Before the
Pennsylvania Public Utility Commission

PECKVILLE - PAUPACK 230 kV LINE
PAUPACK – BLOOMING GROVE 230 kV LINE

ATTACHMENTS IN SUPPORT OF THE
LETTER OF NOTIFICATION

Application Docket No. ____________

Submitted by: PPL Electric Utilities Corp.

SUMMARY

This filing is submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC) regulations at 52 Pa. Code §§ 57.71 through 57.77, for PUC approval to reinforce the 69 kV systems in Lackawanna and Wayne Counties. This Project is one of three separate but related transmission line projects. Each transmission line project will be the subject of a separate filing.

Studies conducted for PPL Electric's transmission system revealed that an outage of the single circuit Blooming Grove – West Damascus (BLGR-WDAM) 69 kV line would violate PPL Electric's "Reliability Principles & Practices" (RP&P) guidelines for load loss allowed due to a contingency (unplanned outage). Together, these three separate transmission line projects will replace a "weak link" in the 69 kV transmission system between the Peckville and Blooming Grove regional substations by replacing small, aging, low capacity #2/0 copperweld copper wire with larger, high capacity 556 kcmil[1] ACSR[2] wire.

Here, PPL Electric seeks PUC approval of the second transmission line project. This Project involves the construction of two single circuit 230 kV lines each 0.9 miles in length, the Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line, to supply power to the proposed Paupack 230-69 kV Substation.[3] The new 230 kV Lines will intersect the existing Peckville – Blooming Grove 230 kV Transmission Line and continue south to provide a power source to the newly proposed Paupack 230-69 kV Substation. These new Lines and Substation are needed to resolve the violation of PPL Electric's RP&P described above and more fully explained in Attachment 1.

The new regional Paupack 230-69 kV Substation, will be constructed and located between the Blooming Grove and Peckville Substations, which is central to the load it will serve. The Paupack 230-69 kV Substation will tie into the Blooming Grove-Honesdale and Blooming Grove-West Damascus 139/69 kV Transmission Lines, will reduce the load on these lines by

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[1] Wire sizes are expressed in thousands of circular mils (kcmil). A circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².
[2] Aluminum conductor steel reinforced.
[3] PPL Electric is also submitting a Zoning Petition for a finding that will exempt the control equipment building at the proposed Paupack 230-69 kV Substation from the Paupack Township Zoning Ordinance.

providing a new 230 kV source, and reduce the length of each 138/69 kV line through re-sectionalizing. The Paupack 230-69 kV Substation also will provide a backup source to the Blooming Grove and Peckville Substations using interconnected 69 kV lines.

This Project is located in Paupack Township, Wayne County. The two new single-circuit 230 kV Lines will be constructed entirely within right-of-way previously acquired by PPL Electric or on PPL Electric fee-owned property. A more detailed description of the existing and rebuilt lines involved in this Project is provided in Attachment 2.

On April 30, 2012, PPL Electric filed a Letter of Notification for the first transmission line project, at Docket No. A-2012-2301698, which is currently pending before the PUC. Therein, PPL Electric seeks PUC approval for the reconstruction of 19.4 miles of the existing single circuit Peckville – Honesdale 69 kV Line for double circuit 138/69 kV operation. This line section will be rebuilt within the existing right-of-way as a double circuit 138/69 kV line, but 15 out of the 19.4 miles will initially operate as a single circuit 69 kV line. The reconstructed Peckville – Honesdale 138/69 kV Line is also needed to resolve the violations of PPL Electric's RP&P guidelines as described herein.

In the filings for the third transmission line project, PPL Electric will seek PUC approval for the reconstruction of 2.9 miles of the Lakeville 138/69 kV Tap and 4.0 miles of the existing Blooming Grove – Honesdale 138/69 kV Transmission Line. The reconstruction will be within the existing right-of-way. An additional 0.5 miles of new line will be built within new right-of-way to connect the Paupack 230-69 kV Substation to the existing Lakeville Tap Line. The total project length is 7.4 miles. These line sections will be reconstructed from single circuit 138/69 kV lines to double circuit 138/69 kV lines. These reconstructed line sections are also needed to resolve the violations of PPL Electric's RP&P guidelines as described herein.

The Letter of Notification for the first transmission line project was filed first to coordinate with the construction schedule of the previously approved Susquehanna –Roseland 500 kV line, a portion of which the Peckville – Honesdale 69 kV Line will parallel. PPL Electric herein seeks PUC approval of this Project second to coincide with the construction of the newly proposed Paupack 230-69 kV Substation, and the expected outage of the existing

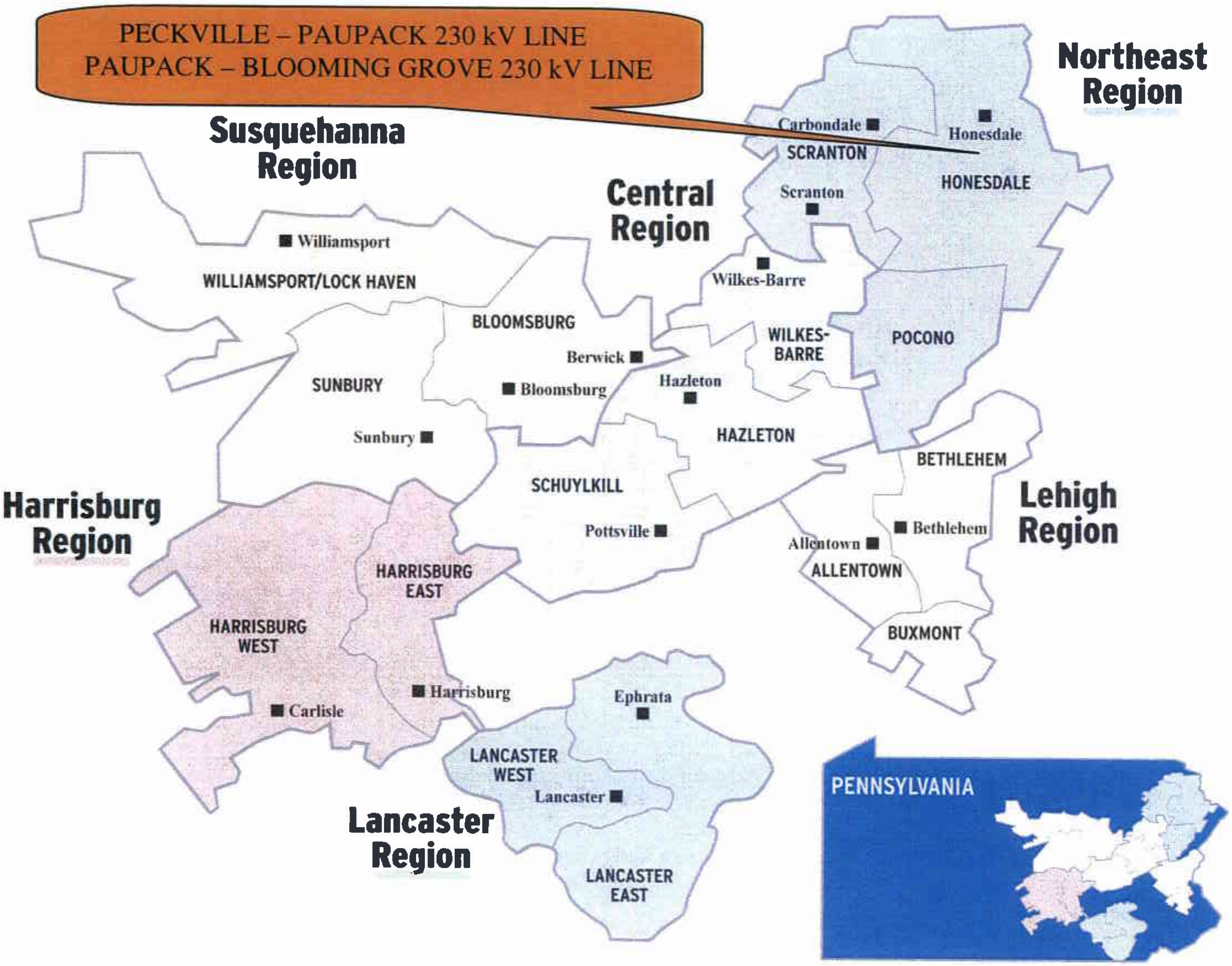
Peckville – Blooming Grove 230 kV Line due to it's reconstruction for the Susquehanna – Roseland 500 kV project.

Construction of this Project is scheduled to begin in Spring 2013, to support an in-service date of November 2014. The estimated cost to site, design and construct the single-circuit Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line is $1,700,000.

This document, which describes the need for the Project and discusses the engineering and siting analysis for the proposed construction, consists of the following exhibits and appendices:

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

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

1

ATTACHMENT 1

PECKVILLE – PAUPACK & PAUPACK – BLOOMING GROVE 230 kV LINES

NECESSITY STATEMENT

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1.0 INTRODUCTION

PPL Electric Utilities Corporation ("PPL Electric") proposes to reinforce the 69 kV systems in Lackawanna and Wayne Counties. This Project is one of three separate but related transmission line projects. Each transmission line project will be the subject of a separate filing.

PPL Electric conducted transmission system studies that revealed that an outage of the single circuit Blooming Grove – West Damascus (BLGR-WDAM)[1] 69 kV Line would violate PPL Electric's "Reliability Principles & Practices" (RP&P) guidelines for load interruption due to a contingency (unplanned outage). The three separate transmission line projects will replace a "weak link" in the 69 kV transmission system that currently exists between the Peckville and Blooming Grove regional substations by replacing small, aging, low capacity #2/0 copperweld-copper (CWC) wire with larger, high capacity 556 kcmil ACSR wire.

Here PPL Electric seeks PUC approval of the second transmission line Project. For this Project, PPL Electric proposes to build the new Paupack 230 – 69 kV Substation along SR 3031 in northwestern Paupack Township, Wayne County. The new Substation will be connected to the existing 230 kV transmission systems by building two new single-circuit (s/c) 230 kV transmission lines, the Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line. These Lines will provide a 230 kV source of power to the new Paupack 230 – 69 kV Substation by connecting the Substation to the existing Blooming Grove-Peckville 230 kV Transmission Line. The length of each Line is approximately 0.9 miles. The Lines will be designed to current 230 kV standards and operated at 230 kV. A more detailed description of the existing and proposed lines involved in this Project is provided in Attachment 2.

PPL Electric will seek PUC approval to connect the new Paupack 230 – 69 kV Substation to the 69 kV system in the filings for the third transmission line project. The Paupack 230 – 69 kV Substation will be connected to the existing 69 kV system by construction of

[1] Abbreviated names of facilities appear on the figures at the end of this Attachment.

a new 138/69 kV double-circuit (d/c) line that will extend approximately 0.5 miles from the Substation to the existing Lakeville 138/69 kV Tap Line. The existing single circuit Lakeville 138/69 kV Tap Line will be rebuilt for double circuit 138/69 kV operation for approximately 2.9 miles, extending from the Paupack Substation connection point to the main Lakeville Tap connection point. The existing single circuit Blooming Grove – Honesdale 138/69 kV Line also will be rebuilt for double circuit 138/69 operation for approximately 4.0 miles, extending from the Lakeville Tap to the Varden Tap. The reconstruction will be within the existing rights-of-way. These new line sections will be designed and constructed for future 138 kV double circuit operation, but initially will be operated at 69 kV until load growth in the area dictates the need to increase the operating voltage. These line sections will be the subject of the filings for the third transmission project.

The proposed new regional substation and subsequent line resectionalizing (changing the normally open point) will reduce the electrical loading on the existing Blooming Grove – West Damascus and Blooming Grove-Honesdale 138/69 kV circuits. Further the proposed facilities will provide operating flexibility and improved reliability for customers in Archbald Borough and Jefferson Township in Lackawanna County, and South Canaan Township, Cherry Ridge Township, Honesdale Borough, Texas Township, Dyberry Township, and Berlin Township in Wayne County.

