 69 kV Tap circuit to supply the customer-owned Howmet substation on the bottom. This Project will support the conversion from 69 kV to 138 kV operation of the transmission system serving the core of the Lancaster Region. This phase of the Project is required to maintain a 69 kV source of supply for the Howmet Substation, which is owned by Alcoa, Inc.

This Project is located in East Hempfield, and Manheim Townships, Lancaster County. A plot plan for this phase of the transmission line Project is provided in the Attachment 2 map pocket.

The section of transmission line to be rebuilt is approximately one mile in length. To accomplish the rebuild, nine existing double circuit monopole structures will be replaced with eight new double-circuit 138 and 69 kV structures for each of the new double circuit lines (16 new poles in total). Two circuits will be installed on each pole. The top circuit on each pole will be designed and constructed for 138 kV operation while the bottom circuit on each pole will be designed and constructed for 69 kV operation. While the existing structures range in height from 100 to 115 feet, the new structures will be approximately 115 to 155 feet in height. The average height of the new structures will be approximately 127 feet. All of the new steel poles will be installed on foundations. The two new sections of double circuit transmission line will each utilize six 556.5 thousand circular mills (kcmil)¹, 24/7 stranding, aluminum conductor steel reinforced (“ACSR”) power conductors. One new half-inch extra high strength (EHS) steel overhead ground wire (OHGW) will be installed on each double circuit line to provide lightning protection for the Line.

¹ KCMIL wire size is the equivalent cross sectional area in thousands of circular mils. A circular mil is the area of a circle with a diameter of one thousandth (0.001) of an inch.

A sketch of the proposed transmission structures that will be used for the new section of the line is provided in Figure 1 to this Attachment.

The proposed line section will be designed to, and will generally exceed, National Electric Safety Code (NESC) minimum standards. The design specifications and safety rules practiced by PPL Electric are explained in Attachment 4. The minimum conductor to ground clearance will be 70 feet for the new section of 138 kV Line (top circuit). The minimum conductor to ground clearance for the new section of 69 kV line will be 30 feet (bottom circuit). Both of these clearances occur at the maximum thermal conductor temperature of 125 degrees Celsius.

The designed minimum conductor clearances and conductor thermal ratings for the line are as follow:

**TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 556.5 KCMIL 24/7 STRANDING ACSR***

<u>Condition</u>	<u>New Section 138 kV Clearance-to-Ground</u>	<u>New Section 69 kV Clearance-to-Ground</u>
Normal load; average weather (16°C ambient, 60°F temperature)	81.0 feet	41.0 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	70.0 feet	30.0 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	73.0 feet	33.0 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -10°C, 15°F temperature)	75 feet	35.0 feet
	* Clearances based on a maximum tension of 11,880 pounds and a ruling span of 800 feet	* Clearances based on a maximum tension of 11,880 pounds and a ruling span of 800 feet

**TABLE 2
CONDUCTOR THERMAL RATING
556.5 KCMIL 24/7 STRANDING ACSR
(257°F) 125°C MAXIMUM CONDUCTOR TEMPERATURE**

<u>Condition</u>	<u>Ambient Temperature °C</u>	<u>Wind Speed Knots</u>	<u>Ampacity Amps</u>
Summer Normal	35	0	815
Winter Normal	10	0	926
Summer Emergency	35	1 1/2	1,041
Winter Emergency	10	1 1/2	1,163

B. MAGNETIC FIELD MANAGEMENT

PPL Electric's Magnetic Field Management Program, summarized in Attachment 5, is applied to new and reconstructed transmission line projects. The company 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 has been developed to implement that policy decision. To reduce magnetic field exposures, the program generally prescribes the use of a line design that provides five feet higher ground clearance and reverse phasing of new double-circuit lines where it is feasible to do so at low or no cost.

