



Before the
Pennsylvania Public Utility Commission

**HARWOOD – HUMBOLDT #2
&
HARWOOD – JENKINS #1
138/69 kV MODIFICATIONS**

EXHIBITS AND ATTACHMENTS IN SUPPORT OF THE
Letter of Notification

Application Docket No. _____

Submitted by: PPL Electric Utilities Corp.

SUMMARY

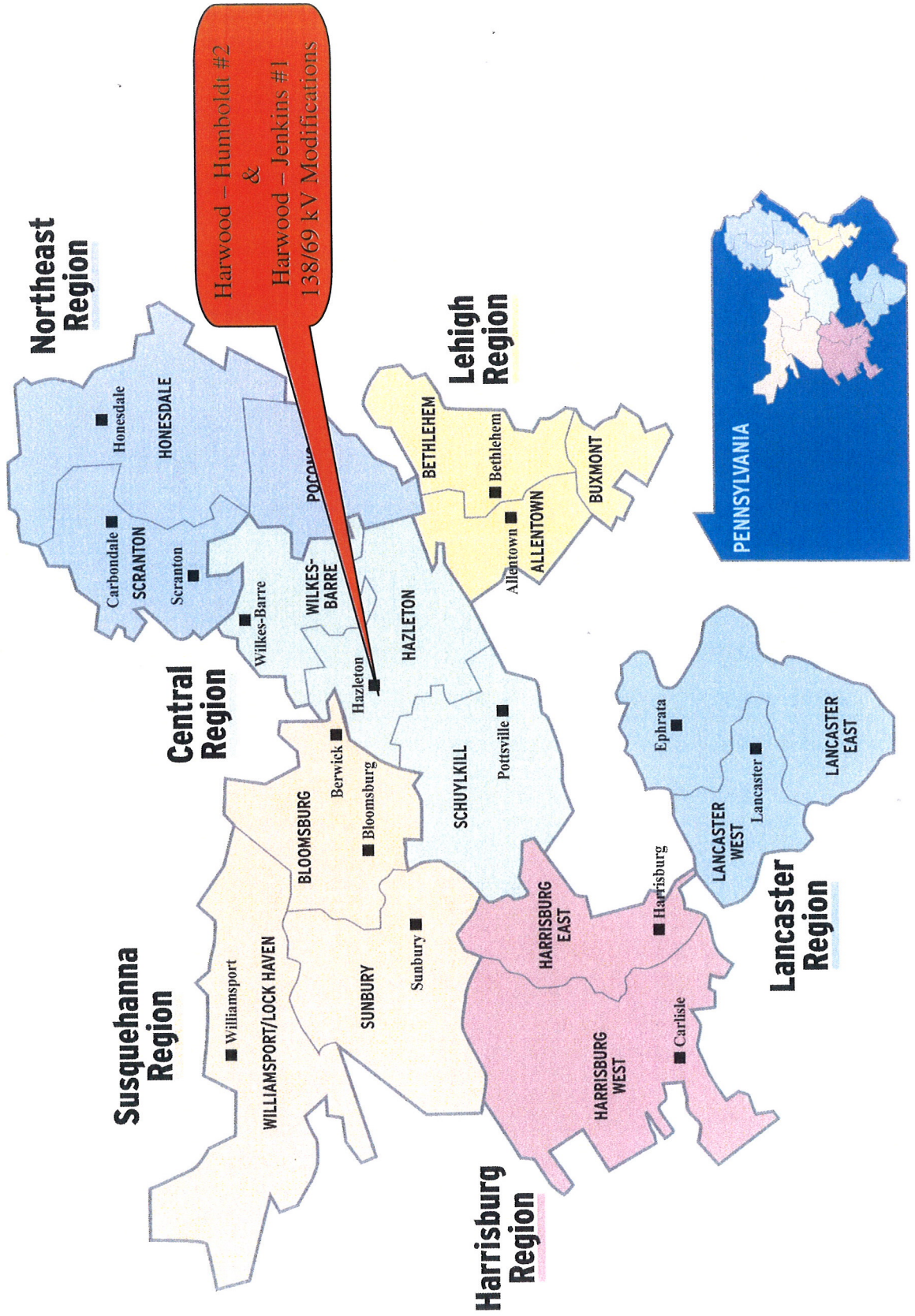
This filing is submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for PUC approval to modify transmission facilities around the new Harwood 138/69 kV Substation located in Hazle Township, Luzerne County. This work involves the existing Harwood – Humboldt #2 138/69 kV Line and the Harwood – Jenkins #1 138/69 kV Line. This project is required to: (i) avoid overloading the two 230-69 kV transformers at Harwood Substation during a contingency; (ii) maintain proper voltage on the Harwood 69 kV lines; and (iii) avoid an overload on the Hunlock-Berwick 69 kV line.

The estimated cost to design and construct the modified Harwood – Humboldt #2 138/69 kV Line and the Harwood – Jenkins #1 138/69 kV Line is \$570,000. Construction is scheduled to begin in January, 2011 to support the project's in-service date of November, 2011.

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 Involved Governmental Agencies, Municipalities,
and Other Public Entities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment 1

ATTACHMENT "1"

**HARWOOD – HUMBOLDT #2 138/69 kV LINE & HARWOOD – JENKINS #1
138/69 kV LINE MODIFICATIONS**

NECESSITY STATEMENT

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HARWOOD 230-69 kV SUBSTATION

MAP

MAP 1 PPL ELECTRIC SYSTEM MAP

Attachment "1"
Map Pocket

ATTACHMENT "1"

HARWOOD – HUMBOLDT #2 138/69 kV LINE & HARWOOD – JENKINS #1 138/69 kV LINE MODIFICATIONS

NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric proposes to reinforce the 230 kV and 69 kV transmission facilities in Luzerne County by installing a third 230-69 kV transformer and a new 138/69 yard at the Harwood Substation. To accomplish this reinforcement, PPL Electric requests PUC approval to re-terminate the Harwood-Humboldt #2 138/69 kV Line and Harwood-Jenkins #1 138/69 kV Line from the existing 69 kV yard at the Harwood Substation into a new 138/69 kV yard at the Harwood Substation. The new Harwood Substation 138/69 kV yard will be designed and constructed for 138 kV operation, although it initially will operate at 69 kV. The proposed Harwood-Humboldt #2 and Harwood-Jenkins #1 Line re-terminations collectively will require approximately 1,100 feet of new 138/69 kV line to be constructed to connect the existing lines with the new Harwood 138/69 kV yard.

This project is required to: (i) avoid overloading the two 230-69 kV transformers at Harwood Substation during a contingency; (ii) maintain proper voltage on the Harwood 69 kV lines; and (iii) avoid an overload on the Hunlock-Berwick 69 kV Line.

The estimated cost to design and construct the re-termination portion of this project is approximately \$570,000. Construction is scheduled to commence January, 2011 to meet a required in-service date of November, 2011. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads or unacceptable voltage levels that could potentially damage equipment and result in service interruptions to customers.

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

B. EXISTING SYSTEM

Figure 1 shows all the existing PPL Electric 230kV, 69 kV and 138kV transmission facilities at the Harwood Substation. Currently connected to the Harwood Substation are the following:

- Connected to the existing 230 kV yard:
 1. Susquehanna-Harwood #1 230 kV Line
 2. Susquehanna-Harwood #2 230 kV Line.
 3. Harwood-East Palmerton 230 kV Line.
 4. Siegfried-Harwood 230 kV Line.
 5. Two 230-69 kV transformers (designated T4 and T5), which are connected to two overhead 69 kV tie lines.

- Connected to the existing 69 kV yard:
 1. Two overhead 69 kV tie lines, which are connected to the two 230-69 kV transformers (designated T4 and T5).
 2. Three 69-12 kV transformers.
 3. Harwood-Berwick 69 kV Line.
 4. Harwood-Humboldt #2 138/69 kV Line. (formerly Harwood-Continental).
 5. Harwood-East Hazleton #1 138/69 kV Line.
 6. Harwood-East Hazleton #2 138/69 kV Line.
 7. Harwood-Jenkins #1 138/69 kV Line.
 8. Harwood-Jenkins #2 138/69 kV Line.