This Project is required to prevent the interruption of load that exceeds PPL Electric's RP&P guidelines if the Blooming Grove – West Damascus s/c 138/69 kV Line is unexpectedly removed from service by a contingency (unplanned outage) near the Blooming Grove Substation. In addition, this filing and the third related filing for of this overall project will: (i) reduce the electrical loading on the single-circuit Blooming Grove – West Damascus 138/69 kV Line below the 60 MW line loading limit to comply with PPL Electric's RP&P; and (ii) prevent the interruption of load that exceeds PPL Electric's RP&P guidelines if the double circuit Blooming Grove – West Damascus and Blooming Grove- Honesdale 138/69 kV Line is unexpectedly removed from service by a contingency (unplanned outage) near the Blooming Grove Substation.

The estimated cost to site, design, and construct this Project is approximately $1,7 million. This cost includes the siting, design and construction of the proposed the Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line. The required in-service date, defined as the date that the proposed facility must be placed in service to prevent the above mentioned reliability criteria violations, is November 2014. In order to meet that in-service date, subject to the PUC's approval, construction is scheduled to commence in the Spring of 2013.

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

2.0 SYSTEM PLANNING PROCESS

System Planning is the process which assures that PPL Electric's non-bulk electric transmission system can supply electricity to all customer load in a manner that is reliable and economic. This process assures that PPL Electric's non-bulk electric system (non-BES) transmission system is planned and constructed so that:

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

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

- The system expansion should be coordinated to achieve the most economical balance of construction and operating expenditures;

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

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

1. Normal operation of the system will not load any electric facility beyond its normal continuous rating.
2. The loss of any single transmission line, generating unit connected to the non-BES transmission system, power transformer, substation bus, circuit breaker, or double-circuit line due to the outage of a single tower or pole, does not result in any system electric facility being operated beyond its applicable emergency rating.
3. No customer load should remain interrupted for routine maintenance of non-BES transmission facilities.
4. The loss of any single facility should not result in a voltage drop of more than 5% on the 138/69 kV transmission system.
5. Stability of the electric system should be maintained from a permanent three-phase transmission line fault cleared by normal primary relay action. In addition to this, system stability should also be maintained for a permanent single phase to ground line fault and the failure of the protective devices to operate properly resulting in a failed circuit breaker.
6. No large-scale, long-term or frequent interruption may cause excessive load

loss due to their adverse effects on, and hazard to, the public.

7. Excessive load is not interrupted for the loss of a single-circuit 69 kV line or double-circuit 69 kV line.

These principles are incorporated in the PPL Electric Utilities Transmission Planning RP&P document.

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

Once the system model is complete, comprehensive power flow simulations are performed to determine the ability of the system to comply with the PPL Electric transmission planning reliability criteria. This is accomplished by simulating an outage of each non-BES transmission and bulk electric facility. All conditions where the system is not in conformance with the reliability criteria are identified and system reinforcement alternatives are added to bring the system into conformance. Also identified are estimated costs and lead-times to implement the reinforcements under consideration. Computer simulations of the system with the identified reinforcement alternatives are completed to identify the best overall reinforcement that will meet the needs of the region in a reliable and economic manner.

3.0 EXISTING SYSTEM

Presently, the only sources of electrical power to the northern Blooming Grove area are the Blooming Grove-West Damascus 69 kV Line, the Blooming Grove-Honesdale 69 kV line, and the Peckville-Varden 69 kV Line.

The Blooming Grove-West Damascus 69 kV line, including the length of related taps, is

38 miles in length and has one normally open (sectionalizing) point located at the Honesdale Substation. This line supplies one-half of the Honesdale Substation load. A second line, the Blooming Grove-Honesdale 69 kV line, follows an independent route and supplies the other half of the Honesdale Substation. This configuration results in increased reliability to the Honesdale and surrounding area. Figure "1" shows the functional arrangement of the existing transmission facilities in the area.

From the Blooming Grove Substation to the Kimbles 69-12 kV Substation,[2] the Blooming Grove-West Damascus 69 kV circuit is built on double-circuit 69 kV structures, sharing the line route and those structures with the Blooming Grove-Honesdale (BLGR-HONE) 69 kV line. The majority of the Blooming Grove-West Damascus circuit is constructed for future 138 kV operation, but is currently operated at 69 kV. The Blooming Grove-West Damascus 69 kV circuit is a radial circuit (only one source of electrical power) with only one 69 kV tie line (Peckville-Varden, via the Blooming Grove-Honesdale / Honesdale Tap 69 kV Line) to provide a back-up source of power for a double circuit interruption of the Blooming Grove-West Damascus and Blooming Grove-Honesdale 69 kV lines occurring near the Blooming Grove Substation.

The Peckville-Varden 69 kV line, including the length of related taps, is approximately 24 miles in length and has one normally open point located at the Varden Tap. Currently, the Peckville-Varden 69 kV line provides the only alternate source of electric power to the northern Blooming Grove area in the event of a double circuit interruption of the Blooming Grove-West Damascus and Blooming Grove-Honesdale 69 kV lines. However, the line is a weak electrical tie due to of the small-sized conductor (#2/0 copperweld copper) and its length.

From the Peckville Substation to the Varden Tap, the Peckville-Varden 69 kV circuit is built on single-circuit 69 kV structures. The circuit is not constructed for future 138 kV operation and is currently operated at 69 kV. Most of the Peckville-Varden line dates to the late 1920's. Other than routine maintenance and a reconductoring of the first 1.7

[2] Assumption is that the 2.3 miles of a second 69 kV circuit is added between Wallenpaupack HES and Kimbles Substation by 2013 under a separate Letter of Notification.

miles from the Peckville Substation to the Archbald Tap, the line has not been upgraded since its original installation.

Under abnormal operating conditions, when PPL Electric temporarily closes the normally open point (re-sectionalize the line) at Varden Tap, the most additional load that the Peckville-Varden line can supply is the Honesdale 69-12 kV Substation. Otherwise, the line capacity would be exceeded, and the 69 kV bus voltages would drop below the lower permissible limit.

4.0 DEFINITION OF THE PROBLEM

This Project is part of three separate but related transmission line projects that are being proposed to collectively resolve the single-circuit contingency reliability violations described below.

> Under winter peak conditions, with all generation at Wallenpaupack Hydroelectric Station out of service, PPL Electric projects that, by 2014, an outage of the Blooming Grove-West Damascus 69 kV single-circuit line occurring near the Blooming Grove Substation would result in the interruption of 73 MW of load. This interruption would violate the RP&P guideline for maximum allowable load loss for a single-circuit line outage, which is 60 MW until manual sectionalizing can be performed – usually a 2 hour or less duration.
>
> The Blooming Grove-West Damascus 69 kV circuit is a radial line (only one source of electrical power) with only one 69 kV tie line (Peckville-Varden, via the Blooming Grove-Honesdale / Honesdale Tap 69 kV line) to provide a back-up source of power for a double circuit interrupton of the Blooming Grove-West Damascus and Blooming Grove Honesdale 69 kV lines between Blooming Grove Substation and the Wallenpaupack Hydroelectric Station. Transferring load between Blooming Grove and Peckville regional substations is limited presently because, as explained above, the Peckville-Varden 69 kV Line is constructed of a small-sized conductor (#2/0 copperweld copper) and because voltage is inadequate

due to the circuit length.

If there were an outage of the Blooming Grove-West Damascus 69 kV circuit, only the Honesdale 69-12 kV Substation load could be transferred to the Peckville-Varden 69 kV Line without exceeding the winter emergency thermal rating of the conductor or causing low voltage levels at the end of the "re-sectionalized" Peckville-Varden 69 kV circuit. If the West Damascus 69-12 kV Substation load were to be transferred, the Peckville-Varden 69 kV Line would be loaded to 106% of its winter emergency thermal rating, and the West Damascus 69 kV bus voltage would be at the lower limit of acceptable voltage (62 kV).

In addition, the outage of the Blooming Grove-West Damascus 69 kV circuit would cause the customer load served by the Tennessee Gas distribution substation (customer-owned), Indian Orchard distribution substation, West Damascus distribution substation, and Bohemia distribution substation to remain interrupted because inadequate voltage would exist if complete load restoration was attempted. That outage would result in approximately 53 MW (approximately 9500 customers) of load remaining interrupted for an extended period of time until repairs could be made. This amount of interrupted load would violate the RP&P guideline for maximum allowable load loss for a single-circuit line outage, which only allows 30 MW or less to be interrupted until overhead line repairs can be completed.

In addition, this Project (the second filing) together with the third filing also will resolve the double-circuit reliability violations described below.

Under winter peak conditions, with all generation at Wallenpaupack out of service, PPL Electric projects that, by 2014, an outage of both the Blooming Grove-West Damascus and Blooming Grove-Honesdale 69 kV lines, *i.e.*, a double-circuit outage, occurring near the Blooming Grove Substation would result in the interruption of 133 MW of load.[3] This amount of interrupted load would violate the RP&P guideline for maximum allowable load loss for a double-circuit line outage, which allows only 120 MW or less to be interrupted for that period of time until manual sectionalizing can be performed – usually a 2 hour or less duration.

In addition, the double circuit outage of both the Blooming Grove-West Damascus and Blooming Grove-Honesdale single circuit lines would require load served by at the Tennessee Gas distribution substation (customer-owned), Bohemia distribution substation, Kimbles distribution substation, and Tafton distribution substation to remain out of service in order to ensure voltage remains above acceptable minimum limits. Said another way, only 65 MW of the total 133 MW could be restored with voltage remaining within acceptable levels at the local 69 kV substation buses. As such, approximately 68 MW would remain interrupted for an extended period of time until repairs can be completed. This amount of interrupted load violates the RP&P guideline for maximum allowable load loss for a double-circuit line outage, which only allows up to 45 MW to be interrupted until overhead line repairs can be completed. In general, the duration to repair a damaged overhead transmission line might last for an extended work day or longer.

Under winter peak conditions, with all generation at Wallenpaupack out of service, PPL Electric projects that, by 2014, the projected loading on the Blooming Grove-West Damascus Line will be 72 MW.[4] This loading would violate the RP&P guideline, which recommends that loading not exceed 60 MW so that the load from an out-of-service line can be transferred to the remaining in-service line and the in-service line can still operate within its emergency ampacity rating and maintain acceptable voltage.

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[3] From the Blooming Grove Substation to the Kimbles 69-12 kV Substation,[3] the Blooming Grove-West Damascus 69 kV circuit is built on double-circuit 69 kV structures, sharing the line route and those structures with the Blooming Grove-Honesdale (BLGR-HONE) 69 kV line.

[4] If the generation from the Wallenpaupack Hydroelectric Plant were operation, the amount of load observed on the Blooming Grove-West Damascus Line would be reduced.

5.0 PROPOSED SOLUTION

To resolve the reliability issues described above, PPL Electric, with approval from the PUC, plans to construct three separate but related transmission line projects. Here, PPL Electric seeks PUC approval of the second transmission line Project. The Project involves the following:

- Build a new regional 230-69 kV substation, the Paupack 230-69 kV Substation. The 230 kV yard will initially terminate two 230 kV lines. The Substation will break the existing Blooming Grove-Peckville 230 kV line (Diagram 3). The 69 kV yard, will be initially constructed to terminate two 69 kV lines. Two 230/69 kV transformers (170 MVA) will be installed off the 230 kV bus.

- Construct two new single circuit (s/c) 230 kV lines to supply the new Paupack 230-69 kV regional substation, each 0.9 miles in length, the Peckville– Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line. The Lines will provide a 230 kV power source to the Paupack 230-69 kV Substation and will extend from the Substation to the existing Blooming Grove-Peckville 230 kV Line. The Lines will be designed to current 230 kV standards and operated at 230 kV. These Lines are the subject of this Letter of notification before the PUC.

