Before the
Pennsylvania Public Utility Commission

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

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 reconstruct a 1.4 mile long section of the existing single-circuit Harwood-Jenkins #2 69 kV Transmission Line and a 0.6 mile long section of the existing single-circuit Harwood-Jenkins #1 69 kV Transmission Line, and to replace them with a double-circuit 138/69 kV transmission line. Completion of this project will add an additional circuit to the Harwood – Jenkins line. In order to connect the new circuit to the existing 138/69 kV switch yard at the Harwood Substation, PPL Electric will also construct 1,700 feet of new 138/69 kV line on PPL Electric property. The new circuit will be named the Harwood – Jenkins #1 138/69 kV Line. All new line construction will be designed and built for 138 kV operation, although all circuits initially will operate at 69 kV. The project is located in Hazle Township, Luzerne County.[1]

This project is required for two primary reasons. First, the project will prevent overloading either the Harwood-Jenkins #1 or #2 69 kV Transmission Line if an outage occurs on the other circuit. Second, the modifications will prevent PPL Electric from dropping an amount of load that exceeds its Reliability Principles and Practices guidelines if there were a simultaneous outage of both the Harwood-Jenkins #1 and #2 69 kV Lines.

The estimated cost to modify the Harwood – Jenkins #1 & #2 69 kV Lines, and to construct 1,700 feet of new transmission line, is $2,082,000. Construction is scheduled to begin in January, 2012 to support the project's in-service date of November, 2012.

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

[1] As part of the Project, the existing Harwood – Jenkins #1 Line will be severed at the Valmont Taps. It will remain connected with the Valmont 69 kV Tap #1. The resulting line will be renamed the Harwood – Valmont 69 kV Line. This portion of the Project is not a subject of the Letter of Notification because it will continue to be designed to operate at 69 kV and is therefore not subject to the siting regulations.

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
Attachment "7"	-	List of Property Owners Within the Proposed Right-of-Way

PPL ELECTRIC UTILITIES SERVICE TERRITORY

Attachment 1

ATTACHMENT "1"

HARWOOD – JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

NECESSITY STATEMENT

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MAP

ATTACHMENT "1"

HARWOOD–JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric is requesting PUC approval to reinforce the 138/69 kV transmission facilities in Luzerne County by constructing a third transmission line between the Harwood Substation and the Valmont Taps. Installation of a third circuit will be accomplished by reconstructing a 1.4 mile portion of the existing single-circuit Harwood – Jenkins #2 69 kV Transmission Line for double-circuit 138/69 kV operation and a 0.6 mile portion of the existing Harwood – Jenkins #1 69 kV Transmission Line, for double circuit 138/69 kV operation. In addition, approximately 1,700 feet of new 138/69 kV single-circuit line will be installed on PPL Electric property in order to terminate the new third circuit into the existing Harwood 138/69 kV Switchyard. The new lines will be designed and constructed for 138 kV operation, although both initially will operate at 69 kV. The lines will be converted to 138 kV operation when the increasing demand for electricity makes this conversion appropriate.

This project is required to avoid overloading of one of the Harwood – Jenkins 69 kV Lines if an outage occurs on the other line, and to prevent PPL Electric from dropping an amount of load that exceeds the Company's Reliability Principles and Practices (RP&P) guidelines if both Harwood – Jenkins #1 and #2 69 kV Lines were out of service.

The estimated cost to design and construct the new transmission line facilities is approximately $2,082,000. Construction is scheduled to commence in January, 2012 to meet a required in-service date of November, 2012. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads 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 systems in this portion of Luzerne County.

B. EXISTING SYSTEM

Currently, the Harwood – Jenkins #1 and #2 69 kV Lines are built on separate structures and take independent routes from Harwood Substation to the Valmont Taps. The line sections from the Valmont Taps to the Jenkins Substation are built as a double-circuit 138/69 kV design on common structures. Currently, the Harwood – Jenkins #1 and #2 Lines terminate on separate buses in the existing 69 kV yard at PPL Electric's Harwood Substation. Figure 1 shows the section of the Harwood – Jenkins #1 and #2 69 kV Lines from Harwood Substation to the Valmont Taps.

C. DEFINITION OF THE PROBLEM

Due to increasing load in the area, transmission planning studies project, for 2012 and beyond, that if either of the Harwood – Jenkins #1 or #2 Transmission Lines were removed from service as a result of an unplanned outage (contingency), during periods of peak usage, the remaining in-service line will experience an overloaded condition. Each of the existing lines has an emergency summer rating of 124 MVA[2]. An unplanned outage would require the remaining line to carry a projected 136 MVA combined peak load, which the line could not do. Operating the remaining line in an overloaded condition, above its emergency rating, would initially damage the conductors and would ultimately cause a failure of those conductors.

Furthermore, if both the Harwood – Jenkins #1 and #2 69 kV Lines were out of service, the amount of load interrupted would exceed two of PPL Electric's RP&P guidelines established for maximum acceptable load loss. The first provides that no more than 120 MVA may be interrupted for an outage of this type. The second requires that no more than 45 MVA remain out of service until the lines are repaired. By 2012, under peak loading, a double-circuit failure of the Harwood – Jenkins #1 and #2 Lines would initially lose 136 MVA of load, 16 MVA above the RP&P guideline. Even after transferring customers to alternate sources, more than 45 MVA of load will remain out of service until repairs are made.

[2] Million volt-amperes.

Specifically, the transmission planning studies project that, during peak summer and winter periods, line overloading and an excessive amount of load interruption will occur under the following unplanned line outage scenarios:

- Loss of the Harwood-Jenkins #1 69 kV Line would cause an overload on the Harwood-Jenkins #2 69 kV Line.
- Loss of the Harwood-Jenkins #2 69 kV Line would cause an overload on the Harwood-Jenkins #1 69 kV Line.
- Loss of both the Harwood-Jenkins #1 and #2 69 kV Lines would cause excessive load to be shed (interrupted).

All of these scenarios would violate the reliability standards of the North American Electric Reliability Corporation, ReliabilityFirst Corporation, and PJM Interconnect LLC, as well as PPL Electric's RP&P.

D. PROPOSED SOLUTION

To resolve the issues described above, PPL Electric proposes the following:

- Approximately 1.4 miles of the existing Harwood – Jenkins #2 69 kV Line will be reconstructed between the Harwood Substation and the Valmont Taps. The Harwood – Jenkins #1 Line will also be rebuilt between the Harwood Substation and the Valmont Taps. The existing single-circuit 69 kV lines will be rebuilt for double-circuit 138/69 kV operation. Both circuits will initially operate at 69 kV.
- To avoid impacting wetlands near the Valmont Taps, the new Harwood – Jenkins #1 138/69 kV Line will cross under the Harwood – Jenkins #2 138/69 kV Line. The renamed Harwood – Valmont 69 kV Line, and approximately 3000 feet of Harwood – Jenkins #1 138/69 kV Line will be built on common structures.
- The existing Harwood – Jenkins #1 69 kV Line will be disconnected from the Jenkins to Harwood section of the circuit at the Valmont Taps but it will remain connected to the #1 Valmont 69 kV Tap. It will continue to serve the Valmont Substation. This line segment from the Harwood Substation to the Valmont Substation will be renamed the Harwood – Valmont 69 kV Line.

