

Before the
Pennsylvania Public Utility Commission

ELROY #2 500 kV TIE LINE

ATTACHMENTS IN SUPPORT OF THE
Letter of Notification

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

SUMMARY

This Letter of Notification is being submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Commission's regulations at 52 Pa. Code §§ 57.71 through 57.77, for approval to site and construct the new Elroy #2 500 kV Tie Line, which will be approximately 215 feet long. The proposed tie line will be constructed between the PECO Energy Company's ("PECO") Elroy 500 kV Switchyard and PPL Electric's Elroy 500-138-69 kV Substation, and will be situated adjacent to the existing Elroy #1 500 kV Tie Line. This proposed tie line is required to feed the new double circuit Elroy-Hatfield #1 & #2 138/69 kV Transmission Line which was the subject of PPL Electric's October 25, 2010 *Petition for a Waiver of Certain Provisions of the Siting Regulations*, at Docket No. P-2010-2206466. This project will be conducted in concert with the proposed construction of the Elroy-Hatfield 138/69 kV Transmission Line. A Letter of Notification for the proposed Elroy-Hatfield Transmission Line is being submitted concurrently with this submission.

This project is located in Hatfield Township, Montgomery County, as shown on the PPL Electric Service Territory figure located at the end of this section. The proposed tie line will be designed and constructed as a single 500 kV circuit and will be placed adjacent to the existing Elroy #1 500 kV Tie Line. The estimated cost to site, design and construct the Elroy #2 500 kV Tie Line is \$2 million. Construction is scheduled to begin as early as February of 2012, depending on PPL Electric's ability to schedule outages at the PECO Elroy 500 kV Switchyard to enable it to perform the necessary work, to support the project's in-service date of March 2013.

This document, which describes the need for the project and explains the engineering and siting analysis for the proposed construction, consists of the following:

- | | |
|----------------|---|
| Attachment "1" | Necessity Statement |
| Attachment "2" | Engineering Description |
| Attachment "3" | Environmental Assessment |
| Attachment "4" | PPL Electric Design Criteria and Safety Practices |
| Attachment "5" | PPL Electric Magnetic Field Management Program |

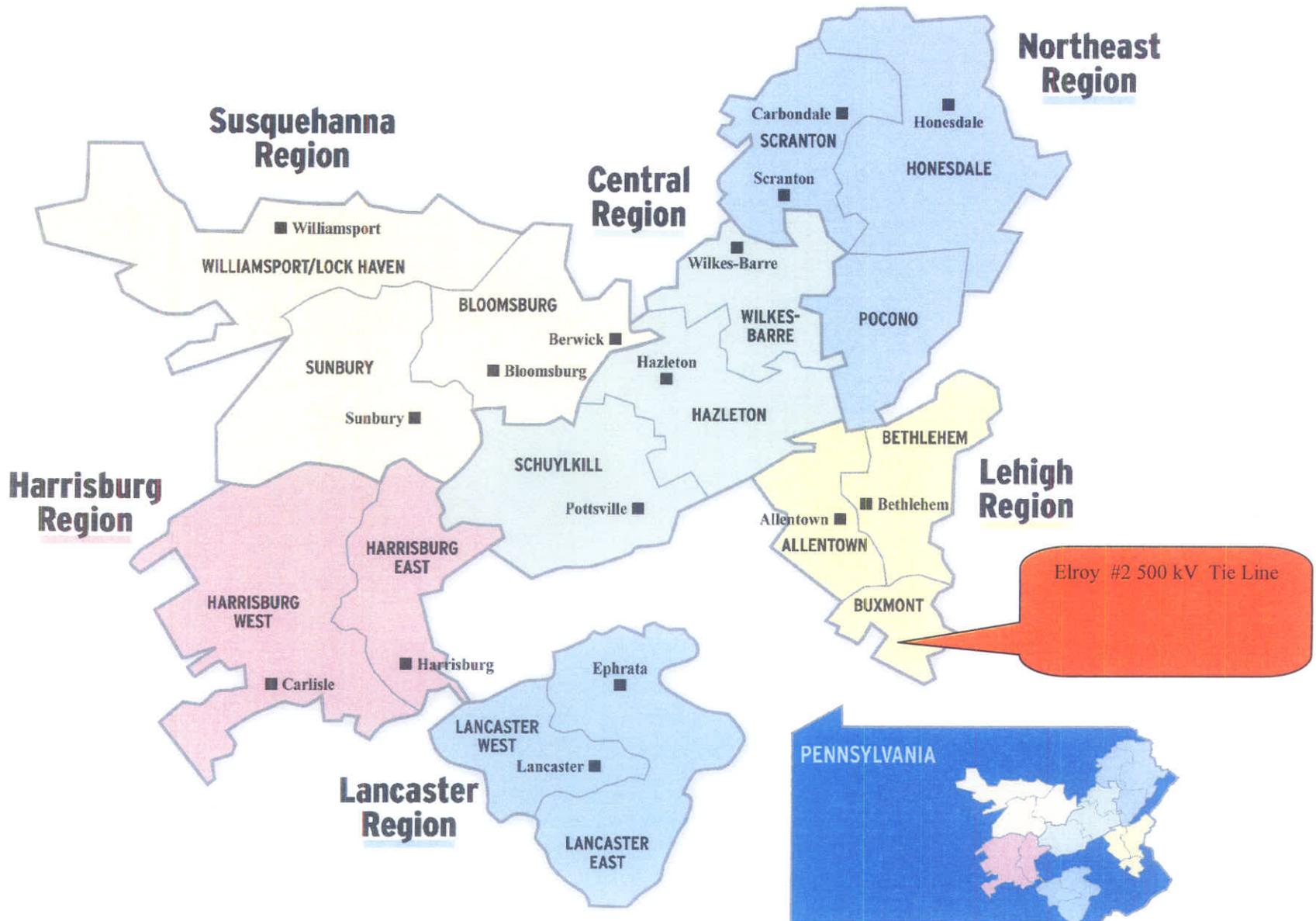
Attachment "6"

List of Owners of Property Within the Right-of-Way

Attachment "7"

List of Involved Governmental Agencies, Municipalities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



Attachment

1

ATTACHMENT "1"
ELROY#2 500 kV TIE LINE
NECESSITY STATEMENT

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ATTACHMENT "1"
ELROY#2 500 kV TIE LINE
NECESSITY STATEMENT

A. PROJECT NECESSITY

PPL Electric's Elroy 500-138-69 kV Substation is presently supplied from the Elroy #1 500 kV Tie Line off the PECO Elroy 500 kV Switchyard. PPL Electric's Elroy Substation has one 500-138 kV transformer in series, with one 138-69 kV transformer which feeds two 69 kV transmission lines. These two transmission lines are named the Buxmont-Elroy #1 & #2 69 kV Lines and serve approximately 18,000 customers in Hatfield and Lansdale Boroughs and Hatfield, Franconia, and West Rockhill Townships. PPL Electric's Buxmont 230-69 kV Substation is supplied by two 230 kV transmission lines, one from PPL Electric's Hosensack and one from the Whitpain Substations. The Buxmont Substation has two 230-69 kV transformers which feed six 69 kV lines. Buxmont Substation has a load shed scheme that will drop load for the loss of the two 230 kV sources.