Approximately 270 MVA of load is served through the Harwood Substation. The Substation also receives into PPL Electric's network electricity generated by three independent generators.

C. DEFINITION OF THE PROBLEM

As a result of growth in the load served by the Harwood Substation, planning studies for 2011 project overloads on both 230-69 kV transformers beyond their emergency ratings under certain contingencies. Further, low 69 kV voltage, and voltage deviations greater than 5% are projected to occur on all the existing Harwood 138/69 kV lines should certain unplanned line and equipment outages occur under peak loading conditions. Overload conditions above the emergency rating or loss of either 230-69 kV transformer at the Harwood Substation would ultimately cause a failure of these lines. Low voltage levels or large changes in voltage could affect proper operation of residential customers' appliances as well as the operation of equipment supporting commercial and industrial businesses. Bus voltages lower than the planning limit of 62 kV would cause unacceptable customer service voltage that would be outside the limits required by PUC regulations.

Specifically, the planning studies projected overloading and low voltage under following contingencies:

- Loss of either Harwood 230-69 kV transformer could cause an overload on the other Harwood 230-69 kV transformer.
- Loss of the Susquehanna-Harwood #1 230 kV Line could cause an overload on the Harwood T4 Transformer.
- Loss of the north bus in the Harwood 230 kV yard could cause an overload on the Harwood T4 Transformer.
- Loss of the south bus in the Harwood 230 kV yard could cause an overload on the Harwood T5 Transformer.
- Loss of the Susquehanna-Harwood #1 and #2 230 kV Lines could cause an overload on the networked Harwood-Berwick 69 kV Line and could cause a voltage drop of between 5 and 10 percent for a significant portion of the load served from the Harwood Substation.

Any such overloading or low voltage would violate the reliability standards of the North American Electric Reliability Corporation, ReliabilityFirst Corporation and PJM Interconnect LLC, as well as PPL Electric's Reliability Principles and Practices.

D. PROPOSED SOLUTION

To resolve the issues discussed above, PPL Electric, with PUC approval of the two re-terminations set forth below, plans to construct the following:

- A new third 230-69 kV transformer (designated as T6) will be added to the Harwood Substation. The new transformer will connect with the existing Harwood-East Palmerton 230 kV Line. A new underground 69 kV transmission line will connect the new 230-69 kV T6 Transformer to the existing Harwood 69 kV yard.
- Motor operators will be added to breakers in the 230 kV yard to prevent the loss of two 230-69 kV transformers when outages with a stuck breaker condition occur.
- A new 138/69 kV yard will be added to the Harwood Substation. The new 138/69 kV yard will be designed and constructed for 138 kV operation, although it initially will operate at 69 kV. The two existing overhead 69 kV lines connecting the 69 kV yard with the T4 and T5 transformers at the 230 kV yard will be replaced by two new underground 69 kV lines that will connect the 69 kV yard to the T5 and T6 Transformers at the 230 kV yard.
- Approximately 250 feet of new 138/69 kV transmission line will be constructed to re-terminate the Harwood-Humboldt #2 138/69 kV Line from the existing 69 kV yard at the Harwood Substation into the new 138/69 kV yard.
- Approximately 850 feet of 138/69 kV line will be constructed to re-terminate the Harwood-Jenkins #1 138/69 kV Line from the existing 69 kV yard at the Harwood Substation into the new 138/69 kV yard.
- A 750-foot Yard Span will be constructed from the existing 69 kV yard at the Harwood Substation to the new 138/69 kV yard. This tie line will connect the existing 69 kV yard to the new 138/69 kV yard while the new yard is operated at 69 kV. The tie line will be removed at some future date when the new yard is converted to 138 kV operation.
- A Special Protection Scheme will be added to open the Yard Span when local generation would overduty breakers in the existing 69 kV yard at the Harwood Substation.

- The Harwood-Berwick 69 kV Line will be split and both line sections will terminate in the existing 69 kV yard. The portion connecting Harwood to Berwick will remain to be called the Harwood-Berwick 69 kV Line, and the split portion of the line will be terminated into the existing Harwood 69 kV yard and called the Harwood-Humboldt #1 69 kV Line.

Figure 2 shows the proposed PPL Electric 230kV, 69 kV and 138kV transmission facilities at the Harwood Substation. The total estimated cost for the proposed work is approximately \$15 million, which includes approximately \$12,860,000 for the substation work at Harwood, \$2,070,000 for all transmission line work, including the re-termination and undergrounding work, and \$60,000 for the relocation of related distribution lines. This filing covers only the 1,100 feet of new 138/69 kV line collectively required to re-terminate the Harwood-Humboldt #2 138/69 kV Line and Harwood-Jenkins #1 138/69 kV Line into the new 138/69 kV yard at the Harwood Substation. The estimated cost to design and construct these re-terminated transmission lines is approximately \$570,000. The re-termination of the Harwood-Humboldt #2 138/69 kV Line and Harwood-Jenkins #1 138/69 kV Line require prior PUC approval under 52 Pa. Code, Chapter 57, Subchapter G.

E. FUNCTIONAL ALTERNATIVES

PPL Electric considered one functional alternative that did not involve adding a new 138/69 kV yard at the Harwood Substation. This alternative would have required replacing multiple breakers in the existing 69 kV yard and rebuilding and expanding the 69 kV yard. PPL Electric, however, anticipates converting most of the 69 kV lines in the Harwood area to 138 kV operation in the near future. Therefore, it would not be economical to spend money on adding capacity to the existing 69 kV yard when most of the load would be moved to a new 138 kV yard in the near future. This alternative would also have required significant line rerouting and would have required construction of additional transmission lines at a higher cost.

