Before the
Pennsylvania Public Utility Commission

MIDDLETOWN JUNCTION – COPPERSTONE 230 kV LINE
&
COPPERSTONE – NORTH LEBANON 230 kV LINE

EXHIBITS AND APPENDICES 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 Commission approval to reinforce the 230 kV and 69 kV systems in central Dauphin County. As part of this reinforcement, PPL Electric proposes to construct the Copperstone 230-69 kV Substation ("Copperstone Substation"). This Project involves the construction of three separate transmission lines. Each transmission line will be connected to the Copperstone Substation. Each transmission line will be the subject of a separate filing.

Here, PPL Electric seeks the Commission's approval of Part 3 of the Project, the construction of the new Middletown Junction - Copperstone 230 kV Transmission Line, and the Copperstone – North Lebanon 230 kV Transmission Line, which will be approximately 0.22 miles in total. This Project is located in South Hanover Township, Dauphin County. Studies conducted for PPL Electric's transmission system, in conjunction with the PJM Regional Transmission Expansion Process ("RTEP"), revealed several transmission line thermal overload violations pertaining to the Bulk Electric System ("BES," generally defined as 100 kV and above), as well as PPL Electric's underlying 69 kV transmission system and substation equipment in the summer of 2012.

The estimated cost to site, design, and construct the transmission facilities for Part 3 of the Project is $1,716,000. Construction is scheduled to begin in March 2011, to support the project's in-service date of May 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:

Exhibit "A"-Necessity Statement

Exhibit "B"-Engineering Description

Exhibit "C"-Environmental Assessment

Appendix A-PPL Design Criteria and Safety Practices

Appendix B-Magnetic Field Management at PPL Electric

Appendix C- List of property owners within the proposed Right-of-Way

Appendix D -List of Involved Governmental Agencies, Municipalities, and Other Public Entities

PPL ELECTRIC UTILITIES SERVICE TERRITORY

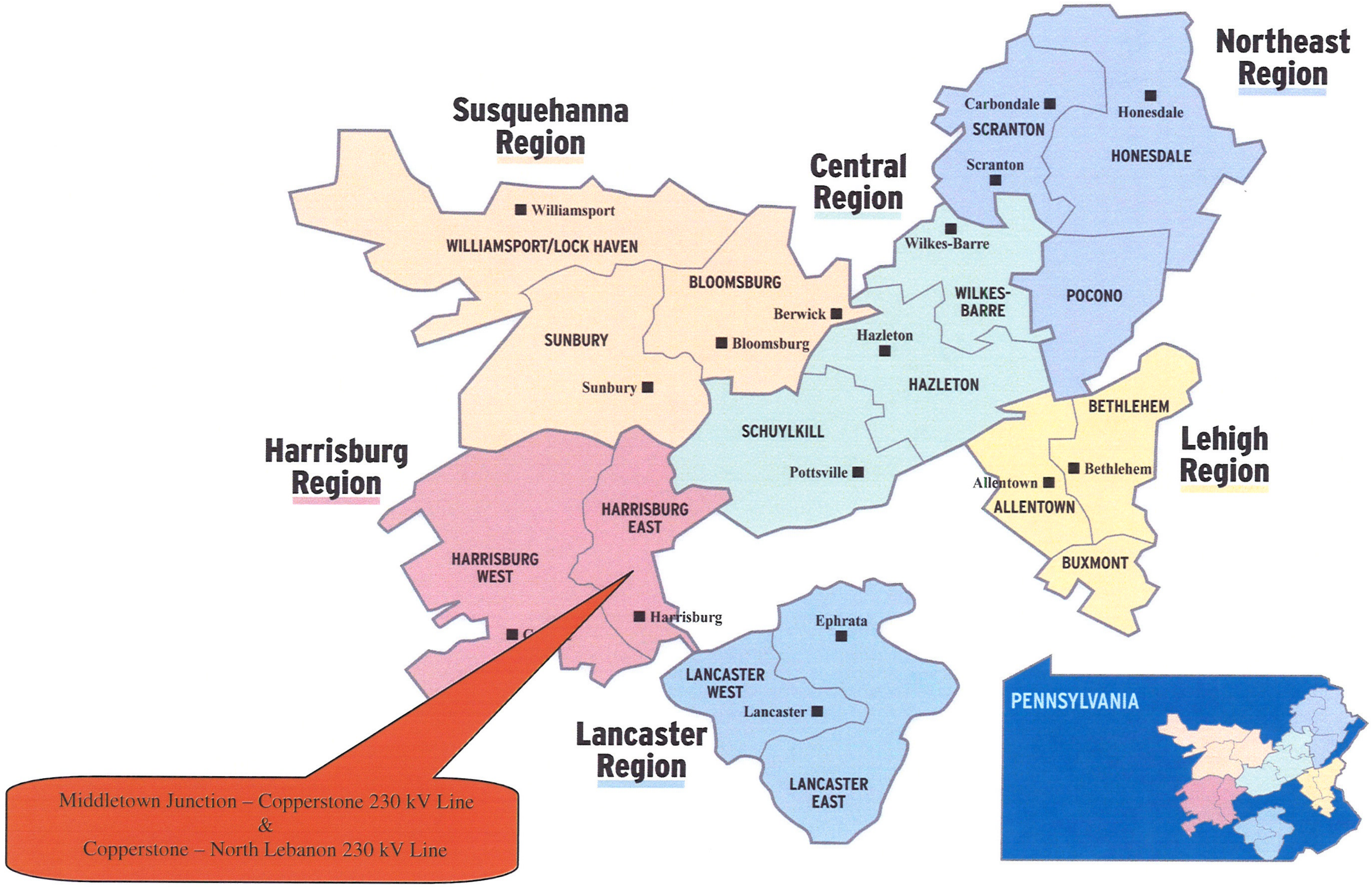

Exhibit
A

EXHIBIT "A"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

&

COPPERSTONE – NORTH LEBANON 230 kV LINE

NECESSITY STATEMENT

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EXHIBIT "A"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

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COPPERSTONE – NORTH LEBANON 230 kV LINE

NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric proposes to construct the Copperstone 230-69 kV Substation ("Copperstone Substation") to reinforce the 230 kV and 69 kV systems in central Dauphin County. This Project involves the construction of three separate transmission lines that will connect to the Copperstone Substation. Each transmission line will be the subject of a separate filing with the Commission.

In Part 3 of the Project, which is the subject of this filing, PPL Electric requests Commission approval to construct the Middletown Junction - Copperstone 230 kV Transmission line section and the Copperstone – North Lebanon 230 kV line section. Both single circuit lines are 0.22 miles long in total length and will be designed for and operated at 230 kV. The proposed Middletown Junction – Copperstone and Copperstone – North Lebanon 230 kV Transmission Lines will tie into the existing Metropolitan Edison North Lebanon – Middletown Junction 230 kV Transmission Line, just east of the proposed Copperstone substation, and connect with the proposed Copperstone Substation. See Figure 2

In Part 1 of the Project, a portion of the existing Hummelstown-Harrisburg #3 & #4 69 kV Transmission Line will be connected with the proposed Copperstone 230-69 kV Substation by constructing approximately 1.33 miles of new double circuit 138/69 kV line, initially operated at 69 kV. This will create the new Copperstone - Harrisburg #1 & #2 138/69 kV Transmission Line. A Letter of Notification seeking PUC approval of Part 1 was filed on February 12, 2010, at Docket No. A-2010-2159604, and is currently pending review by the PUC.