In order to guide its planning processes and to establish standards for its transmission and distribution systems which will enable it to provide safe and reliable service at a reasonable cost, PPL Electric has adopted its Reliability Principles and Practices ("RP&P"). PPL Electric relies on the standards set forth in the RP&P for guidance in determining when it is appropriate to reinforce its transmission and distribution systems.

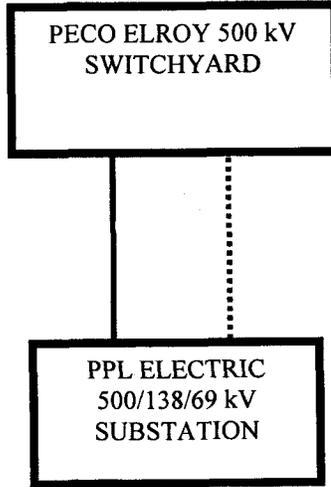
By the summer of 2013, certain facilities in Montgomery and Bucks Counties will no longer meet the standards set forth in the RP&P. During peak load periods by the summer of 2013, loading on the Elroy 138-69 kV regional substation transformer will be at 101% of its normal rating and 97% of its one-month rating for the loss of the 230-69 kV Transformer #2 at the Buxmont Substation. Service to approximately 18,000 customers in Bucks and Montgomery Counties served by the Elroy Substation would be interrupted by a transformer failure, and those interruptions would continue until the transformer could be replaced.

To relieve the transformer limitation, PPL Electric is proposing to install a second 500-138 kV transformer and a second 138-69 kV transformer in series to increase transformer capacity at Elroy Substation and supply the proposed Elroy – Hatfield #1 & #2 138/69 kV Transmission Line. As part of this project, a 500 kV tie line, approximately 215 feet long, will be extended from a new dead end structure in the PECO Elroy Switchyard to a new dead end structure in the PPL Electric Elroy Substation.

Increasing the transformer capacity at Elroy Substation will reduce the loading on the existing 138-69 kV Elroy transformer and the Buxmont 230-69 kV #1 and #2 transformers. These reinforcements will allow for improved transfer capability between PPL Electric's Elroy and Buxmont Substations for load restoration without limitations from insufficient transformation capacity. Approximately 33,000 customers served from these electric facilities in Bucks and Montgomery Counties will experience increased reliability of service.

As an alternative to increasing transformer capacity at Elroy Substation, 138 kV conversion of the Elroy-Hatfield 69 kV Lines was considered but would have cost significantly more.

FIGURE 1
Functional One-Line Diagram



————— EXISTING 500 kV TIE LINE
..... PROPOSED 500 kV TIE LINE

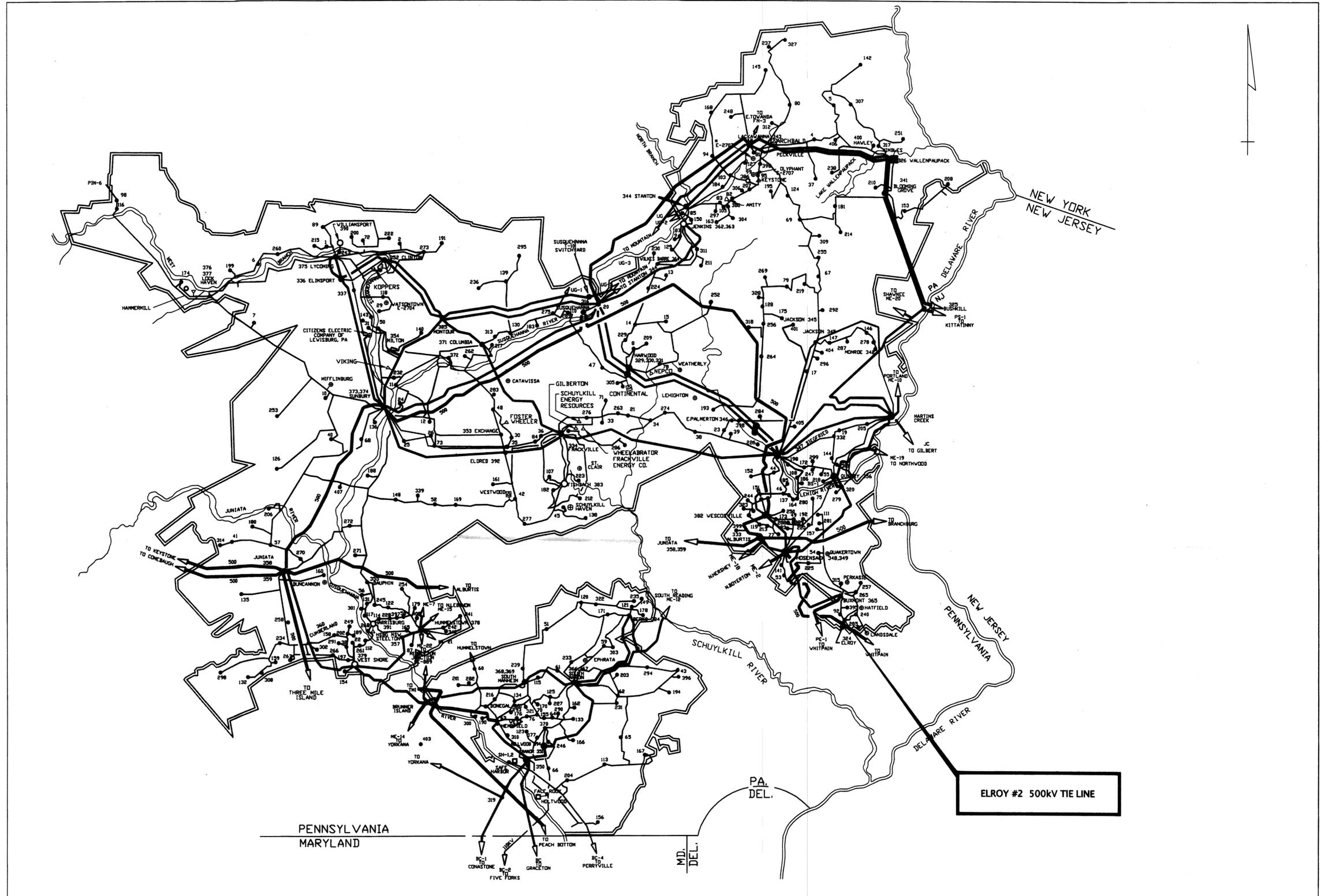
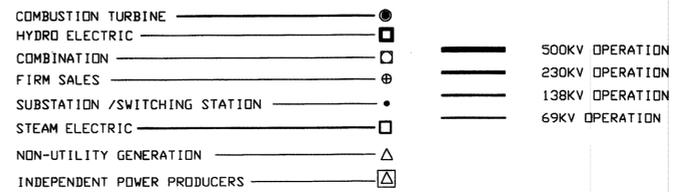
SUBSTATION LISTING