- Install fiber-optic ground wire (OPGW) on the entire length of the new the Peckville– Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line for protective relay use, SCADA, and voice.

After the three separate transmission projects are complete, a single-circuit outage on the Blooming Grove – West Damascus 69 kV circuit occurring near the Blooming Grove Substation would interrupt no load for an extended period of time after switching is completed.

Further, after this Project and the third transmission line project are complete, a double-circuit outage on the Blooming Grove – West Damascus and Blooming Grove-Honesdale

69 kV d/c circuit, with the interruption occurring near the Blooming Grove Substation, would interrupt no load for an extended period of time after switching is completed.

In addition, the new Paupack 230-69 kV Substation will be located near the Lakeville Tap between the Blooming Grove and Peckville Substations, which is more centrally located to the load it will serve. The Paupack 230-69 kV Substation will tie into the Blooming Grove-Honesdale and Blooming Grove-West Damascus 139/69 kV lines, will reduce the load on these lines by providing a new 230 kV source, and will reduce the exposure of each line through expected resectionalizing. Portions of the Blooming Grove-West Damascus and Blooming Grove-Honesdale 69 kV lines will become the new Paupack-Honesdale #1 and Paupack-Honesdale #2 69 kV lines that will be the subject of the filings for the third transmission line project.

The Paupack 230-69 kV Substation will provide a backup source to the Blooming Grove and Peckville Substations using interconnected 69 kV lines. This backup source would be needed during a single contingency outage of one or more of these lines. The table below shows the affect of resectionalizing as a result of the new regional substation.

69 kV Transmission Lines	Network Configuration Before 11/2014	Paupack I/S (After 11/2014)
	Normal Winter Loading (MW)	Normal Winter Loading (MW)
BLGR-HONE	60	26
BLGR-WDAM	73	58
PECK-VARD	30	30
PAUP-HONE #2	**N/A**	31
PAUP-HONE #1	**N/A**	24

After completion of these projects, the loading of the Blooming Grove-West Damascus will be in compliance with RP&P guidelines.

Figure 2 shows the functional arrangement of the proposed transmission facilities in the area. The cost to Site, design and constructed the 230 kV transmission lines is expected to cost $ 1.7 million.

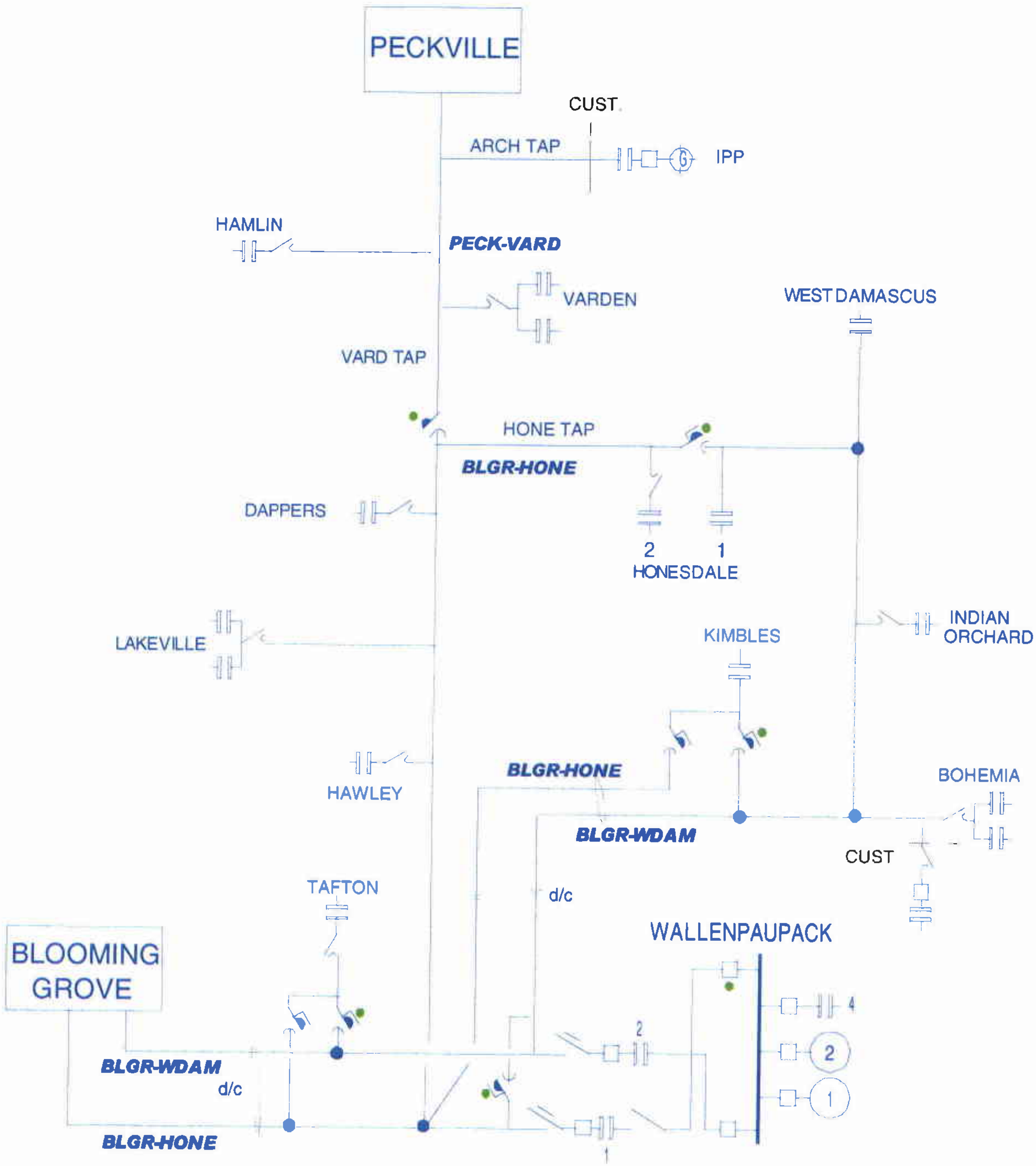
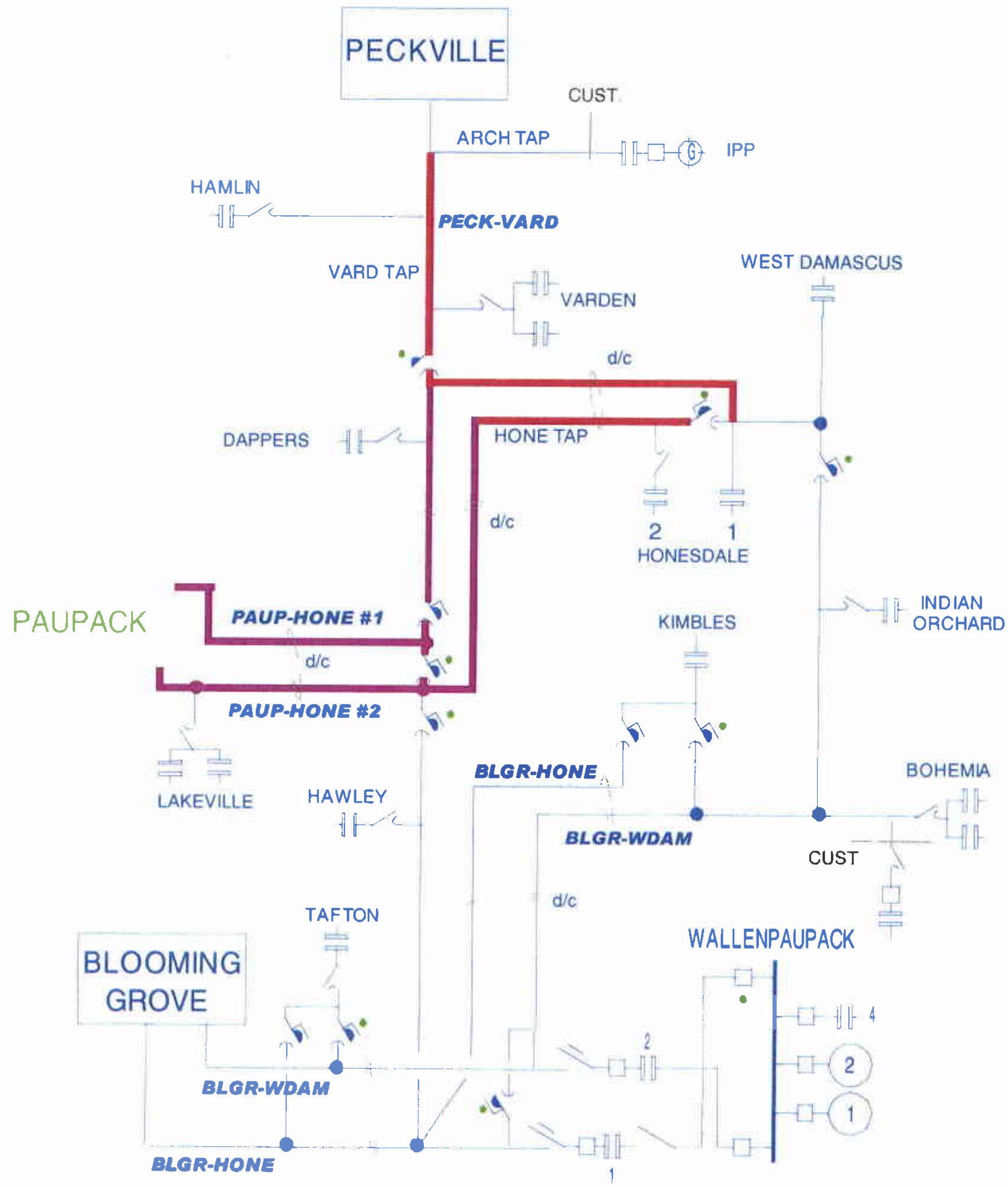


FIGURE 1 – ONE LINE DIAGRAM EXISTING TRANSMISSION FACILITIES



(green)	New Transmission Facility to be built as part of this project (Paupack).
(purple)	Other project that will be filed under a different Letter Of Notification (Paupack-Honesdale #1 & #2 d/c line). Rebuilt portion of the former Blooming Grove-Honesdale 69 kV circuit.
(red)	Other project that will be filed under a different Letter Of Notification (Peckville-Varden) Rebuilt portion of the Peckville-Varden & former Blooming Grove-Honesdale 69 kV circuits.

