Before the
Pennsylvania Public Utility Commission

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

ATTACHMENTS IN SUPPORT OF THE
Letter of Notification

Application Docket No.____________

Submitted by: PPL Electric Utilities Corporation

SUMMARY

A Letter of Notification is being 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 approval to site and construct the Fountain Hill #1 & #2 138/69 kV Tap Line (Fountain Hill Tap) to serve the planned Fountain Hill 69-12 kV Substation (Fountain Hill Substation). Together, the Tap Line and Substation are required to improve reliability of service in the Fountain Hill area of Lehigh County. This Project is located in Salisbury Township, Lehigh County. The proposed tap line will be approximately 700 feet in length. Initially, it will be a double tap-single feed configuration and designed for 138 kV operation. Initially, the tap will operate at 69 kV. Later, when future load increases make it appropriate, a second circuit will be extended into the Fountain Hill substation, and the operating voltage will be increased to 138 kV.

The total estimated cost of the proposed transmission work associated with this Project is approximately $106,000. In addition, PPL Electric estimates that it will spend approximately $1.620 million (including the transformer cost) for the substation and $440,000 for distribution work associated with this Project. Subject to the Commission's approval, this Project has a scheduled construction start date of April 2012, in order to meet an in-service date of May 2013.

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

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

PPL ELECTRIC UTILITIES SERVICE TERRITORY

Attachment

1

ATTACHMENT 1

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

NECESSITY STATEMENT

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ATTACHMENT 1
FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE
NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric is requesting PUC approval to site and construct the Fountain Hill #1 and #2 138/69 kV Tap Line (Fountain Hill Tap). The proposed facilities are required to meet the load growth in the Fountain Hill area. The purpose of the proposed tap line is to supply the proposed Fountain Hill 69-12 kV Substation (Fountain Hill Substation). In order to energize the proposed Tap, both circuits on the Elliot Heights #1 & #2 138/69 kV Transmission Tap Line will be tapped through two Load Sectionalizing Air Break (LSAB) switches to a common point. From this point, a single circuit will be extended to the proposed new Fountain Hill Substation. The proposed tap will be constructed using two LSAB switches so that service can be maintained or restored quickly in the event of an outage on either circuit on the Elliot Heights #1 or #2 138/69 kV Transmission Tap Line.

The Fountain Hill Tap will be built for future 138 kV operation but will initially operate at 69 kV. In addition, a second circuit will be extended into the substation, and the tap will be upgraded to 138 kV operation when future demand for electricity warrants this construction.

The estimated cost to design and construct the proposed Fountain Hill Tap is approximately $106,000. In addition, PPL Electric estimates that it will spend approximately $1.620 million (including the transformer cost) for the substation and $440,000 for distribution work associated with this Project. The total cost of the Project is estimated to be $2.166 million.

The required in-service date for this Project is May 2013. The required in-service date is defined as the date the proposed facility needs to be placed in service to prevent equipment overloads that have the potential to damage existing facilities, and, thereby, cause the interruption of service to customers. In order to meet this in-service date, subject to the Commission's approval, construction is scheduled to start in May, 2012.

A PPL Electric system map showing existing transmission facilities with a design voltage of 35 kV or greater is included in the map pocket at the end of Attachment 1. This filing addresses only the existing and proposed 138/69 kV system in the Fountain Hill area.

B. EXISTING SYSTEM

Presently the Elliot Heights and Seidersville 69 – 12 kV Substations provide service to the area of concern. The Elliot Heights 69 – 12 kV Substation has two 69 – 12 kV transformers that are energized from the two circuits of the Elliot Heights #1 and #2 138/69 kV Transmission Tap Line. The Elliot Heights Substation currently supplies five 12 kV distribution lines, which serve a total of nearly 9,000 customers.

The Seidersville 69 – 12 kV Substation has two 69 – 12 kV transformers that are energized from the Hosensack – Quarry #1 and #2 138/69 kV Transmission Line. The Seidersville 69 – 12 kV Substation currently supplies five 12 kV distribution lines, which in total serve about 8,000 customers.

C. DEFINITION OF THE PROBLEM

PPL Electric plans its system in accordance with its Reliability Principles and Practices (RP&P) guidelines, so that PPL Electric can sustain probable contingencies and disturbances with minimal customer service interruptions and so that it can adequately serve each customer's needs with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle. System Planning is the process which assures that PPL Electric's regional system can supply electricity to all customer load in a manner that is reliable and economic. In addition, the system is planned so that system reliability can be maintained to prevent large scale, long term, or frequent service interruptions in order to avoid adverse effects and hazards to the public.

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

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

Due to the increasing demand for electricity, the Elliot Heights 69 – 12 kV Substation is expected to serve a peak load of approximately 37 MVA in the summer of 2012, which exceeds its rating of 35.5 MVA determined by its 12 kV underground transformer cables. If in the event that all load at Elliot Heights must be served by one transformer, the underground cables could fail interrupting nearly 5,000 customers until repairs can be made.

In addition to the concerns with loading at Elliot Heights Substation, the Seidersville 39-2 12 kV Distribution Line is expected to serve a peak load of 9.9 MVA in the summer of 2015. A portion of this line is composed of 2/0 Copper conductor which has a normal planning guideline of 8 MVA in the RP&P. If this guideline is exceeded there could be possible conductor damage or failure that would interrupt customers until repairs could be made.

The Seidersville 39-2 Distribution Line is particularly important because it is the principal source of supply for the Saint Lukes' Hospital. In the event of an outage of the Seidersville 39-2 Distribution Line, the Hospital can be served through the Seidersville 39-4 Distribution Line, but when the load is transferred, the load on the Seidersville 39-4 Distribution Line exceeds its emergency planning guideline for a portion of the line. Exceeding the emergency planning guideline can result in damage to the line and could result in an outage.

Also, the Elliot Heights 12-4 12 kV Distribution Line has been one of PPL Electric's worst performing circuits in terms of outages in recent years.

D. PROPOSED SOLUTION

To resolve the projected conductor overload and reliability issues discussed in Section C, PPL Electric proposes construction of the new Fountain Hill Substation, which will be supplied by the Fountain Hill Tap which is proposed in this Letter of Notification. PPL Electric will own, operate and maintain the new Fountain Hill Substation and the Fountain Hill Tap.

Two new 12 kV circuits which will be supplied from the Fountain Hill Substation will initially be installed. The new Fountain Hill Substation and the new 12 kV distribution circuits will allow transfer of load to relieve the projected overloading on the Elliot Heights Substation and the Seidersville 39-2 Distribution Line.