Consistent with the program, PPL Electric will construct the new line section for five feet higher ground clearance than NESC standards to reduce magnetic field exposures. Reverse phasing will be implemented on the South Akron-Dillverville 138 kV circuits since the existing circuits are already configured for reverse phasing. The existing 69 kV circuits are not currently configured for reverse phasing. To achieve reverse phasing of the 69 kV circuits, line termination rearrangements are required at various substations. The cost associated with the line rearrangements is not consistent with PPL Electric's Magnetic Field Management Program. Therefore, the proposed Howmet 69 kV Tap circuits will not be reverse phased at this time. The proposed line configuration discussed above results in lower magnetic field levels than the configuration which exists today.

C. RIGHT-OF-WAY STATUS

This phase of the Project is located entirely within existing PPL Electric right-of-way. No additional right-of-way is required. Attachment 6 contains a list of the owners of property that are crossed by the proposed construction.

DATE: _____
 ER No. _____
 DESIGNED BY: _____

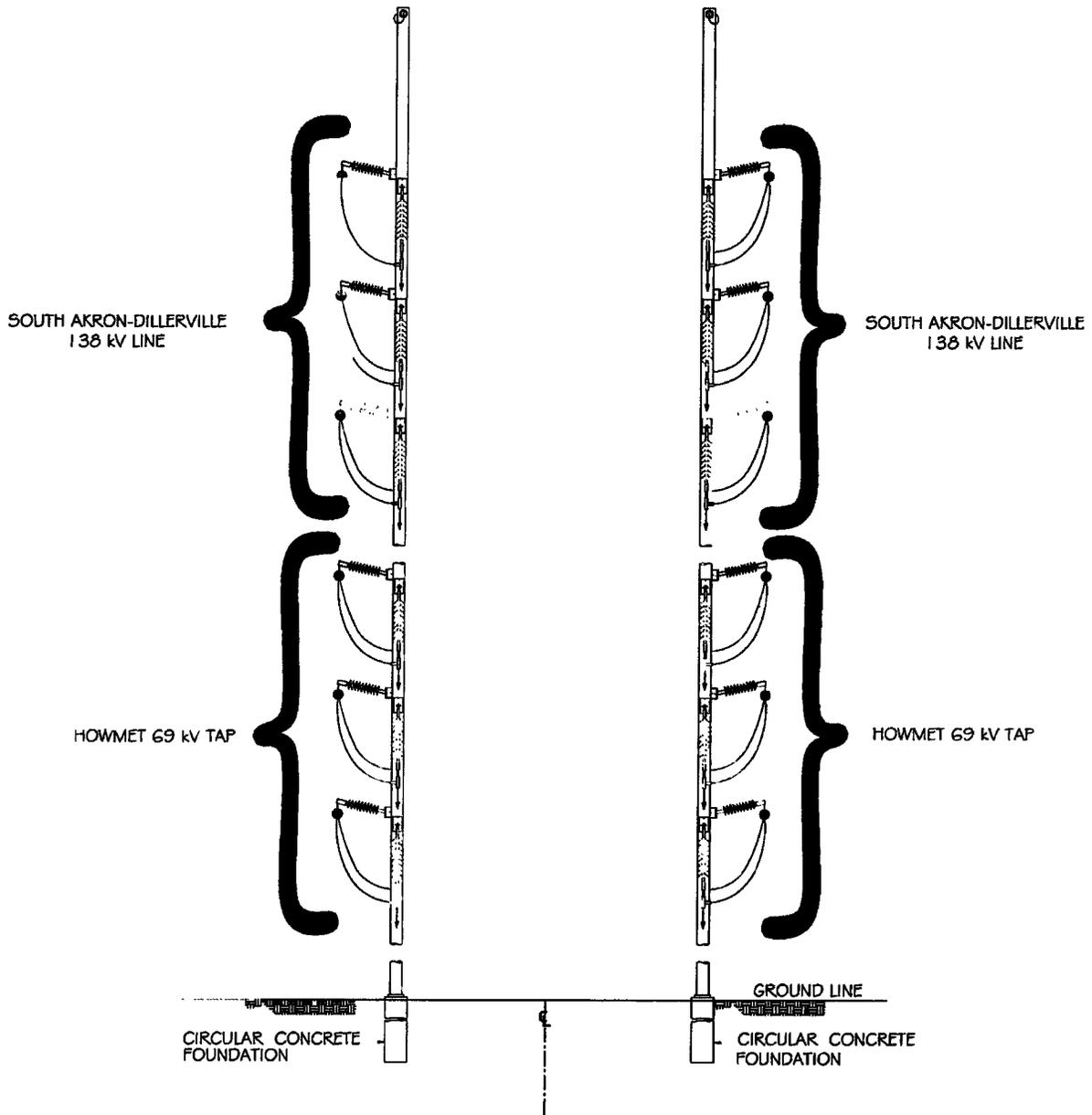


FIGURE 1 – TYPICAL STRUCTURE SKETCH

Attachment

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**ATTACHMENT 3
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
ENVIRONMENTAL ASSESSMENT**

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**ATTACHMENT 3
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
ENVIRONMENTAL ASSESSMENT**

A. INTRODUCTION

PPL Electric is seeking Commission approval to make certain modifications to a portion of the existing South Akron-Dillerville #1 and #2 138 kV Line to support the overall 69 kV to 138 kV conversion of the transmission system serving the central core of the Lancaster Region. PPL Electric proposes to rebuild an approximately one mile long section of the existing South Akron – Dillerville #1 and #2 138 kV Line from one double circuit line to two separate double circuit lines. The top circuit of each line will be designed and operated at 138 kV while the bottom circuit of each line will be designed and operated at 69 kV.

This phase of the overall Project is in support of the conversion from the 69 kV to 138 kV operation of the transmission system to resolve violations of PPL Electric’s RP&P guidelines, increase reliability of service, and improve operating flexibility in the core of the Lancaster region. Specifically, this phase of the conversion Project is required to maintain a 69 kV source of supply to the Howmet Substation, which is owned by Alcoa, Inc.

The conversion Project, including this phase, was reviewed with East Hempfield and Manheim Townships, and Lancaster County. The Townships and the County had no objection. A list of involved governmental agencies, municipalities and other public entities is included as Attachment 7.