- Approximately 1,700 feet of new, single-circuit, 138/69 kV transmission line will be constructed in order to connect the new Harwood – Jenkins #1 Circuit to Bay 3S in the existing 138/69 kV switchyard in PPL Electric's Harwood Substation. This line will provide a source to the distribution substations located along the Harwood to Jenkins 138/69 kV corridor, and will no longer feed the Valmont Substation.

Figure 2 shows the proposed PPL Electric transmission facilities between the Harwood Substation and the Valmont Taps.

The total estimated cost for the proposed work is approximately $2,211,000, which includes approximately $129,000 for the substation work at Harwood, and $2,082,000 for the transmission line work.

E. FUNCTIONAL ALTERNATIVES

PPL Electric considered one functional alternative that did not involve reconstructing the existing Harwood - Jenkins #1 & #2 69 kV Lines. This alternative would have required converting the existing Harwood - Jenkins #1 and #2 Lines from the Harwood Substation to the Jenkins Substation to 138 kV operation, a distance of approximately 32.5 miles. This would require PPL Electric to replace the 230-69 kV transformers at the Harwood Substation with 230–138 kV transformers, install two 230-138 kV transformers at the Jenkins Substation, and replace seventeen, 69-12 kV transformers at the distribution substations served by the two lines with 138–12 kV transformers. A new 230–138 kV yard would also be required at the Jenkins Substation to provide the 138 kV voltage source. This alternative would be significantly more expensive, estimated at over $50 million dollars, versus rebuilding portions of the existing Harwood - Jenkins # 1 & # 2 69 kV Lines, as proposed above. Due to the extreme price difference between the two projects, PPL Electric determined that rebuilding the Harwood - Jenkins #1 and #2 69 kV Transmission Lines was the preferred alternative.

Figure 1 – ONE LINE DIAGRAM SHOWING EXISTING AND/OR APPROVED HARWOOD-JENKINS #1 AND #2 69 kV LINES FROM HARWOOD SUBSTATION TO THE VALMONT TAPS

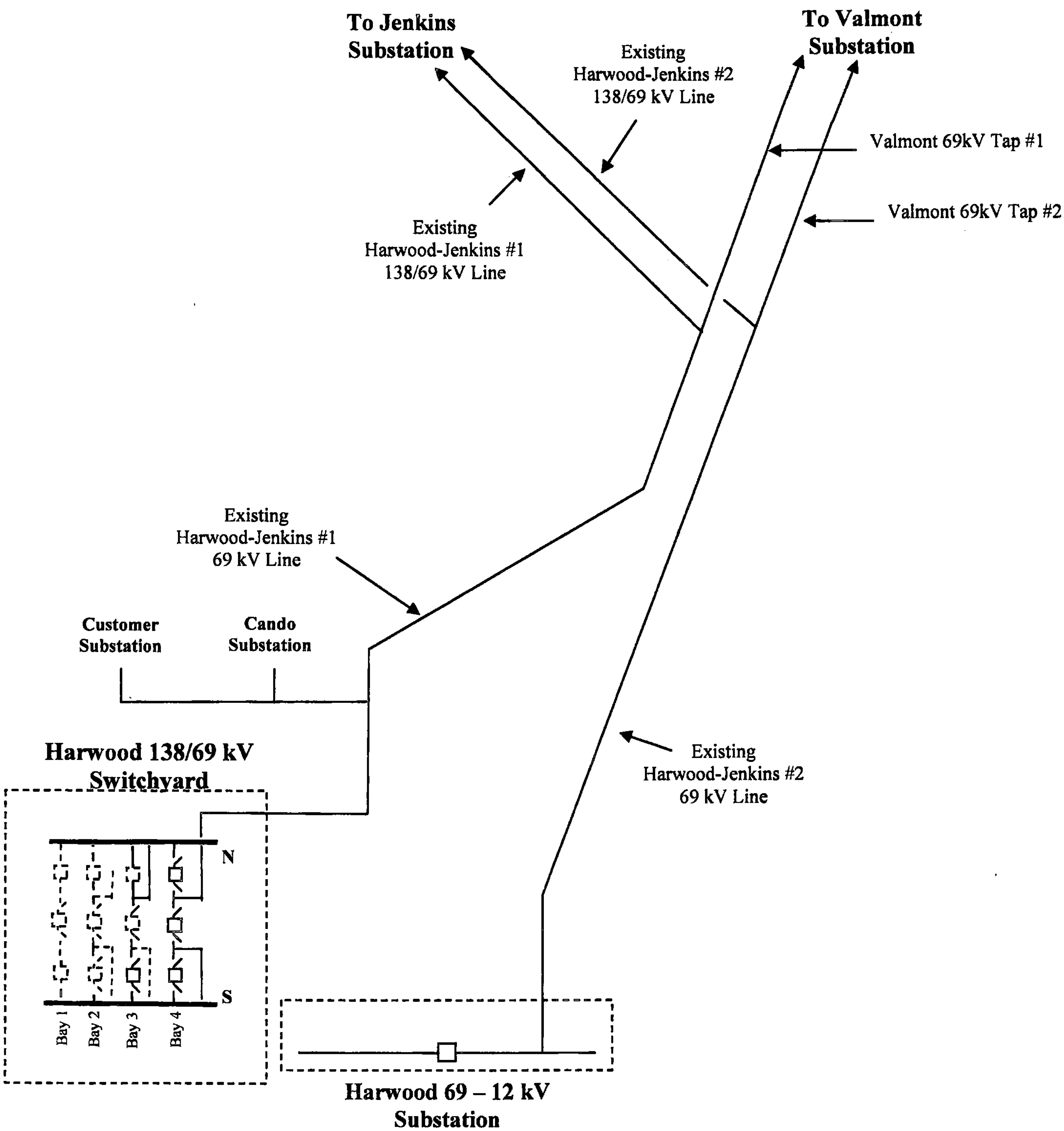
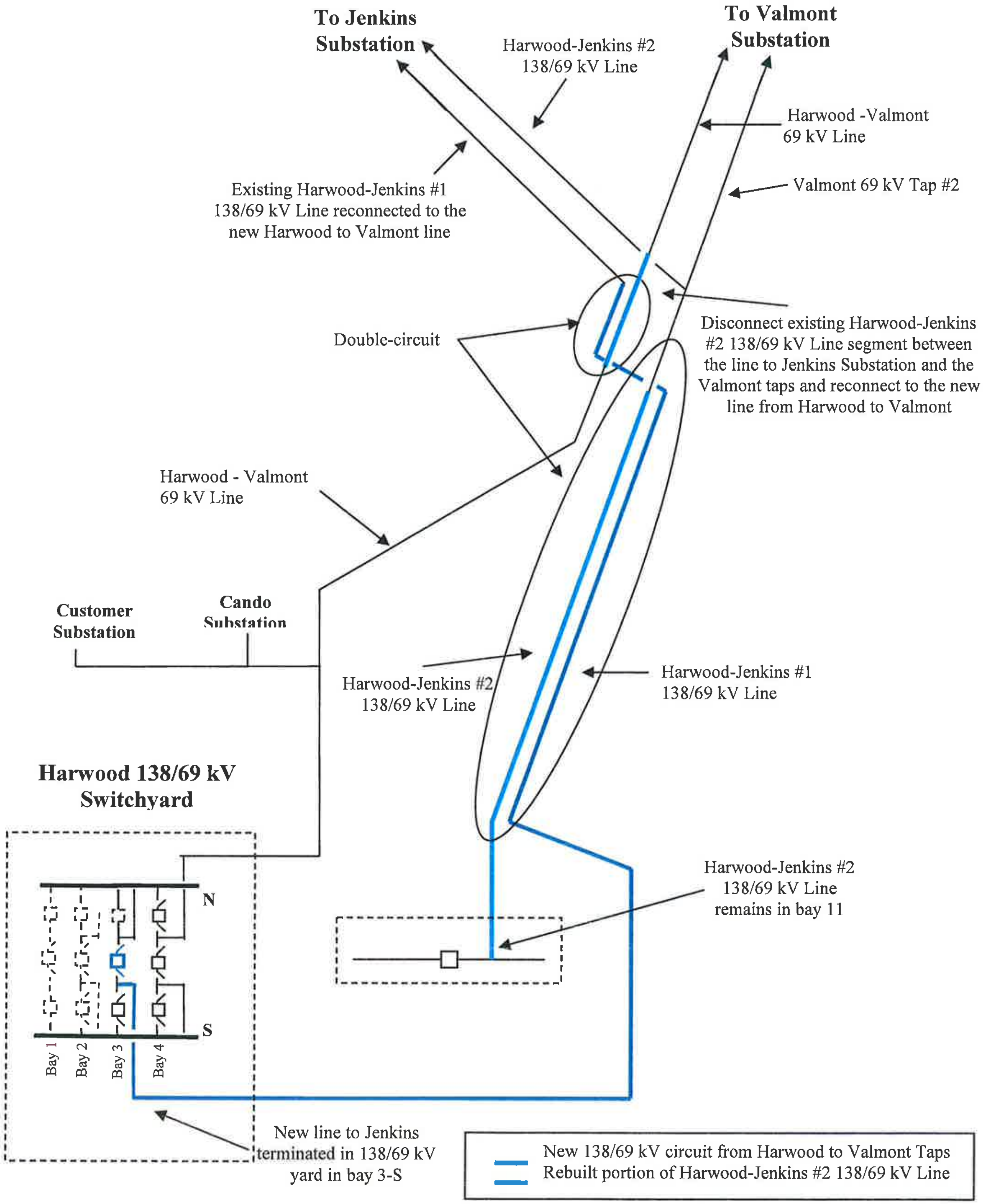