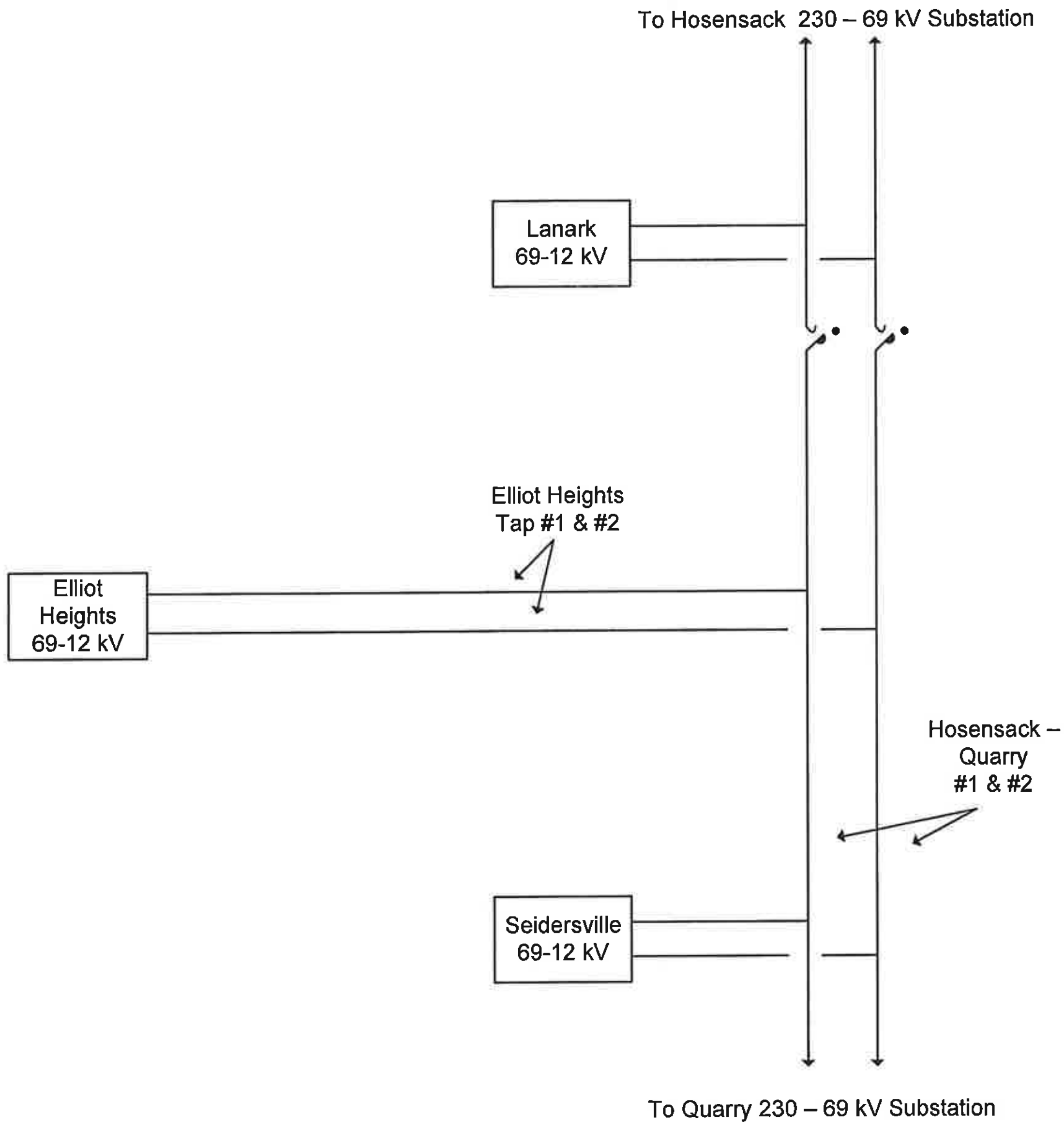
The Fountain Hill Substation and new 12 kV distribution lines will tap into the Elliot Heights 12-4 12 kV distribution line, picking up its entire load. This load transfer will reduce loading at the Elliot Heights Substation by about 5.8 MVA. The addition of motorized switching on this new line will reduce restoration times on the former Elliot Heights 12-4 12 kV distribution line during outages by allowing remote operation of switching devices.

The second new circuit from the Fountain Hill Substation will tap into the Seidersville 39-2 Distribution Line picking up approximately 3.1 MVA bringing load on the 2/0 Copper section well within its planning guidelines.

Presently, Saint Luke's Hospital is supplied by the Seidersville 39-2 12 kV Distribution Line. After the completion of the Fountain Hill Tap and Substation, it will be supplied by one of the new Fountain Hill circuits. Therefore, in addition to reducing the load on the Seidersville 39-2 12 kV distribution line, Saint Luke's Hospital will be supplied from two separate substations served by two separate transmission lines. The Hospital will be supplied by two separate distribution lines, thus further improving the reliability of electric service to this critical human needs customer because, with transmission lines, two substations and two feeds, service can be maintained or quickly restored in the event of an outage of either source of supply.

The new substation will provide an additional source for load transfers between distribution circuits, which will improve the reliability and operating flexibility on the Elliot Heights and Seidersville 12 kV Distribution Lines.

FIGURE 1
FUNCTIONAL ONE-LINE DIAGRAM OF EXISTING TRANSMISSION FACILITIES



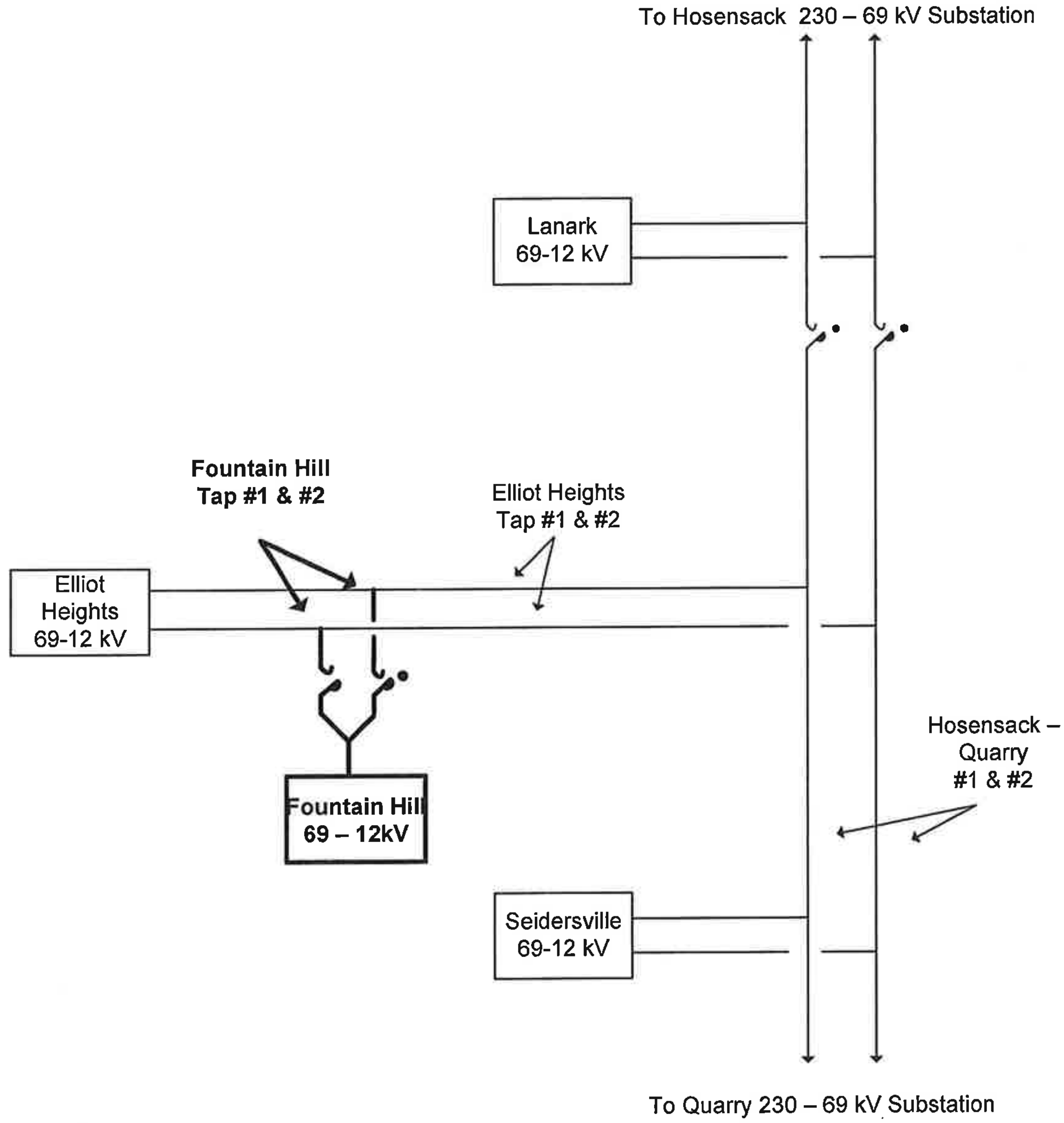
LEGEND:

- Existing Construction
- New Construction
- Load Air Break Switch
- Normally Open
- Customer Sub

Fountain Hill Area
Existing Transmission Facilities

DSR 11/14/11

FIGURE 2
FUNCTIONAL ONE-LINE DIAGRAM OF PROPOSED TRANSMISSION FACILITIES



LEGEND:

- Existing Construction
- New Construction
- Load Air Break Switch
- Normally Open
- Customer Sub

Fountain Hill Area
Existing and Proposed New
Transmission Facilities

DSR 11/14/11

FIGURE 3
FUNCTIONAL ONE-LINE DIAGRAM OF EXISTING DISTRIBUTION FACILITIES

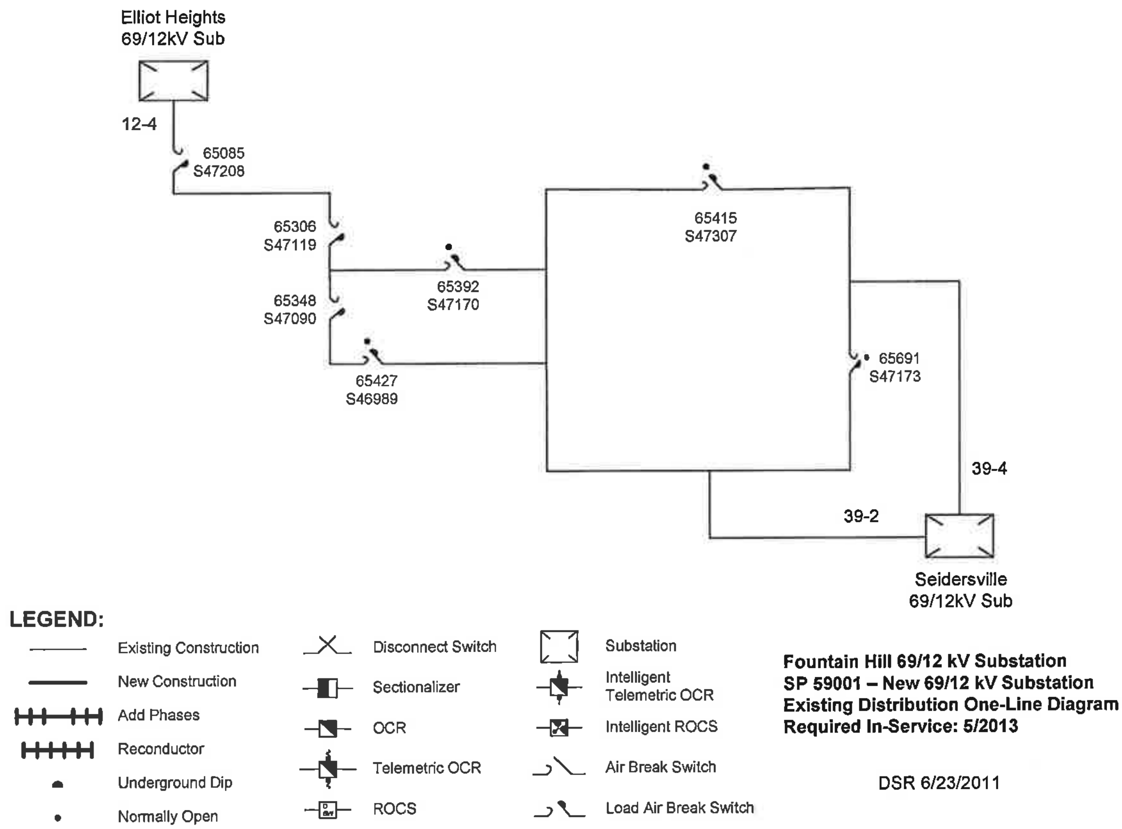
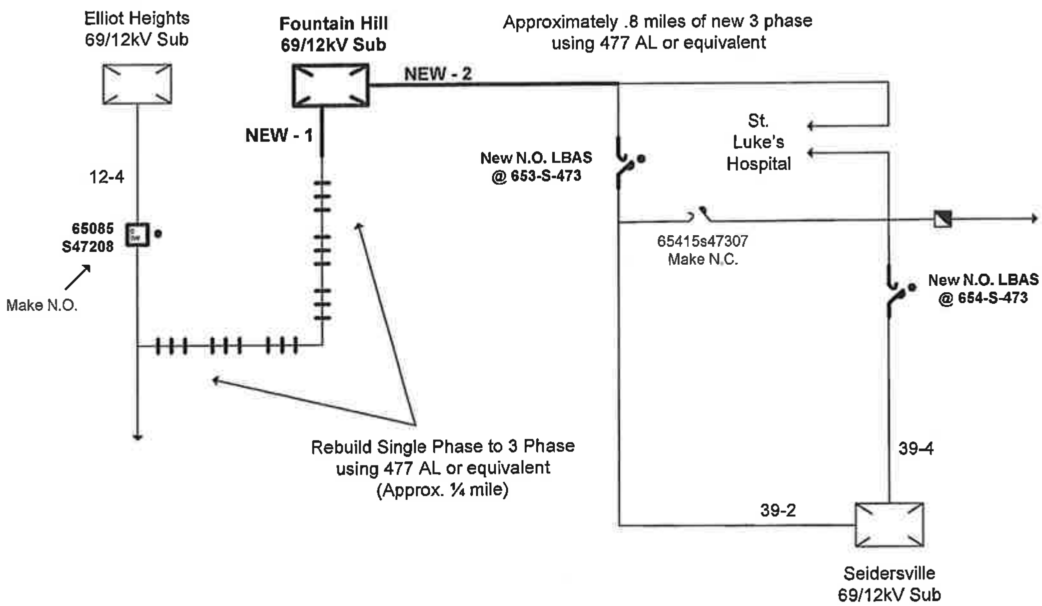