1 WEST WILLIAMSPORT	151 CRACKERSPORT	301 CENTER CITY
2 FAIRFIELD	152 SCHNECKSVILLE	302 NEW KINGSTOWN
3 MONTGOMERY	153 HEMLOCK	303 REAMSTOWN
4 VARDEN	154 PRINCE	304 DUPONT
5 HONESDALE	155 WAKEFIELD	305 HUMBOLDT
6 JERSEY SHORE	156 LOGANSPORT	306 CEDAR AVE.
7 LOGANSPORT	157 WERTZVILLE	307 INDIAN ORCHARD
8 VALMONT	158 WEST CARLISLE	308 NOTTINGHAM
9 RIVER	159 BENTON	309 NORTH COOLBAUGH
10 LIMESTONE	160 HEGINS	310 LEFORT
11 NORTHUMBERLAND	161 LEOLA	311 EAST MOUNTAIN
12 REED	162 YATESVILLE	312 JERMYN
13 WRIGHT	163 ST. JOHNS	313 BLOOMSBURG
14 FREELAND	164 OBERLIN	314 MIFFLINTOWN
15 GILBERT	165 STRASBURG	315 RIDGE ROAD
16 CHERRY HILL	166 BROOKSIDE	316 SUSQUEHANNA
17 SUSQUEHANNA 230KV	167 WILLIAMSTOWN	317 T-10 SW. YD.
18 TAMANEND	168 E. PETERSBURG	318 CHRISTMANS
19 WHITE HILL	169 FARMERSVILLE	319 OTTER CREEK
20 PALMERTON	170 WERNERSVILLE	320 JACK CREEK
21 HAMILTON	171 N. BETHLEHEM	321 MCGOVERNVILLE
22 FAIRVIEW	172 W. ALLENTOWN	322 ROBEESONIA
23 MONTGOMERY	173 FLEMINGTON	323 S. FIDELSVILLE
24 MT. CARMEL	174 MECKESVILLE	324 ELROY
25 KELLY HILL	175 DONERVILLE	325 BUSHKILL
26 MAHANDY CITY	176 MILLERSVILLE	326 WALLENPAUPACK
27 GREENWOOD	177 SHILLINGTON	327 ELK MOUNTAIN
28 MDVARY	178 DUKE	328 JACK FREST
29 ALTA MOUNT	179 MCALLISTERVILLE	329 HARWOOD 230/69KV
30 HAMLIN	180 NEW FOUNDLAND	330 HARWOOD CTG
31 ASHFIELD	181 WEST BERWICK	331 HARWOOD 69/12KV
32 SOUTH SLATINGBURG	182 KEYSER AVENUE	332 NAZARETH
33 WALKER	183 MICKLEYS	333 ALBURTIS
34 FRAILEY	184 PENNBOUR	334 FRACKVILLE
35 HICKERTOWN	185 NORTH COLUMBIA	335 ALLENWOOD
36 EGYPT	186 HUGHESVILLE	336 ELMSPORT
37 CRESSONA	187 SOUTH ALLENTOWN	337 ALLENWOOD
38 SOUTH WHITEHALL	188 WEISSPORT	338
39 EAST TOMHICKEN	189 HONEYBROOK	339 GRATZ
40 BEAR GAP	190 MOSCOW	340 HICKERSVILLE
41 SALISBURY	191 ROSSMOYNE	341 BLOOMING GROVE
42 SOUTH MILTON	192 NORTHAMPTON	342 MONROE
43 HEIDELBERG	193 WOODRICH	343 LACKAWANNA #
44 LYKENS	194 FAXON	344 STANTON
45 UPPER HANDVER	195 ELIZABETHTOWN	345 JACKSON
46 RICHLAND	196 ENOLA	346 EAST PALMERTON
47 MACADA	197 TERRA HILL	347 SIEGFRIED
48 ROCKVILLE	198 BUCK	348 HOESACK 230/69KV
49 THOMPSONTOWN	199 MT. BETHEL	349 HOESACK 500KV
50 PAXTON	200 SCRANTON	350 CONESTOGA
51 COCALICO	201 TWIN LAKES	351 MANDOR
52 EAST ELIZABETHTOWN	202 HARLTGH	352 CLINTON
53 WARFIELD	203 TAYLOR	353 EXCHANGE
54 EARL	204 BEAR CREEK	354 MILTON
55 HEMPFIELD	205 DRWIGSBURG	355 DAUPHIN
56 KINZER	206 EAST TEXAS	356 QUARRY SUB.
57 MT. NEBO	207 CANDENSIS	357 STEELTON
58 MT. POCONO	208 LINDEN	358 JUNIATA 500/230KV
59 PENNS	209 MT. JOE	359 JUNIATA 230/69KV
60 GOULDSBORO	210 WEST BLOOMSBURG	360 CUMBERLAND
61 DILLERSVILLE	211 MINSI TRAIL	361 DONEGAL
62 GERRARD HANOR	212 LAKE NAOMI	362 JENKINS 230/69KV
63 KENMAR	213 LANARK	363 JENKINS CTG
64 GOWEN CITY	214 MONTGOMERY	364 WILKES-BARRE
65 ELLIOT HEIGHTS	215 PORT CARBON	365 BUXMONT
66 ROHRERTOWN	216 BLYTHEBURN	366 SOUTH AKRON 230/138/69KV
67 MACUNGIE	217 MILFORD	367 SOUTH AKRON 69/12KV
68 EAST HAZLETON	218 TREICHLERS	368 SOUTH MANHEIM 69/12KV
69 WAGNERS	219 ROSVILLE	369 SOUTH MANHEIM 230/69KV
70 EAST CARBONDALE	220 EAST HERBORD	370 ENGLISIDE
71 EYOND	221 COLUMBIA	371 COLUMBIA
72 MIDKKA	222 PARRISH	372 DANVILLE
73 OLD FORGE	223 WEST NEW HOLLAND	373 SUNBURY
74 FOUNTAIN SPRINGS	224 POINT	374 HUMMELS WHARF
75 SULLIVAN TRAIL	225 LINCOLN	375 LYCOMING
76 SWATARA	226 MIDDLETON	376 LOCK HAVEN CTG
77 HEPBURN	227 STATE HILL	377 LOCK HAVEN 69/12KV
78	228 MILLVILLE	378 HUMMELSTOWN
79	229 TINKER	379 WEST SHORE
80	230 LAKEVILLE	380 MONTAGE
81	231 NORTH MANHEIM	381 SOUTH FARMERSVILLE
82	232 HATFIELD	382 VESGOSVILLE
83	233 HERSHEY	383 FISHBACH
84	234 S. WILLIAMSPORT	384 BERKS
85	235 FIDELSVILLE	385 MONTOUR
86	236 WINDSOR	386 SUBURBAN YARD
87	237 W. WILLOW	387
88	238 WESTGATE	388
89	239 EDLA	389 MACK
90	240 SUMMERDALE	390 WILLIAMSPORT
91	241 DORNEYVILLE	391 HARRISBURG
92	242 BOHEMIA	392 ELSDRED
93	243 WHITE HAVEN	393 POND FARM
94	244 LAURELTON	394 HICKORY RUN
95	245 LINGLESTOWN	395 BLOOMING GLEN
96	246 POND FARM	396 SHERMANSDALE
97	247 HICKORY RUN	397 LARRYS CREEK
98	248 BLOOMING GLEN	398 SPANGLER MILLS
99	249 SHERMANSDALE	399 DANVILLE
100	250 W. WILLOW	400 DELAND
101	251 WESTGATE	401 CARBON
102	252 EDLA	402 SELLERSVILLE
103	253 SUMMERDALE	403 MECHANISBURG
104	254 DORNEYVILLE	404 CARLISLE
105	255 BOHEMIA	405 CEDAR
106	256 WHITE HAVEN	406 ABBOTTSHEAD
107	257 LAURELTON	407 NEWPORT
108	258 LINGLESTOWN	408 HALIFAX
109	259 POND FARM	409 MILLERSBURG
110	260 HICKORY RUN	410 MUNNY
111	261 BLOOMING GLEN	411 HAUTO
112	262 SHERMANSDALE	412 BERWICK
113	263 W. WILLOW	413 SHENANDDAH
114	264 WESTGATE	414 PINE GROVE
115	265 EDLA	415 LAKE HARMONY
116	266 SUMMERDALE	416 FREEMANSBURG
117	267 DORNEYVILLE	417 ALLENTOWN
118	268 BOHEMIA	418 BINGEN
119	269 WHITE HAVEN	419 RHEEM
120	270 LAURELTON	420 OLEVELAND
121	271 LINGLESTOWN	421 LITTLE GAP
122	272 POND FARM	422 ORVILLE
123	273 HICKORY RUN	423 TUSCARORA
124	274 BLOOMING GLEN	424 BARTONSVILLE
125	275 SHERMANSDALE	425 ALTON PARK
126	276 W. WILLOW	426 SALEM
127	277 WESTGATE	427 NORTH BRIDGEPORT
128	278 EDLA	428 HAMPDEN
129	279 SUMMERDALE	429 CAMELBACK
130	280 DORNEYVILLE	430 SUMNER
131	281 BOHEMIA	431 FARMERSVILLE
132	282 WHITE HAVEN	432 BRECKNOCK
133	283 LAURELTON	433 BENTON
134	284 LINGLESTOWN	434 MCMICHAELS
135	285 POND FARM	435 HIGHESTOWN
136	286 HICKORY RUN	436 NEWVILLE
137	287 BLOOMING GLEN	437 POINT NORTH
138	288 SHERMANSDALE	438 MARIETTA
139	289 W. WILLOW	
140	290 WESTGATE	
141	291 EDLA	
142	292 SUMMERDALE	
143	293 DORNEYVILLE	
144	294 BOHEMIA	
145	295 WHITE HAVEN	
146	296 LAURELTON	
147	297 LINGLESTOWN	
148	298 POND FARM	
149	299 HICKORY RUN	
150	300 BLOOMING GLEN	