In Part 2 of the Project, a different portion of the existing Hummelstown-Harrisburg #3 & #4 69 kV Transmission Line will be connected with the proposed Copperstone 230-69 kV Substation by constructing approximately 0.53 miles of new double circuit 138/69 kV line, initially operated at 69 kV. This will create the new Dauphin–Copperstone #1 & #2 138/69 kV Transmission Line. A Letter of Notification seeking PUC approval of Part 2 was filed on March 18, 2010, at Docket No. A-2010-2164657, and is currently pending review by the PUC.

The estimated cost to site, design, and construct the transmission facilities for Part 3 of the Project are approximately $1,716,000. Part 3 has a scheduled construction start date of March 2011, to meet a required in-service date of May 2012. The required in-service date is defined as the date that the proposed facility must be placed in service to prevent overloads or unacceptable voltage levels that could potentially damage equipment and result in service interruptions to customers.

A PPL system map showing existing transmission facilities with a design voltage of 35 kV or greater is included in the Exhibit "A" map pocket. This filing addresses only the existing and proposed transmission system in central Dauphin County.

B. EXISTING SYSTEM

Presently, central Dauphin County receives the bulk of its electric power from two sources, the Hummelstown 230-69 kV Substation and the Dauphin 230-69 kV Substation. The existing 69 kV transmission lines that exit these substations deliver electric power to various 69-12 kV substations throughout central Dauphin County. The existing transmission arrangement is shown in Figure 1.

C. DEFINITION OF THE PROBLEM

Studies conducted for PPL Electric's transmission system, in conjunction with the PJM RTEP (Regional Transmission Expansion Process), revealed several transmission line thermal overload violations pertaining to the Bulk Electric System (BES, generally defined as 100 kV and above) in central Dauphin County, as well as the PPL Electric underlying 69 kV transmission system and substation equipment in the summer of 2012.

The studies indicated that NERC and PJM violations are likely to occur on PPL Electric's 230 kV electric system in central Dauphin County under N-1-1 conditions. An N-1-1 condition is defined as one 230 kV line outage, followed by a subsequent second 230 kV line outage. The studies conducted for PPL Electric's summer peak transmission system for the year 2012 indicated the following N-1-1 conditions are likely to cause overloads on the BES system in central Dauphin County:

- By the summer of 2012, under forecasted summer peak load conditions, a forced outage of the Dauphin–Juniata 230 kV Transmission Line and a subsequent outage of the Hummelstown–Middletown Junction #1 230 kV Transmission Line would overload the Hummelstown-Middletown Junction #2 - Steel Tap 230 kV Transmission Line.

- By the summer of 2012, under forecasted summer peak load conditions, a forced outage of the Dauphin–Juniata 230 kV Transmission Line and subsequent outage of Hummelstown–Middletown Junction #2 - Steel Tap 230 kV Transmission Line would overload Hummelstown-Middletown Junction #1 230 kV Transmission Line.

The studies also indicated that, in violation of PPL Electric's Reliability Principles and Practices (RP&P), the following overloads will occur on PPL Electric's 69 kV system in central Dauphin County for single contingency operations:

- The Dauphin 230-69 kV Substation is designed with two 230-69 kV transformers. By the summer of 2012, under forecasted summer peak load conditions, a forced outage of either transformer at the Dauphin 230-69 kV Substation would overload the remaining transformer.

- The Hummelstown 230-69kV Substation is designed with three 230-69 kV transformers. By the summer of 2012, under forecasted summer peak load conditions, a forced outage of one transformer at the Hummelstown 230-69 kV Substation would overload the remaining 230-69 kV transformers.

- By the summer of 2012, under forecasted summer peak load conditions, a forced outage of the Hummelstown–Harrisburg #1 and #2 69 kV Transmission Line would cause overloads on the Hummelstown–Harrisburg #3 and #4 69 kV Transmission Line.

- By the summer of 2012, under forecasted summer peak load conditions, a forced outage of the Hummelstown–Harrisburg #4 69 kV Transmission Line or the Harrisburg Substation 69 kV bus section #3, would cause overloads on the Hummelstown–Harrisburg #3 69 kV Transmission Line.

D. PROPOSED SOLUTION (SEE FIGURE 2)

To resolve the issues discussed above, PPL Electric requests Commission approval to construct two short single circuit 230 kV line sections to provide a source for the proposed Copperstone Substation.

The Copperstone Substation will be constructed with a 230 kV four breaker ring bus and will be supplied power via two short 230 kV single-circuit lines by sectionalizing the existing Middletown Junction-North Lebanon 230 kV Transmission Line creating the Middletown Junction – Copperstone 230 kV Line and the Copperstone – North Lebanon 230 kV line. The single circuit 230 kV lines will supply two 230-69 kV 150 MVA transformers that will provide power supply to the 69 kV system. From the 69 kV system, four short 138/69 kV overhead transmission lines (two double circuit lines) will be constructed and sectionalized into the existing Hummelstown – Harrisburg #3 and #4 69 kV Lines: one double-circuit line approximately 1.3 miles and one double-circuit line approximately half a mile long.

This reinforcement alternative resolves all the overloads explained in section C above, and provides additional capacity for future electric system load growth.

This alternative will have the least amount of impact because it requires the construction of relatively short overhead transmission lines utilizing PPL Electric fee-owned property. Further, this project will not require extensive outages of the existing facilities, which would maintain reliable electric service to the customers in the area during construction. Hence, this option is considered the preferred option.

The estimated cost of this Alternative is $28 million, which includes the total estimated cost to site, design, and construct all overhead transmission facilities and the 230-69 kV substation.

E. FUNCTIONAL ALTERNATIVES

Alternative 2

Upgrade the following substations and 69kV transmission lines:

- Add a 3rd 230-69 kV transformer at the Dauphin 230-69 kV Substation.
- Add a 3rd 230-69 kV transformer at the West Shore 230-69 kV Substation.
- Rebuild the West Shore–Harrisburg #1 and #2 69 kV Transmission Lines.
- Build a new double circuit 69 kV line from the Hummelstown 230-69 kV Substation to the Duke 69kV tap.
- Build a new 230 kV line from the Hummelstown 230-69 kV Substation to the Middletown Junction 230 kV Substation.

The total estimated cost of the Alternative 2 projects would be approximately $43.0 million.

This reinforcement alternative also resolves the contingency overloads explained in section C above and provides long term capacity upgrades for future growth. However, Alternative 2 has several deficiencies when compared to the preferred option. Specifically, Alternative 2 was not selected as the preferred option due to the following:

- More expensive.

- Requires extensive new rights-of-way for 230 kV and 69 kV transmission lines.
- Requires extensive outages at several substations and on the 69 kV transmission systems, thus reducing reliability to customers supplied from these transmission lines.

Alternative 3

Construct a new 230-69 kV substation at PPL Electric's existing Steelton 230 - 69 kV Substation. Construct four new 138/69 kV lines from the new 230-69 kV substation and sectionalize them into the existing West Shore–Harrisburg #1 and #2 69 kV Transmission Lines. In addition, Alternative 3 would require the following upgrades:

- Install a 3rd 230-69 kV transformer at the Dauphin 230-69 kV Substation.
- Rebuild 2 miles of the West Shore–Harrisburg #1 and #2 69 kV Transmission Lines from the Harrisburg 69 kV Substation to the Steelton–Harrisburg 69 kV Transmission Line tap point.
- Rebuild the Steel 230 kV Tap from the Hummelstown-Middletown Junction #2 230 kV Transmission Line to Steelton Substation with higher capacity conductors.
- Build a new 230 kV line between the Hummelstown 230-69 kV Substation and the Middletown Junction 230 kV Substation.

The total estimated cost of the Alternative 3 projects would be approximately $58.85 million.