FIGURE 4
FUNCTIONAL ONE-LINE DIAGRAM OF PROPOSED DISTRIBUTION FACILITIES



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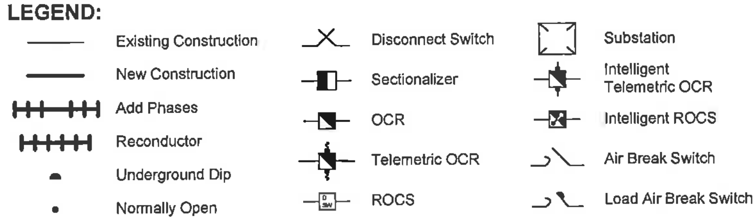


Fountain Hill 69/12 kV Substation
SP 59001 – New 69/12 kV Substation
Distribution Functional One-Line Diagram
Required In-Service: 5/2013

DSR 11/14/2011

SUBSTATION LISTING

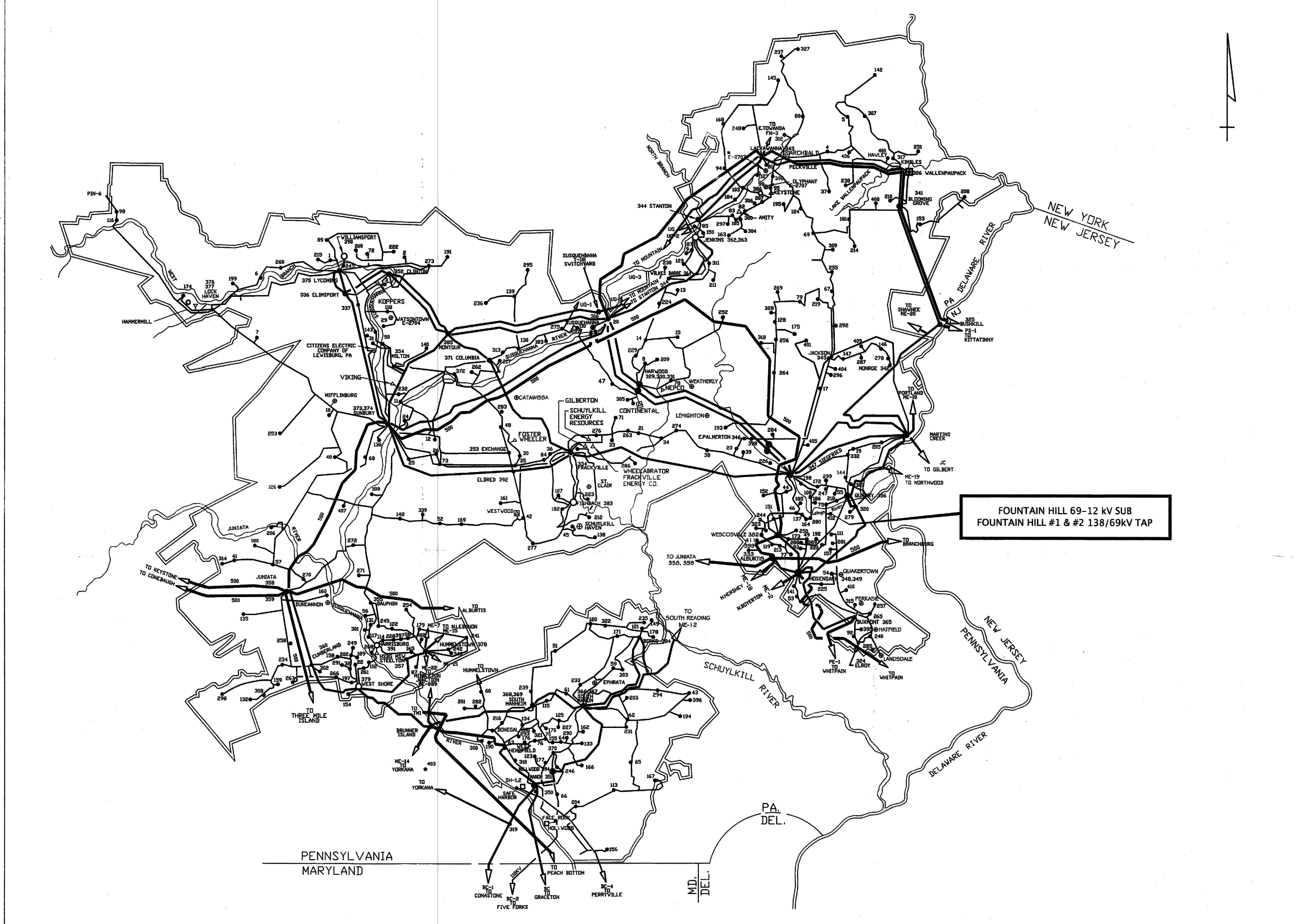
1. WEST WILLIAMSPORT
2. FAIRFIELD
3. MONTGOMERY
4. VARDEN
5. HONESDALE
6. JERSEY SHORE
7. LOGANTON
8. VALMONT
9. RIVER
10. LIMESTONE
11. NORTHUMBERLAND
12. REED
13. WRIGHT
14. ST. JOHNS
15. FREELAND
16. *
17. GILBERT
18. *
19. CHERRY HILL
20. SUSQUEHANNA 230kV
21. TAMAMEND
22. WHITE HILL
23. PALMERTON
24. HAMILTON
25. HUNTER
26. FAIRVIEW
27. *
28. *
29. MONTOUR PUMP
30. MT. CARMEL
31. KELLY
32. SPORTING HILL
33. MAHANOY CITY
34. GREENWOOD
35. MOWERY
36. ALTAMOUNT
37. HAMLIN
38. ASHFIELD
39. SOUTH SLATINGTON
40. SOUTH MIDDLEBURG
41. WALKER
42. FRAILEY
43. MORGANTOWN
44. EGYPT
45. CRESSONA
46. SOUTH WHITEHALL
47. 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. CATASAUQUA
109. *
110. SUSQUEHANNA 500kV
111. SEIDERSVILLE
112. ROSEMONT
113. QUARRYVILLE
114. LAWNTON
115. LITITZ
116. RENOVO
117. WALNUT
118. WATSON
119. TREXLERTOWN
120. LAVINO
121. SPRING
122. COLONIAL PARK
123. WEST LANCASTER
124. MADISONVILLE
125. NEFFSVILLE
126. BEAVERTOWN
127. BELMONT
128. LAKE HARMONY
129. GEORGETOWN
130. SCOTT
131. NORTH HARRISBURG
132. MOUNT ROCK
133. GREENLAND
134. LANDISVILLE
135. GREEN PARK
136. SELINSGROVE
137. SUMNER
138. AUBURN
139. ROHRSBURG
140. DERRY
141. EAST GREENVILLE
142. WEST DAMASCUS
143. NEW COLUMBIA
144. FARMERSVILLE
145. GREENVILLE
146. NORTH STROUDSBURG
147. TANNERSVILLE
148. ELIZABETHVILLE
149. WYOMISSING
150. EXETER
151. CRACKERSPORT
152. SCHNECKSVILLE
153. HEMLOCK
154. MT. ALLEN
155. PRINCE
156. WAKEFIELD
157. COOPERSBURG
158. WERTZVILLE
159. WEST CARLISLE
160. BENVENUE
161. HEGINS
162. LEOLA
163. YATESVILLE
164. CENTRAL ALLENTOWN
165. OBERLIN
166. STRASBURG
167. ATGLEN
168. BROOKSIDE
169. WILLIAMSTOWN
170. EAST PETERSBURG
171. WERNERSVILLE
172. NORTH BETHLEHEM
173. WEST ALLENTOWN
174. FLEMINGTON
175. MECKESVILLE
176. DONERVILLE
177. MILLERSVILLE
178. SHILLINGTON
179. DUKE
180. MCALLISTERVILLE
181. NEWFOUNDLAND
182. MARLIN
183. WEST BERWICK
184. KEYSER AVENUE
185. MICKLEYS
186. EAST ALLENTOWN
187. PINE RIDGE
188. DALMATIA
189. PENNSBORO
190. NORTH COLUMBIA
191. HUGHSVILLE
192. SOUTH ALLENTOWN
193. WEISSPORT
194. HONEYBROOK
195. MOSCOW
196. *
197. ROSSMOYNE
198. NORTHAMPTON
199. WOOLRICH
200. FAXON
201. ELIZABETHTOWN
202. ENOLA
203. TERRE HILL
204. BUCK
205. MT. BETHEL
206. RICHFIELD
207. SCRANTON
208. TWIN LAKES
209. HARLEIGH
210. TAFTON
211. BEAR CREEK
212. ORWIGSBURG
213. EAST TEXAS
214. CANDENSIS
215. LINDEN
216. MT. JOY