* - 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.
 ME METROPOLITAN EDISON CO. (FIRST ENERGY)
 PE PHILADELPHIA ELECTRIC CO. (PECO ENERGY)
 BC BALTIMORE GAS AND ELECTRIC CO.
 SA 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)



ELROY #2 500KV TIE LINE

ACCT- 805201	ELECTRICAL SYSTEM MAP		
SCALE- NONE	ELROY #2 500KV TIE LINE		
BY- CDW	APPROVED	DATE	PPL ELECTRIC UTILITIES
	G. HAKUN III	7/17/85	
PPL DRAWING NO.	SHEET NO.	REV.	
D191830		1	85

84	4/8/11	169004	ADDED ELROY - HATFIELD #1 & #2 138/69 KV LINE.	MG	RWM	DJG
83	4/5/11	161723	ADDED SOUTH AKRON - DILLERSVILLE #1 & #2 138/69KV LINES	MG	RWM	JBW
82	3/31/11	165192	ALLENTOWN-SIEGFRIED #1 & #2 138KV LINE & E.ALLENTOWN #1 & #2 138KV TAP REBUILD	MG	RWM	DG
85	4/13/11	169004	ADDED ELROY #2 500KV TIE LINE	MG	RWM	DG

REFERENCE TITLE	NUMBER	REFERENCE TITLE	NUMBER

Attachment

2

ATTACHMENT "2"
ELROY#2 500 kV TIE LINE
ENGINEERING DESCRIPTION

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ATTACHMENT "2"
ELROY#2 500 kV TIE LINE
ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to design and construct the Elroy #2 500 kV Tie Line to provide a second connection between PECO's Elroy Switchyard and PPL Electric's Elroy Substation. The proposed tie line will exit the existing PECO 500 kV Switchyard and extend approximately 215 feet to the existing Elroy 500-138-69 kV Substation. The tie line will be located adjacent to the existing Elroy #1 Tie Line and will be designed and constructed for single-circuit 500 kV operation. The location of the proposed tie line is depicted on the Aerial Exhibit included in the map pocket located at the end of Attachment "2".

The proposed tie line will be supported by two dead end structures with an approximate height of 65 feet. The proposed dead end structures will be steel h-frames and will be placed on concrete foundations (see Figure 1). The proposed dead end structures will be located within the fenced areas of the PECO Switchyard and the PPL Electric Substation. This work will be completed entirely within property owned in fee by PECO and PPL Electric.

The proposed tie line will consist of three power conductors and two overhead optical ground wires ("OPGW"). Each conductor will consist of two 2493 kcmil,¹ 54/37 stranding ACAR² double-bundled conductors. The two OPGWs will be 0.752-inch diameter OPGW with 48 single mode fibers. The overhead ground wire will provide lightning protection for the proposed tie line.

In addition to construction of the 500 kV tie line and dead end structure, additional modifications will be completed within the fenced portion of PPL Electric's Elroy Substation to receive the

¹ A kcmil is a thousand circular mils. A circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².

² Aluminum conductor aluminum reinforced.

proposed feed. These modifications include the installation of 138-69 kV transformer and associated switches, breakers and bus line. The 500-138 kV transformer is presently installed at the site for use as a backup on an as-needed basis.

The new 500 kV Tie Line will be designed according to, and will generally surpass, National Electrical Safety Code (“NESC”) minimum standards. Additional design criteria and safety rules practiced by PPL Electric are explained in Attachment “4”. The minimum conductor-to-ground clearance will be 42 feet for the proposed 500 kV tie line. This minimum clearance occurs at a maximum thermal conductor temperature of 125°C. The design minimum conductor clearances and conductor thermal rating are provided in Table 1 and Table 2 respectively.

TABLE 1

**DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 2493 KCMIL 54/37 STRAND ACAR³**

<u>Condition</u>	<u>Double-Circuit Design Clearance-to-Ground</u>
Normal load, average weather (16°C ambient, 60°F temperature)	44.3 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	42 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	44.2 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -18°C, 0°F)	45 feet

³ Clearances based on an initial maximum tension of 4,883 lbs @ 1" Ice, 8 lbs wind and a ruling span of 215 feet.