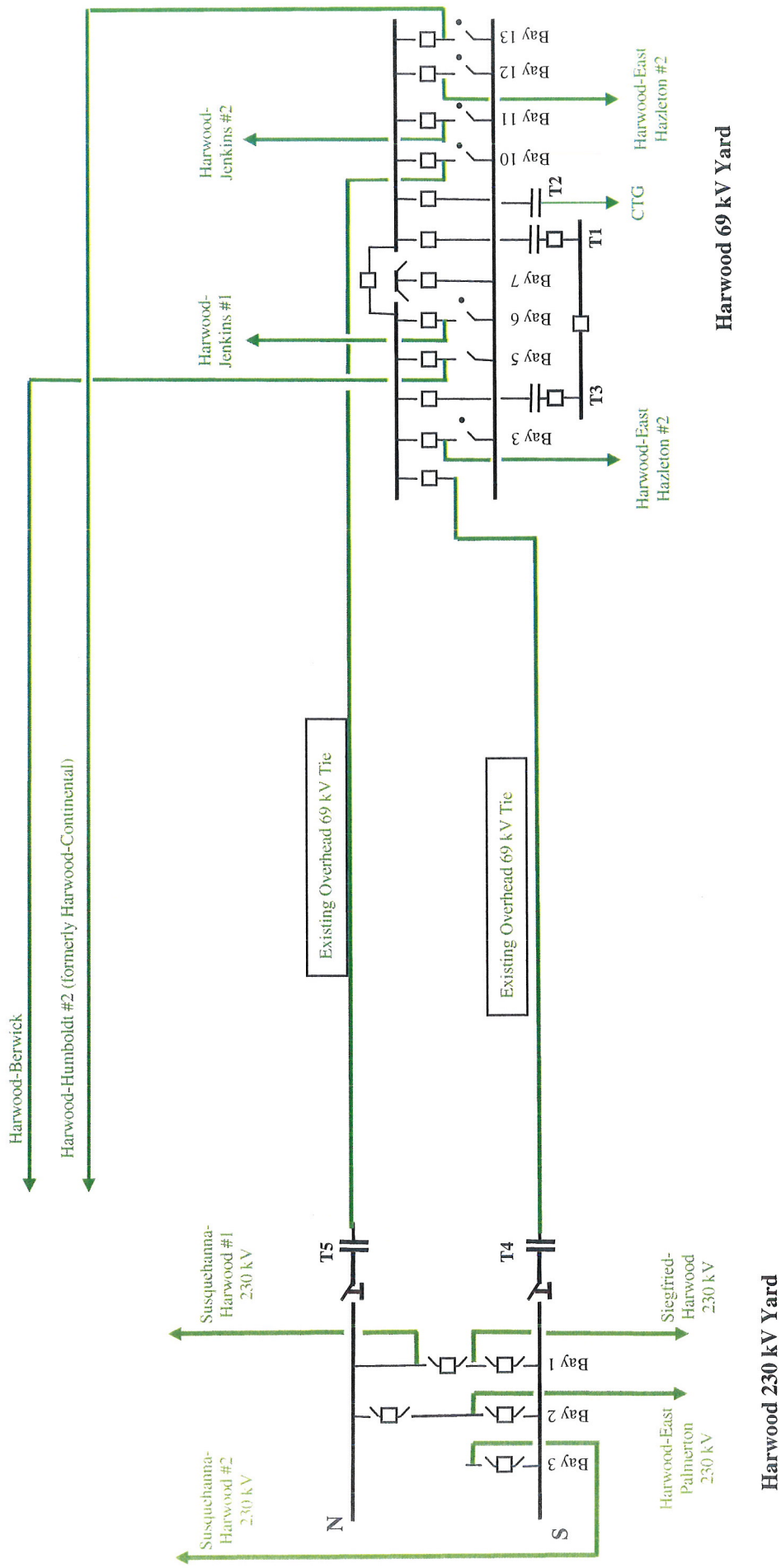
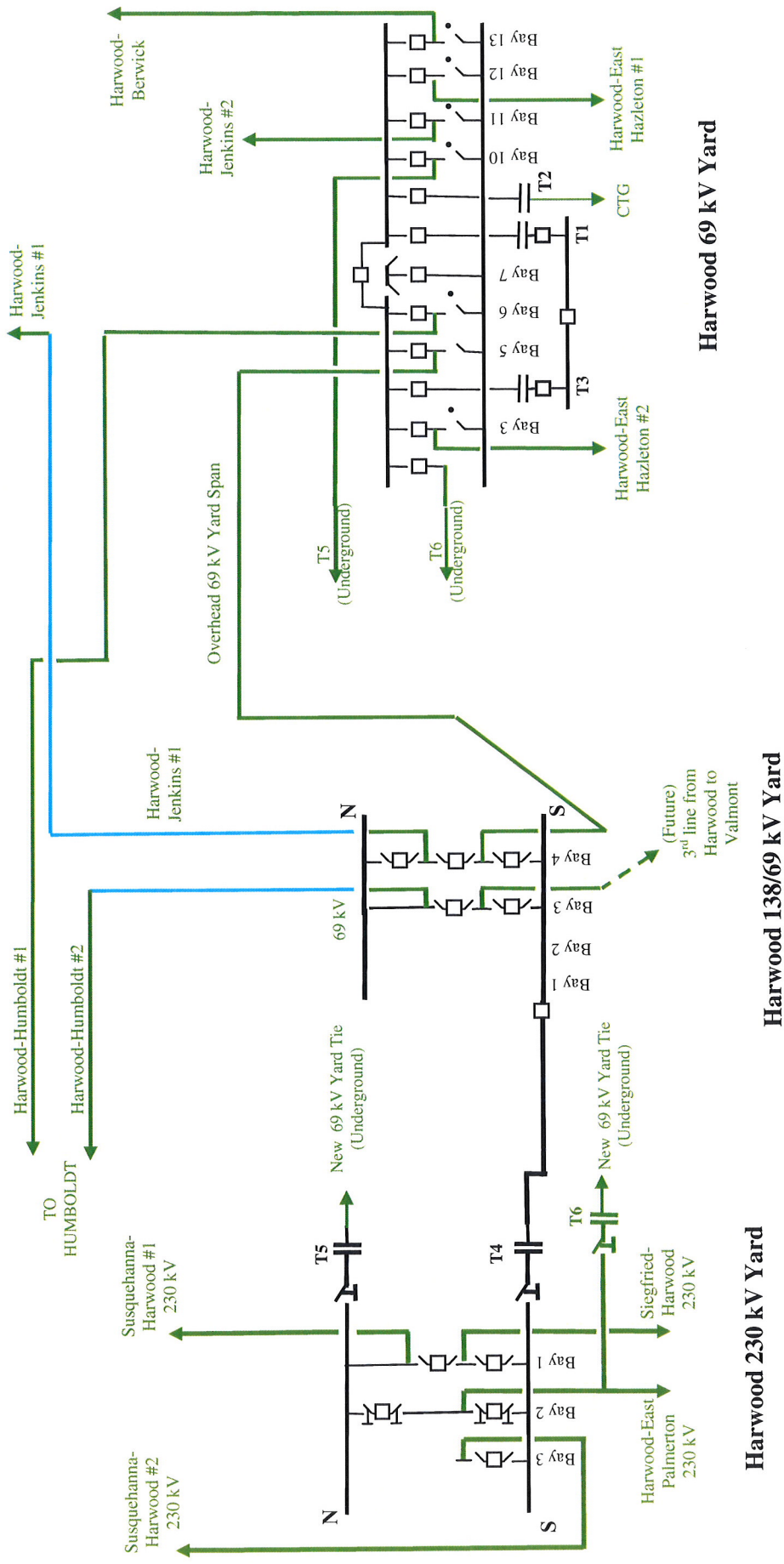