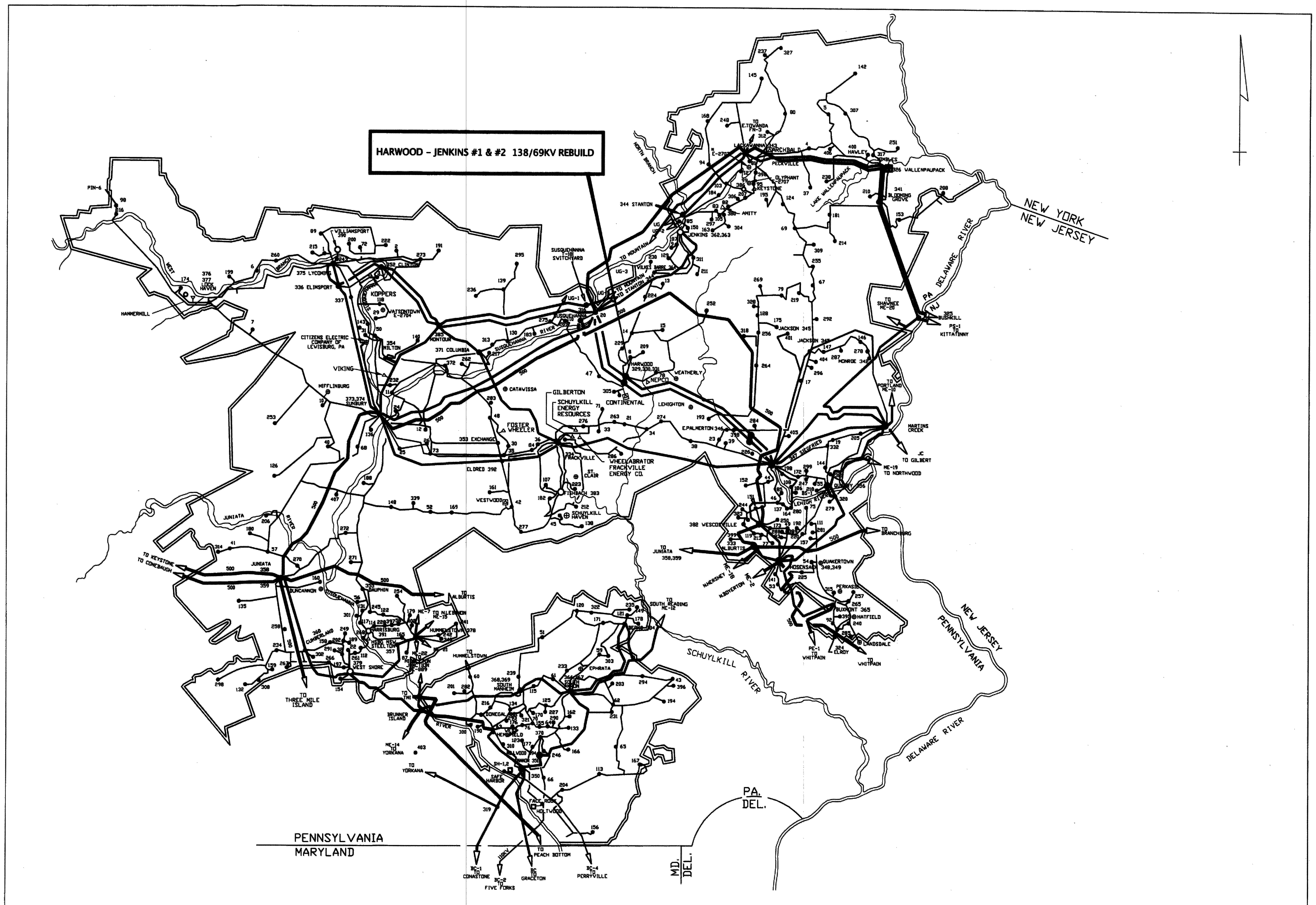
Figure 2 – ONE LINE DIAGRAM SHOWING PROPOSED HARWOOD – JENKINS #1 AND #2 138/69 KV LINES FROM HARWOOD SUBSTATION TO THE VALMONT TAPS



SUBSTATION LISTING

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

* - 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.
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

NO.	DATE	ACCT.		BY	REVIEWED	APPROVED
84	4/8/11	169004	ADDED ELROY - HATFIELD #1 & #2 138/69 kV LINE.	MG	RWM	DJG
87	4/19/11	10014284	ADDED HARWOOD - JENKINS #1 & #2 138/69kV REBUILD	MG	RWM	DLH
86	4/15/11	10013847	ADDED HOSENSACK - WESCOSVILLE #3 230kV LINE REPLACEMENT	MG	RWM	DLH
85	4/13/11	169004	ADDED ELROY #2 500kV TIE LINE	MG	RWM	DG