TABLE 2
CONDUCTOR THERMAL RATING
2493 KCMIL 54/37 ACAR
125°C MAXIMUM CONDUCTOR TEMPERATURES

<u>Condition</u>	<u>Ambient Temperature (°C)</u>	<u>Wind Speed (Knots)</u>	<u>Ampacity (Amps)</u>
Summer Normal	35	0	3470
Winter Normal	10	0	4160
Summer Emergency	35	1.5	4312
Winter Emergency	10	1.5	5028

B. MAGNETIC FIELD MANAGEMENT

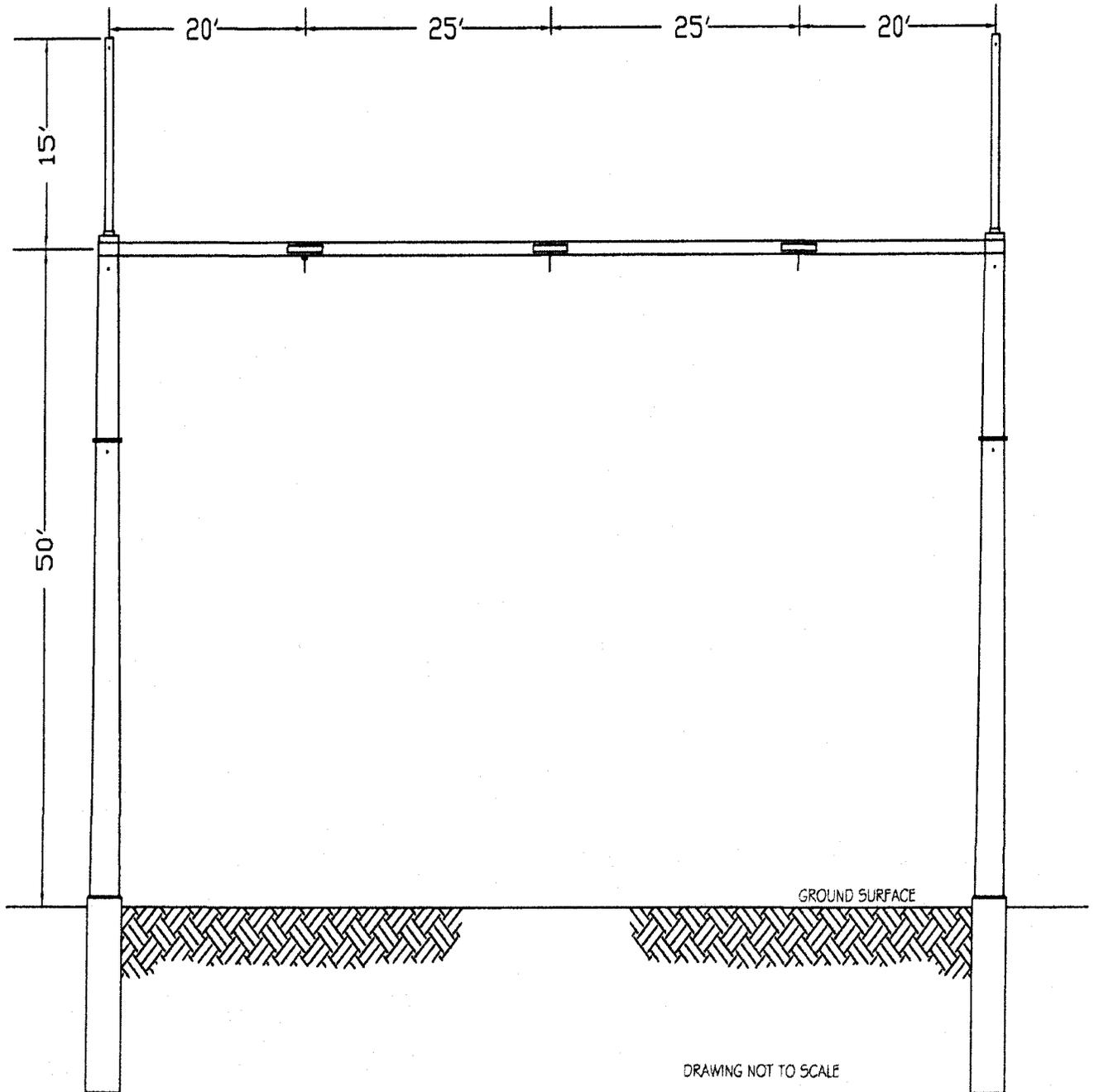
PPL Electric has instituted a Magnetic Field Management Program for new and rebuilt transmission lines, which is included as Attachment “5”. PPL Electric does not believe that current scientific evidence demonstrates that magnetic fields cause any adverse health effects or pose a health and safety danger to the public. Nevertheless, PPL Electric has determined, as a matter of policy, to design its new and rebuilt transmission lines to reduce magnetic fields when that can be done at low or no cost and consistent with functional requirements. This program generally calls for the use of line design that provides 20 feet higher ground clearances for 500 kV lines and reverse phasing of new double circuit lines.

Reverse phasing is not possible because the proposed line is single-circuit. The use of taller structures is also not feasible, because the proposed line is being installed between a switchyard and a substation and will be supported by two dead-end structures instead of taller transmission poles.

C. RIGHT-OF-WAY STATUS

This work will be completed entirely on property owned in fee by PPL Electric and PECO. PPL Electric and PECO have appropriate agreements in place which allow PPL Electric to install the proposed tie line on PECO's property.

FIGURE 1
Proposed Dead End Structure





**PPL ELECTRIC
SUBSTATION**

GRAYSON DRIVE
ADDISON LANE

ELROY ROAD

①

②

**PECO
SWITCHYARD**

PROPERTY ID NUMBER	PROPERTY OWNER
①	PPL UTILITIES TWO NORTH NINTH STREET ALLENTOWN, PA 18101
②	PECO ENERGY CO. 2301 MARKET STREET PHILADELPHIA, PA 19103

LEGEND

- EXISTING 500 kV TIE LINE
- PROPOSED 500 kV TIE LINE
- EXISTING FENCE
- PROPERTY LINE (APPROXIMATE)

SOURCE: PENNSYLVANIA SPACIAL DATA ACCESS (PASDA),
DEPARTMENT OF CONSERVATION AND NATURAL
RESOURCES ORTHOIMAGERY (2005).

DRAWING NOT TO SCALE

AERIAL EXHIBIT

ELROY 500 kV TIE LINE
HATFIELD TOWNSHIP
MONTGOMERY COUNTY, PA.



PREPARED BY:
PPL ELECTRIC UTILITIES CORP.