FIGURE 1



Harwood 69 kV Yard

Harwood 138/69 kV Yard

Harwood 230 kV Yard

— New lines to be certified for 138 kV

FIGURE 2

SUBSTATION LISTING

1 WEST WILLIAMSPORT	151 CRACKERSPORT	301 CENTER CITY
2 FAIRFIELD	152 SCHNECKSVILLE	302 NEW KINGSTOWN
3 MONTGOMERY	153 HEMLOCK	303 REAMSTOWN
4 HONESDALE	154 MT. ALLEN	304 DUPONT
5 JERSEY SHORE	155 PRINCE	305 HUMBOLDT
6 LOGANSBURG	156 WAKEFIELD	306 CEDAR AVE.
7 VALMONT	157 ODERSBURG	307 INDIAN ORCHARD
8 RIVER	158 WERTZVILLE	308 NOTTINGHAM
9 LIMESTONE	159 WEST CARLISLE	309 NORTH COOLBAUGH
10 NORTHUMBERLAND	160 BENVENUE	310 LETORT
11 REED	161 HEGINS	311 EAST MOUNTAIN
12 WRIGHT	162 LEDLA	312 JERMYN
13 ST. JOHNS	163 YATESVILLE	313 BLOOMSBURG
14 FRELAND	164 CENTRAL ALLENTOWN	314 MITCHELLTOWN
15 GILBERT	165 BERLIN	315 RIDGE ROAD
16 CHERRY HILL	166 STRASBURG	316 SUSQUEHANNA
17 SUSQUEHANNA 230KV	167 ATGLEN	317 -10 SW. YD.
18 TAMANEND	168 BROOKSIDE	318 CHRISTMANS
19 WHITE HILL	169 WILLIAMSTOWN	319 DITTER CREEK
20 PALMERTON	170 E. PETERSBURG	320 STEEL CITY
21 HAMILTON	171 WERNERSVILLE	321 MCGOVERNVILLE
22 HUNTER	172 N. BETHLEHEM	322 ROBESONIA
23 FAIRVIEW	173 V. ALLENTOWN	323 S.FOGELSVILLE
24 MONTOUR PUMP	174 HEMLOCK	324 ELROY
25 MT. CARMEL	175 MECKESVILLE	325 BUSHWILL
26 KELLY	176 DONERVILLE	326 WALLENPAUPACK
27 SPIRITING HILL	177 MILLERSVILLE	327 ELK MOUNTAIN
28 MAHANETOWN CITY	178 SHILLINGTON	328 JACK FROST
29 GREENWOOD	179 MCALLISTERVILLE	329 HARWOOD 230/69KV
30 NORTHUMBERLAND	180 NEWFOUNDLAND	330 HARWOOD CTG
31 WALKER	181 HARTIN	331 HARWOOD 69/12KV
32 FRAYLEY	182 EAST BERTWICK	332 NAZARETH
33 MORANTOWN	183 KEYSER AVENUE	333 ALBURTIS
34 CRESSONA	184 MICKLEYS	334 FRACKVILLE
35 SOUTH WHITEHALL	185 EAST ALLENTOWN	335
36 LACKY TOMCHICKEN	186 PINE RIDGE	336 DALMATIA
37 BEAR GAP	187 ASHFIELD	337 PENNSBURG
38 SALISBURY	39 SOUTH SLATINGTON	338 NORTH COLUMBIA
39 SOUTH MILTON	40 WALKER	339 SOUTH ALLENTOWN
40 LYKENS	41 FRAYLEY	340 MOSSPORT
41 UPPER HANDOVER	42 MORANTOWN	341 HONEYBROOK
42 MACADA	43 WEST	342 ROSSCOV
43 ROCKVILLE	44 CRESSONA	343 SOUTH WHITEHALL
44 THOMPSONTOWN	45 SOUTH WHITEHALL	344 LACKAWANNA
45 EAST CARBONDALE	46 SOUTH WHITEHALL	345 NORTHAMPTON
46 EARL	47 SOUTH WHITEHALL	346 WOODRICH
47 HEMPFIELD	48 SOUTH WHITEHALL	347 FAYON
48 EAST LANCASTER	49 SOUTH WHITEHALL	348 ELIZABETHTOWN
49 MT. NEBO	50 SOUTH WHITEHALL	349 ENOLA
50 MT. POCONO	51 SOUTH WHITEHALL	350 TERRE HILL
51 PENNS	52 SOUTH WHITEHALL	351 BUCK
52 DILLERVILLE	53 SOUTH WHITEHALL	352 MT. BETHEL
53 GIRARD HANOR	54 SOUTH WHITEHALL	353 RICHFIELD
54 KENMAR	55 SOUTH WHITEHALL	354 THOMPSONTOWN
55 GOVEN CITY	56 SOUTH WHITEHALL	355 PAXTON
56 ELLIOT HEIGHTS	57 SOUTH WHITEHALL	356 COCALICO
57 SHREWSBURY	58 SOUTH WHITEHALL	59 EAST ELIZABETHTOWN
58 MACUNGIE	59 SOUTH WHITEHALL	60 WARTICK
59 EAST HAZLETON	60 SOUTH WHITEHALL	61 EARL
60 WAGNER	61 SOUTH WHITEHALL	62 HEMPFIELD
61 EAST CARBONDALE	62 SOUTH WHITEHALL	63 EAST LANCASTER
62 EYNON	63 SOUTH WHITEHALL	64 MT. NEBO
63 MINDOKA	64 SOUTH WHITEHALL	65 MT. POCONO
64 OLD FORGE	65 SOUTH WHITEHALL	66 PENNS
65 MOUNTAIN SPRINGS	66 SOUTH WHITEHALL	67 DILLERVILLE
66 SULLIVAN TRAIL	67 SOUTH WHITEHALL	68 GIRARD HANOR
67 SVATARA	68 SOUTH WHITEHALL	69 KENMAR
68 HEPBURN	69 SOUTH WHITEHALL	70 GOVEN CITY
69 HATFIELD	70 SOUTH WHITEHALL	71 ELLIOT HEIGHTS
70 HERSHEY	71 SOUTH WHITEHALL	72 SHREWSBURY
71 S. HERSHEY	72 SOUTH WHITEHALL	73 MACUNGIE
72 WILLIAMSPORT	73 SOUTH WHITEHALL	74 EAST HAZLETON
73 FOGELSVILLE	74 SOUTH WHITEHALL	75 WAGNER
74 WINDSOR	75 SOUTH WHITEHALL	76 EAST CARBONDALE
75 V. WILLOW	76 SOUTH WHITEHALL	77 EYNON
76 WESTGATE	77 SOUTH WHITEHALL	78 MINDOKA
77 EDLA	78 SOUTH WHITEHALL	79 OLD FORGE
78 SUMMERDALE	79 SOUTH WHITEHALL	80 MOUNTAIN SPRINGS
79 DORNEVILLE	80 SOUTH WHITEHALL	81 SULLIVAN TRAIL
80 BOWEN	81 SOUTH WHITEHALL	82 SVATARA
81 WHITE HAVEN	82 SOUTH WHITEHALL	83 HEPBURN
82 LAURELTON	83 SOUTH WHITEHALL	84 HATFIELD
83 LINGLESTOWN	84 SOUTH WHITEHALL	85 HERSHEY
84 POCONO FARMS	85 SOUTH WHITEHALL	86 S. HERSHEY
85 HICKORY RUN	86 SOUTH WHITEHALL	87 WILLIAMSPORT
86 BLOOMING GLEN	87 SOUTH WHITEHALL	88 FOGELSVILLE
87 SHERMANSDALE	88 SOUTH WHITEHALL	89 WINDSOR
88 LARRY CREEK	89 SOUTH WHITEHALL	90 V. WILLOW
89 SPANGLER MILLS	90 SOUTH WHITEHALL	91 WESTGATE
90 E. DANVILLE	91 SOUTH WHITEHALL	92 EDLA
91 DELAND	92 SOUTH WHITEHALL	93 SUMMERDALE
92 CARBON	93 SOUTH WHITEHALL	94 DORNEVILLE
93 SELERSVILLE	94 SOUTH WHITEHALL	95 BOWEN
94 MECHANICSBURG	95 SOUTH WHITEHALL	96 WHITE HAVEN
95 CARLISLE	96 SOUTH WHITEHALL	97 LAURELTON
96 ARROWHEAD	97 SOUTH WHITEHALL	98 LINGLESTOWN
97 NEWPORT	98 SOUTH WHITEHALL	99 POCONO FARMS
98 HALIFAX	99 SOUTH WHITEHALL	100 HICKORY RUN
99 MILLERSBURG	100 SOUTH WHITEHALL	101 BLOOMING GLEN
100 MUNCY	101 SOUTH WHITEHALL	102 SHERMANSDALE
101 HALTIC	102 SOUTH WHITEHALL	103 LARRY CREEK
102 BEVILICK	103 SOUTH WHITEHALL	104 SPANGLER MILLS
103 SHENANDOAH	104 SOUTH WHITEHALL	105 E. DANVILLE
104 PINE GROVE	105 SOUTH WHITEHALL	106 DELAND
105 STROUDSBURG	106 SOUTH WHITEHALL	107 CARBON
106 FREENANSBURG	107 SOUTH WHITEHALL	108 SELERSVILLE
107 ALLENTOWN	108 SOUTH WHITEHALL	109 MECHANICSBURG
108 BINGEN	109 SOUTH WHITEHALL	110 CARLISLE
109 KEYSER	110 SOUTH WHITEHALL	111 ARROWHEAD
110 CLEVELAND	111 SOUTH WHITEHALL	112 NEWPORT
111 LITTLE GAP	112 SOUTH WHITEHALL	113 HALIFAX
112 GRVILLA	113 SOUTH WHITEHALL	114 MILLERSBURG
113 TUSCARORA	114 SOUTH WHITEHALL	115 MUNCY
114 BARTONSVILLE	115 SOUTH WHITEHALL	116 HALTIC
115 ALTON PARK	116 SOUTH WHITEHALL	117 BEVILICK
116 SALEN	117 SOUTH WHITEHALL	118 SHENANDOAH
117 NORTH BRIDGEPORT	118 SOUTH WHITEHALL	119 PINE GROVE
118 HAMPDEN	119 SOUTH WHITEHALL	120 STROUDSBURG
119 CAMEL BACK	120 SOUTH WHITEHALL	121 FREENANSBURG
120 SILVER SPRING	121 SOUTH WHITEHALL	122 ALLENTOWN
121 BRECKNOCK	122 SOUTH WHITEHALL	123 BINGEN
122 BENTON	123 SOUTH WHITEHALL	124 KEYSER
123 MICHAELS	124 SOUTH WHITEHALL	125 CLEVELAND
124 HUGHESTOWN	125 SOUTH WHITEHALL	126 LITTLE GAP
125 NEWVILLE	126 SOUTH WHITEHALL	127 GRVILLA
126 POINT E NORTH	127 SOUTH WHITEHALL	128 TUSCARORA
127 MARIETTA	128 SOUTH WHITEHALL	129 BARTONSVILLE
128	129 SOUTH WHITEHALL	130 ALTON PARK
129	130 SOUTH WHITEHALL	131 SALEN
130	131 SOUTH WHITEHALL	132 NORTH BRIDGEPORT
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134	135 SOUTH WHITEHALL	136 BRECKNOCK
135	136 SOUTH WHITEHALL	137 BENTON
136	137 SOUTH WHITEHALL	138 MICHAELS
137	138 SOUTH WHITEHALL	139 HUGHESTOWN
138	139 SOUTH WHITEHALL	140 NEWVILLE
139	140 SOUTH WHITEHALL	141 POINT E NORTH
140	141 SOUTH WHITEHALL	142 MARIETTA
141	142 SOUTH WHITEHALL	143
142	143 SOUTH WHITEHALL	144
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150	151 SOUTH WHITEHALL	