217. WEST BLOOMSBURG
218. 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. SOUTH HERSHEY
243. SOUTH WILLIAMSPORT
244. FOGELSVILLE
245. WINDSOR
246. WEST WILLOW
247. WESTGATE
248. EDELA
249. SUMMERDALE
250. DORNEYVILLE
251. BOHEMIA
252. WHITE HAVEN
253. LAURELTON
254. LINGLESTOWN
255. POCONO FARMS
256. HICKORY RUN
257. BLOOMING GLEN
258. SHERMANSDALE
259. *
260. LARRYS CREEK
261. SPANGLER MILLS
262. EAST DANVILLE
263. DELANO
264. CARBON
265. SELLERSVILLE
266. MECHANICSBURG
267. CARLISLE
268. CEDAR
269. ARROWHEAD
270. NEWPORT
271. HALIFAX
272. MILLERSBURG
273. MUNCY
274. HAUTO
275. BERWICK
276. SHENANDOAH
277. PINE GROVE
278. STROUDSBURG
279. FREEMANSBURG
280. ALLENTOWN
281. BINGEN
282. RHEEMS
283. CLEVELAND
284. LITTLE GAP
285. ORVILLA
286. TUSCARORA
287. BARTONSVILLE
288. ALTON PARK
289. SALEM
290. NORTH BRIDGEPORT
291. HAMPDEN
292. CAMELBACK
293. SILVER SPRING
294. BRECKNOCK
295. BENTON
296. McMICHAELS
297. HUGHSTOWN
298. NEWVILLE
299. POINTE NORTH
300. MARIETTA
301. CENTER CITY
302. NEW KINGSTOWN
303. REAMSTOWN
304. DUPONT
305. HUMBOLT
306. CEDAR AVE.
307. INDIAN ORCHARD
308. NOTTINGHAM
309. NORTH COOLBAUGH
310. LETORT
311. EAST MOUNTAIN
312. JERMYN
313. BLOOMSBURG
314. MIFFLINTOWN
315. RIDGE ROAD
316. SUSQUEHANNA T-10 SW. YARD
317. KIMBLES
318. CHRISTMANS
319. OTTER CREEK
320. STEEL CITY
321. McGOVERNVILLE
322. ROBESONIA
323. SOUTH FOGELSVILLE
324. ELROY
325. BUSHKILL
326. WALLENPAUPACK
327. ELK MOUNTAIN
328. JACK FROST
329. HARWOOD 230/69kV
330. HARWOOD CTG
331. HARWOOD 69/12kV
332. NAZARETH
333. ALBURTIS
334. FRACKVILLE
335. *
336. ELIMSPORT
337. ALLENWOOD
338. *
339. GRATZ
340. HOCKERSVILLE
341. BLOOMING GROVE
342. MONROE
343. LACKAWANNA ##
344. STANTON
345. JACKSON
346. EAST PALMERTON
347. SIEGFRIED
348. HOSENSACK 230/69kV
349. HOSENSACK 500kV
350. CONESTOGA
351. MANOR
352. CLINTON
353. EXCHANGE
354. MILTON
355. DAUPHIN
356. QUARRY SUB.
357. STEELTON
358. JUNIATA 500/230kV
359. JUNIATA 230/69kV
360. CUMBERLAND
361. DONEGAL
362. JENKINS 230/69kV
363. JENKINS CTG
364. WILKES-BARRE
365. BUXMONT
366. SOUTH AKRON 230/138/69kV
367. SOUTH AKRON 69/12kV
368. SOUTH MANHEIM 69/12kV
369. SOUTH MANHEIM 230/69kV
370. ENGLESIDE
371. COLUMBIA
372. DANVILLE
373. SUNBURY
374. HUMMELS WHARF
375. LYCOMING
376. LOCK HAVEN CTG
377. LOCK HAVEN 69/12kV
378. HUMMELSTOWN
379. WEST SHORE
380. MONTAGE
381. SOUTH FARMERSVILLE
382. WESCOSVILLE
383. FISHBACH
384. BERKS
385. MONTOUR
386. SUBURBAN YARD
387. *
388. *
389. MACK
390. WILLIAMSPORT
391. HARRISBURG
392. ELDRED
393. *
394. MILLWOOD
395. TELFORD
396. TWIN VALLEY
397. DEVONSHIRE
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
408. LEDGEDALE
409. EAST TANNERSVILLE
410. TRUMBAUERSVILLE
411. WEST TREXLERTOWN
412. FOUNTAIN HILL

* - SUBSTATIONS THAT HAVE BEEN RETIRED.