FIGURE 2 – ONE LINE DIAGRAM PROPOSED TRANSMISSION FACILITIES

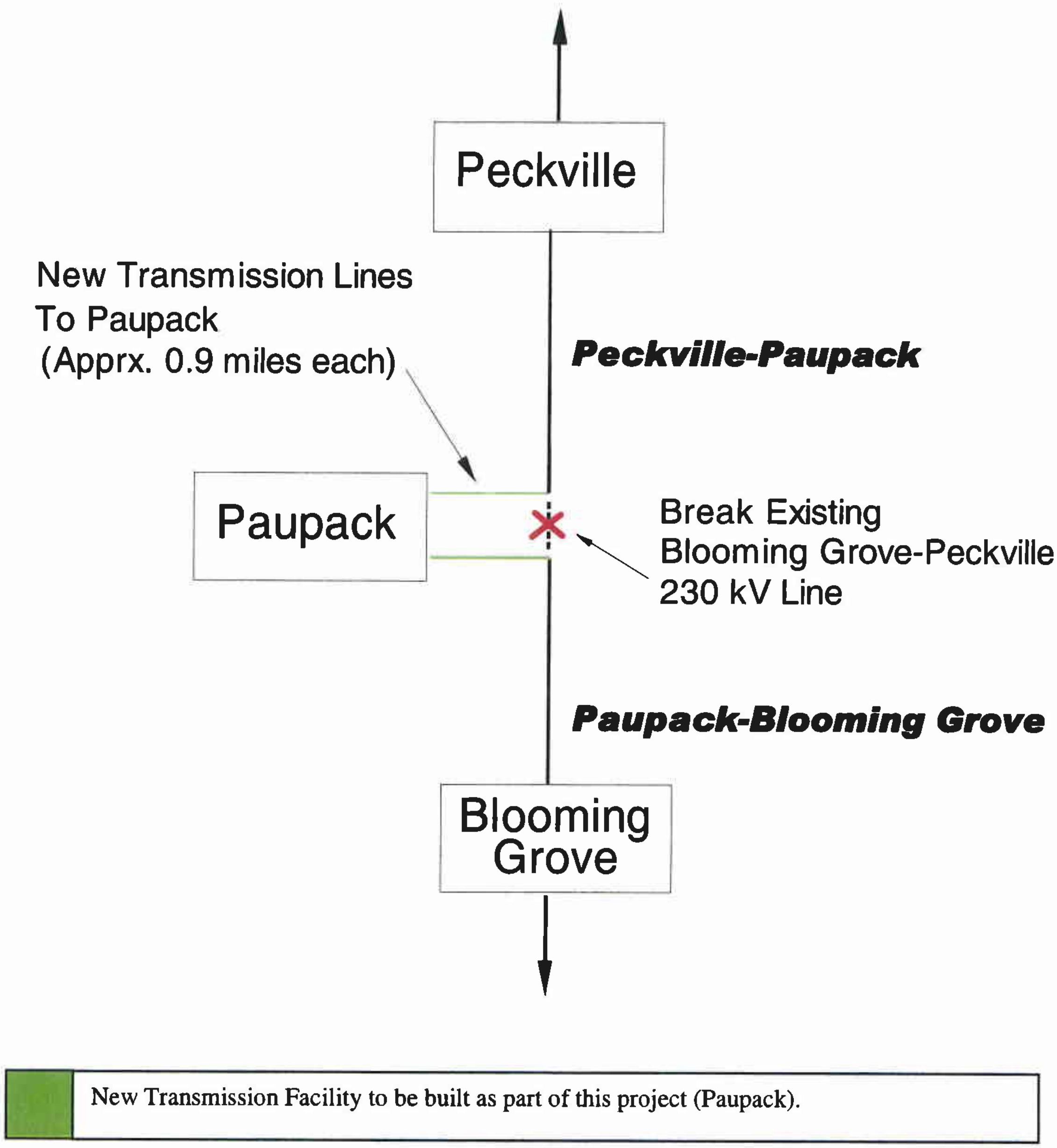


FIGURE 3 – ONE LINE DIAGRAM PROPOSED 230 KV TRANSMISSION FACILITIES

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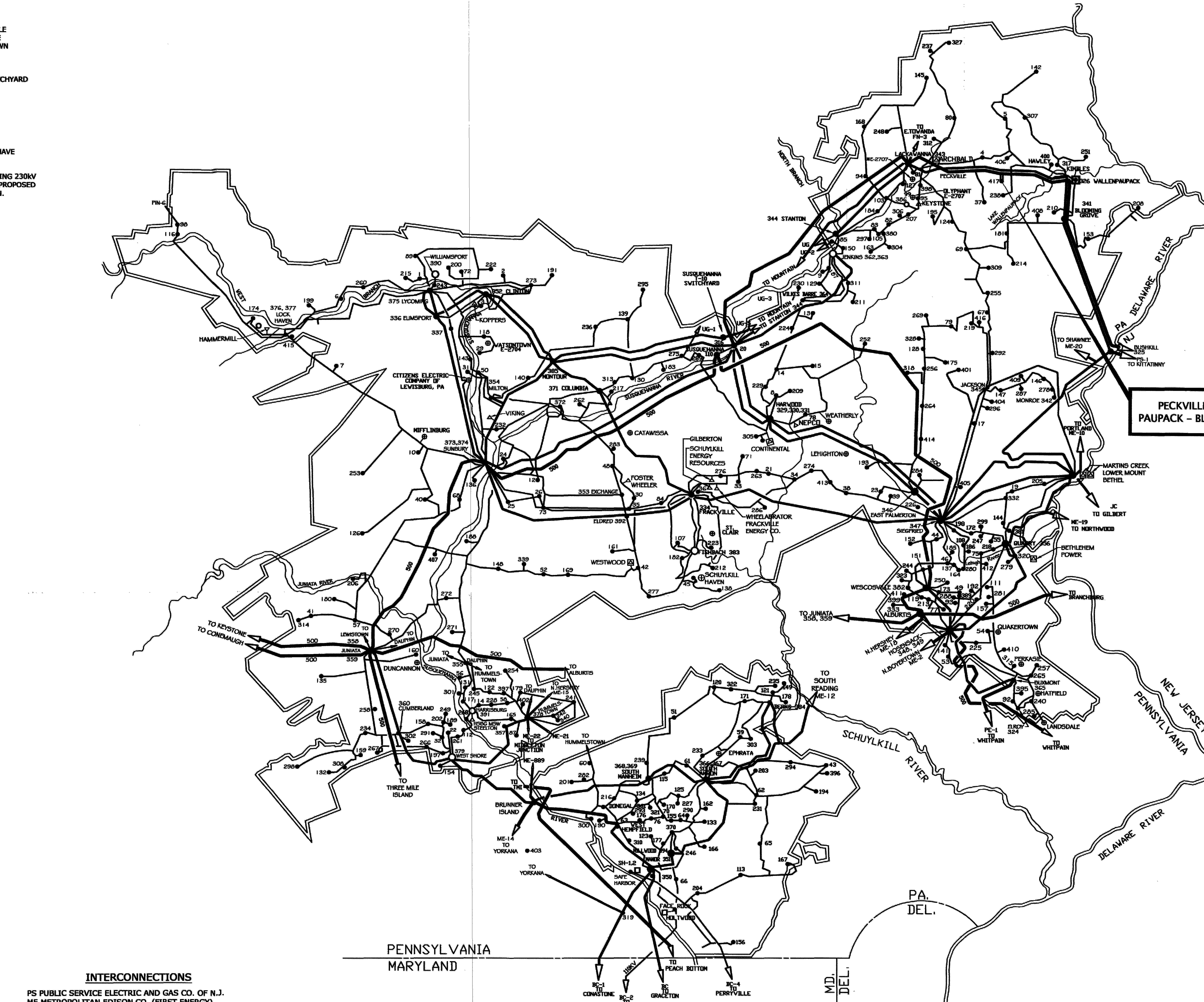
SUBSTATION LISTING

1. WEST WILLIAMSPORT
2. FAIRFIELD
3. MONTGOMERY
4. VARDEN
5. HONESDALE
6. JERSEY SHORE
7. LOGANTON
8. VALMONT
9. RIVER
10. LIMESTONE
11. *
12. REED
13. WRIGHT
14. ST. JOHNS
15. FREELAND
16. *
17. GILBERT
18. *
19. CHERRY HILL
20. SUSQUEHANNA 230kV
21. TAMANEND
22. WHITE HILL
23. PALMERTON
24. HAMILTON
25. HUNTER
26. FAIRVIEW
27. *
28. *
29. MONTOUR PUMP
30. MT. CARMEL
31. KELLY
32. SPORTING HILL
33. MAHANOY CITY
34. GREENWOOD
35. MOWERY
36. ALTAMOUNT
37. HAMLIN
38. ASHFIELD
39. SOUTH SLATINGTON
40. SOUTH MIDDLEBURG
41. WALKER
42. FRAILEY
43. MORGANTOWN
44. EGYPT
45. CRESSONA
46. SOUTH WHITEHALL
47. *
48. BEAR GAP
49. SALISBURY
50. SOUTH MILTON
51. HEIDELBERG
52. LYKENS
53. UPPER HANOVER
54. RICHLAND
55. MACADA
56. ROCKVILLE
57. THOMPSONTOWN
58. PAXTON
59. COCALICO
60. EAST ELIZABETHTOWN
61. WARWICK
62. EARL
63. HEMPFIELD
64. EAST LANCASTER
65. KINZER
66. MT. NEBO
67. MT. POCONO
68. PENNS
69. GOULDSBORO
70. DILLERVILLE
71. GIRARD MANOR
72. KENMAR
73. GOWEN CITY
74. *
75. ELLIOT HEIGHTS
76. ROHRERSTOWN
77. MACUNGIE
78. EAST HAZLETON
79. WAGNERS
80. EAST CARBONDALE
81. EYNON
82. MINOOKA
83. OLD FORGE
84. FOUNTAIN SPRINGS
85. SULLIVAN TRAIL
86. *
87. SWATARA
88. *
89. HEPBURN
90. *
91. *
92. FRANCONIA
93. EMMAUS
94. MORGAN
95. THROOP
96. *
97. *
98. CHAPMAN
99. SUBURBAN
100. *
101. *
102. *
103. PROVIDENCE
104. *
105. AVOCA
106. *
107. CASS
108. CATASAQUA
109. *
110. SUSQUEHANNA 500kV
111. SEIDERSVILLE
112. ROSEMONT
113. QUARRYVILLE
114. LAWNTON
115. LITITZ
116. RENOVO
117. WALNUT
118. WATSON
119. TREXLERTOWN
120. LAVINO
121. SPRING
122. COLONIAL PARK
123. WEST LANCASTER
124. MADISONVILLE
125. NEFFSVILLE
126. BEAVERTOWN
127. BELMONT
128. LAKE HARMONY
129. GEORGETOWN
130. SCOTT
131. NORTH HARRISBURG
132. MOUNT ROCK
133. GREENLAND
134. LANDISVILLE
135. GREEN PARK
136. SELINSGROVE
137. SUMNER
138. AUBURN
139. ROHRSBURG
140. DERRY
141. EAST GREENVILLE
142. WEST DAMASCUS
143. NEW COLUMBIA
144. FARMERSVILLE
145. GREENVILLE
146. NORTH STROUDSBURG
147. TANNERSVILLE
148. ELIZABETHVILLE
149. WYOMISSING
150. EXETER
151. CRACKERSPORT
152. SCHNECKSVILLE
153. HEMLOCK
154. MT. ALLEN
155. PRINCE
156. WAKEFIELD
157. COOPERSBURG
158. WERTZVILLE
159. WEST CARLISLE
160. BENVENUE
161. HEGINS
162. LEOLA
163. YATESVILLE
164. CENTRAL ALLENTOWN
165. OBERLIN
166. STRASBURG
167. ATGLEN
168. BROOKSIDE
169. WILLIAMSTOWN
170. EAST PETERSBURG
171. WERNERSVILLE
172. NORTH BETHLEHEM
173. WEST ALLENTOWN
174. FLEMINGTON
175. MECKESVILLE
176. DONERVILLE
177. MILLERSVILLE
178. SHILLINGTON
179. DUKE
180. MCALLISTERVILLE
181. NEWFOUNDLAND
182. MARLIN
183. WEST BERWICK
184. KEYSER AVENUE
185. MICKLEYS
186. EAST ALLENTOWN
187. PINE RIDGE
188. DALMATIA
189. PENNSBORO
190. NORTH COLUMBIA
191. HUGHSVILLE
192. SOUTH ALLENTOWN
193. WEISSPORT
194. HONEYBROOK
195. MOSCOW
196. *
197. ROSSMOYNE
198. NORTHAMPTON
199. WOOLRICH
200. FAXON
201. ELIZABETHTOWN
202. ENOLA
203. TERRE HILL
204. BUCK
205. MT. BETHEL
206. RICHFIELD
207. SCRANTON
208. TWIN LAKES
209. HARLEIGH
210. TAFTON
211. BEAR CREEK
212. ORWIGSBURG
213. EAST TEXAS
214. CANDENSIS
215. LINDEN
216. MT. JOY
217. WEST BLOOMSBURG
218. MINST TRAIL
219. LAKE NAOMI
220. LANARK
221. *
222. MONTOURSVILLE
223. PORT CARBON
224. BLYTHEBURN
225. MILFORD
226. TREICHLERS
227. ROSEVILLE
228. RUTHERFORD
229. HARTLAND
230. PARRISH
231. WEST NEW HOLLAND
232. POINT
233. LINCOLN
234. MIDDLETON
235. STATE HILL
236. MILLVILLE
237. TINKER
238. LAKEVILLE
239. NORTH MANHEIM
240. HATFIELD
241. HERSHEY
242. SOUTH HERSHEY
243. SOUTH WILLIAMSPORT
244. FOGELSVILLE
245. WINDSOR
246. WEST WILLOW
247. WESTGATE
248. EDELA
249. SUMMERDALE
250. DORNEYVILLE
251. BOHEMIA
252. WHITE HAVEN
253. LAURELTON
254. LINGLESTOWN
255. POCONO FARMS
256. HICKORY RUN
257. BLOOMING GLEN
258. SHERMANSDALE
259. *
260. LARRYS CREEK
261. SPANGLER MILLS
262. EAST DANVILLE
263. DELANO
264. CARBON
265. SELLERSVILLE
266. MECHANICSBURG
267. CARLISLE
268. CEDAR
269. ARROWHEAD
270. NEWPORT
271. HALIFAX
272. MILLERSBURG
273. MUNCY
274. HAUTO
275. BERWICK
276. SHENANDOAH
277. PINE GROVE
278. STROUDSBURG
279. FREEMANSBURG
280. ALLENTOWN
281. BINGEN
282. RHEEMS
283. CLEVELAND
284. LITTLE GAP
285. ORVILLA
286. TUSCARORA
287. BARTONSVILLE
288. ALTON PARK
289. SALEM
290. NORTH BRIDGEPORT
291. HAMPDEN
292. CAMELBACK
293. SILVER SPRING
294. BRECKNOCK
295. BENTON
296. McMICHAELS
297. HUGHSTOWN
298. NEWVILLE
299. POINTE NORTH
300. MARIETTA
301. CENTER CITY
302. NEW KINGSTOWN
303. REAMSTOWN
304. DUPONT
305. HUMBOLT
306. CEDAR AVE.
307. INDIAN ORCHARD
308. NOTTINGHAM
309. NORTH COOLBAUGH
310. LETORT
311. EAST MOUNTAIN
312. JERMYN
313. BLOOMSBURG
314. MIFFLINTOWN
315. RIDGE ROAD
316. SUSQUEHANNA T-10 SW. YARD
317. KIMBLES
318. CHRISTMANS
319. OTTER CREEK
320. STEEL CITY
321. McGOVERNVILLE
322. ROBESONIA
323. SOUTH FOGELSVILLE
324. ELROY
325. BUSHKILL
326. WALLENPAUPACK
327. ELK MOUNTAIN
328. JACK FROST
329. HARWOOD 230/69kV
330. HARWOOD CTG
331. HARWOOD 69/12kV
332. NAZARETH
333. ALBURTIS
334. FRACKVILLE
335. *
336. ELIMSPORT
337. ALLENWOOD
338. *
339. GRATZ
340. HOCKERSVILLE
341. BLOOMING GROVE
342. MONROE
343. LACKAWANNA ##
344. STANTON
345. JACKSON
346. EAST PALMERTON
347. SIEGFRIED
348. HOSENSACK 230/69kV
349. HOSENSACK 500kV
350. CONESTOGA
351. MANOR
352. CLINTON
353. EXCHANGE
354. MILTON
355. DAUPHIN
356. QUARRY SUB.
357. STEELTON
358. JUNIATA 500/230kV
359. JUNIATA 230/69kV
360. CUMBERLAND
361. DONEGAL
362. JENKINS 230/69kV
363. JENKINS CTG
364. WILKES-BARRE
365. BUXMONT
366. SOUTH AKRON 230/138/69kV
367. SOUTH AKRON 69/12kV
368. SOUTH MANHEIM 69/12kV
369. SOUTH MANHEIM 230/69kV
370. ENGLESIDE
371. COLUMBIA
372. DANVILLE
373. SUNBURY
374. HUMMELS WHARF
375. LYCOMING
376. LOCK HAVEN CTG
377. LOCK HAVEN 69/12kV
378. HUMMELSTOWN
379. WEST SHORE
380. MONTAGE
381. SOUTH FARMERSVILLE
382. WESCOSVILLE
383. FISHBACH
384. BERKS
385. MONTOUR
386. SUBURBAN YARD
387. *
388. *
389. MACK
390. WILLIAMSPORT
391. HARRISBURG
392. ELDRED
393. *
394. MILLWOOD
395. TELFORD
396. TWIN VALLEY
397. DEVONSHIRE
398. JESSUP
399. SCHOENECK
400. HAWLEY
401. EFFORT MOUNTAIN
402. COPPERSTONE
403. RED FRONT
404. APPENZELL
405. BLUE MOUNTAIN
406. DAPPERS 69/12kV
407. MEISERVILLE
408. LEDGEDALE
409. EAST TANNERSVILLE
410. TRUMBAUERSVILLE
411. WEST TREXLERTOWN
412. FOUNTAIN HILL
413. LANSFORD
414. BELTZVILLE
415. LOCK HAVEN SWITCHYARD
416. LONG POND
417. PAUPACK