This reinforcement alternative also resolves the contingency overloads explained in section C above and provides long term capacity upgrades for future growth. However, Alternative 3 has several deficiencies when compared to the preferred option. Specifically, Alternative 3 was not selected as the preferred option due to the following:

- More expensive.
- Requires new rights-of-way for 230 kV and 69 kV transmission lines.
- Requires extensive outages at several substations and on the 69 kV transmission system reducing reliability to customers supplied from these transmission lines.

FIGURE 1
EXISTING 230 KV SYSTEM

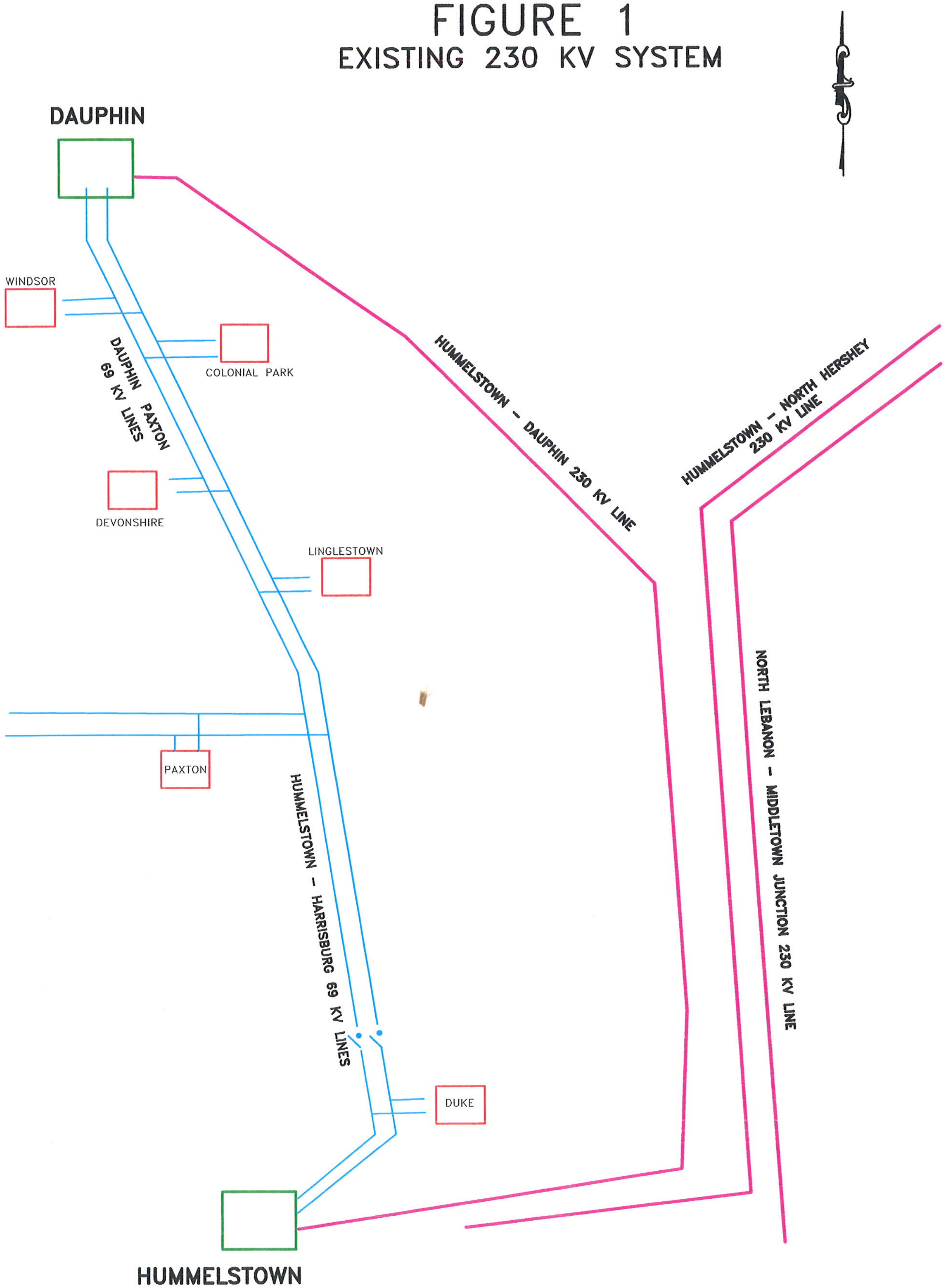
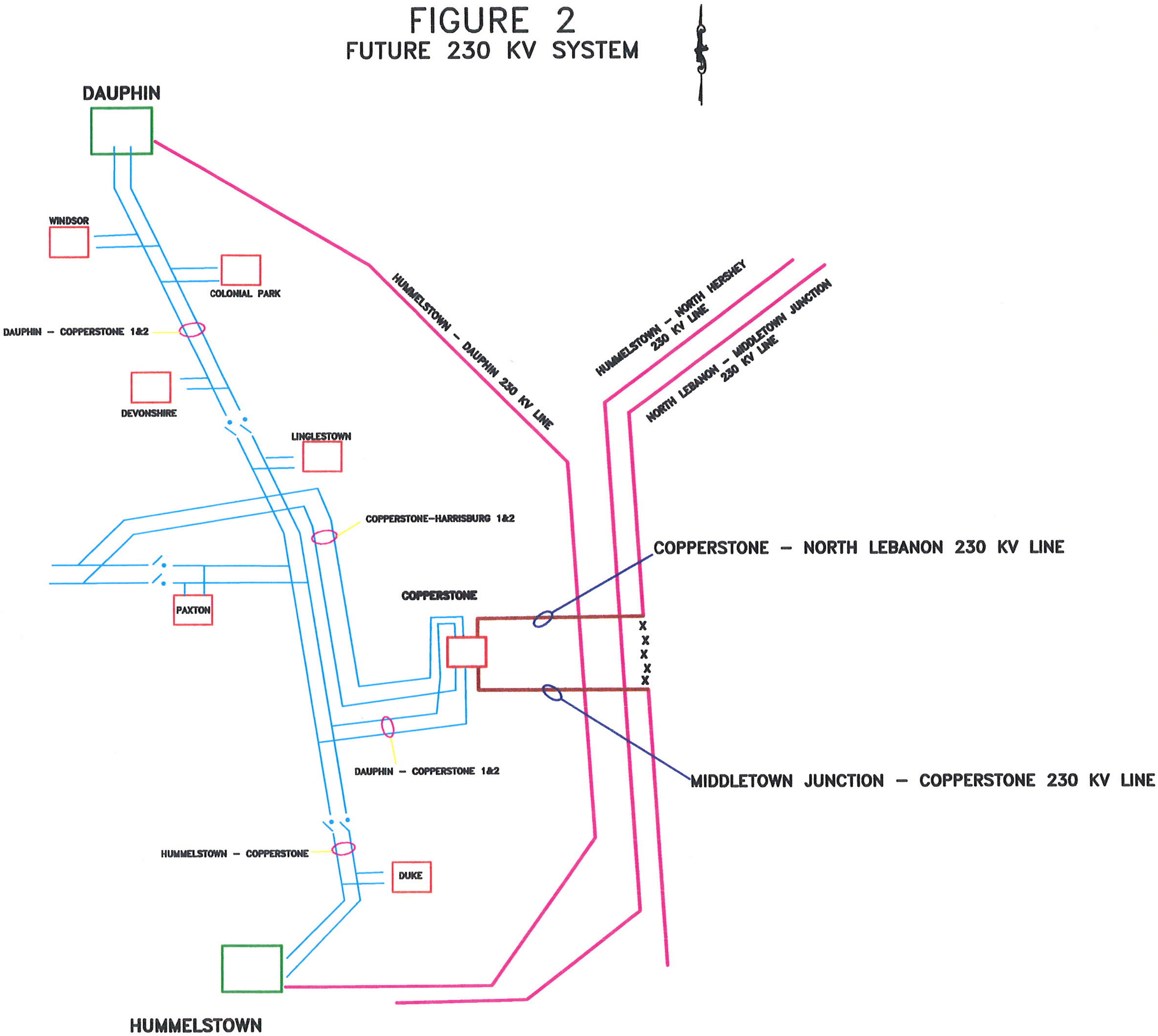