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

INTERCONNECTIONS

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



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
100	12/19/11	10013359	ADDED FOUNTAIN HILL 69-12 kV SUB AND FOUNTAIN HILL #1 & #2 138/69kV TAP	mg		DJG
99	12/09/11	10016114	ADDED WEST TREXLERTOWN 69-12 kV SUB AND WEST TREXLERTOWN #1 & #2 69/138kV TAP	mg		DJG
98	12/02/11	10016984	ADDED SUSQUEHANNA - HARWOOD #1 & #2 230KV LINES PROJECT LOCATION	mg		KBK
97	11/30/11	169989	ADDED WEST SHORE - HARRISBURG #1 & #2 138/69kV LINE - PROJECT LOCATION	mg		KBK

REFERENCE TITLE | NUMBER | REFERENCE TITLE | NUMBER

ACCT- 805201
SCALE- NONE
BY- CDW

ELECTRICAL SYSTEM MAP
FOUNTAIN HILL 69-12 kV SUBSTATION
FOUNTAIN HILL #1 & #2 138/69 kV TAP

APPROVED G. HAKUN III
DATE 7/17/85

PPL ELECTRIC UTILITIES

PPL DRAWING NO. D191830
SHEET NO. 1
REV. 100

#6000

D191830_S001.DWG

PPL EU FORM 4877 (7/80)

Attachment

2

ATTACHMENT "2"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

ENGINEERING DESCRIPTION

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Map

ATTACHMENT "2"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

ENGINEERING DESCRIPTION

A. DESCRIPTION OF PROPOSED LINE

PPL Electric proposes to construct the Fountain Hill Tap, which will extend approximately 800 feet in length and connect the existing the Elliot Heights #1 & #2 Transmission Tap Line to the planned Fountain Hill Substation. The proposed Fountain Hill Tap will be located in Salisbury Township, Lehigh County. The location of these proposed facilities is shown on the Aerial Attachment at the end of Attachment "2."

The Fountain Hill Tap will be designed as a double tap-single feed for 138 kV operation. Initially, however, it will be operated at 69 kV. The circuit will operate at 138 kV and a complete second circuit between the Elliot Heights #1 & #2 Transmission Tap Line and the Fountain Hill Substation will be added when future load increases make it appropriate to maintain service reliability.

The Fountain Hill Tap will be supported by steel mono-poles. The double-circuit tap structure will consist of a high pole that is approximately 125 feet tall and a low pole that is approximately 85 feet tall and they will be installed on concrete foundations. The double-circuit tap poles will be located in-line with the existing Elliot Heights #1 & #2 Transmission Tap Line (see Figure 1). The remaining steel poles will range in height from to approximately 50 to 70 feet (see Figure 2). Angle structures will either be self-supporting on foundations or direct embedded and guyed. Tangent, or no-angle, structures will be direct embedded.

The Fountain Hill #1 & #2 138/69 kV Transmission Tap Line initially will be a double-tap, single feed configuration and will contain six power conductors between the tap and the point where the single feed begins. Three more power conductors will be installed parallel to the single feed when the second circuit is added. There will be one or two overhead ground wire(s). The power conductors will be 556.5 kcmil,[1] 24/7 strand ACSR.[2] A 3/8-inch steel overhead ground wire(s) will provide lightning protection for the proposed tap line. In addition, two Load Sectionalizing Air Brake (LSAB) switch poles will be installed in the proposed Fountain Hill Tap (see Figure 3).

The new Fountain Hill Tap will be designed according to, and will generally surpass, National Electrical Safety Code ("NESC") minimum standards. Additional design criteria and safety rules practiced by PPL Electric are explained in Attachment 4. The minimum conductor-to-ground clearance will be 30 feet for the new Tap. This minimum clearance occurs at a maximum thermal conductor temperature of 125°C. The design minimum conductor ground clearances and conductor thermal ratings are as follow:

TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 556.5 KCMIL 24/7 STRAND ACSR[3]

Condition	Single-circuit Design Clearance-to-Ground
Normal load, average weather (16°C ambient, 60°F temperature)	33.3 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	30 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	32.3 feet
Predicted extreme weather conditions, 0°F (1-inch ice, 4 lbs. wind, -18°C)	32 feet

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

[2] Aluminum conductor steel reinforced.

[3] Clearances based on a maximum tension of 7,000 pounds and a ruling span of 279 feet.

TABLE 2
CONDUCTOR THERMAL RATING 556.5 KCMIL 24/7 ACSR
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	1.5	1041
Winter Emergency	10	1.5	1103

B. MAGNETIC FIELD MANAGEMENT

PPL Electric's Magnetic Field Management Program is summarized in Attachment 5 and applied to reconstruction and new line projects. In order to lower magnetic field exposures, the program generally prescribes a line design that provides 5 feet higher ground clearances than required under the NESC and reverse phasing of new double-circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications will be considered, provided those modifications can be made at low or no cost and will not interfere with the operation of the line.

Increased structure height will be utilized in the design of the new line to reduce magnetic field exposures. Reverse phasing cannot be utilized at this time because only one circuit will be installed. Reverse phasing requires a double-circuit line. Reverse phasing will be considered when a second circuit is added in the future.

C. RIGHT-OF-WAY STATUS

The Fountain Hill Tap will be constructed on property owned by Lehigh County. PPL Electric will acquire sufficient right-of-way from the County to contain the tap line and maintain all required NESC clearances. The Substation will be constructed on property that PPL Electric will acquire in fee from the County. PPL Electric and Lehigh County have an agreement in principle for right-of-way for the Tap and a fee interest in the property for the substation.

FIGURE 1
PROPOSED 138/69 kV DOUBLE CIRCUIT TAP STRUCTURE
APPROXIMATE HEIGHT OF HIGH POLE - 125'
APPROXIMATE HEIGHT OF LOW POLE – 85'