* - SUBSTATIONS THAT HAVE BEEN RETIRED.

\## - SITE OF THE EXISTING 230kV SUBSTATION AND PROPOSED 500kV SYBSTATION.



INTERCONNECTIONS

PS PUBLIC SERVICE ELECTRIC AND GAS CO. OF N.J.
ME METROPOLITAN EDISON CO. (FIRST ENERGY)
PE PHILADELPHIA ELECTRIC CO. (PECO ENERGY)
BC BALTIMORE GAS AND ELECTRIC CO.
SH SAFE HARBOR WATER POWER CORPORATION
UP THE UNITED GAS IMPROVEMENT CO. - LUZERNE ELECTRIC DIVISION
PN PENNSYLVANIA ELECTRIC CO. (FIRST ENERGY)
JC JERSEY CENTRAL POWER AND LIGHT CO. (FIRST ENERGY)

LEGEND

500KV OPERATION
230KV OPERATION
138KV OPERATION
69KV OPERATION

COMBUSTION TURBINE
HYDRO ELECTRIC
COMBINATION
FIRM SALES
SUBSTATION / SWITCHING STATION
STEAM ELECTRIC
NON-UTILITY GENERATION
INDEPENDANT POWER PRODUCERS

PPL ELECTRIC UTILITIES

108	04/18/12	10015377	DEPICT LOCATION OF PECKVILLE - HONESDALE 138/69kV LINE REBUILD	mg		JBW	
107	04/03/12	10017780	ADDED LYCOMING - LOCK HAVEN #4 138/69kV LINE & LOCK HAVEN SWITCHYARD	mg		JBW	
110	5/24/12	10016386	ADDED PECKVILLE - PAUPACK 230kV & PAUPACK - BLOOMING GROVE 230kV LINES & PAUPACK SUB	mg		JBW	
109	04/27/12	10013123	ADDED LONG POND 138/69kV TAP & SUBSTATION.	mg		JBW	
NO.	DATE	ACCT.		BY	REVIEWED	APPROVED	

REFERENCE TITLE | NUMBER | REFERENCE TITLE | NUMBER

ACCT- 805201
SCALE- NONE
BY- CDW
REVIEWED

PPL ELECTRIC UTILITIES
ELECTRICAL SYSTEM MAP
PECKVILLE - PAUPACK 230 kV LINE
PAUPACK - BLOOMING GROVE 230 kV LINE

APPROVED G. HAKUN III | DATE 7/17/85 | PPL ELECTRIC UTILITIES

PPL DRAWING NO. D191830 | SHEET NO. 1 | REV. 110

FRACTIONAL | DECIMAL

#6000 | LOCATION CODES | PLAN & PROFILE NO. | TRANSMISSION MAP NO. | C SORTS

D191830_S001.DWG

PPL EU FORM 4877 (7/80)

Attachment

2

ATTACHMENT "2"
PECKVILLE – PAUPACK 230 kV LINE &
PAUPACK – BLOOMING GROVE 230 kV LINE
ENGINEERING DESCRIPTION

TABLE OF CONTENTS

ATTACHMENT "2"
PECKVILLE – PAUPACK 230 kV LINE &
PAUPACK – BLOOMING GROVE 230 kV LINE
ENGINEERING DESCRIPTION

A. DESCRIPTION OF THE PROPOSED LINE

PPL Electric Utilities Corporation ("PPL Electric") proposes to construct the new single-circuit Peckville – Paupack 230 kV Line and single-circuit Paupack – Blooming Grove 230 kV Line. The proposed Lines will be located in Paupack Township, Wayne County. This Project is one of three separate but related transmission line projects to reinforce the 69 kV systems in Lackawanna and Wayne Counties. Each transmission line project will be the subject of a separate filing.

Here, PPL Electric seeks PUC approval of the second transmission line project. The proposed single-circuit Peckville – Paupack 230 kV Line and single-circuit Paupack – Blooming Grove 230 kV Line will supply power to the new Paupack 230 – 69 kV Substation. The new Lines will extend approximately 0.9 miles from the existing Peckville – Blooming Grove 230 kV Transmission Line just north of the proposed Substation. The Aerial Exhibit at the end of Attachment 2 depicts the location of these facilities.

This Project requires the installation of approximately 20 poles. The new Poles will be self supported, steel monopole structures. The proposed single-shaft steel poles will be installed on concrete foundations and will be approximately 110-120 feet in height.

The proposed Lines will be constructed for single-circuit 230 kV operation only. Each Line will utilize three 1,590 kcmil,[1] 45/7 stranding, ACSR[2] conductors, and one C.752" optical ground wire for lightning protection and for communication between circuit breakers that will remove the line from service when a fault in the line is detected.

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[1] Wire sizes are expressed in thousands of circular mils (kcmil). A circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².
[2] Aluminum conductor steel reinforced.

The proposed line facilities will be designed to meet, and generally exceed, the National Electrical Safety Code (NESC) minimum standards. Design specifications and safety rules practiced by PPL Electric are included in Appendix 4. The minimum conductor to ground clearance will be 32 feet on all new transmission line facilities. Those clearances occur at a 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 1590 KCMIL, 45/7 STRANDING ACSR*

PECKVILLE - PAUPACK 230 kV LINE

PAUPACK – BLOOMING GROVE 230 kV LINE

Condition	Single-Circuit Design Clearance-to-Ground
Normal load; average weather (16°C ambient temperature)	39.1 feet
Predicted extreme thermal load (125°C conductor temperature)	32.0 feet
Predicted NESC Extreme wind load (100 mph, 16°C)	44.7 feet
Predicted extreme weather conditions (1inch ice, 8 lbs. wind, -18°C)	39.0 feet

*Clearances based on a maximum tension of 20,500 pounds, at 1 inch ice, 0° F, 8 lb wind, and a ruling span of 650 feet.