B. LAND USE

This phase of the conversion Project is located within existing PPL Electric transmission line right-of-way. No additional property rights are required to complete this phase. This phase of the conversion Project will have little impact on the existing land use because it involves modifications in an area which contains existing PPL Electric transmission facilities.

Land use in the area is mixed. While the majority of the existing land use along this section of the line is commerce and industry, portions are currently used for agricultural purposes. Land use impacts are anticipated to be minimal due to the fact that this phase of the Project is located in areas that already contain PPL Electric transmission facilities. Interference with existing land uses will be further minimized because, where possible, PPL Electric will use previously established access roads for construction.

No nearby communication towers, pipelines or other utilities will be affected by the proposed construction. Airport operations will not be affected. The closest airport is the Lancaster Airport, and the closest point of the Lancaster Airport is approximately 3.5 miles from the proposed construction. PPL Electric will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation, if necessary.

C. CULTURAL RESOURCES

This phase of the conversion Project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has determined that there are properties near the proposed construction which are listed in or eligible for the National Register of Historic Places.

Correspondence from the PHMC, dated February 8, 2012, however, indicates that the proposed activities associated with this phase of the Project will have no effect on these properties (File No. ER 2010-0123-071-C). In addition, this correspondence indicates that no archaeological investigations or other investigations for cultural resources are necessary. If, however, PPL Electric becomes aware of any previously unidentified resources that would be affected by the construction, the Bureau for Historic Preservation will be contacted immediately.

D. NATURAL FEATURES

This phase of the Project will not affect any unique geological, scenic, or natural areas. The Fruitville Quarry Fossil Site and Getz Farm Fossil Locality are located approximately one mile and 1.25 miles from the proposed construction, respectively. These features will not be affected due their distance from the proposed construction and the extensive development in the area. No

National Natural Landmarks, parks, recreational facilities, or natural areas are located near the construction area. Longs Park, a regional park, is located approximately 0.7 miles south of the proposed construction. No impacts to the Park are anticipated due to the distance from the proposed construction and the extensive development in the area.