REFERENCE TITLE | NUMBER | REFERENCE TITLE | NUMBER

#6000

ACCT- 805201
SCALE- NONE
BY- CDW
REVIEWED

ppl PPL ELECTRIC UTILITIES

ELECTRICAL SYSTEM MAP
HARWOOD - JENKINS #1 & #2 138/69KV REBUILD

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

PPL DRAWING NO. D191830
SHEET NO. 1
REV. 87

D191830_S001.DWG

Attachment
2

ATTACHMENT "2"

HARWOOD-JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

ENGINEERING DESCRIPTION

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ATTACHMENT "2"

HARWOOD-JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to reconstruct portions of the existing single-circuit Harwood – Jenkins #1 & #2 69 kV Transmission Lines between the Harwood Substation and the Valmont Taps for double-circuit 138/69 kV operation. The total distance of reconstructed line will be approximately 2.0 miles. This proposed project adds an additional circuit to the area which will provide a direct source from the Harwood Substation to the Valmont Substation. In addition to the reconstruction, PPL Electric proposes to construct approximately 1,700 feet of new, single-circuit, 138/69 kV transmission line on property owned in fee by the Company. The new portion of the line is required to reterminate the reconstructed Harwood – Jenkins #1 Line into the Harwood 138/69 kV Switchyard.

Approximately 1.4 miles of the existing Harwood – Jenkins #2 Transmission Line will be reconstructed beginning at the Harwood Substation. The existing lattice structures, averaging 85 feet tall, will be removed and replaced with double-circuit, weathering steel monopoles equipped with upswept weathering steel arms and polymer 138 kV insulator assemblies. Six 556.5 kcmil,[3] 24/7 stranding, ACSR[4] conductors and one 0.752 inch diameter Optical Ground Wire (OPGW) will be used to provide lightning protection and for communication between circuit breakers that remove the line from service when a faulted line is detected. The tangent poles used in this segment of the project will be direct embedded. Angle poles and the poles on both sides of I-81 will be installed on concrete foundations. The twelve new monopoles will have an average height of 95 feet above ground level. This segment of line will be completed under existing PPL Electric Right-of-Way Agreements and within existing easements. This section of reconstructed 138/69 kV transmission line will contain both Harwood – Jenkins circuits.

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[3] Kcmil stands for thousand circular mills. Kcmil wire size is the equivalent cross sectional area in thousands of circular mils. A circular mil is the area of a circle with a diameter of one thousandth (.001) of an inch.
[4] ACSR stands for aluminum conductor steel reinforced.

In addition, approximately 0.6 miles of the existing Harwood – Jenkins #1 transmission line will be reconstructed using components similar to the Harwood – Jenkins #2 line segment described above. The height of the five new steel monopoles will average 95 feet above ground. Tangent structures will be direct embedded and angle structures will be installed on concrete foundations. This segment of line will be completed under existing PPL Electric Right-of-Way Agreements and within existing easements. This section of reconstructed 138/69 kV transmission line will contain the Harwood – Jenkins #1 Line and the Harwood – Valmont 69 kV Line.

To terminate the additional circuit into the Harwood 138/69 kV Switchyard, approximately 1,700 feet of new, single-circuit, transmission line will be constructed. This segment will use six new single-circuit, weathering steel monopoles with horizontal line post polymer 138 kV insulator assemblies. The proposed tangent poles for this segment of the project will be direct embedded. The two angle structures will be installed on concrete foundations. The new monopoles will have an average height of 80 feet above ground level. There will be three 556.5 kcmil, 24/7 stranding, ACSR conductors, and one 0.752 inch diameter OPGW for lightning protection and for communication between circuit breakers that remove the line from service when a faulted line is detected. This segment of line will be installed entirely 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 will generally exceed, National Electrical Safety Code (NESC) minimum 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*

Condition	Transmission Double-Circuit Design Clearance-to-Ground
Normal load; average weather (16°C ambient temperature)	36 feet
Predicted extreme thermal load (125°C conductor temperature)	30 feet
Predicted extreme wind load (25lb wind, 16°C ambient temperature)	42 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -9°C)	33 feet

*Clearances based on a maximum tension of 9900 pounds and a ruling span of 600 feet.

TABLE 2

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

Condition	Ambient Temperature °C	Wind Speed Knots	Ampacity Amps
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