FIGURE 2
FUTURE 230 KV SYSTEM



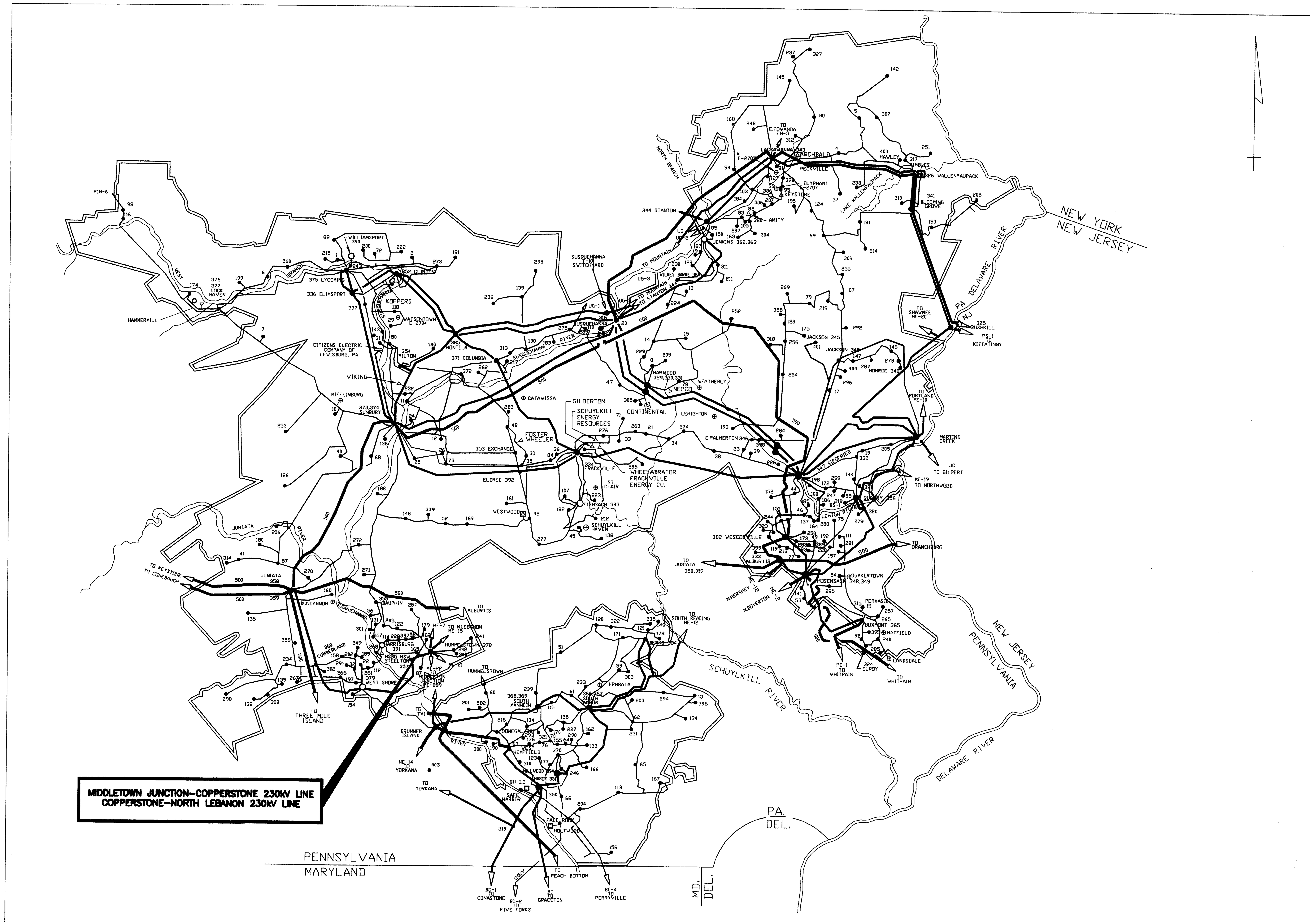
SUBSTATION LISTING

- WEST WILLIAMSPORT
- FAIRFIELD
- MONTGOMERY
- VARDEN
- HONESDALE
- JERSEY SHORE
- LOGANTON
- VALMONT
- RIVER
- LIMESTONE
- NORTHUMBERLAND
- REED
- WRIGHT
- ST.JOHNS
- FREELAND
- *
- GILBERT
- *
- CHERRY HILL
- SUSQUEHANNA 230KV
- TAMANEND
- WHITE HILL
- PALMERTON
- HAMILTON
- HUNTER
- FAIRVIEW
- *
- *
- MONTOUR PUMP
- MT. CARMEL
- KELLY
- SPORTING HILL
- MAHANOY CITY
- GREENWOOD
- MOWRY
- ALTAMOUNT
- HAMLIN
- ASHFIELD
- SOUTH SLATINGTON
- SOUTH MIDDLEBURG
- WALKER
- FRAILEY
- MORGANTOWN
- EGYPT
- CRESSONA
- SOUTH WHITEHALL
- EAST TOMHICKEN
- BEAR GAP
- SALISBURY
- SOUTH MILTON
- HEIDELBERG
- LYKENS
- UPPER HANOVER
- RICHLAND
- MACADA
- ROCKVILLE
- THOMPSONTOWN
- PAXTON
- COCALICO
- EAST ELIZABETHTOWN
- WARWICK
- EARL
- HEMPFIELD
- EAST LANCASTER
- KINZER
- MT. NEBO
- MT. POCONO
- PENNS
- GOULDSBORO
- DILLERVILLE
- GIRARD MANOR
- KENMAR
- GOWEN CITY
- *
- ELLIOT HEIGHTS
- ROHRERSTOWN
- MACUNGIE
- EAST HAZLETON
- WAGNERS
- EAST CARBONDALE
- EYNON
- MINOOKA
- OLD FORGE
- FOUNTAIN SPRINGS
- SULLIVAN TRAIL
- *
- SWATARA
- *
- HEPBURN
- *
- *
- FRANCONIA
- EMMAUS
- MORGAN
- THROOP
- *
- *
- CHAPMAN
- SUBURBAN
- *
- *
- *
- PROVIDENCE
- *
- AVOCA
- *
- CASS
- CATASAQUA
- *
- SUSQUEHANNA 500KV
- SEIDERSVILLE
- ROSEMONT
- QUARRYVILLE
- LAWNTON
- LITITZ
- RENOVO
- WALNUT
- WATSON
- TREXLERTOWN
- LAVINO
- SPRING
- COLONIAL PARK
- WEST LANCASTER
- MADISONVILLE
- NEFFSVILLE
- BEAVERTOWN
- BELMONT
- LAKE HARMONY
- GEORGETOWN
- SCOTT
- N. HARRISBURG
- MOUNT ROCK
- GREENLAND
- LANDISVILLE
- GREEN PARK
- SELINSGROVE
- SUMNER
- AUBURN
- ROHRSBURG
- DERRY
- EAST GREENVILLE
- WEST DAMASCUS
- NEW COLUMBIA
- FARMERSVILLE
- GREENFIELD
- NORTH STROUDSBURG
- TANNERSVILLE
- ELIZABETHVILLE
- WYOMISSING
- 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 DELAND
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