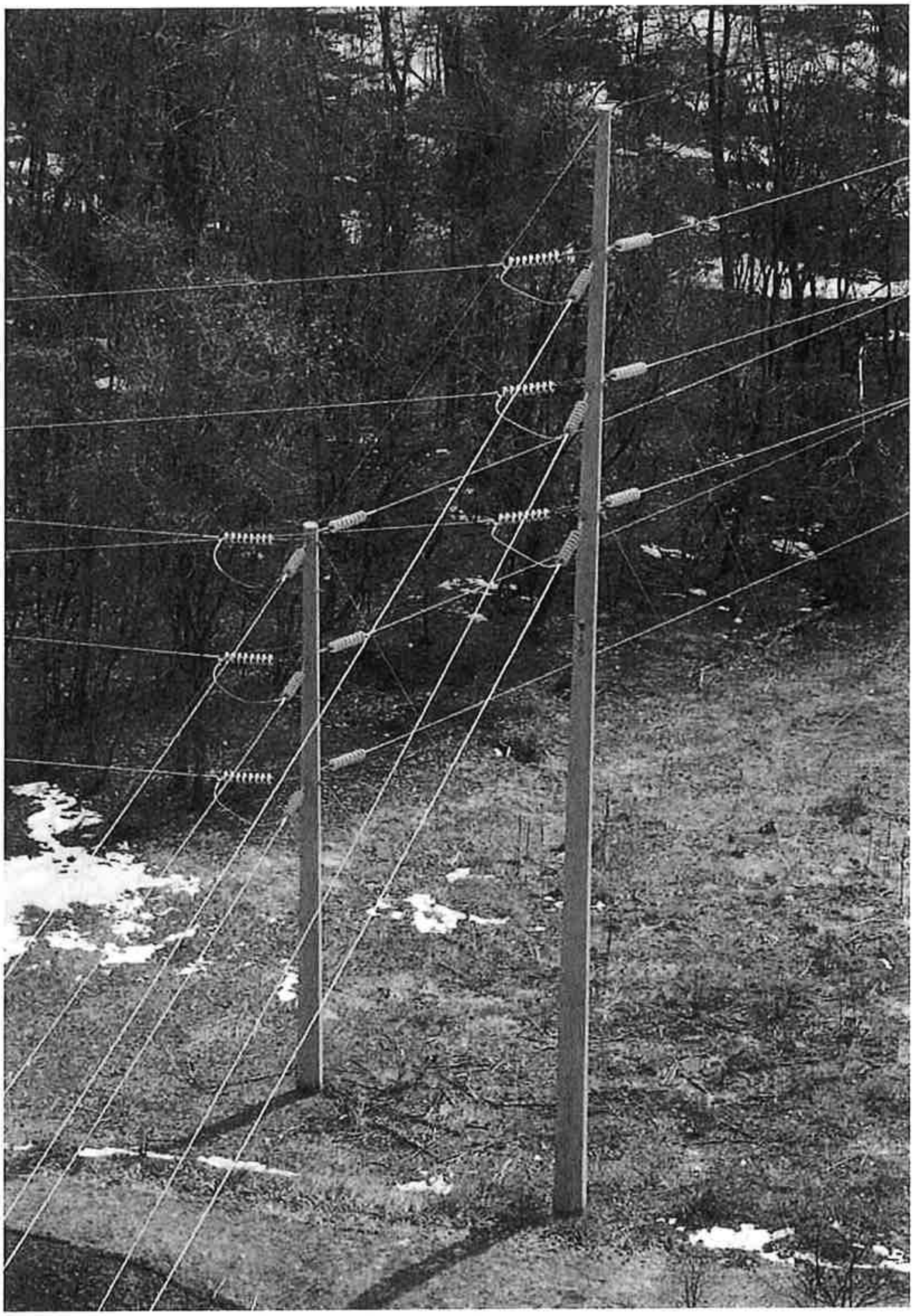


FIGURE 2
PROPOSED 138/69 kV TANGENT STRUCTURE
APPROXIMATE HEIGHT – 70'