TABLE 2

CONDUCTOR THERMAL RATING
1590 KCMIL 45/7 STRANDING ACSR
(257°F) 125°C MAXIMUM CONDUCTOR TEMPERATURE

Condition	Ambient Temperature °C	Wind Speed Knots	Ampacity Amps
Summer Normal	35	0	1640
Winter Normal	10	0	1888
Summer Emergency	35	1 1/2	2030
Winter Emergency	10	1 1/2	2286

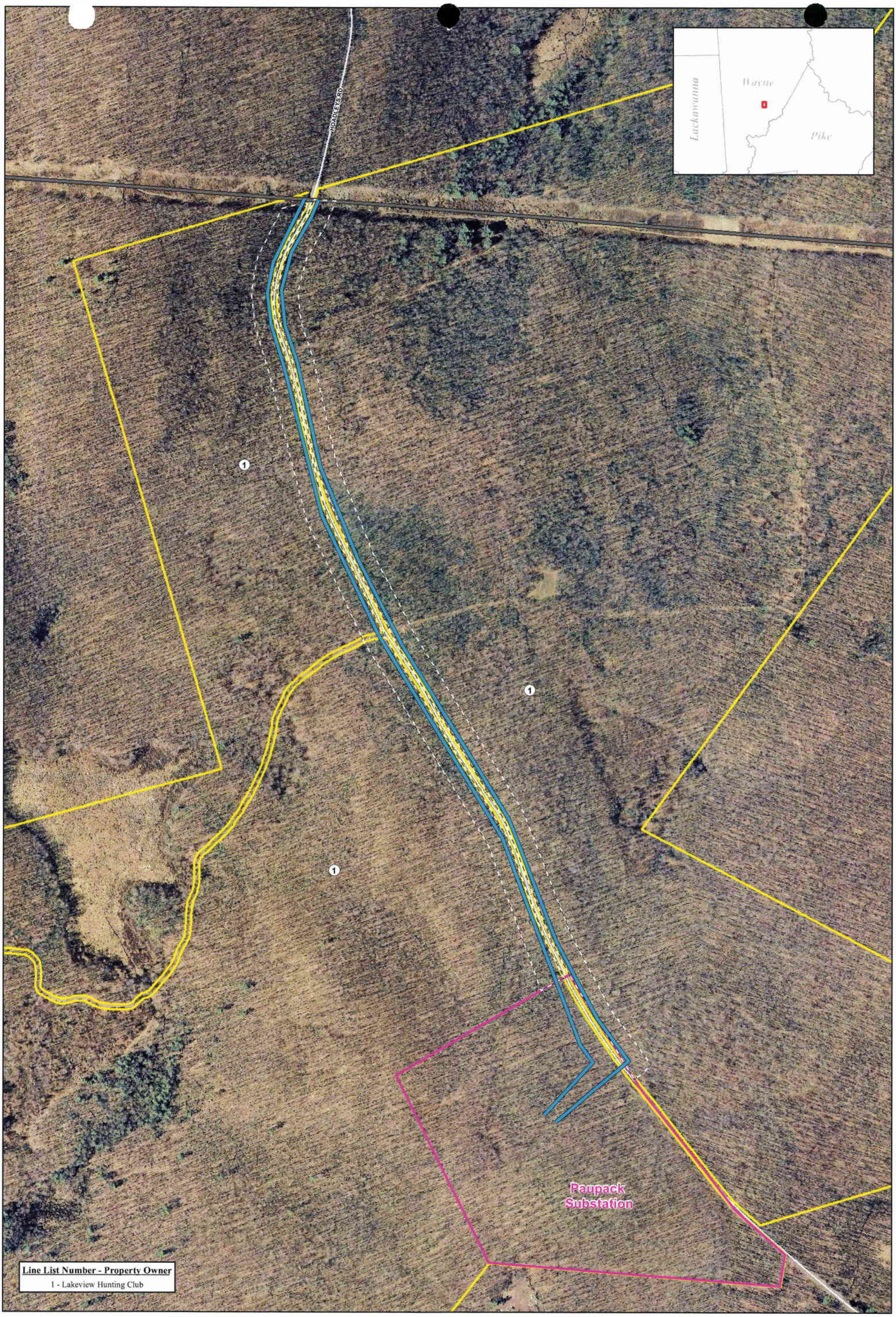
B. MAGNETIC FIELD MANAGEMENT

PPL Electric's Magnetic Field Management Program is summarized in Attachment 5 and applies to new and reconstructed transmission line projects. In order to lower magnetic field exposures, the program generally prescribes the use of a line design that provides five foot higher ground clearance and reverse phasing of new double circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications will be considered, provided those modifications can be made at low or no cost.

The proposed Peckville – Paupack 230 kV Line and Paupack – Blooming Grove 230 kV Line will be constructed for single-circuit 230 kV operation only, thus reverse phasing will not be accomplished, although five foot higher ground clearance will be implemented. However, the flow of electricity to and from the Paupack 230-69 kv Substation on these two single circuit Lines will be in opposite directions. When the flow of electricity on two nearby circuits is in opposite directions, some reduction in the magnetic field will occur even without reverse phasing.

C. <u>RIGHT-OF-WAY STATUS</u>

Construction of the new Peckville - Paupack and the Paupack – Blooming Grove 230 kV Lines will be entirely within right-of-way previously acquired by PPL Electric or on the PPL Electric fee-owned property for the Paupack Substation. A list of property owners is presented in Attachment 6.



0 200 400 800
Feet
1 inch = 400 feet

NAD 1983 StatePlane Pennsylvania North
Projection: Lambert Conformal Conic
Linear Unit: US Foot

Parcel Data generated based on
PPL Metes and Bounds Survey

PPL Transmission Data 2011
GIS State & Local Road Data provided by
Pennsylvania Department of Transportation
PA MAP 2008 Digital Imagery

N

Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line
Real Estate Review
PPL Northeast/Pocono Reliability Project

Legend
- Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line
- 230 kV line ROW
- New Substation

Existing Transmission
- 69 kV & 138 kV
- 230 kV
- Parcel Boundaries

PPL Electric Utilities

Attachment

3

ATTACHMENT "3"
PECKVILLE - PAUPACK 230 kV LINE &
PAUPACK – BLOOMING GROVE 230 kV LINE
ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

LIST OF MAPS

ATTACHMENT "3"
LACKAWANNA - PAUPACK 230 kV LINE &
PAUPACK – BLOOMING GROVE 230 kV LINE
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric is seeking Commission approval to build two single circuit (s/c) 230 kV transmission lines from the new Paupack 230-69 kV Substation to the existing Blooming Grove- Peckville 230 kV line. The two new lines, the Peckville – Paupack 230 kV and Paupack – Blooming Grove 230 kV Lines, will each be approximately 0.9 miles long and run north from the new Paupack 230-69 kV Substation. One Line will be on each side of Hoadleys Road in Paupack Township, Wayne County. This Project is needed to integrate the new Paupack 230-69 kV Substation into the existing 230 kV transmission system (**Figure 1**).

B. LAND USE

Land use information for the Project was obtained from review of the *Wayne County Agricultural Land Use/Land Cover Study* coordinated by the Wayne County Planning Commission (WCPC) and examination of the GIS data provide by WCPC (WCPC 2002, 2010). The land use in and around the Project right-of-way ("ROW") is almost entirely forested. The only deviation from forested land is the northern end of each of the lines where they will connect to the existing Blooming Grove – Peckville 230 kV Line. At this point the lines are within an existing transmission line ROW, which is categorized as pasture/brush. The construction of the line will involve vegetation removal because the ROW is entirely new and runs through forest vegetation. This impact will be reduced significantly by the orientation of the ROW along an existing road. As such, the Project will not impact any residential, commercial, industrial, recreational, or agricultural land.

Airports

The northern terminus of each the proposed Peckville – Paupack 230 kV and Paupack – Blooming Grove 230 kV Lines is located approximately 2.40 miles south of the Cherry Ridge Airport, a public facility equipped for single-engine airplanes. Construction of line will require notification of the Federal Aviation Administration (FAA) and the Pennsylvania Department of Transportation (PennDOT) Bureau of Aviation. FAA coordination would involve completion of Form 7460-1 "Notice of Proposed Construction or Alteration" and coordination with PennDOT's Bureau of Aviation would involve completion of Form AV-57, similarly titled "Notice of Proposed Construction or Alteration." Because of the distance between the proposed lines and the airport and their orientation roughly parallel to the airport runway, the proposed construction is not anticipated to be considered a hazard to flight operations at the Cherry Ridge Airport.

Other Utilities

Field and desktop reviews, including review of the 24K USGS Topographic maps and Platt's POWERmap data was done to identify pipelines and communication towers within the vicinity of the Project. There were no pipelines identified within the area surrounding the Project. There was one communication tower identified in the vicinity, located approximately 2.65 miles south of the southern terminus of the Project, in the Cove Haven Resort. The project is not anticipated to have any impact on this communication tower.

C. CULTURAL RESOURCES

A desktop survey of archaeological and historic architectural resources within the Project area was completed. The survey consisted of accessing the Pennsylvania Historical and Museum Commission (PHMC) Cultural Resources Geographic Information System (CRGIS) system to review available information on previously-recorded archaeological and historic architectural sites on and near the transmission ROW alignment. Based on this review, there were no listed or eligible National Register of Historic Places (NRHP) identified within a 0.5-mile review area around the proposed Peckville – Paupack and Paupack – Blooming Grove 230 kV Lines ROW. A review of the Project was coordinated with PHMC, which indicated in an April 9, 2012 response that no further actions are required from an architectural resources perspective. A Phase I archaeological survey may be required, however, pending additional consultation with PHMC. If PPL Electric becomes aware of any previously unidentified resources that would be affected by the construction of the proposed Lines, the PHMC will be contacted immediately.

Along with the lack of historic properties, there also are no state lands, national parks, state parks, or local parks within the Project area. Thus, the proposed construction and activities associated with this Project are unlikely to have an effect on any cultural or historic resources.

D. NATURAL FEATURES

The short length of the lines corresponds with a relatively simple natural environment. The Project is entirely within one physiographic section, the Glaciated Low Plateau Section of the Appalachian Plateau Province. This section is generally defined by remnants of its once glaciated landscape. Glacial erosion and deposition have carved a topography that consists of valleys, smooth hills and glacial deposits. Beneath the glacially influenced surficial geology, the bedrock of the Project area is dominated by the Catskill Formation, a Devonian Age sedimentary rock deposited when the Catskill Delta covered much of modern day Pennsylvania. The Project ROW itself crosses through two bedrock formations; the Long Run and Walcksville Members of the Catskill Formation, and the Poplar Gap and Packerton Members of the Catskill Formation (**Figure 2**). These members are all Devonian age sandstones with shale and siltstones present as secondary rock types (Berg 1980). The Project will not negatively impact any identified unique geologic areas.

The new transmission line ROWs are almost completely underlain by the Wellsboro soil map unit, which is identified as a hydric "extremely stony loam" (See hydric soil extent in **Figure 2**). The presence of hydric soils within the ROW will play a role in identifying tower locations and other engineering measures of the transmission line (USDA 1985).

The Project area does not cross any streams, 100-year floodplains, or National Wetland Inventory identified wetlands (PADEP 2011, PADEP 1996, & USFWS 2011). Further, identification and delineation of wetlands and watercourses within the ROW will take place before determining tower locations. By taking these measures, the Project will not negatively impact any surface water features. The surface water features of the surrounding area are displayed on **Figure 2**.

Vegetative cover across the Project area is a dense mixed hardwood forest. The dominant trees in this northern hardwood forest include oak (*Quercus* spp.), maple (*Acer* spp.), birch (*Betula* spp.), and hickory (*Carya* spp.). Scattered pockets of conifers, specifically eastern white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*), are located throughout these forests. This vegetation will be impacted within the ROWs for both Tap Lines (Fike 1999). 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.

E. THREATENED AND ENDANGERED SPECIES

Natural Areas Inventory

The Nature Conservancy's *Wayne County Natural Areas Inventory* identified one site within the vicinity of the proposed Lines (**Figure 2**). The site is identified as the Heron Rookery Natural Area (SA514) and is located about 0.5-miles west of the northern-end of the ROW in Paupack Township. Herons, a particular species, were last observed here in 1986, but the site remains protected in the event the birds return to the area in the future (TNC 1991). The area is approximately 160 acres of wooded land bordered by the Wangum Creek to the northwest and an existing transmission ROW to the south. There are 0.5 miles of densely wooded vegetation as well as a number of high voltage power lines separating the Project from the Heron Rookery Natural. Thus, the proposed construction is unlikely to negatively impact any identified natural areas.