* - 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
64	11/17/09	389331	ADDED RED FRONT 115 kV TAP LINE.	RRC		KBK
67	4/13/10	169983	ADDED MIDDLETOWN JUNCTION-COPPERSTONE & COPPERSTONE-NORTH LEBANON 230kV LINE.	RRC		DH
66	3/10/10	169983	ADDED DAUPHIN-COPPERSTONE #1 & #2 138 kV LINES	RRC		DH
65	3/4/10	169020	ADDED APPENZELL #1 & #2 138kV TAPS.	RRC		DH

REFERENCE TITLE | NUMBER | REFERENCE TITLE | NUMBER

FRACTIONAL | DECIMAL

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

ACCT- 805201
SCALE- NONE
BY- CDW
REVIEWED

ELECTRICAL SYSTEM MAP
MIDDLETOWN JUNCTION-COPPERSTONE 230kV
COPPERSTONE-NORTH LEBANON 230kV LINE

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

PPL DRAWING NO. D191830 | SHEET NO. 1

D191830_S

Exhibit
B

EXHIBIT "B"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

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COPPERSTONE – NORTH LEBANON 230 kV LINE

ENGINEERING DESCRIPTION

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EXHIBIT "B"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

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COPPERSTONE – NORTH LEBANON 230 kV LINE

ENGINEERING DESCRIPTION

A. DESCRIPTION OF THE PROPOSED LINE

PPL Electric proposes to construct the new single-circuit Middletown Junction- Copperstone 230 kV and single-circuit Copperstone – North Lebanon 230 kV Transmission Lines. These proposed lines will supply the new Copperstone 230-69 kV Substation. They will extend approximately 0.22 miles from the existing Middletown Junction – North Lebanon 230 kV Transmission Line just east of the proposed Substation. The proposed lines would be constructed for single-circuit 230 kV operation.

The new lines will consist of single and multi-pole fabricated weathering steel structures. Three power conductors and one overhead ground wire will be installed for each circuit. The power conductors will be 1590 kcmil, 45/7 stranding, ACSR conductors, and one 1/2 inch high-strength steel overhead ground wire. All new poles for the proposed Middletown Junction - Copperstone and Copperstone - North Lebanon 230 kV Transmission Lines will be either direct embedded or installed on concrete foundations with an approximate above-ground height of 120 - 130 feet. Line angles and tap structures could be guyed. This work will be completed on PPL Electric fee owned property.

This project is located in South Hanover Township, Dauphin County. An aerial plot plan for the proposed transmission line project is provided in the Exhibit "B" map pocket.

The proposed line facilities will be designed to, and generally exceed, National Electrical Safety Code (NESC) standards. Design specifications and safety rules practiced by PPL Electric are included in Appendix A. The minimum conductor to ground clearance will be

32 feet on all new transmission line facilities. Those clearances occur at a maximum thermal conductor temperature of 125 degrees Celsius.

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

TABLE 1

DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 1590 KCMIL, 45/7 STRANDING ACSR*

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINES

COPPERSTONE – NORTH LEBANON 230 KV LINES

Condition	Single-Circuit Design Clearance-to-Ground
Normal load; average weather (16°C ambient temperature)	34.6 feet
Predicted extreme thermal load (125°C conductor temperature)	32.0 feet
Predicted NESC Extreme wind load (100 mph, 16°C)	34.2 feet
Predicted extreme weather conditions (1inch ice, 8 lbs. wind, -18°C)	35.1 feet

*Clearances based on a maximum tension of 8,000 pounds, at 1 inch ice, 0° F, 8 lb wind, and a ruling span of 270 feet.

TABLE 2

CONDUCTOR THERMAL RATING
795 KCMIL 30/19 STRANDING ACSR
(257°F) 125°C MAXIMUM CONDUCTOR TEMPERATURE

Condition	Ambient Temperature °C	Wind Speed Knots	Ampacity Amps
Summer Normal	35	0	1056
Winter Normal	10	0	1217
Summer Emergency	35	1 1/2	1347
Winter Emergency	10	1 1/2	1517

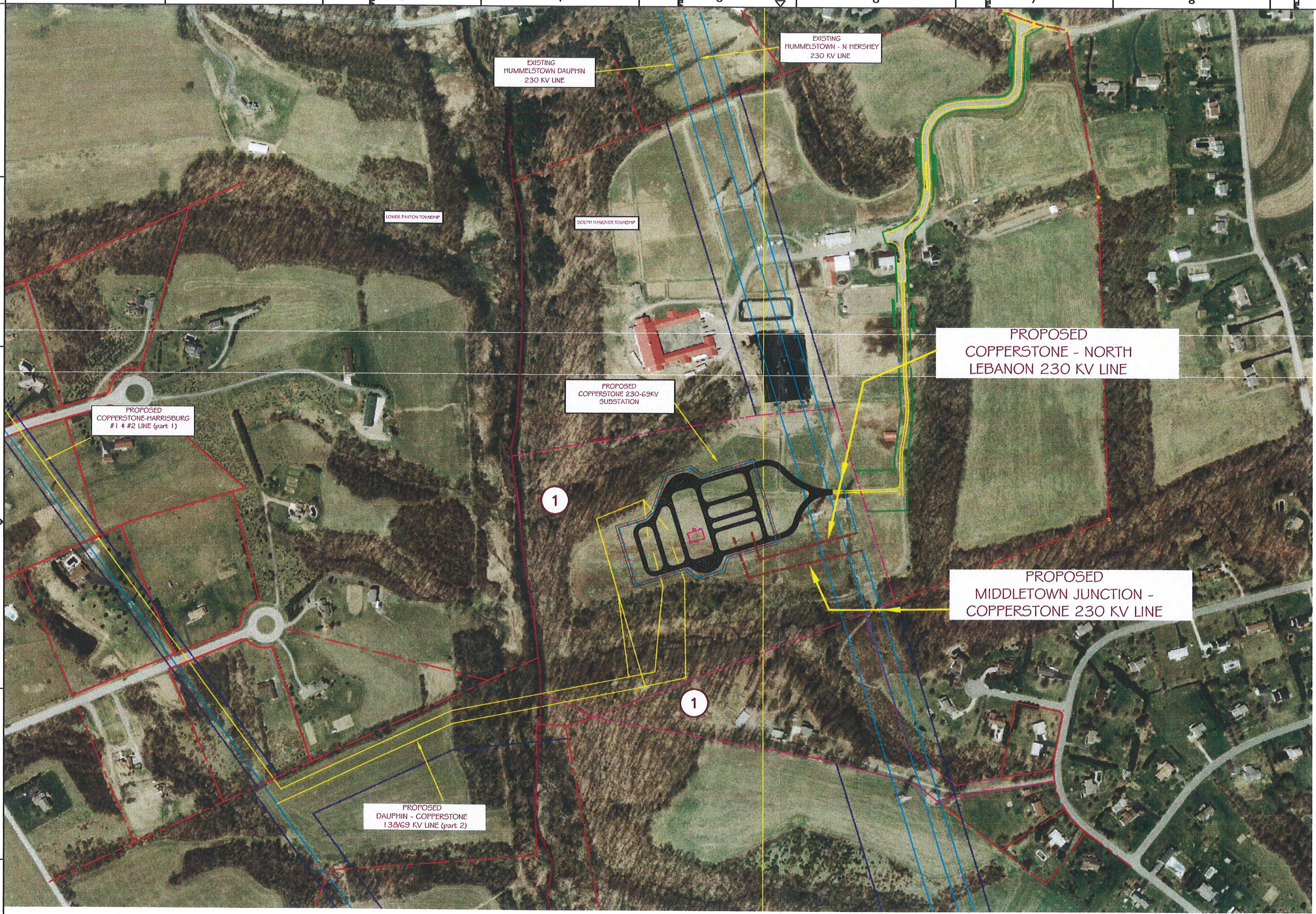
B. MAGNETIC FIELD MANAGEMENT

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

Increased ground clearance and reverse phasing are included in the design of the new double circuit Dauphin - Copperstone #1 & #2 138/69 kV Transmission Line.