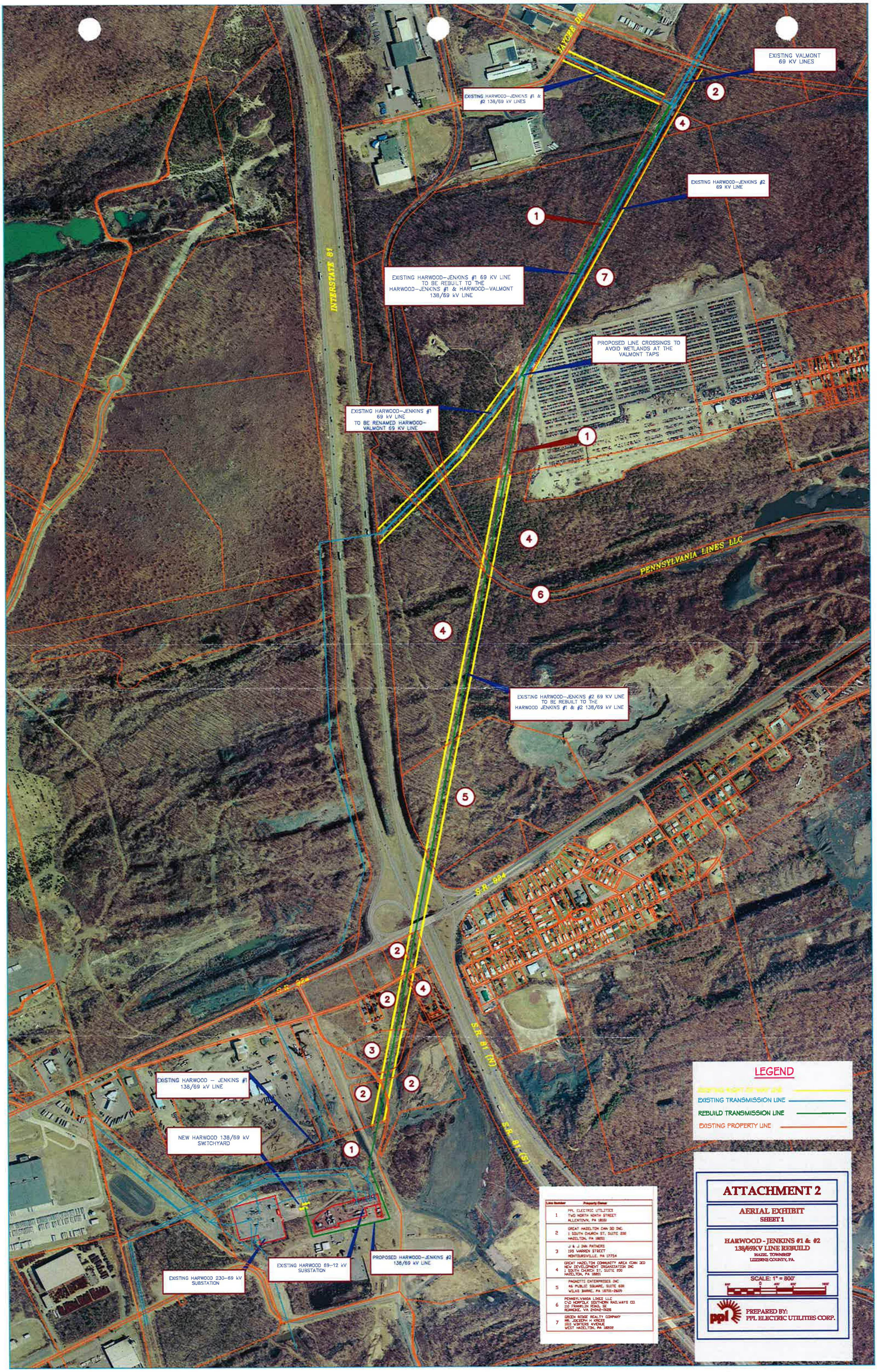
B. MAGNETIC FIELD MANAGEMENT

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 1.4 and 0.6 mile line sections will be reconstructed for double circuit operation and will utilize reverse phasing, in accordance with PPL Electric's policy. Additional reduction of magnetic fields is anticipated through the use of greater ground clearance. The 1,700 foot section of line into the Harwood Switchyard is only being built for single circuit operation and, therefore, reverse phasing is not possible. However, five foot higher ground clearances will be utilized on that portion, resulting in some reduction of the magnetic field.

C. RIGHT-OF-WAY STATUS

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



JAYCEE DR.
EXISTING VALMONT 69 KV LINES
EXISTING HARWOOD-JENKINS #1 & #2 138/69 KV LINES
EXISTING HARWOOD-JENKINS #2 69 KV LINE
INTERSTATE 81
EXISTING HARWOOD-JENKINS #1 69 KV LINE TO BE REBUILT TO THE HARWOOD-JENKINS #1 & HARWOOD-VALMONT 138/69 kV LINE
PROPOSED LINE CROSSINGS TO AVOID WETLANDS AT THE VALMONT TAPS
EXISTING HARWOOD-JENKINS #1 69 KV LINE TO BE RENAMED HARWOOD-VALMONT 69 KV LINE
PENNSYLVANIA LINES LLC
EXISTING HARWOOD-JENKINS #2 69 KV LINE TO BE REBUILT TO THE HARWOOD JENKINS #1 & #2 138/69 KV LINE
S.R. 924
S.R. 81 (N)
S.R. 81 (S)
EXISTING HARWOOD - JENKINS #1 138/69 kV LINE
NEW HARWOOD 138/69 kV SWITCHYARD
EXISTING HARWOOD 230-69 kV SUBSTATION
EXISTING HARWOOD 69-12 kV SUBSTATION
PROPOSED HARWOOD-JENKINS #2 138/69 kV LINE
1
2
3
4
5
6
7
Line Number
Property Owner
1 PPL ELECTRIC UTILITIES TWO NORTH NINTH STREET ALLENTOWN, PA 18101
3 195 WARREN STREET
4 GREAT HAZELTON COMMUNITY AREA (CAN DO) NEW DEVELOPMENT ORGANIZATION INC 1 SOUTH CHURCH ST, SUITE 200 HAZELTON, PA 18201
6 PENNSYLVANIA LINES LLC C/O NORFOLK SOUTHERN RAILWAYS CO. 110 FRANKLIN ROAD, SE ROANOKE, VA 24042-0028
7 GREEN RIDGE REALTY COMPANY WEST HAZELTON, PA 18202
LEGEND
EXISTING TRANSMISSION LINE
REBUILD TRANSMISSION LINE
EXISTING PROPERTY LINE
ATTACHMENT 2
AERIAL EXHIBIT
SHEET 1
HARWOOD - JENKINS #1 & #2
138/69KV LINE REBUILD
HAZEL TOWNSHIP
LUZERNE COUNTY, PA.
SCALE: 1" = 800'
0
PREPARED BY:
PPL ELECTRIC UTILITIES CORP.

Attachment
3

ATTACHMENT "3"

HARWOOD – JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

ATTACHMENT "3"

HARWOOD – JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

To alleviate conductor overloading between the Harwood 138-69 kV Substation and the Jenkins 230–69 kV Substation, PPL Electric is requesting PUC approval to install an additional transmission circuit between the Harwood Substation and the Valmont Taps. To accommodate this circuit, PPL Electric is proposing to reconstruct approximately 1.4 miles of the existing Harwood – Jenkins #2 Transmission Line and 0.6 miles of the existing Harwood – Jenkins #1 Transmission Line for double-circuit operation. In addition, 1,700 feet of new, single-circuit 138/69 kV transmission line will be constructed on PPL Electric property in order to terminate the new line into the existing Harwood 138/69 kV Switchyard. The proposed lines will accommodate 138 kV operation, although all circuits will initially operate at 69 kV. The project, as proposed, will resolve the issues discussed in the Necessity Statement found in Attachment "1".

This proposed project was reviewed with Hazle Township and Luzerne County, and neither had any objection. A list of involved governmental agencies, municipalities and other public entities is presented in Attachment 6.

B. LAND USE

The existing Harwood – Jenkins #1 and #2 69 kV Transmission Lines are located in Hazle Township, Luzerne County. The proposed project will be reconstructed entirely within existing PPL Electric rights-of-way or on property owned in fee by PPL Electric. The proposed double-circuit steel pole line is generally located in wooded areas, away from residential properties. The proposed project will cross eleven properties held by five property owners. Existing access roads will be used, although new roads may be needed in some locations during construction. The 1,700 feet of new line will be constructed entirely on property owned in fee by PPL Electric. That property already contains numerous transmission related facilities.

No communications towers, pipelines or other utilities will be affected by the proposed project. The reconstructed line, as proposed, will use existing railroad and highway crossing locations. Appropriate permits and licenses will be obtained for all crossings, as required, and PPL Electric will comply with any conditions placed on those permits.

The nearest airport, Hazleton Municipal Airport, is located approximately 1.7 miles away from the proposed project site. PPL Electric will file the appropriate documentation with the Federal Aviation Administration and PennDOT Bureau of Aviation to ensure that the proposed reconstructed lines will not be a hazard to the airport's flight operations. No hazards are anticipated, however, due to the existing transmission lines currently in the area.

C. CULTURAL RESOURCES

The project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has determined that there are no National Register eligible or listed historic or archaeological properties in the area (File No. ER 2011-0251-079-A). Therefore, there are no anticipated impacts to such resources, and no further investigation is required.

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. Minimal tree clearing is required to rebuild this line because construction will take place on pre-existing cleared right-of-way or on property owned in fee by PPL Electric. To minimize the impacts of any required clearing, PPL Electric will apply its "Specification For Initial Clearing and Control Maintenance of Vegetation on or Adjacent To Electric Line Right-of-Way through Use of Herbicides, Mechanical, And Hand-Clearing Techniques."