Pennsylvania Natural Diversity Inventory Review

A review of the Pennsylvania Natural Diversity Inventory (PNDI) database was conducted for the Project area through the online PNDI Environmental Review Tool (PNDI Search ID: 20110825312915). A search of the PNDI records under the jurisdiction of the Department of Conservation and Natural Resources (DCNR), the

Pennsylvania Fish and Boat Commission (PAFBC), and the Pennsylvania Game Commission (PGC), U.S. Fish and Wildlife Service (USFWS) has been completed (PNDI 2011). These agencies indicate that there are no known species of concern within the study area under their jurisdiction. According to this search, the Project will have no negative impact on any threatened or endangered species.

F. REFERENCES

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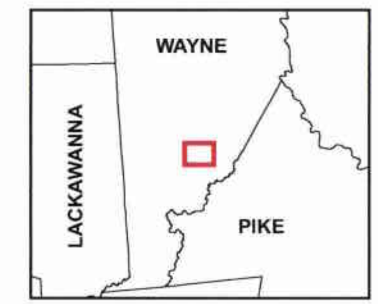
Path: S:\Projects\IMS\PPL\POCONO\Projects\LON Report\230 kV Connectors\PPL 230 kV Connector Figure 1.mxd

Legend

- Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line
- 230 kV Connector Line Right-of-Way (ROW)
- New Substation



Key Map
Not to Scale

N

NAD 1983 StatePlane Pennsylvania North
FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

USGS 24K Topographic Quadrangles-
Hawley (1997) & Lakeville (1994)
PPL Electric Utilities' Data

0 750 1,500 3,000 Feet

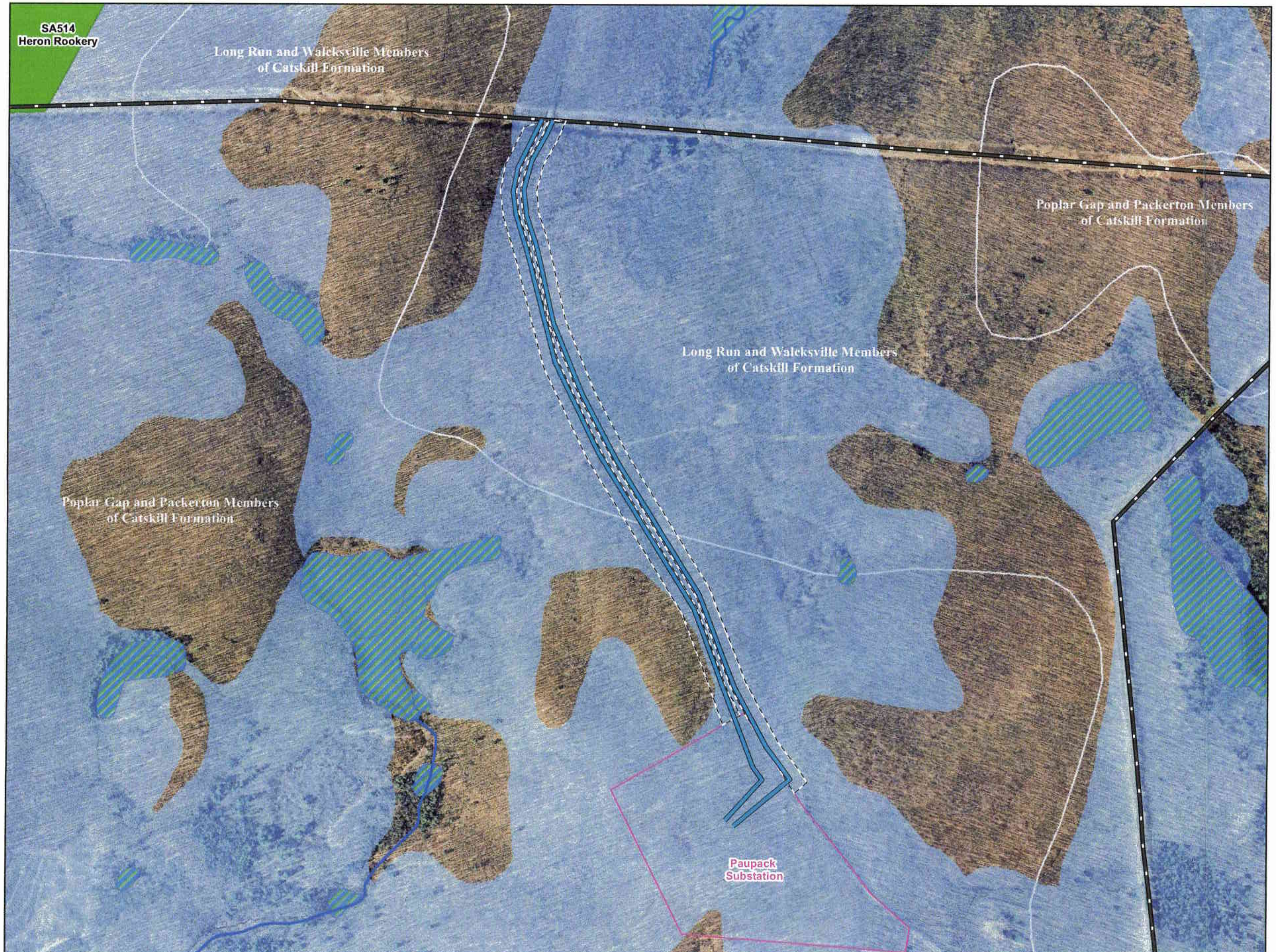
1 inch = 1,500 feet

ppl PPL Electric Utilities URS

Figure 1
Project Location Map
Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line

Paupack Township, Wayne County, Pennsylvania

Prepared By: MAL	Checked By: BAB
Job: 19998855.600	Date: June 2012

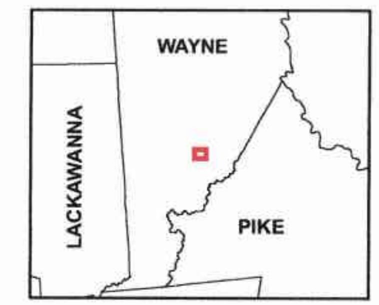


Legend

- Peckville – Paupack 230 kV Line and the Paupack – Blooming Grove 230 kV Line
- 230 kV Connector Line Right-of-Way (ROW)
- Existing Transmission Network

Streams - Designated Use

- High Quality - Cold Water Fishery (HQ-CWF)
- Wetlands
- Hydric Soils
- Natural Areas
- Bedrock Geology
- New Substation



Key Map
Not to Scale

N

NAD 1983 StatePlane Pennsylvania North
FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

PA Map 2008 Imagery (Wayne County)
Designated Use Stream data provided by
Penn State Institutes of the Environment
USFWS NWI Wetlands, Bedrock Geology (2001)
provided by the PA Bureau of Topographic and Geologic Survey,
Natural Area data provided by the PNHP,
NRCS Soils Data Provided by the USDA
PPL Electric Utilities' Data

0 300 600 1,200 Feet

1 inch = 600 feet

PPL Electric Utilities — URS

Figure 2
Project Area Resource Map
Peckville – Paupack 230 kV Line
and the Paupack – Blooming Grove
230 kV Line

Paupack Township, Wayne County, Pennsylvania

Prepared By: MAL	Checked By: BAB
Job: 19998855.600	Date: June 2012

Path: S:\Projects\IMS\PPL\POCONO\Projects\LON Report\230 kV Connectors\PPL 230 kV Connector Figure 2.mxd

Attachment

4

ATTACHMENT "4"

PPL 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 has developed design specifications and safety rules that 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

Surface Underneath Conductors	Vertical Clearance to Ground: NESC Standard	Vertical Clearance to Ground: 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.

Attachment

5

MAGNETIC FIELD MANAGEMENT

PPL Electric Utilities Corporation

Attachment 5

DECEMBER 2004

TABLE OF CONTENTS

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

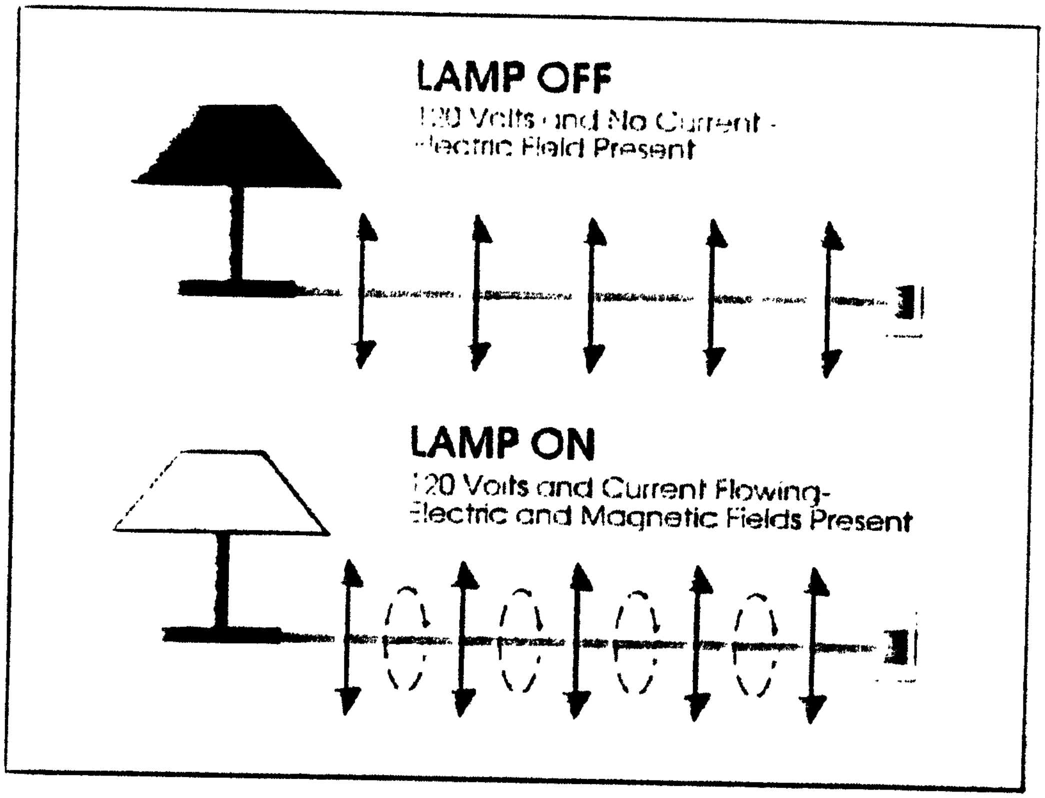

LAMP OFF
120 Volts and No Current -
Electric Field Present
LAMP ON
120 Volts and Current Flowing-
Electric and Magnetic Fields Present

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.