Minor vegetation removal may be necessary for this phase of the Project. In the event that vegetation removal is required to complete construction, PPL Electric will apply its “Specifications 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.

PPL Electric will obtain all necessary permits from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers and will comply with all conditions placed on the permits. In addition, PPL Electric will acquire any required soil erosion and sedimentation control permits and will comply with all conditions placed on those permits.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has contacted different state and federal agencies to obtain information regarding threatened and endangered species in close proximity to the project area. A review of the Pennsylvania Natural Diversity Inventory (“PNDI”) records (PNDI Search ID 20120123335037) indicates that there are no potential impacts for species of special concern and resources within, or in close proximity to, the area.

Attachment

4

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 provisions 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 such things 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

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

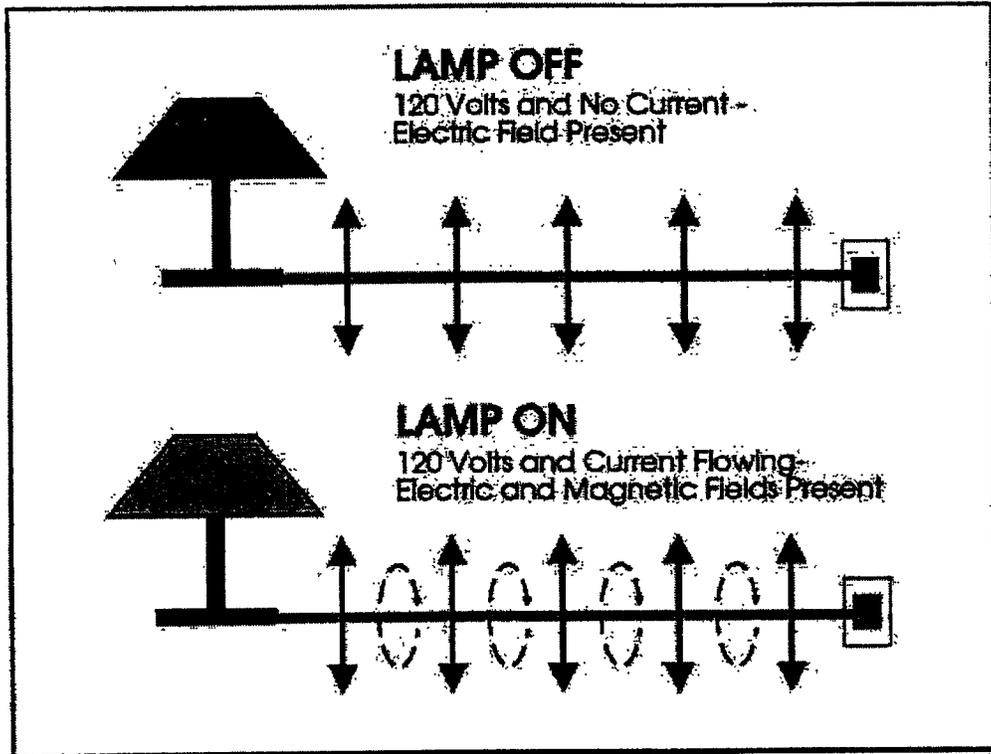


Figure 2

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.

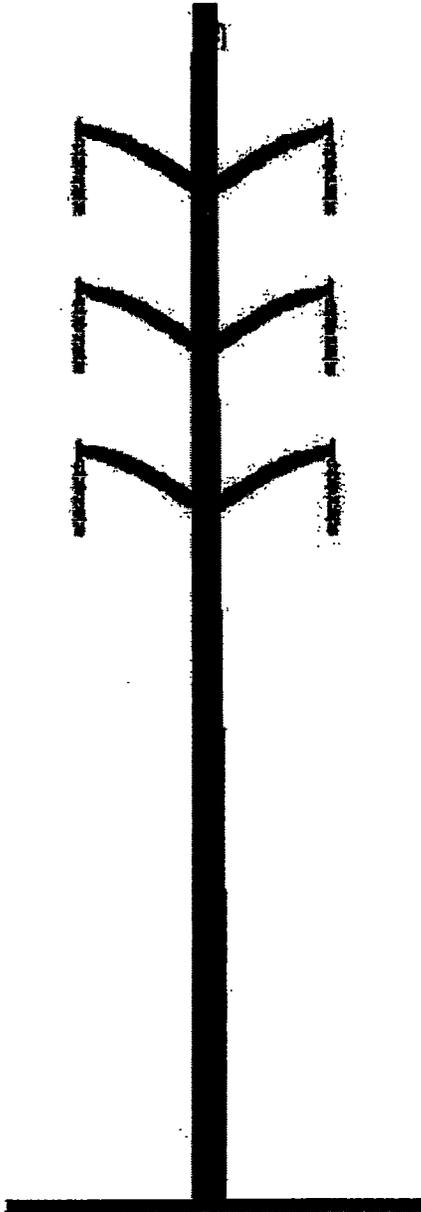
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