C. RIGHT-OF-WAY STATUS

Most of the work for the new Dauphin - Copperstone #1 & #2 138/69 kV Transmission Line will be completed on PPL Electric fee-owned property and under existing PPL Electric right-of-way agreements with defined right-of-way widths. Although some additional rights-of-way were required to construct the Dauphin - Copperstone #1 & #2 138/69 kV Transmission Line, PPL Electric has successfully negotiated with the relevant property owners and secured right-of-way agreements necessary to construct this overhead line section. A list of property owners within the existing right-of-way is presented in Appendix C.



LEGEND

- EXISTING TRANSMISSION LINE
- PROPOSED TRANSMISSION LINE
- EXISTING RIGHT-OF-WAY
- EXISTING PROPERTY LINE
- NEW PPL PROPERTY LINE
- TOWNSHIP LINE

Property Number	Property Owner
1	PPL ELECTRIC UTILITIES 32.7 & 11.4 ACRES

EXHIBIT B

AERIAL EXHIBIT
SHEET 1

MIDDLETOWN JUNCTION - COPPERSTONE
&
COPPERSTONE - NORTH LEBANON
230 kV LINES

SOUTH HANOVER TOWNSHIP
DAUPHIN COUNTY, PA.

SCALE1"=400
400 0 200 400 800

PREPARED BY:
PPL ELECTRIC UTILITIES CORP.

PPL ELECTRIC UTILITIES

REFERENCE TITLE	NUMBER	REFERENCE TITLE	NUMBER	NO.	DATE	ACCT.	REVISION	BY	REVIEWED	APPROVED

ACCT- 169983
SCALE- 1"=400'
BY- RRC
REVIEWED

MIDDLETOWN JUNCTION - COPPERSTONE
COPPERSTONE - NORTH LEBANON
230 KV LINES

SOUTH HANOVER & LOWER PAXTON TOWNSHIP — DAUPHIN COUNTY, PA.

APPROVED: DOUGLAS L. HAUPT — DATE: 2/18/10 — PPL ELECTRIC UTILITIES

PPL DRAWING NO.: EXHIBIT "B" — SHEET NO.: 1 — REV.: 0

Exhibit
C

EXHIBIT "C"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

&

COPPERSTONE – NORTH LEBANON 230 kV LINE

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

EXHIBIT "C"

MIDDLETOWN JUNCTION - COPPERSTONE 230 kV LINE

&

COPPERSTONE – NORTH LEBANON 230 kV LINE

ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

PPL Electric proposes to reinforce the 230 kV and 69 kV electric delivery system in central Dauphin County. To accomplish this, PPL Electric requests Commission approval to construct approximately 0.22 miles of the new Middletown Junction - Copperstone and Copperstone – North Lebanon 230 kV Transmission Lines. These new single-circuit 230 kV lines will sectionalize and connect the existing Middletown Junction – North Lebanon 230 kV Transmission Line with the proposed Copperstone Substation. Although there are other parts to the project, PPL Electric only seeks Commission approval for the proposed 0.22 miles of the new single-circuit Middletown Junction - Copperstone and Copperstone – North Lebanon 230 kV Transmission Lines.

This proposed project was reviewed with South Hanover Township and Dauphin County. Neither the Township or County Officials have any objection to the project. A list of involved governmental agencies, municipalities, and other public entities is presented in Appendix D.

B. LAND USE

The Middletown Junction - Copperstone and Copperstone – North Lebanon 230 kV Transmission Lines will create minimal new land use impacts. These line sections will be constructed adjacent to two other existing overhead 230 kV transmission lines. The new lines will be constructed entirely on PPL Electric fee owned property.

The proposed Middletown Junction - Copperstone and Copperstone – North Lebanon 230 kV Transmission Lines will be generally located on farmland that is currently used for horse grazing. No nearby railroads, communication towers, pipelines, or other utilities will be affected by the proposed project. Existing field access roads will be used, although new roads may be needed in some cases for construction. All disturbed areas will be returned to their original condition after construction.

C. CULTURAL RESOURCES

This project was reviewed with the Pennsylvania Historical and Museum Commission (PHMC). PHMC has determined that, due to the absence of historical sites and the small project size, no further archaeological investigations are required so long as construction activities are located outside a 300-foot buffer of any watercourse. Because of the close proximity to Beaver Creek, PPL Electric has hired Dr. Frank Vento of Clarion University to conduct a Phase 1 presence/absence survey for any possible Cultural or Archaeological features. A report will be submitted upon completion of this survey.

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

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

There are several structures of historical interest in the vicinity of this project. Impacts to these historical structures are not expected due to the distance between the structures and this project. The Reservoir Park Overlook is located approximately 5.5 miles west of the project area, and the Landis Mill Millers House located at the intersection of N. Railroad Street and Duke Street, Hummelstown is approximately 2.2 miles south of the project area.

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. PPL Electric will apply its "Specifications For Initial Clearing and Control of Vegetation on or Adjacent to Electric Line Right-of-Way Through Use of Herbicides, Mechanical and Hand Clearing Techniques," to mitigate the impacts should any tree clearing be required.

The proposed lines will cross no wetlands. All required permits will be obtained from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers prior to construction.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with different state and federal agencies to obtain information regarding endangered and threatened species in the study area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicates that the Pennsylvania Department of Conservation and natural Resources (DCNR) has recorded one potential conflict in the project area. At the request of DCNR, PPL Electric hired Mr. Richard Mellon, Mellon Biological Services to perform a presence/absence survey for the *Triosteum angustifolium* (Tentatively Undetermined, Proposed PA Endanger), which did not detect the presence of any such species. Based on this study a final report from DCNR, dated January 7, 2008, indicated that no impact was likely. Because the report has since expired, PPL Electric has re-submitted its report and on February 24, 2010, DCNR has indicated no impacts are likely (Reference PNDI # 20071017113376 and 20100217229700).

Appendices

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APPENDIX B	-	Magnetic Field Management at PPL Electric
APPENDIX C	-	List of property owners within the existing Right-of-Way
APPENDIX D	-	List of Involved Governmental Agencies, Municipalities, and Other Public Entities

APPENDIX "A"

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 cross-arm dimensions, larger-minimum conductor size, and increased safety factors.