PPL ELECTRIC UTILITIES

Attachment

3

ATTACHMENT "3"
ELROY#2 500 kV TIE LINE
ENVIRONMENTAL ASSESSMENT

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ATTACHMENT "3"
ELROY#2 500 kV TIE LINE
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric proposes to reinforce the 138/69 kV electric delivery system in Montgomery and Bucks Counties. To accomplish this, PPL Electric is proposing upgrades to the Elroy Substation to accommodate the addition of the Elroy – Hatfield #1 & #2 138/69 kV Transmission Line to the electric delivery system in this area. To supply the upgraded Substation, PPL Electric requests approval to construct the Elroy #2 500 kV Tie Line between PECO's Elroy 500 kV Switchyard and PPL Electric's Elroy 500-138-69 kV Substation. The proposed tie line will be constructed entirely on property owned in fee by PECO and land owned in fee by PPL Electric.

PPL Electric provided information describing the project to Hatfield Township and Montgomery County, and neither the Township nor the County objected to the project. A list of involved governmental agencies, municipalities, and other public entities is listed in Attachment "6".

B. LAND USE

Construction of the proposed tie line will have minimal incremental impacts, as it will be placed adjacent to the existing 500 kV tie line and situated between the existing PECO Elroy 500 kV Switchyard and PPL Electric 500-138-69 kV Substation on property owned in fee by PPL Electric and land owned in fee by PECO. The proposed tie line will be essentially the same size as the existing tie line and will be supported by two dead end structures with an approximate height of 65 feet. The two dead end structures will be located entirely within the fenced portions of the PPL Electric Substation and the PECO Switchyard.

Due to the presence of existing development and the extent of electrical facilities on the PECO Switchyard property and PPL Electric Substation property, the incremental visual impacts of the new tie line will be minimal.

No nearby communication towers, pipelines or other utilities will be affected by the proposed project. Pennridge Airport, located in Sellersville, is the nearest airport and is located approximately 8 miles to the north of the project site. Impacts to this airport are not expected due to the following:

- the proposed height of the dead end structures relative to the existing structures within the substation and switchyard
- the presence of taller 500 kV transmission structures situated between the tie line and the airport
- the overall distance between the project and the airport
- the orientation of the runways with respect to the project location

Disturbance of earth will be limited to localized areas within the fenced portions of the substation and switchyard where the new dead end structures will be placed. No new access roads are anticipated for the construction of the tie line.

C. CULTURAL RESOURCES

The project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has determined that this project will have no affect on any historic buildings, structures, districts or objects eligible for the National Register of Historic Places. Furthermore, it is PHMC's opinion that no archeological resources will be affected by this project (File No. ER 10-1181-091-A). Therefore, no impacts to such resources are anticipated and no further investigations are required.

D. NATURAL FEATURES

The project will not affect any unique geological, scenic, state parks, game lands or forests, or natural areas due to their distance from the project site. The recreational areas located closest to the project site include two small local parks.. Those parks are the John S. Clemens Memorial Park, located approximately 0.5 miles from the project site, and the Enos Godshall Park, located approximately 0.9 miles from the project site. There are no anticipated impacts to these features since: (1) the proposed tie line will be constructed adjacent to an existing 500 kV transmission tie line situated between the PECO Switchyard and the PPL Substation, (2) the distance between the project area and the two parks, and (3) the existing vegetative buffer between the project area and the parks.

Substantial tree clearing is not anticipated as part of this project as the proposed tie line will be constructed on property currently owned by PECO and PPL Electric that has already been cleared of large trees. PPL Electric will apply its "Specifications for Initial Clearing and Control of Vegetation on or Adjacent to Electric Right-of-Way Through Use of Herbicides, Mechanical, and Hand Clearing Techniques" if limited tree clearing or brush removal is required.

The tie line will cross one wetland and one stream. The tie line will span the wetland and stream. Therefore no impacts to these features are anticipated. PPL Electric will obtain all required permits from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers prior to construction, and PPL Electric will comply with all conditions placed on the permits. In addition, PPL Electric will obtain any required soil erosion and sedimentation control permits, and comply with conditions placed on those permits as well.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with different state and federal agencies to obtain information regarding threatened and endangered species in close proximity to the project area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicates that no species of concern are located on or in close proximity to the project site (Reference PNDI # 20110405291627).

Attachment

4

LIST OF SUPPLEMENTAL ATTACHMENTS

ATTACHMENT "4" PPL Design Criteria and Safety Practices

ATTACHMENT "5" PPL Magnetic Field Management Program

ATTACHMENT "6" List of Property Owners Within the Right-of-Way

ATTACHMENT "7" List of Involved Governmental Agencies, Municipalities
and Other Public Entities

ATTACHMENT "4"
ELROY#2 500 kV TIE LINE
PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

The National Electrical Safety Code (NESC) is a set of rules to safeguard people during the installation, operation, or 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 which meet or surpass all provisions specified by the NESC.

Engineering Design Criteria and Parameters

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

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

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

138 kV

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

230 kV

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

500 kV

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

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

Periodic Maintenance Program on All Transmission Lines

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use

of helicopter patrols, with supplemental foot and structure climbing patrols. Numerous helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

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

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

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

Personnel Safety Rules

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

Work procedures have been developed to allow work to be performed on energized facilities in a safe manner. When lines or apparatus are removed from service to be worked on, the Energy Control Process system is applied. This system provides that a red tag must be physically placed on the control handle of the de-energized equipment. The red tag may be removed only after proper authorization to energize the equipment. Various other tags are used for limited operations and informational purposes. Employees will not apply or remove a tag or change the status of tagged equipment unless authorized.