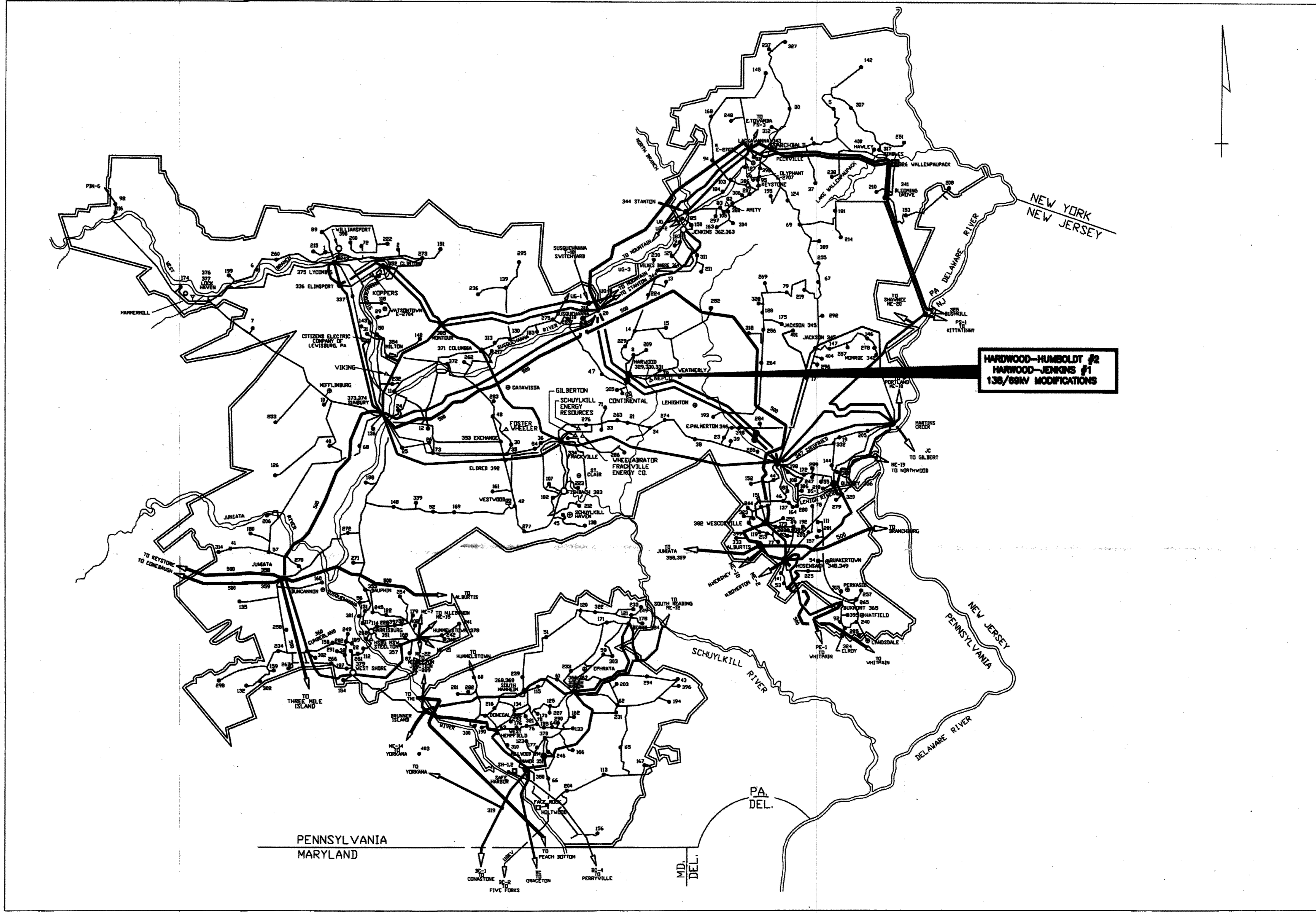
* - SUBSTATIONS THAT HAVE BEEN RETIRED.
 ** - SITE OF THE EXISTING 230KV SUBSTATION AND PROPOSED 500KV SUBSTATION

INTERCONNECTIONS

PS PUBLIC SERVICE ELECTRIC AND GAS CO. OF N.J.
 PE 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)

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

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



**HARDWOOD-HUMBOLDT #2
 HARWOOD-JENKINS #1
 138/69KV MODIFICATIONS**

ACCT- 805201	ELECTRICAL SYSTEM MAP	
SCALE- NONE	HARWOOD-HUMBOLDT #2 138/69KV	
BY- CDW	HARWOOD-JENKINS #1 138/69KV	
APPROVED G. HAKUN III	DATE 7/1/785	PPL ELECTRIC UTILITIES
PPL DRAWING NO. D191830	SHEET NO. 1	REV. 68

PPL E.U. FORM 4877 (7/80)

PC CAD

Attachment 2

ATTACHMENT "2"

**HARWOOD – HUMBOLDT #2 & HARWOOD – JENKINS #1 138/69 kV LINE
MODIFICATIONS**

ENGINEERING DESCRIPTION

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ATTACHMENT "2"

HARWOOD – HUMBOLDT #2 138/69 kV LINE & HARWOOD – JENKINS #1 138/69 kV LINE MODIFICATIONS

ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to reinforce the 230 kV and 69 kV transmission facilities in southern Luzerne County by installing a new third 230-69 kV transformer and new 138/69 kV yard at the Harwood substation. To accomplish this reinforcement, PPL Electric requests PUC approval to re-terminate the existing Harwood-Humboldt #2 and Harwood-Jenkins #1 138/69 kV Lines into the new 138/69 kV yard at Harwood Substation, which will be designed for future 138 kV operation but initially operated at 69 kV. To accomplish this re-termination, PPL Electric, with the PUC's approval, proposes to re-terminate the existing Harwood – Humboldt #2 138/69 kV Line into the new Harwood 138/69 kV yard by constructing approximately 250 feet of new 138/69 kV line. Also, the existing Harwood – Jenkins #1 138/69 kV Line will be re-terminated into the proposed Harwood 138/69 kV yard by constructing approximately 850 feet of new 138/69 kV line. Collectively, these proposed line modifications will require the construction of approximately 1,100 feet of new transmission lines. Both proposed lines will utilize steel mono-poles approximately 85-95 feet high, which will be installed on concrete foundations or direct embedded. These proposed line sections will consist of three power conductors and one overhead ground wire. The conductors will be 556.5 KCMIL, 24/7 stranding ACSR, and the ground wire will be 3/8 inch extra high strength steel. The entire project is on property owned in fee by PPL Electric. The project is located in Hazle Township, Luzerne County. A plot plan for the transmission line project is provided in the Attachment "2" map pocket.