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

138 kV

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

500 kV

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

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

Periodic Maintenance Program on All Transmission Lines

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use of helicopter patrols, with supplemental foot and structure climbing patrols. A number of helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

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

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

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

Personnel Safety Rules

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

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

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

Voltage-kV	Minimum Clearance
138	3’-7”
230	5’-3”
500	11’-3”

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

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

MAGNETIC FIELD MANAGEMENT

PPL Electric Utilities Corporation

APPENDIX B

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

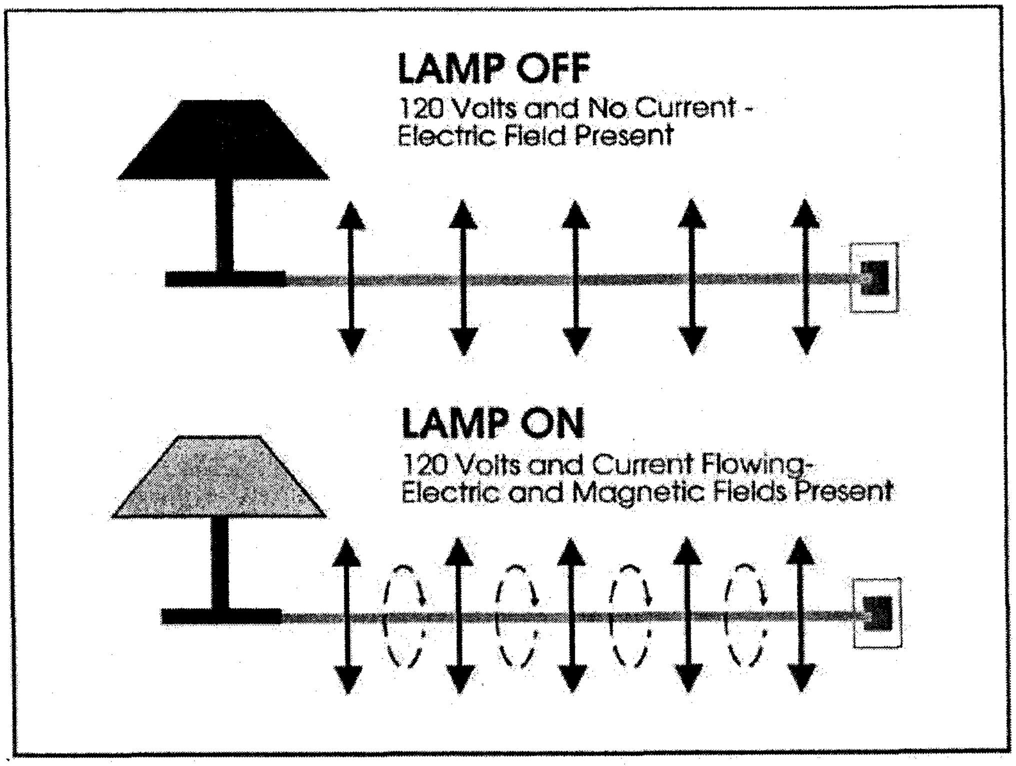

LAMP OFF
120 Volts and No Current - Electric Field Present
LAMP ON
120 Volts and Current Flowing- Electric and Magnetic Fields Present

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.

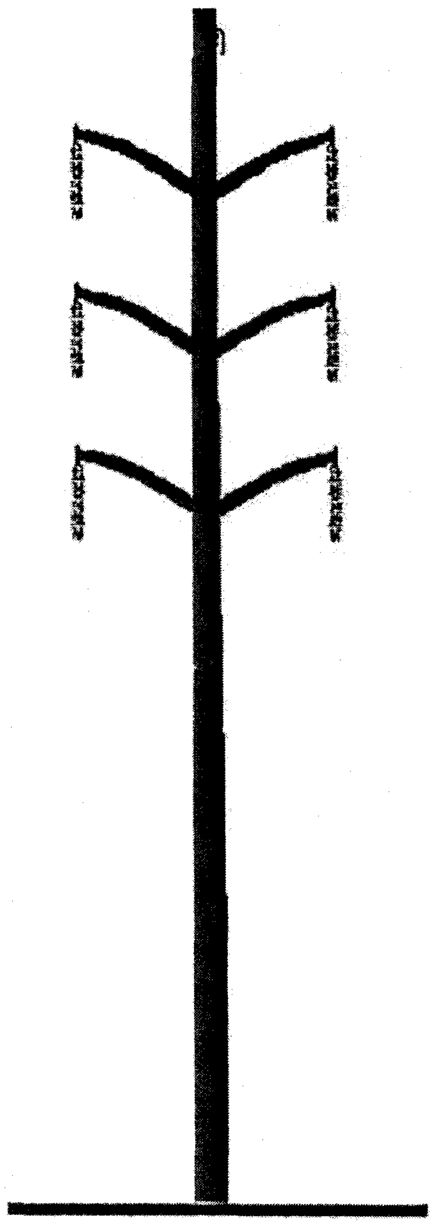
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