The proposed double-circuit Harwood – Jenkins #1 & #2 138/69 kV Transmission Line will cross three wetlands near the Valmont Taps. PPL Electric has contracted Woodland Design Consultants to delineate all water bodies and wetlands in the project area. To minimize environmental impacts in the area, PPL Electric has designed the Project to avoid impacting wetlands and endangered plant species located near the Valmont Taps by spanning those areas. PPL Electric will obtain all required permits and will comply with any conditions placed on the permits.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with relevant state and federal agencies to obtain information regarding endangered and threatened species that may be located in the study area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicated that there are six potential conflicts in the project area. The Pennsylvania Game Commission identified potential conflicts with the Eastern Small-footed Myotis *(Myotis Leibii)* and the Northern Myotis *(Myotis Septentrionalis).* The Pennsylvania Department of Conservation and Natural Resources (DCNR) identified potential conflicts with Screw-stem *(Bartonia Paniculata)*, Bog Copper *(Lycaena Epixanthe)*, Fall Dropseed Muhly (*Muhlenbergia Uniflora)*, and Ridgetop Dwarf-tree Forest *(Quercus Llicifolia-kalmia Latifolia-p. Rigida).*

PPL Electric has contracted Mellon Biological Services, LLC (Mellon) to work with these agencies to avoid affected areas and to mitigate any impacts caused by the construction and operation of the proposed facilities. A report prepared by Mellon was submitted to DCNR on April 19, 2011 to address potential conflicts with endangered plant species. This report proposed construction strategies that would avoid impacts to endangered plant species. DCNR's May 9, 2011 response accepted the strategies proposed by Mellon, and added that if strict Erosion and Sedimentation Control Plans are implemented, no impact to endangered plant species is anticipated.

By letter dated February 4, 2011 the Pennsylvania Game Commission advised that any tree cutting or trimming should occur only during the period from November 16^{th} to March 31^{st}. PPL Electric will comply with this request. (PNDI No. 20100915262551).

Attachment
4

LIST OF ATTACHMENTS

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

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

230 kV

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

500 kV

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

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

Periodic Maintenance Program on All Transmission Lines

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use of helicopter patrols, with supplemental foot and structure climbing patrols. 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:

Voltage-kV	Minimum Clearance
138	3'-7"
230	5'-3"
500	11'-3"

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

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

Attachment
5

MAGNETIC FIELD MANAGEMENT

PPL Electric Utilities Corporation

DECEMBER 2004

TABLE OF CONTENTS

INTRODUCTION

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

PPL EU's View

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

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

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

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

EMF Are All Around Us

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

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

Electric Fields

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

Magnetic Fields

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

Figure 1

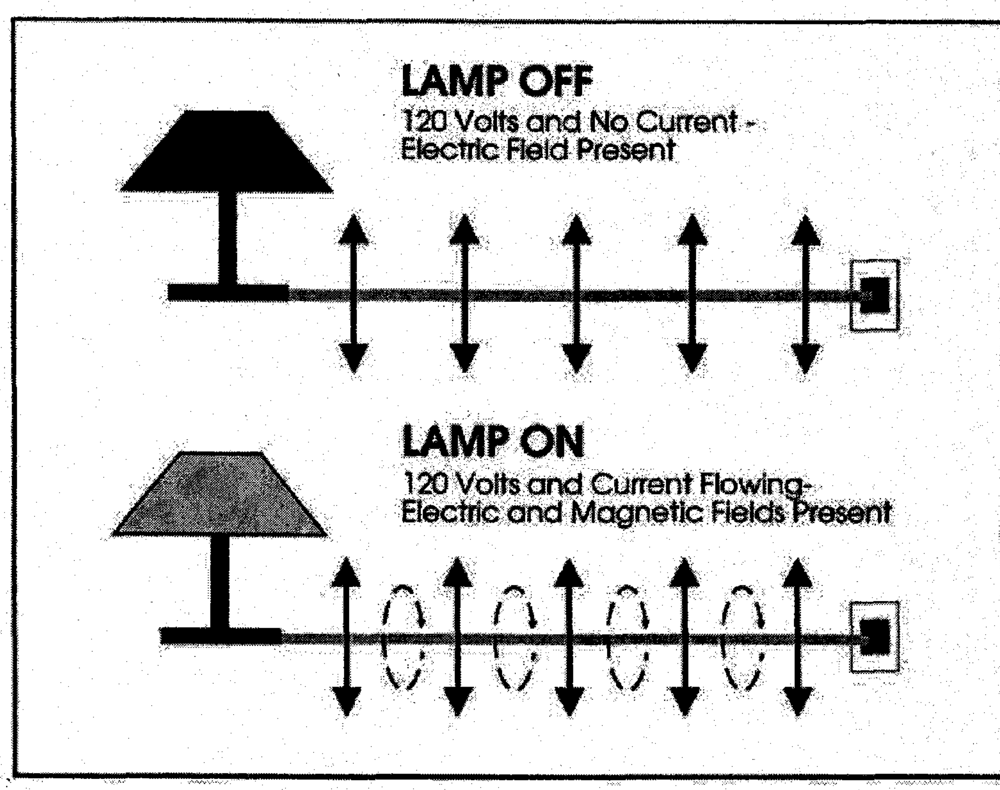

LAMP OFF
120 Volts and No Current -
Electric Field Present
LAMP ON
120 Volts and Current Flowing-
Electric and Magnetic Fields Present

Figure 2

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

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

Measuring Magnetic Fields

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

Figure 3

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

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

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

VARIABLES THAT AFFECT MAGNETIC FIELDS

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

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

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

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

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

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

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

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

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

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

SUMMARY OF PPL EU's
MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

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

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

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

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

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

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

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

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

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

Chart VI illustrates the compact design structure.

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

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

- Reverse phasing was adopted by PPL EU in March 1991 for double-circuit 138/69 kV transmission lines and in April 1992 for all other double circuit transmission lines. Reverse phasing is shown in Chart VII. Reverse phasing will reduce the magnetic fields when the current flow on both circuits is in the same direction. Calculated values contained here are based on balanced and equal phase currents on both circuits.

- Reverse phasing reduces the magnetic field of a double circuit 138 kV single pole transmission line from 29 mG to 9 mG (about 69 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.
- Reverse phasing reduces the magnetic field of a double circuit 230 kV single pole transmission line from 49 mG to 16 mG (about 67 percent) at the edge of the 150-foot-wide right of way as shown on Chart VIII.
- Reverse phasing reduces the magnetic field of a double-circuit 500 kV single pole transmission line from 37 mG to 21 mG (about 43 percent) at the edge of the 200-foot-wide right of way as shown on Chart IX.

- When new or rebuilt double-circuit lines require tapping existing double-circuit lines, PPL EU will review the existing lines to determine if reverse phasing can be provided at low cost.
- Computer modeling is required to develop the optimum phasing and overall conductor arrangements for lines added to, or rebuilt in, multiple-line corridors.
  - Merely adding a reverse-phase double-circuit line to an existing transmission line corridor or reverse phasing a rebuilt line in the multiple-line corridor will not necessarily produce lower magnetic field levels at the edge of the corridor right of way.
  - The corridor must be computer modeled with all the lines, existing phase conductor locations and currents. Then, magnetic field calculations must be made varying the phase arrangements of the new or reconstructed line to determine the appropriate phasing arrangement.
  - Current flow direction on a line also must be considered. For example, a reverse-phased line should have the current flowing in the same direction on both circuits. If the current flow is in the opposite direction for one circuit, reverse phasing will not produce the lowest magnetic field and another phase arrangement that produces lower fields may need to be utilized.