The proposed line will be designed to, and generally exceed, National Electrical Safety Code (NESC) standards. Design specifications and safety rules practiced by PPL Electric are

included in Attachment 4. The minimum conductor to ground clearance will be 30 feet, which occurs 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 556.5 KCMIL 24/7 STRANDING ACSR*

<u>Condition</u>	<u>Transmission Double-Circuit Design Clearance-to-Ground</u>
Normal load; average weather (16°C ambient temperature)	34.5 feet
Predicted extreme thermal load (125°C conductor temperature)	30 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -9°C)	32.5 feet

*Clearances based on a maximum tension of 7500 pounds and a ruling span of 400 feet.

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

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

B. MAGNETIC FIELD MANAGEMENT

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

Both proposed lines will be constructed as single circuit transmission lines. Therefore, reduction of the magnetic field through reverse phasing is not possible. Some reduction of magnetic field is anticipated through the use of taller poles.

C. RIGHT-OF-WAY STATUS

All work will be completed on land owned by PPL Electric in fee. No additional right-of-way or other property interest is required.

LEGEND

- EXISTING TRANSMISSION LINE —
- PROPOSED TRANSMISSION LINE —
- NEW 69 KV LINES —
- EXISTING PROPERTY LINE —
- LINES TO BE REMOVED x x x x x x x x



EXISTING HARWOOD - JENKINS #1
138/69 KV LINE

NEW 138/69 KV LINE
CONNECTIONS

NEW HARWOOD 138/69 KV
SUBSTATION

EXISTING HARWOOD 69 KV
SUBSTATION

EXISTING HARWOOD 230/69 KV
SWITCHYARD

EXISTING HARWOOD HUMBOLDT#1
#2 138/69 KV LINE

ATTACHMENT 2

AERIAL EXHIBIT
SHEET 1

HARWOOD - HUMBOLDT #2
HARWOOD - JENKINS #1
138/69KV LINES
HAZEL TOWNSHIP
LUZERNE COUNTY, PA.

SCALE: 1" = 200'

ppl PREPARED BY:
PPL ELECTRIC UTILITIES CORP.
PPL ELECTRIC UTILITIES

Attachment 3

ATTACHMENT "3"

**HARWOOD – HUMBOLDT #2 138/69 kV LINE & HARWOOD – JENKINS #1 138/69 kV
LINE MODIFICATIONS**

ENVIRONMENTAL ASSESSMENT

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ATTACHMENT "3"

HARWOOD – HUMBOLDT #2 138/69 kV LINE & HARWOOD – JENKINS #1 138/69 kV LINE MODIFICATIONS

ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric plans to reconfigure some of its transmission facilities located in and around the Harwood 230-69 kV Substation in order to eliminate low voltage concerns and potential interruption of electrical service to customers in Luzerne County. This project is required to maintain adequate 69 kV bus voltage under unplanned line and equipment outages. The project involves re-terminating the Harwood – Humboldt #2 138/69 kV Line and the Harwood – Jenkins #1 138/69 kV Line into a new 138-69 kV yard at the Harwood Substation. These line modifications were identified as part of the overall long-term transmission plan that will alleviate reliability and overload concerns in Hazleton and the surrounding areas.

The proposed project was reviewed with Hazle Township and Luzerne County, and neither the Township nor the County has any objection. A list of involved governmental agencies, municipalities and other public entities is presented in Attachment 6.

B. LAND USE

Both the proposed Harwood – Humboldt #2 138/69 kV Line and the Harwood-Jenkins #1 138/69 kV Line construction will be located entirely on PPL Electric property just outside the fence of the Harwood 230-69 kV Substation. Therefore, no additional impact on existing land use is anticipated.

No nearby railroads, communication towers, pipelines or other utilities will be affected by the proposed project. Hazleton Municipal Airport is located approximately 3.6 miles from the project location. PPL Electric, as required, will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation to ensure the proposed line section is not a hazard to the airport's flight operations.

C. CULTURAL RESOURCES

This project was reviewed with the Pennsylvania Historical and Museum Commission (PHMC). PHMC has determined that due to the absence of historical sites and the small project size no further archaeological investigations are required.

The following lists were reviewed for the presence of historical districts and structures in the area:

- National Historic Landmarks in Pennsylvania
- National Register Historic Districts in Pennsylvania
- National Register Individual Properties and Historic Districts in Pennsylvania
- National Register/Listed and Eligible Properties in Pennsylvania

D. NATURAL FEATURES

The proposed project will not affect any unique geological, scenic, or natural areas. No parks or recreational facilities are located near the project area. Some tree clearing will be required. The lines will not cross any wetlands or other aquatic resources. 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 the impacts during any tree clearing activities

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with different state and federal agencies to obtain information regarding endangered and threatened species in the study area. A review of the Pennsylvania Natural Diversity Inventory records indicates there is one potential conflict in the area of this project recorded by Pennsylvania Game Commission (PGC). PPL Electric has requested review of the project area by PGC to be sure that the project will have no impacts to any known threatened and endangered species. A letter dated May 17, 2010 from PGC limits tree cutting activities within the project area to between November 1st and March 31st to protect a species of special concern, known as , Northern Long-eared Bat. PPL Electric will comply with this restriction.

LIST OF ATTACHMENTS

- ATTACHMENT 4 - PPL Electric Design Criteria and Safety Practices
- ATTACHMENT 5 - Magnetic Field Management at PPL Electric
- ATTACHMENT 6 - List of Involved Governmental Agencies, Municipalities, and Other Public Entities

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 Utilities Corp. (PPL Electric) has developed design specifications and safety rules which meet or surpass all provisions specified by the NESC.

Engineering Design Criteria and Parameters

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

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

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

138 kV

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

230 kV

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

500 kV

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

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

Periodic Maintenance Program on All Transmission Lines

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use of helicopter patrols, with supplemental foot and structure climbing patrols. 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, who sits to the right of the pilot, 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 so that hardware can be inspected safely. Overhead patrols of transmission lines are conducted on a schedule determined by line age, operating record, and observed general condition. Any necessary repairs are also done during the inspection outage.

Personnel Safety Rules

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

- Work procedures have been developed to allow work to be performed on energized facilities in a safe manner. When lines or apparatus are removed from service to be worked on, the Energy Control Process system is applied. This system provides that a red tag must be physically placed on the control handle of the de-energized equipment. The red tag may be removed only after

proper authorization to energize the equipment. Various other tags are used for limited operations and informational purposes. Employees will not apply or remove a tag or change the status of tagged equipment unless authorized.