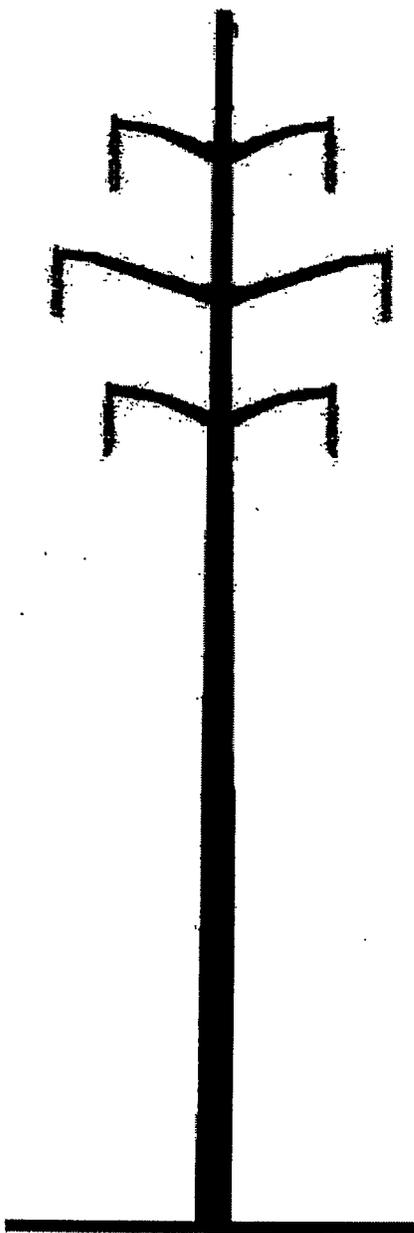
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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



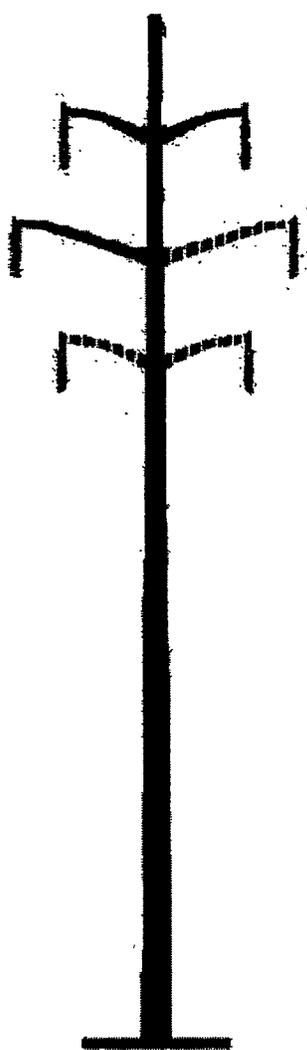
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