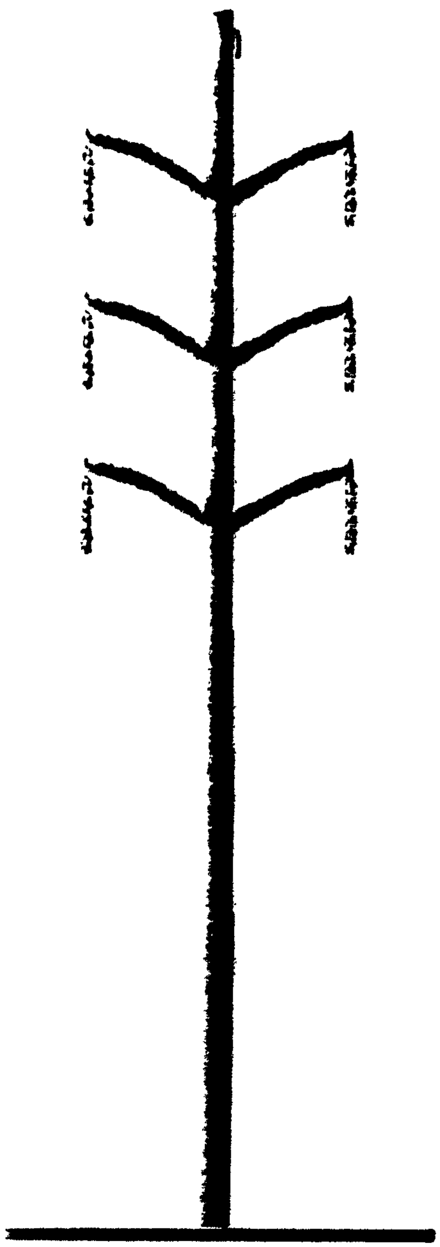
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

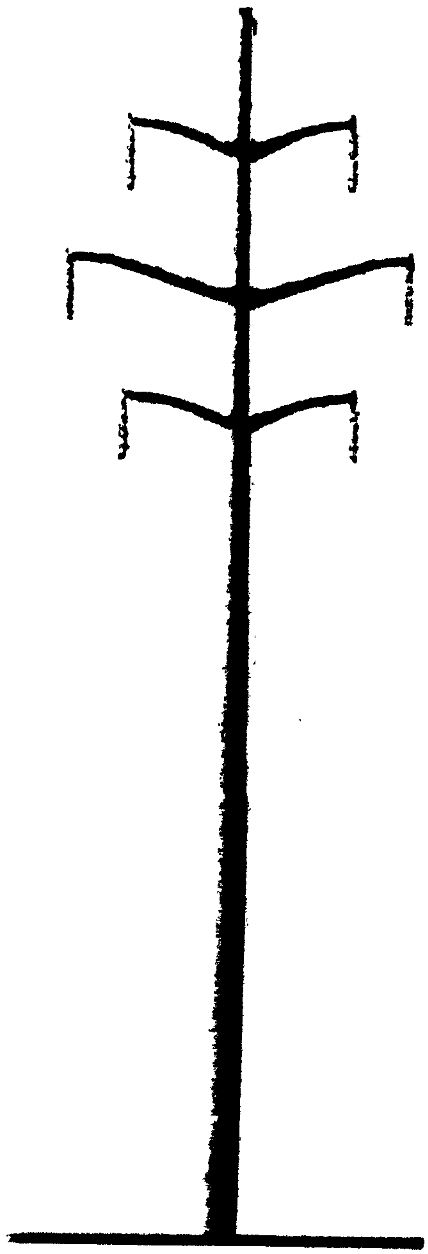
Short-Span Construction



- **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:**

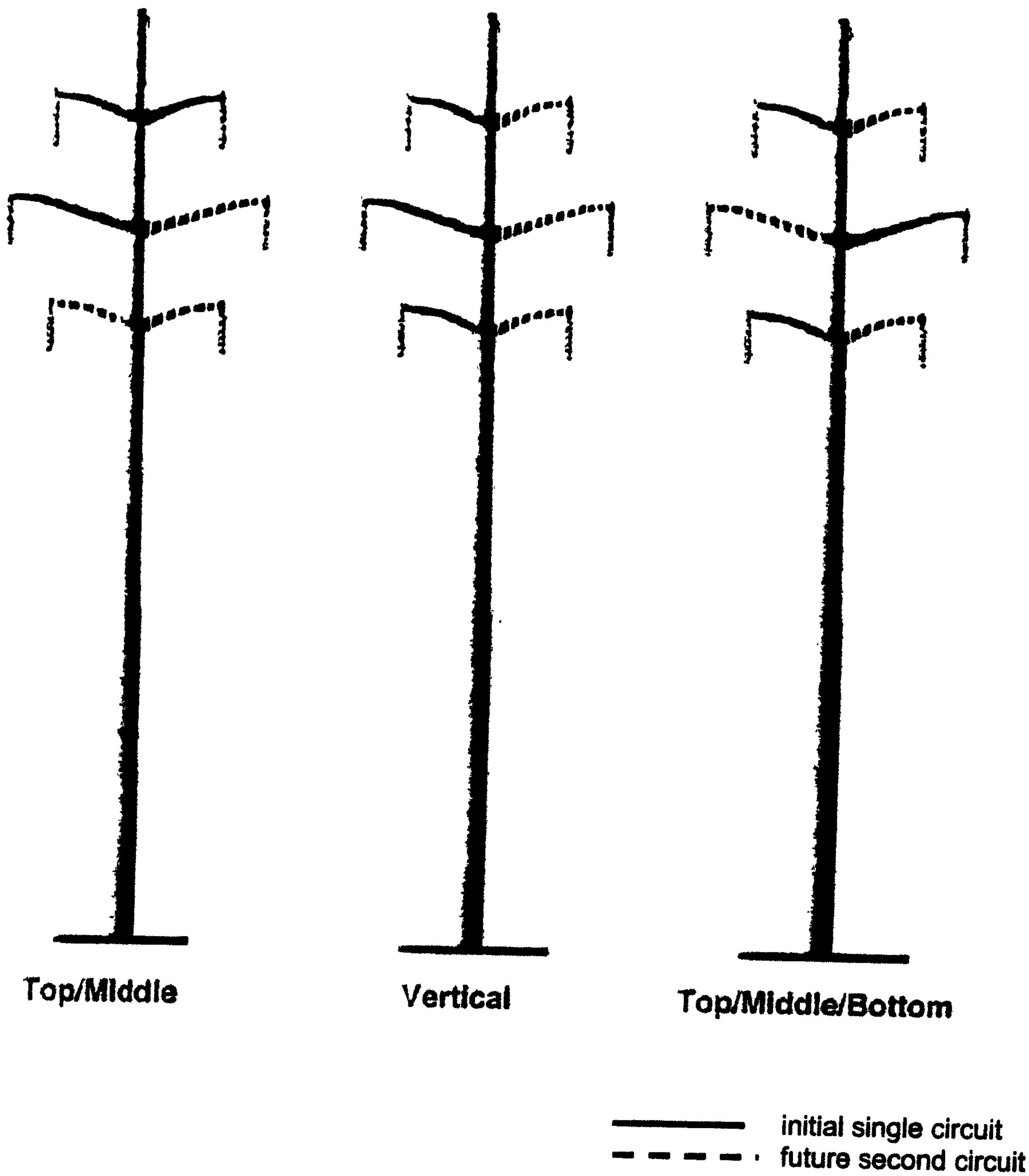
1 3/8" HS steel overhead ground wire - 17.3 feet sag
6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
Average span - 600 feet

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

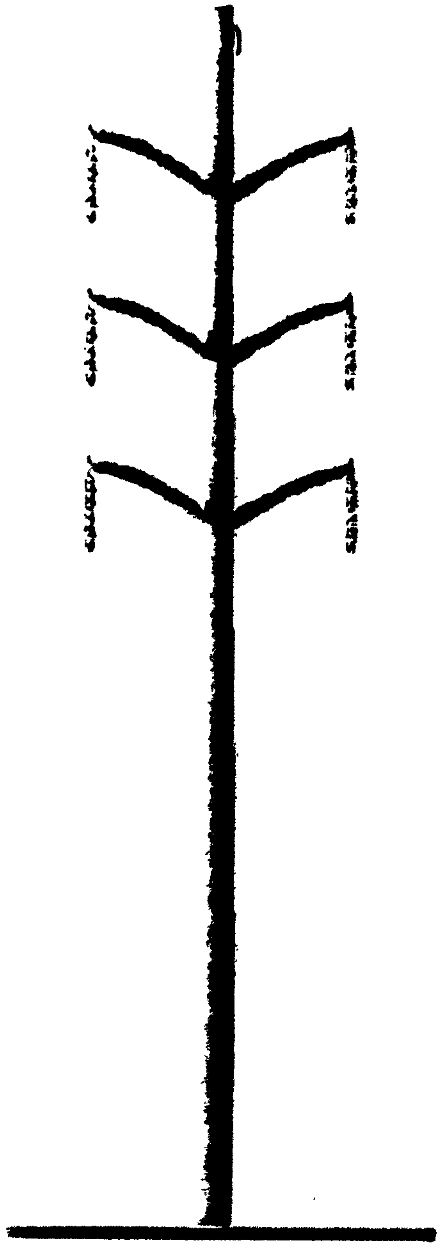


138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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.

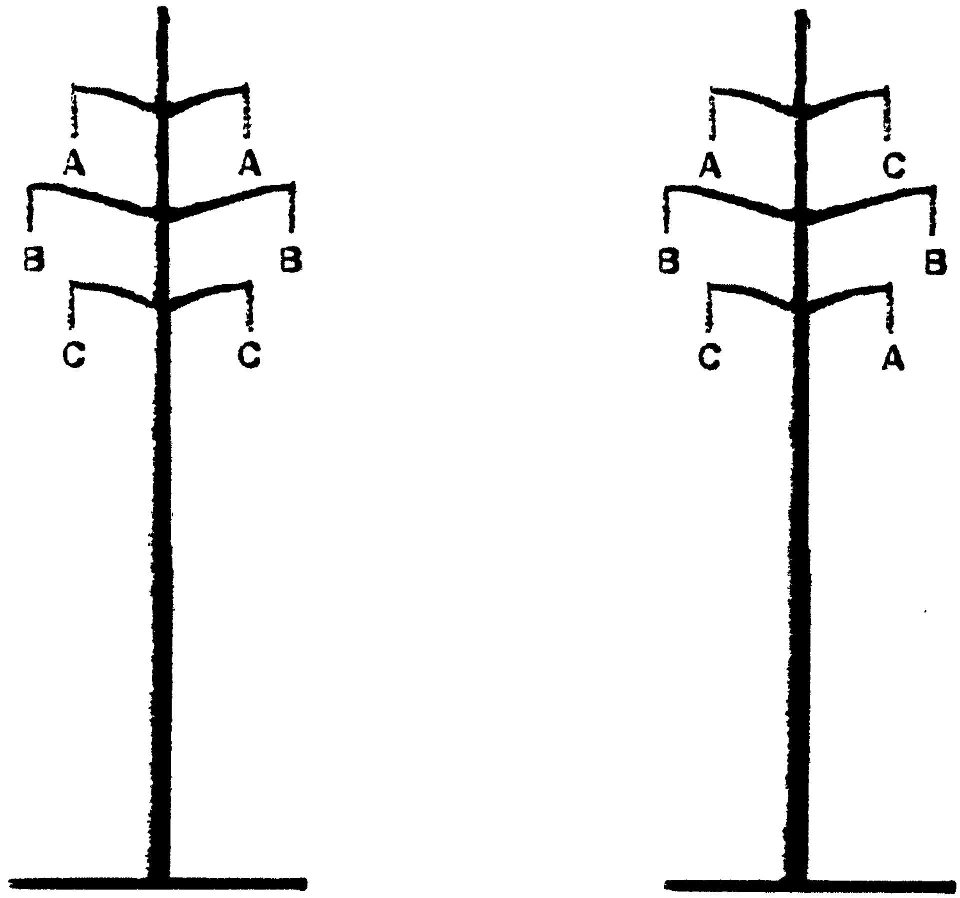
Compact Design Structure



- **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.

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.

Siting/Magnetic Field Management.doc/mlt

Attachment

6

ATTACHMENT "6"

<u>LIST OF PROPERTY OWNERS WITHIN THE AFFECTED RIGHT-OF-WAY</u>

Lakeview Hunting Club
c\o Brian Chapman
PO Box 48
Hamlin, PA 18427-0048

PPL Electric Utilities
2 N 9th Street
Allentown, Pa 18101

Attachment

7

ATTACHMENT "7"

LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND OTHER PUBLIC ENTITIES

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

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

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

Wayne County Planning Commission
Mr. Edward J. Coar - Director
925 Court Street
Honesdale, PA 18431

Wayne County Board of Commissioners
Mr. Brian W. Smith - Chairperson
925 Court Street
Honesdale, PA 18431

Paupack Township Board of Supervisors
Mr. Bruce Chandler – Chairman
25 Daniels Road
Lakeville, PA 18438

Paupack Township Planning Commission
Mr. William Lgoe
25 Daniels Road
Lakeville, Pa 18438