- Temporary safety grounds are used on de-energized facilities for employee safety during maintenance, construction, or reconstruction work. Safety grounds are wires connecting the de-energized facility to an electrical ground. If the facility should be energized, the safety grounds will divert the current directly to ground and reduce the likelihood of personal injury. The conductor size and attachment clamps of temporary safety grounds must be capable of conducting anticipated fault currents. Rubber gloves, rubber sleeves, and additional rubber protective equipment are used as required when applying or removing temporary safety grounds to or from the lines or apparatus to be grounded. An approved nonconductive working stick of sufficient length to allow workers to maintain the following required minimum clearances is used to test that the line has been de-energized and to apply temporary safety grounds:

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

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

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

Attachment 5



**MAGNETIC
FIELD
MANAGEMENT**
PPL Electric Utilities
Corporation

ATTACHMENT 5

DECEMBER 2004

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INTRODUCTION

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

PPL EU's View

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

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

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

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

EMF Are All Around Us

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

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

Electric Fields

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

Electric fields diminish with distance and can be blocked or partially shielded by objects such as trees and houses.

Magnetic Fields

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

Figure 1

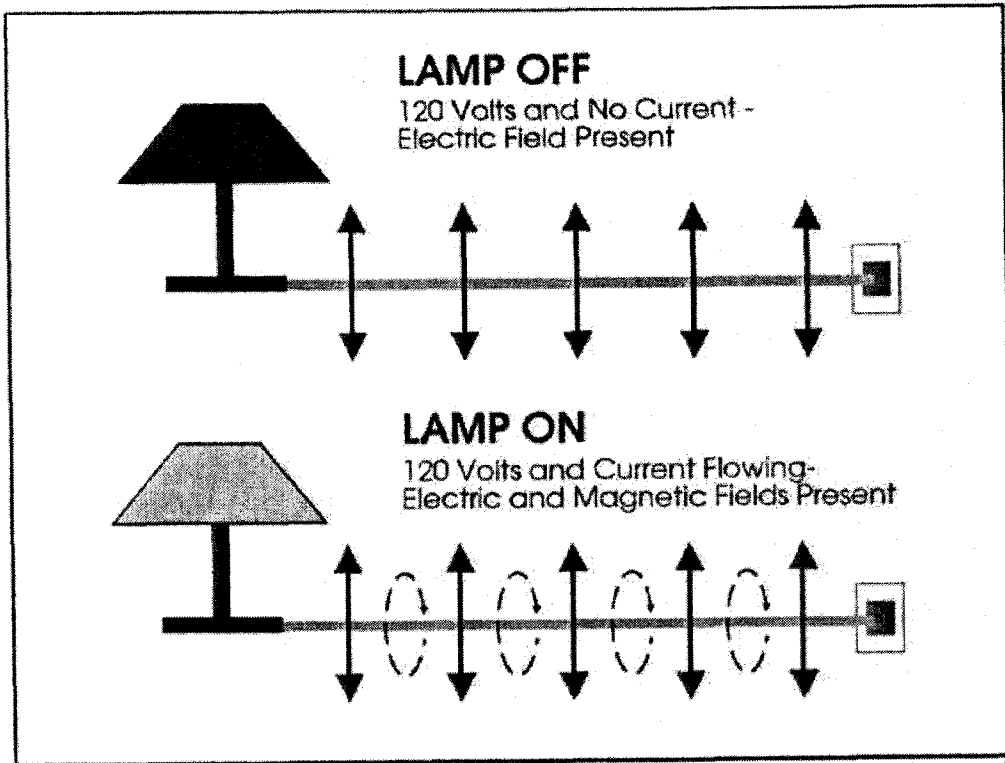


Figure 2









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

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

Measuring Magnetic Fields

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

Figure 3

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

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

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

VARIABLES THAT AFFECT MAGNETIC FIELDS

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

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

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

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

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

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

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

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

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

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

SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

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

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

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

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

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

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

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

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

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

Chart VI illustrates the compact design structure.

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

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

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

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

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

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

138/69 kV Transmission Lines

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

230 kV Transmission Lines

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

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

500 kV Transmission Lines

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

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

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

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

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

DISTRIBUTION LINES

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

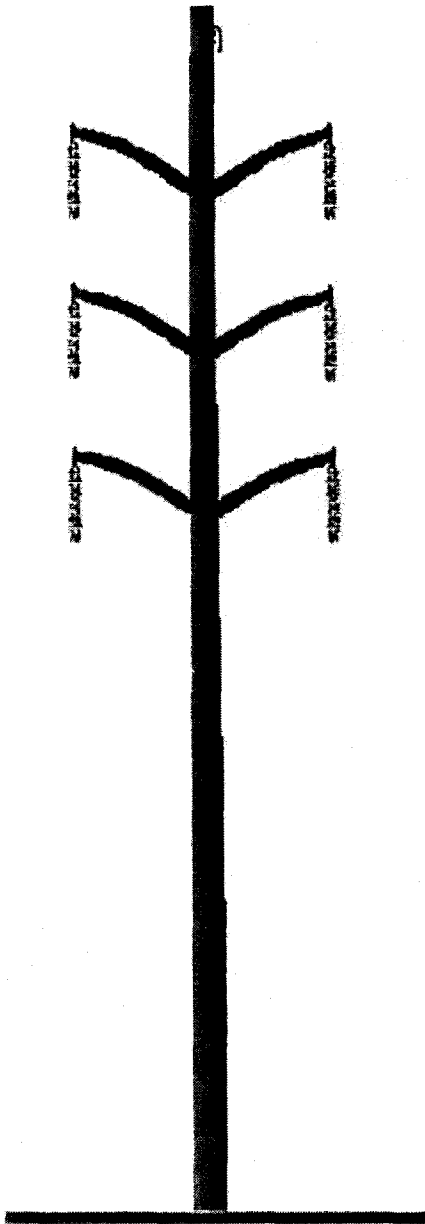
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

UNDERGROUND TRANSMISSION LINES

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

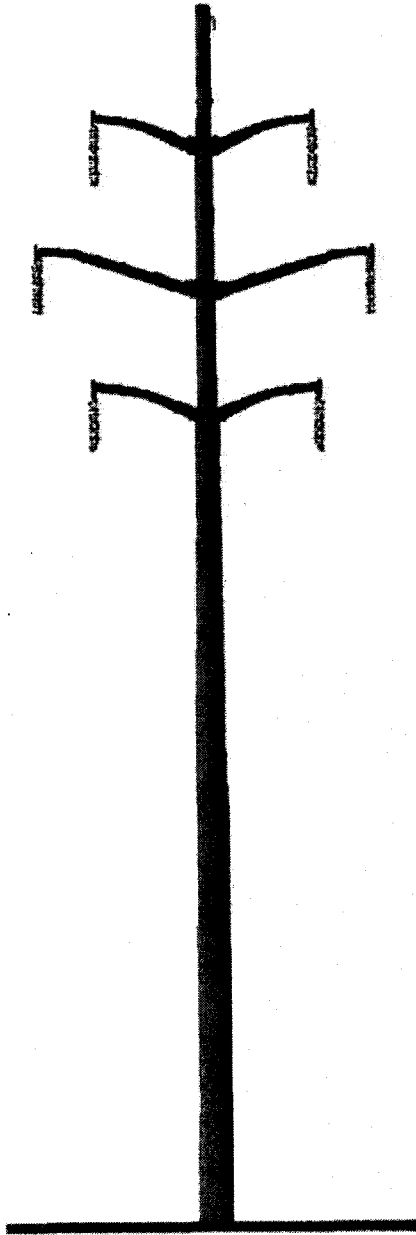
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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

Short-Span Construction



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

Long-Span Construction Remains PPL EU 138 kV Standard



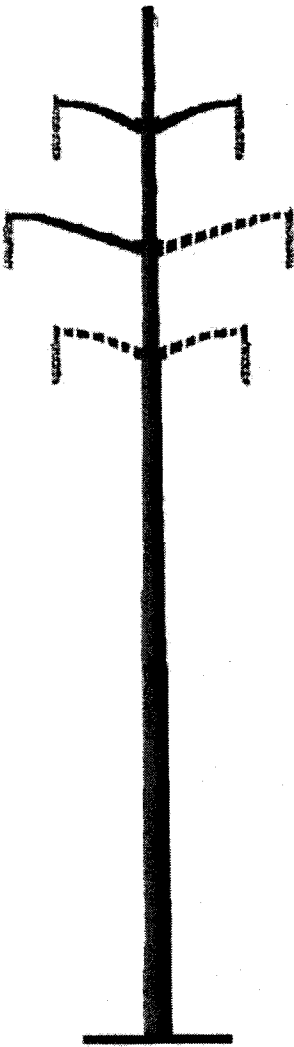
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