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

138/69 kV Transmission Lines

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

230 kV Transmission Lines

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

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

500 kV Transmission Lines

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

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

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

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

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

DISTRIBUTION LINES

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

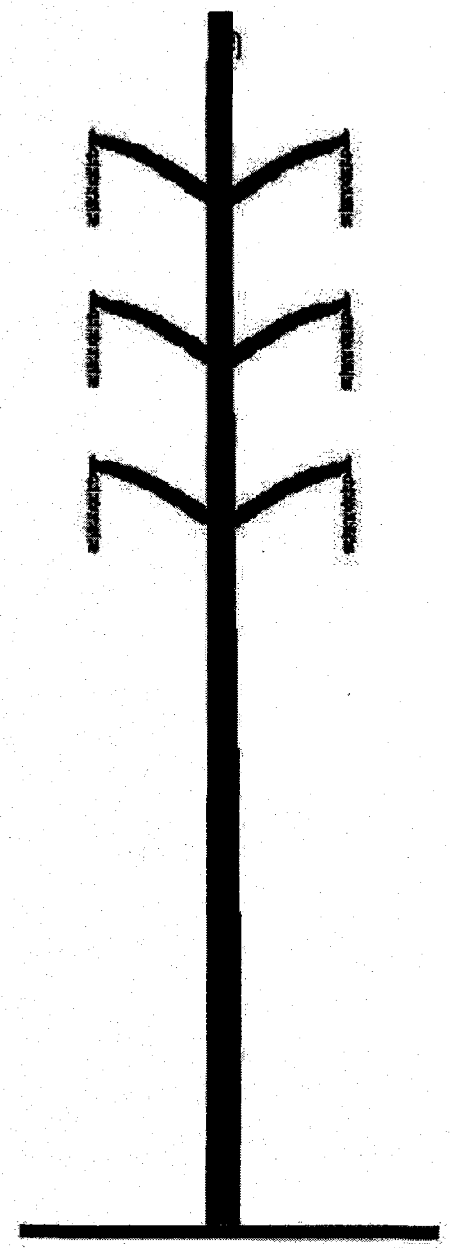
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

UNDERGROUND TRANSMISSION LINES

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

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

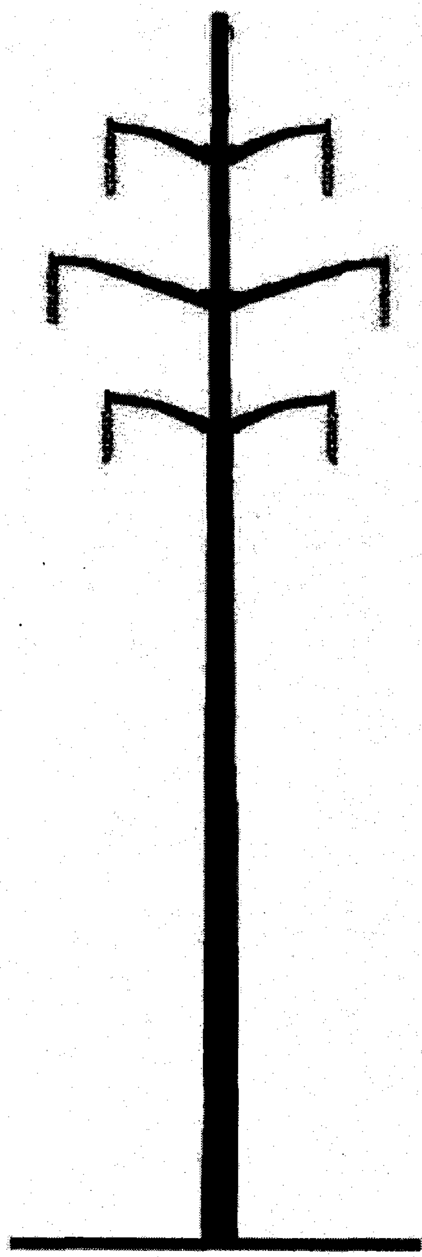
Short-Span Construction



- **More compact design**
- **Should not be used solely to reduce magnetic fields**
- **Typical conductor data:**

1 3/8" HS steel overhead ground wire - 7.3 feet sag
6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 10.0 feet sag
Average span - 400 feet

Long-Span Construction Remains PPL EU 138 kV Standard



- **Lower cost alternative**
- **Reduces magnetic fields due to higher structures**
- **Typical conductor data:**

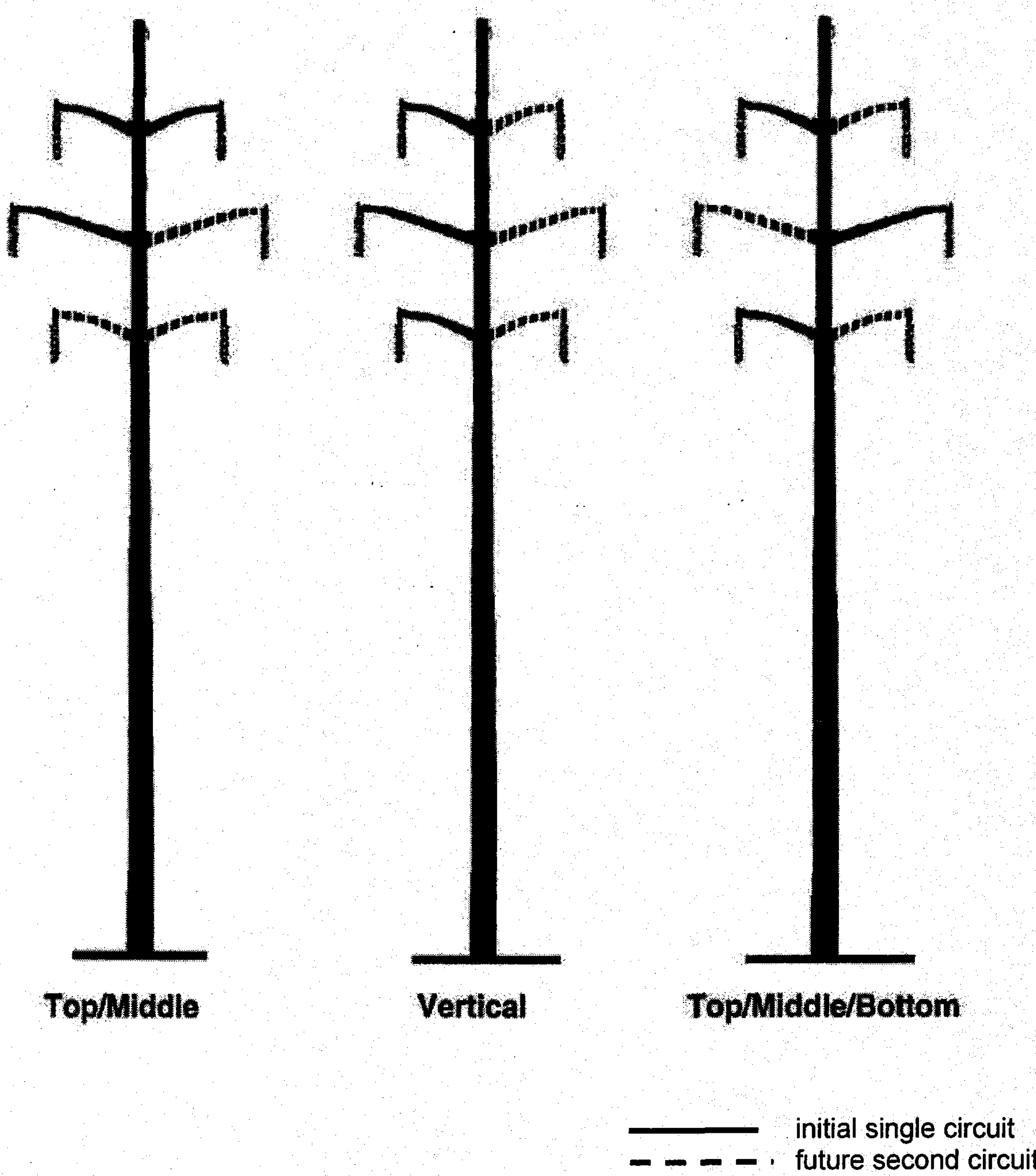
1 3/8" HS steel overhead ground wire - 17.3 feet sag
6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
Average span - 600 feet