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

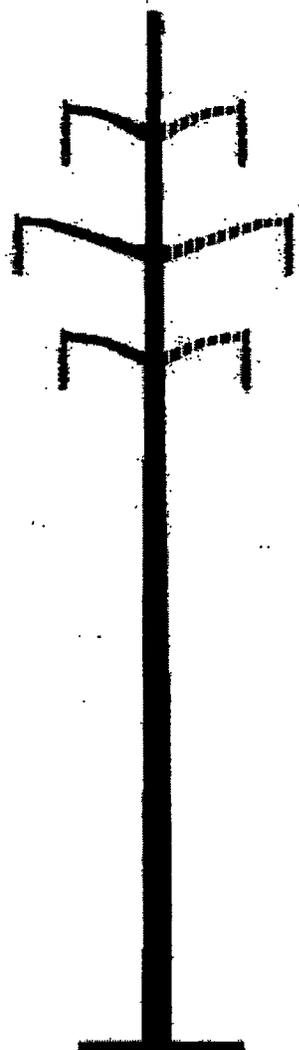
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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.

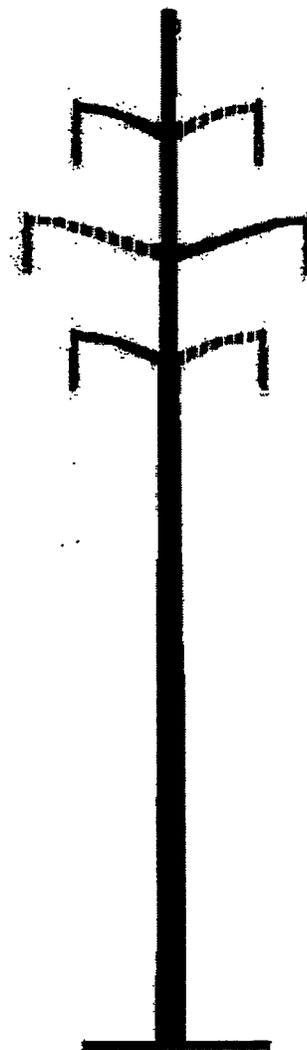
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

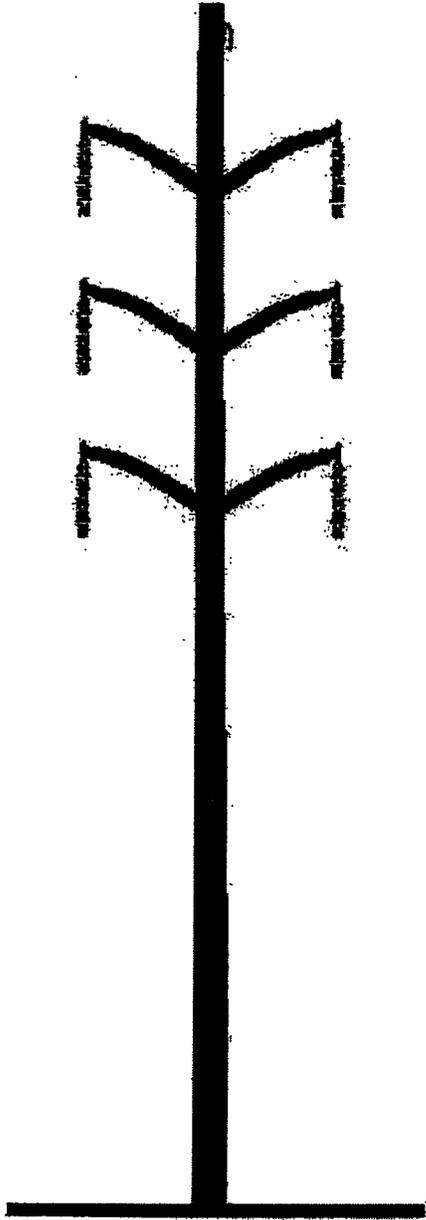
——— initial single circuit
- - - - - future second circuit