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

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

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

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

Attachment

5



**MAGNETIC
FIELD
MANAGEMENT
PPL Electric Utilities
Corporation**

DECEMBER 2004

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INTRODUCTION

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

PPL EU's View

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

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

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

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

EMF Are All Around Us

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

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

Electric Fields

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

Magnetic Fields

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

Figure 1

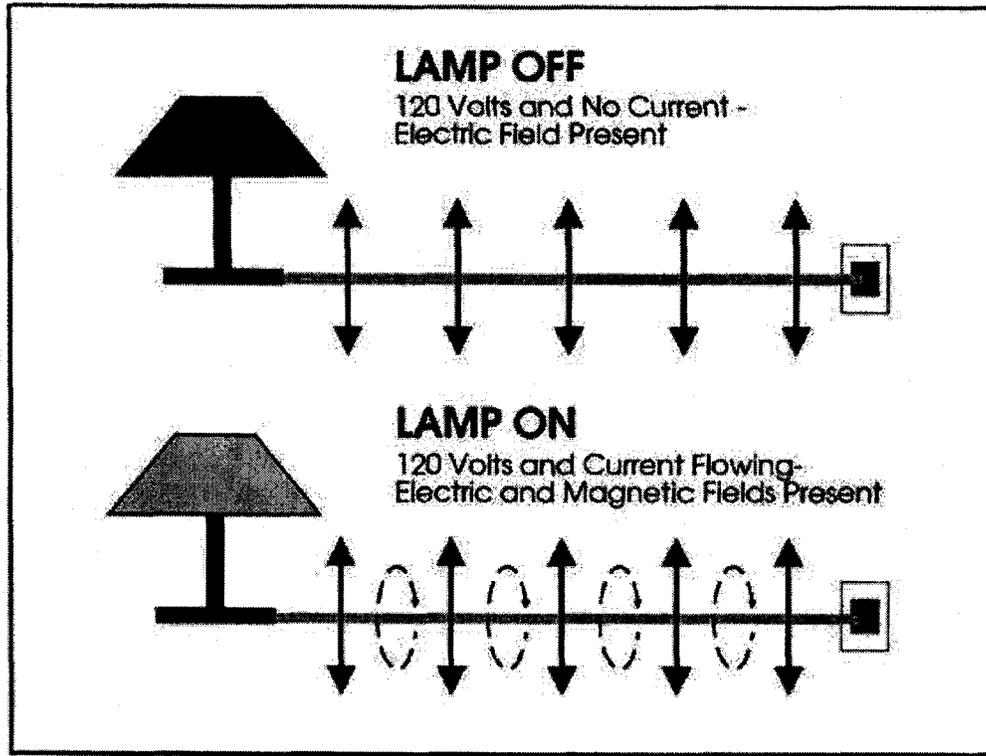


Figure 2

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

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

Measuring Magnetic Fields

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

Figure 3

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

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

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

VARIABLES THAT AFFECT MAGNETIC FIELDS

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

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

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

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

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

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

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

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

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

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

SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

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

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

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

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

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

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

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

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

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

Chart VI illustrates the compact design structure.

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

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

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

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

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

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

138/69 kV Transmission Lines

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

230 kV Transmission Lines

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

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

500 kV Transmission Lines

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

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

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

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

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

DISTRIBUTION LINES

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

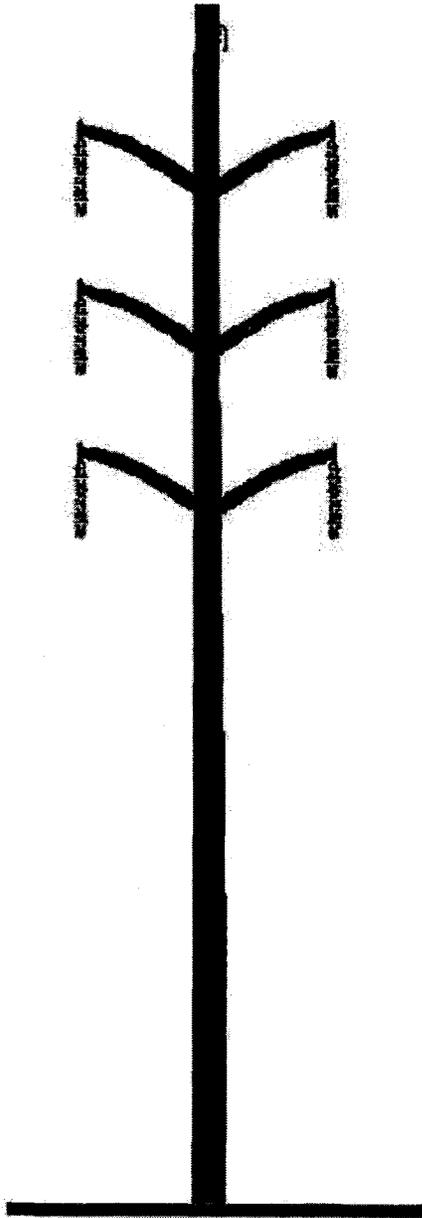
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

UNDERGROUND TRANSMISSION LINES

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

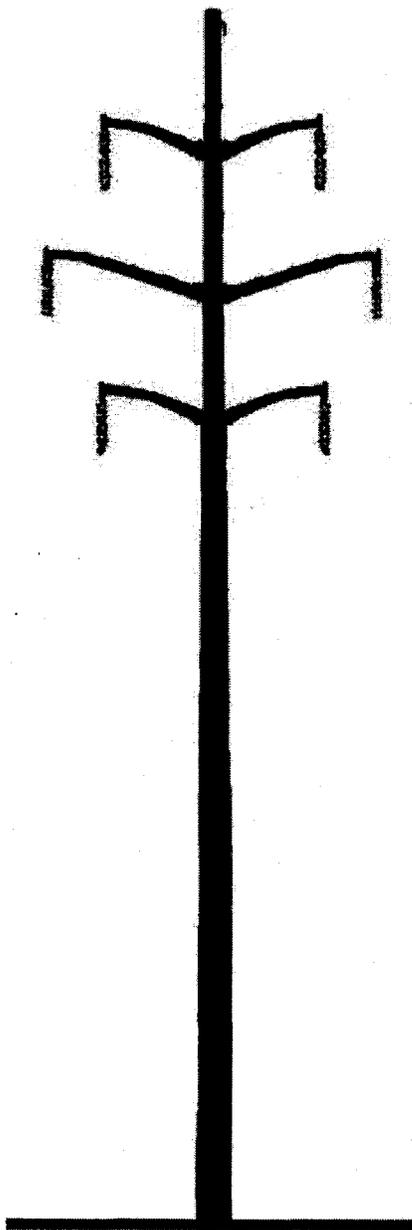
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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

Short-Span Construction



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

Long-Span Construction Remains PPL EU 138 kV Standard



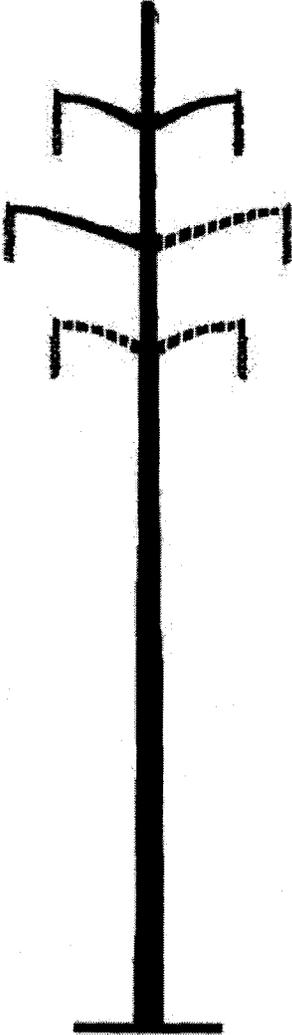
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

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

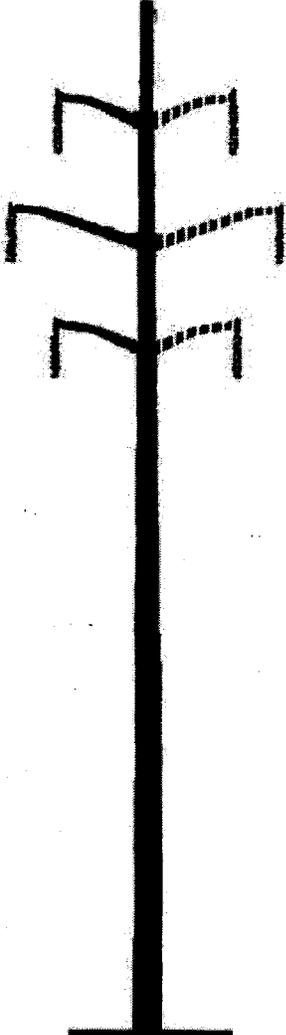
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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