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

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

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

Typical Single-Circuit Structure Designs

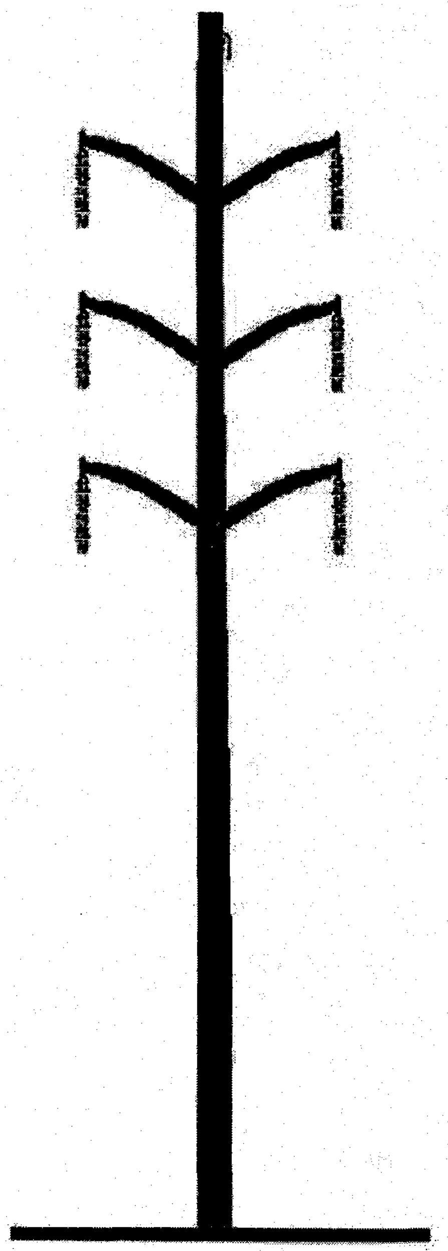


138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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

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

Compact Design Structure

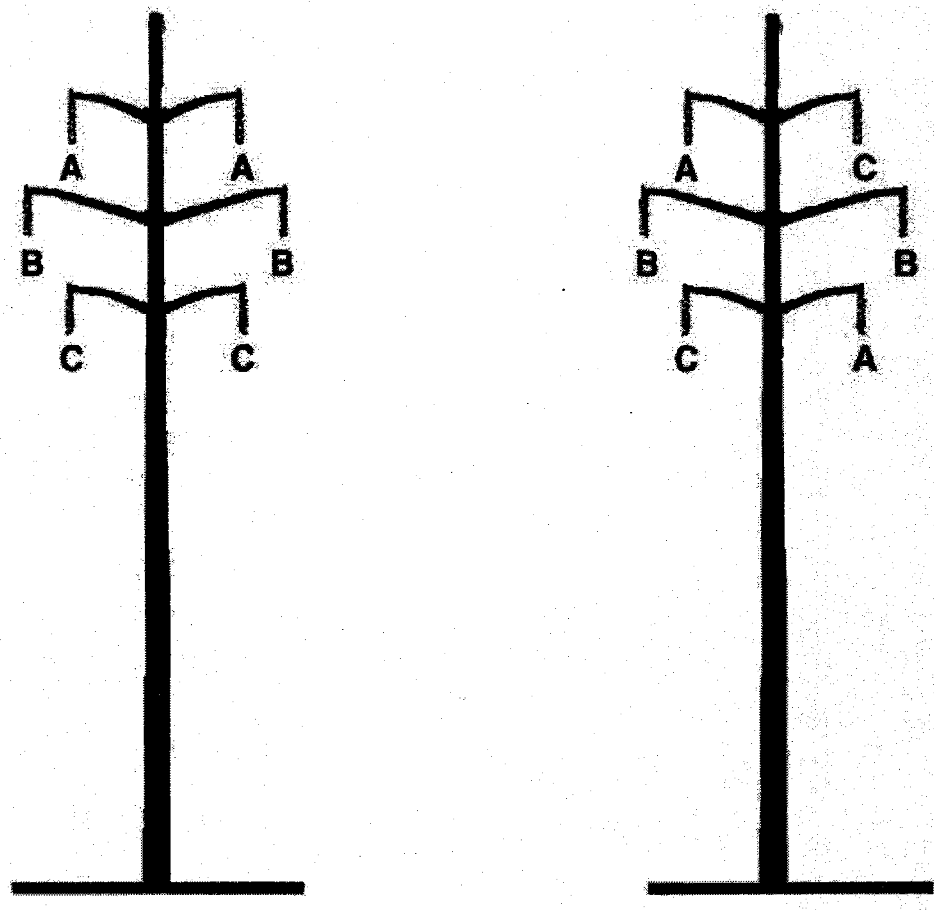


- **Minimize magnetic fields due to compact design**
- **Not a low-cost alternative**
- **Typical conductor data:**

1 3/8" HS steel overhead ground wire - 9.0 feet sag
6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 9.0 feet sag
Average span - 300 feet

CHART VII

Reverse Phasing of Double-Circuit Transmission Lines



From: ⟶ ⟶ ⟶ ⟶ To:

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

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

CHART VIII

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

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

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

CHART IX

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

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

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

CHART X

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

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

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

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

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

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

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

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

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

12 kV DISTRIBUTION LINES
CALCULATED MAGNETIC FIELDS AT 300 AMPERES

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

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

Siting/Magnetic Field Management.doc/mlt

Attachment
6

ATTACHMENT 6

HARWOOD – JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND OTHER PUBLIC ENTITIES

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

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

Attachment 7

ATTACHMENT 7

HARWOOD – JENKINS #1 & #2 138/69 kV TRANSMISSION LINE RECONSTRUCTION

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

PPL Electric Utilities
2 North Ninth St
Allentown, PA 18101

Greater Hazleton Cando Inc
1 South Church St
Hazleton, PA 18201

JandJ Inn Partners
195 Warren Street
Montoursville, PA 17754

Gr Haz Comm Area New Dev Org Inc, CAN DO Inc.
1 South Church St
Hazleton, Pa 18201-6259

Pagnotti Enterprises, Inc.
46 Public Square
Suite 600
Wilkes Barre, PA, 18701-2609

Green Ridge Realty Company
Mr Joseph H Kress
1010 Winters Ave
West Hazleton, PA, 18202