**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

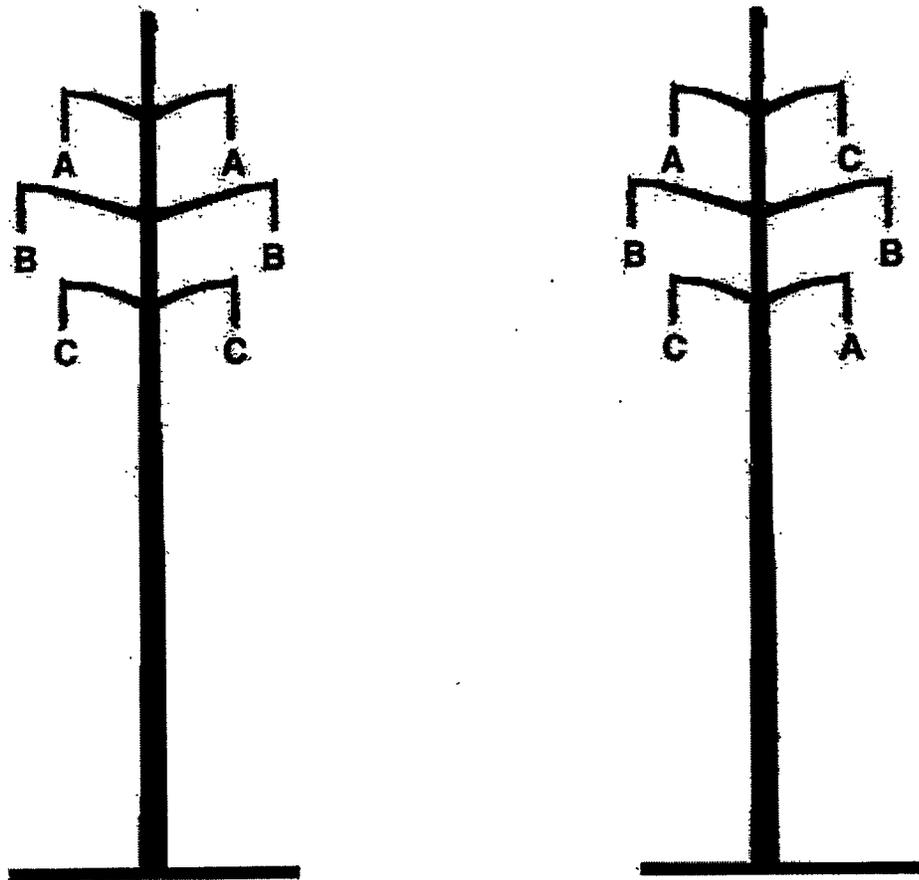
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

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: → → → → 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

6

ATTACHMENT 6
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT OF WAY

Samuel Miller & Sons Inc
1501 Cloister Drive
Lancaster, PA 17601

Specon Inc. Et Al
One Hess Plaza
Woodbridge, NJ 07095

CPI Assoc.
929 State Route 501 South
Newmanstown, PA 17073

Anna Lois Buckwalter & Mary Jane Peffley
17032 Frederick Road
Mt Airy, MD 21771

Ryder Truck Rental Inc Et Al
PO Box 025719
Miami, FL 33102

McGovernville Investments LLC
PO Box 7868
Lancaster, PA 17604

Moove In Partners 741 LP
10 Bentzel Mill Road
York, PA 17404

Alcoa Inc.
201 Isabella Street
Pittsburgh, PA 15212

Attachment

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ATTACHMENT 7
SOUTH AKRON-DILLERVILLE #1 AND #2 138 kV REBUILD
LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES
AND OTHER PUBLIC ENTITIES

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

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

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

4. Lancaster County Planning Commission
150 North Queen Street, Suite 320
Lancaster, PA 17603
Attn: James Cowhey, Executive Director

5. Lancaster County Board of Commissioners
150 North Queen Street, Suite 715
Lancaster, PA 17603
Attn: Dennis Stuckey, Chairman

6. Manheim Township Planning Commission
1840 Municipal Drive
Lancaster, PA 17601
Attn: Jeffrey Sturla, Chairperson

7. Manheim Township Board of Commissioners
1840 Municipal Drive
Lancaster, PA 17601
Attn: Lawrence Downing, President

8. East Hempfield Township Planning Commission
1700 Nissley Road
P.O. Box 128
Landisville, PA 17538
Attn: F. James Fullerton, Chairperson

9. East Hempfield Township Board of Supervisors
1700 Nissley Road
P.O. Box 128
Landisville, PA 17538
Attn: Brett Miller, Chairperson