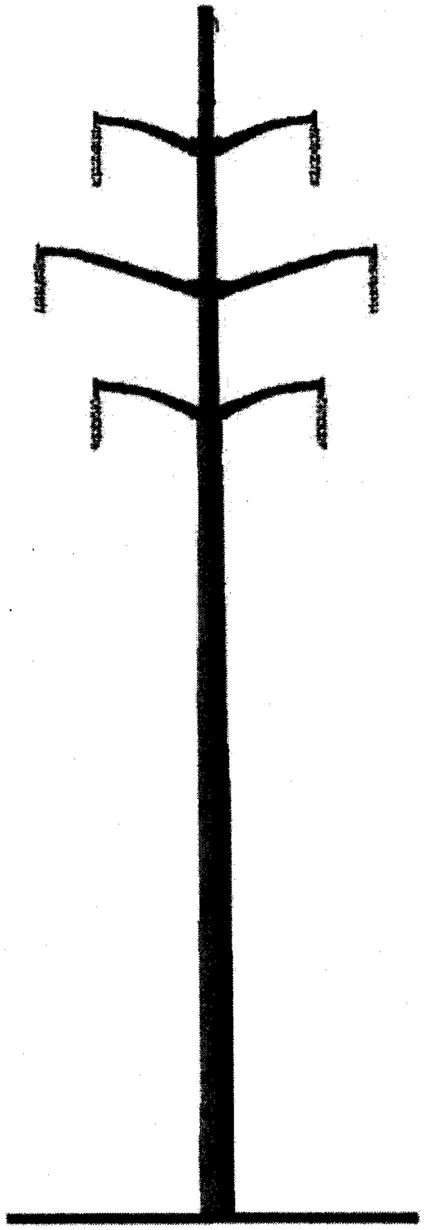
Short-Span Construction



- **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

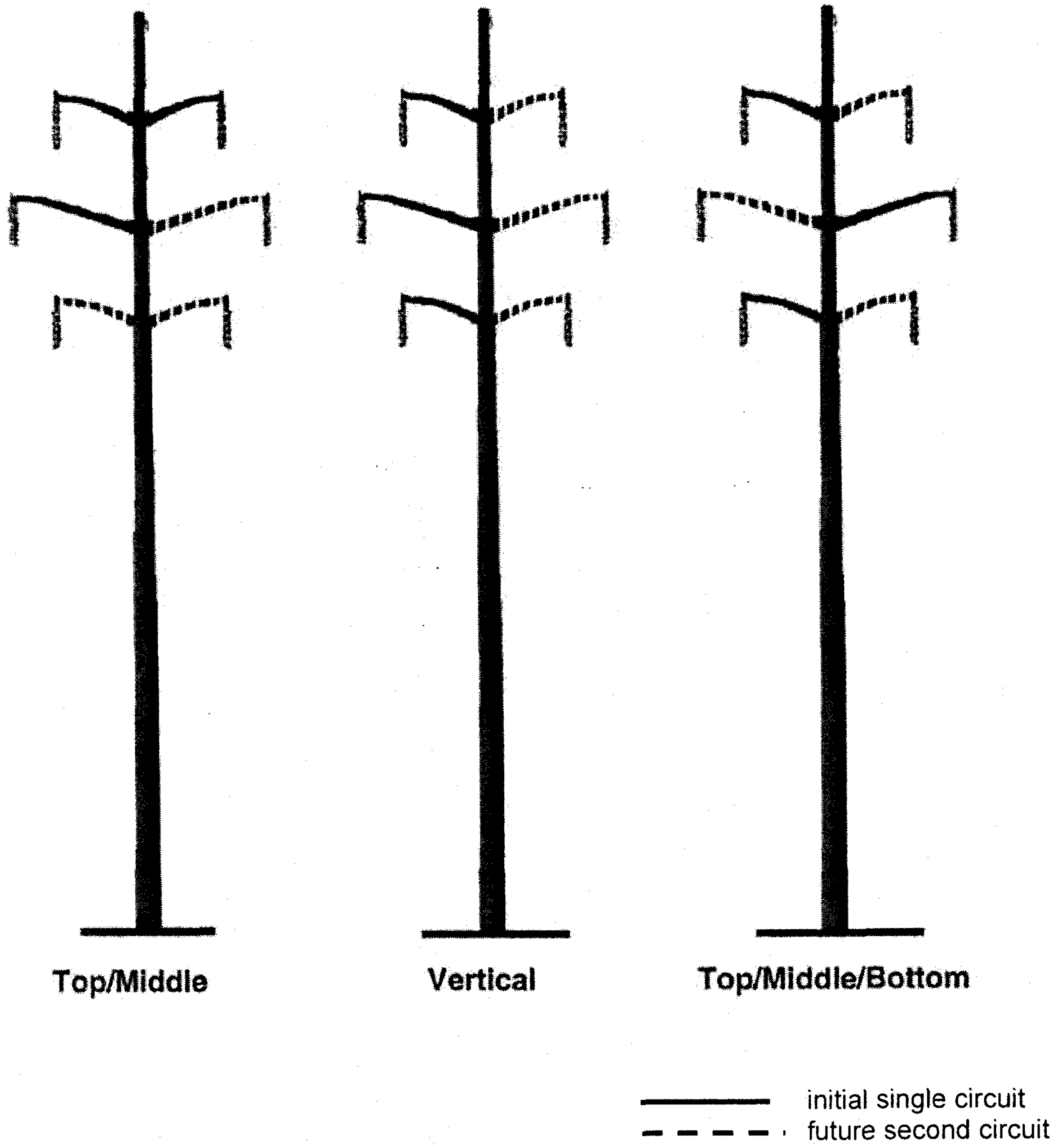
138/69 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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.

CHART IV

Typical Single-Circuit Structure Designs

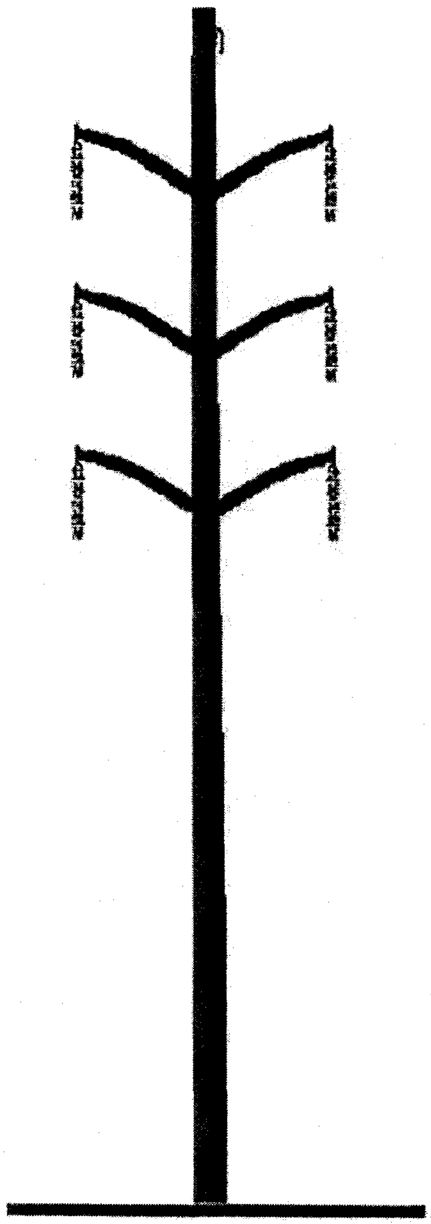


138/69 kV SINGLE CIRCUIT TRANSMISSION LINES CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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

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

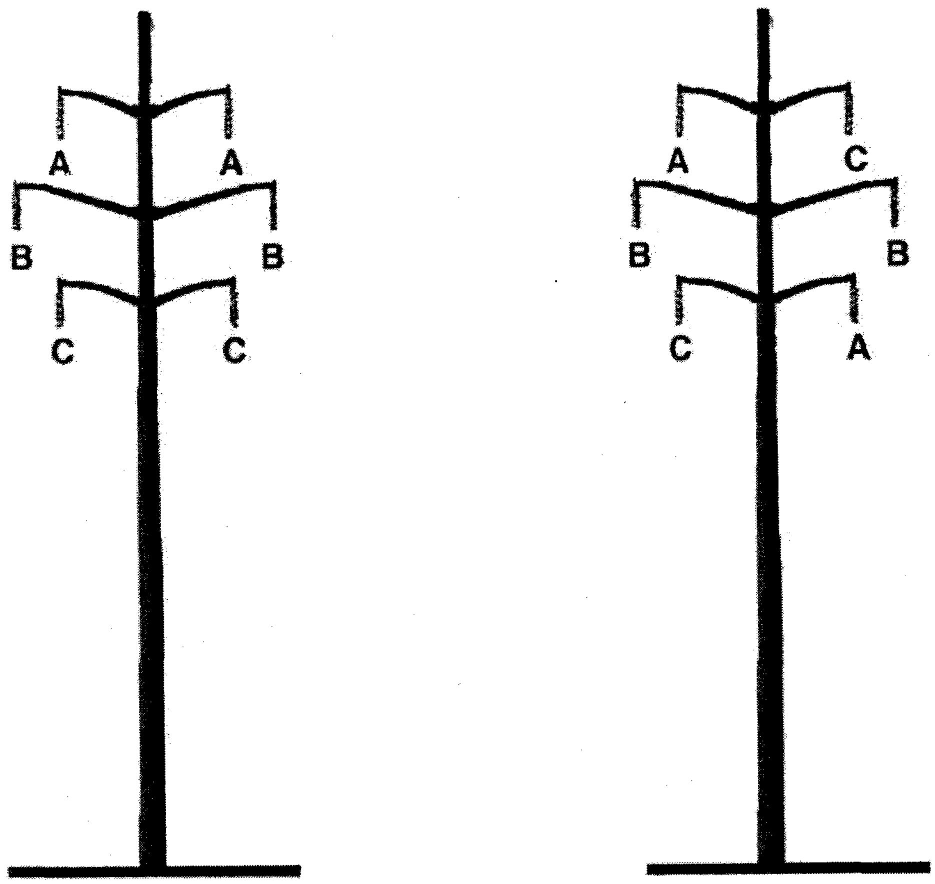
Compact Design Structure



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

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

Reverse Phasing of Double-Circuit Transmission Lines



From: ⟶ ⟶ ⟶ ⟶ **To:**

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

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

CHART VIII

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

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

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

CHART IX

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

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

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

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

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

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

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

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

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

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

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

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

12 kV DISTRIBUTION LINES
CALCULATED MAGNETIC FIELDS AT 300 AMPERES

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

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

APPENDIX "C"

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

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

APPENDIX "D"

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

South Hanover Township Board of Supervisors
111 West Third Street
Hershey, Pa 17033-2498

South Hanover Township Planning Commission
c/o Penny Pollick, Township Manager
111 West Third Street
Hershey, Pa 17033-2498

Dauphin County Planning Commission
112 Market Street, 2nd Floor
Harrisburg, Pa 17101-2015

Dauphin County Commissioners
PO Box 1295
Harrisburg, Pa 17108