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

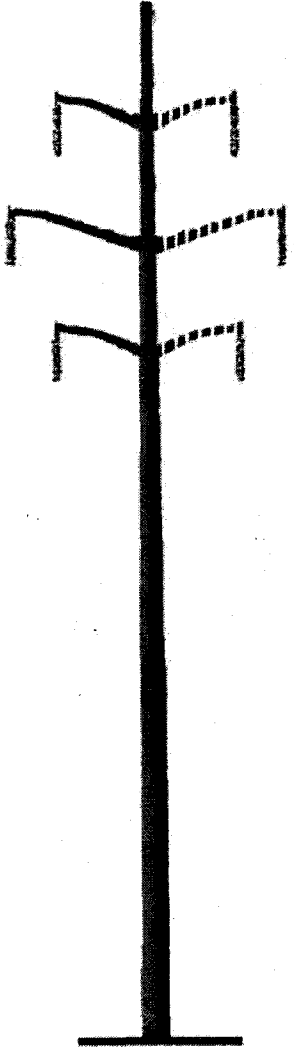
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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

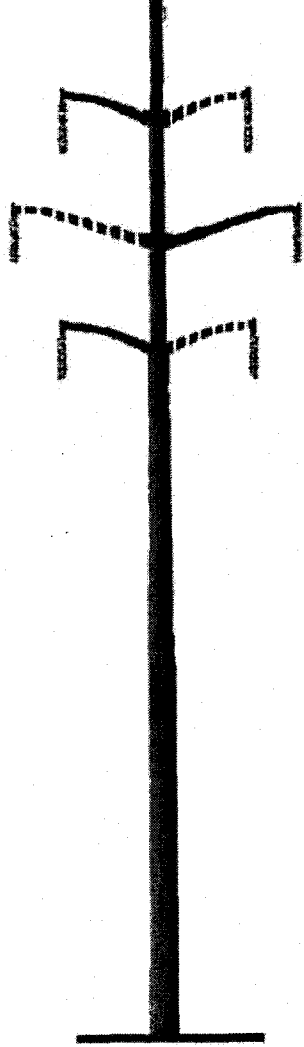
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

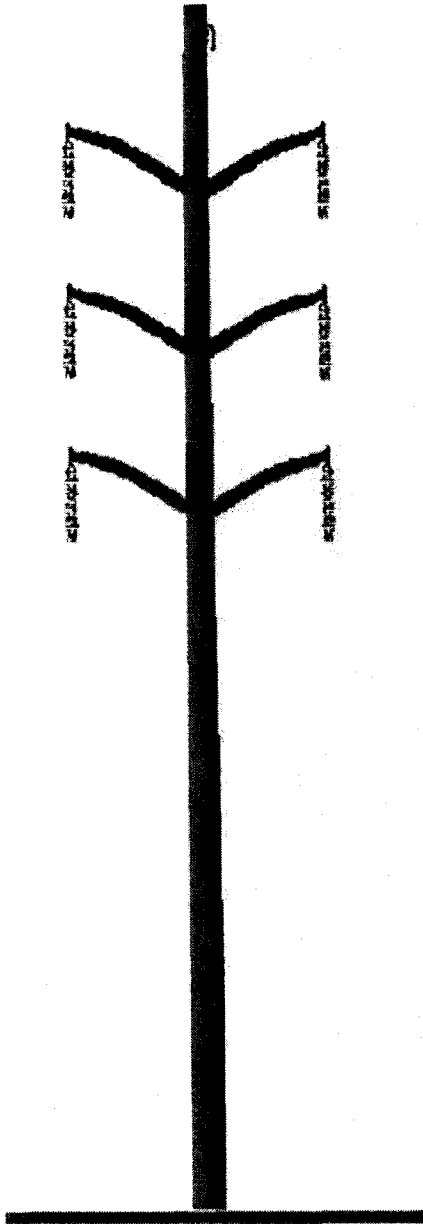
——— initial single circuit
- - - - - future second circuit

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

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

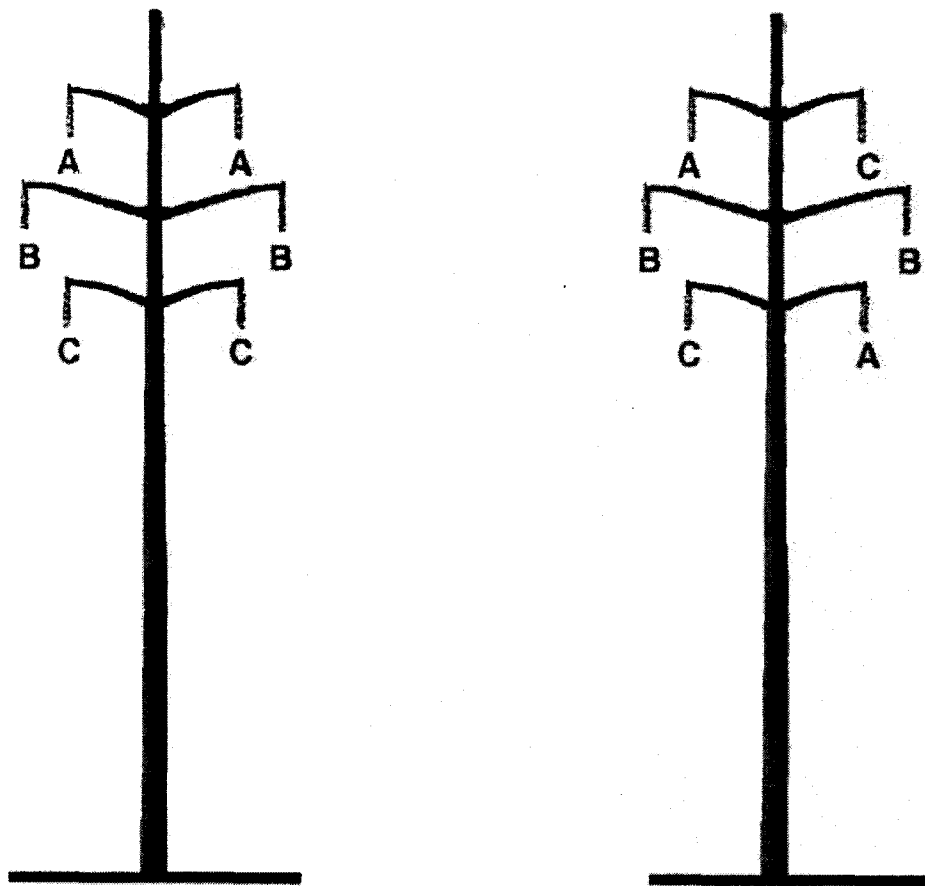
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

Compact Design Structure



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

Reverse Phasing of Double-Circuit Transmission Lines



From: → → → → To:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Attachment 6

ATTACHMENT 6

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. McLearn, Chief

Pennsylvania Department of Transportation
Commonwealth Keystone Building
400 North Street, 8th Floor
Harrisburg, Pennsylvania 17120
Attn: The Honorable Allen D. Biehler, P.E., Secretary

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

Adrian Merolli, Director
Luzerne County Planning Commission
Penn Place
20 N. Pennsylvania Avenue
Wilkes-Barre, PA. 18711

William J. Gallagher, Chair
Hazle Township Board of Supervisors
P.O. Box 506
Harleigh, PA. 18225

Luzerne County Commissioners
200 North River Street
Wilkes-Barre, PA 18711-1001

Paul Matulevich
Hazle Township Planning Department
PO Box 506
Harleigh, PA 18225