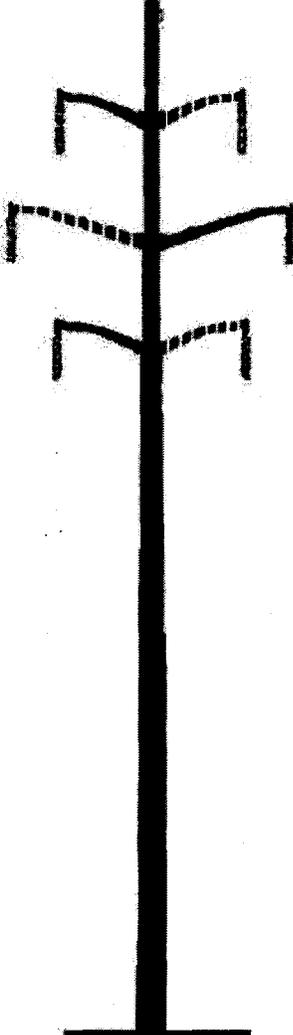
Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

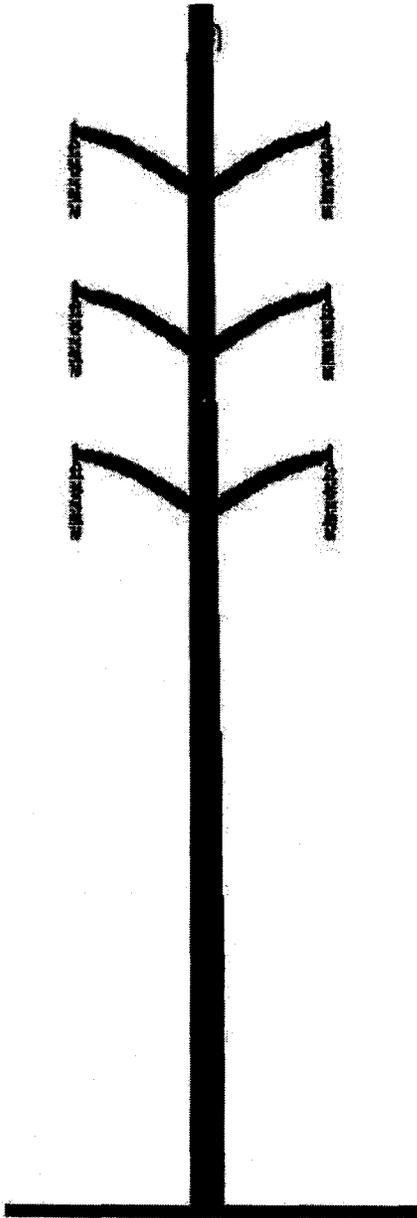
— initial single circuit
- - - future second circuit

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

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

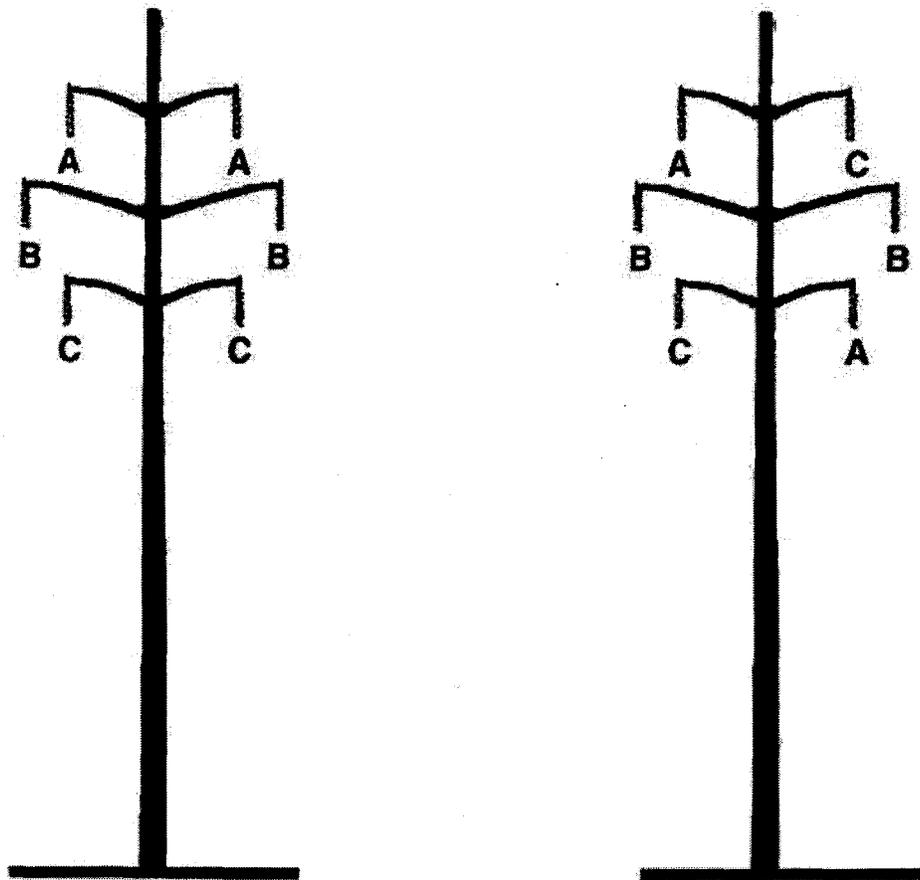
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

Compact Design Structure



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

Reverse Phasing of Double-Circuit Transmission Lines



From: → → → → To:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Attachment

6

ATTACHMENT "6"
ELROY#2 500 kV TIE LINE
LIST OF OWNERS OF PROPERTY

Property Identification Number
(as shown on Aerial Exhibit)

Owners of Property and Mailing Address

- | | |
|---|---|
| 1 | PPL Electric
2 North Ninth Street
Allentown, PA 18101 |
| 2 | PECO Energy Company
2301 Market St
Philadelphia, PA 19103 |

Attachment

7

ATTACHMENT "7"
ELROY#2 500 kV TIE LINE
LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND
OTHER PUBLIC ENTITIES

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

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

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

Montgomery County Commissioners
Montgomery County Courthouse
PO Box 311
Norristown, PA 19404-0311
Attn: Mr. James R. Matthews, Chairman

Montgomery County Planning Commission
Montgomery County Courthouse
PO Box 311
Norristown, PA 19404-0311
Attn: Mr. P. Gregory Shelly, Executive Director

Hatfield Township
1950 School Road
Hatfield PA 19440-1992
Attn: Mr. Andrew S. Haines, Township Manager

Hatfield Township Board of Commissioners
1950 School Road
Hatfield PA 19440-1992
Attn: Mr. Scott Brown, President

Hatfield Township Planning Commission
1950 School Road
Hatfield PA 19440-1992
Attn: Mr. George Zisk, Chair

ATTACHMENT "7" – LIST OF INVOLVED
GOVERNMENTAL AGENCIES,
MUNICIPALITIES AND OTHER PUBLIC
ENTITIES