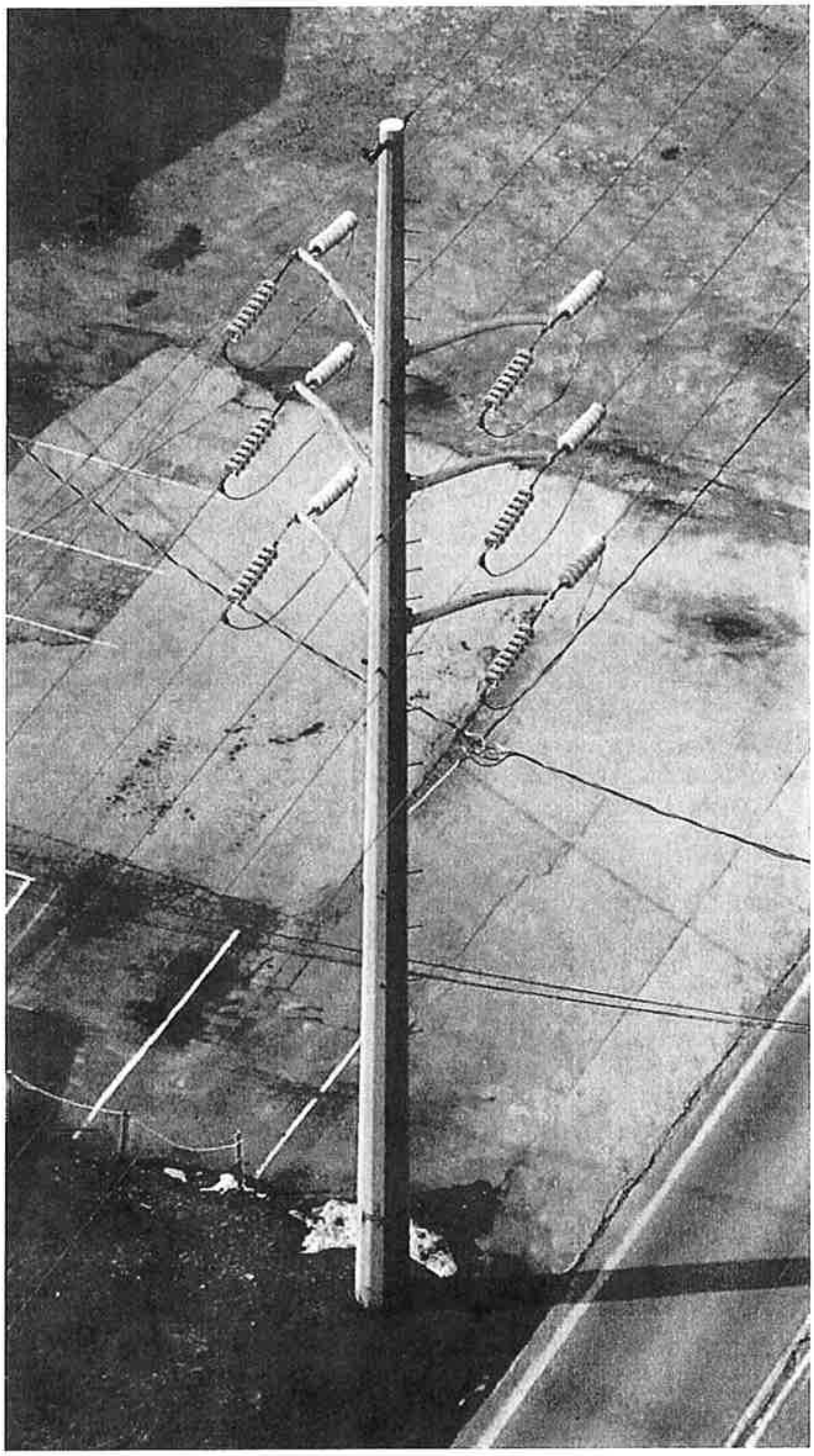
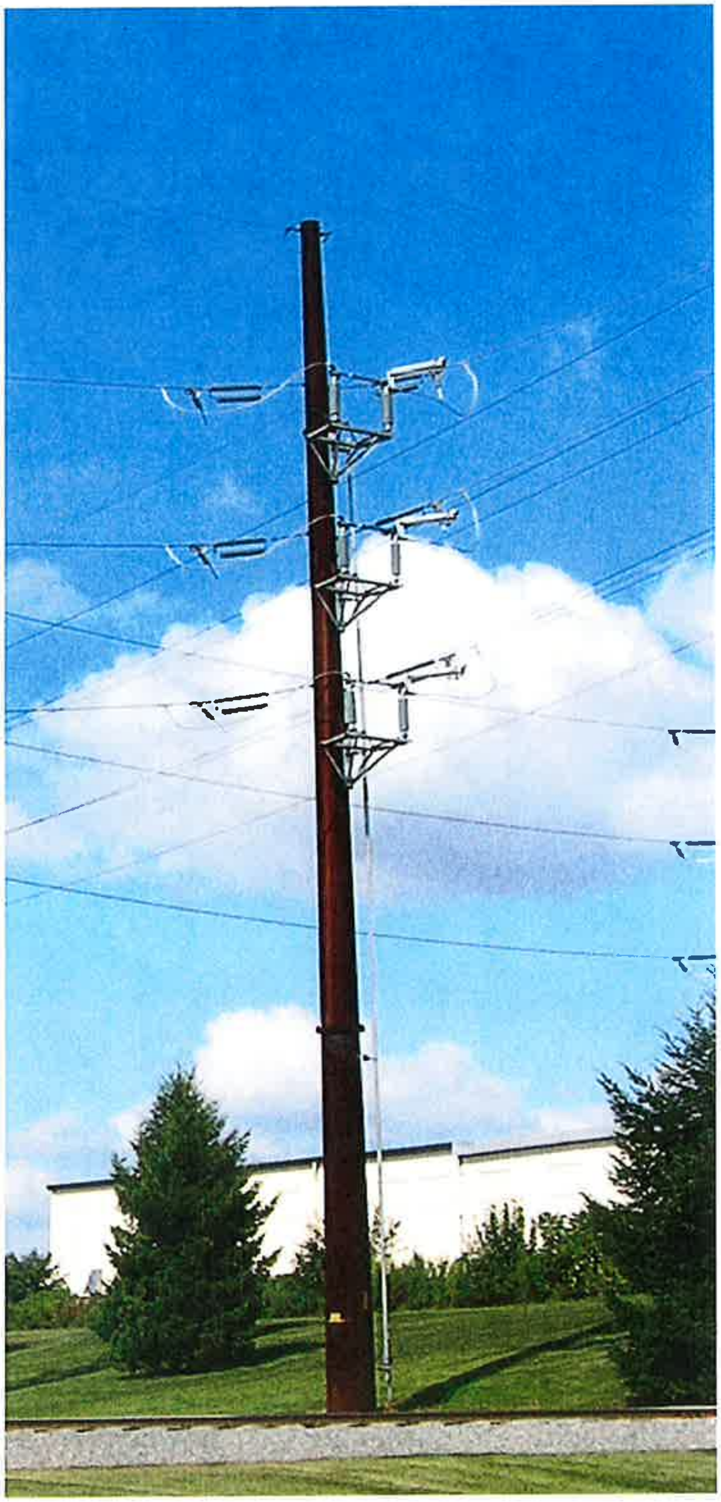
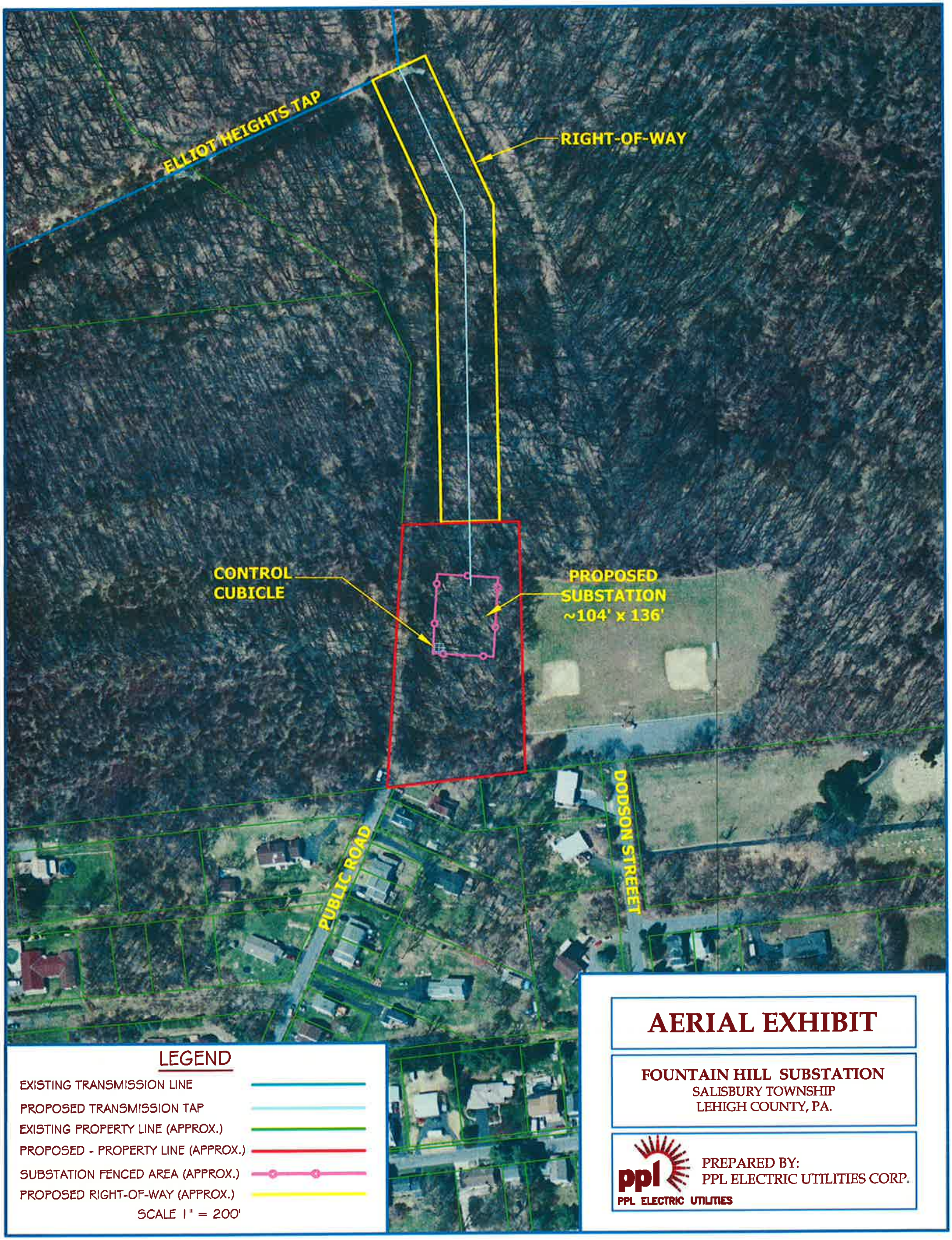


FIGURE 3
PROPOSED 138/69 kV LSAB SWITCH STRUCTURE
APPROXIMATE HEIGHT – 70'




ELLIOT HEIGHTS TAP
RIGHT-OF-WAY
CONTROL CUBICLE
PROPOSED SUBSTATION ~104' x 136'
PUBLIC ROAD
DODSON STREET
LEGEND
EXISTING TRANSMISSION LINE
PROPOSED TRANSMISSION TAP
EXISTING PROPERTY LINE (APPROX.)
PROPOSED - PROPERTY LINE (APPROX.)
SUBSTATION FENCED AREA (APPROX.)
PROPOSED RIGHT-OF-WAY (APPROX.)
SCALE 1" = 200'
AERIAL EXHIBIT
FOUNTAIN HILL SUBSTATION
SALISBURY TOWNSHIP
LEHIGH COUNTY, PA.
ppl
PPL ELECTRIC UTILITIES
PREPARED BY:
PPL ELECTRIC UTILITIES CORP.

Attachment

3

ATTACHMENT "3"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

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Section

ATTACHMENT "3"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

To meet the increasing demand for electricity and improve reliability, PPL Electric is proposing to construct the Fountain Hill Tap to supply the proposed Fountain Hill 69-12 kV Substation. The Project involves the installation of approximately 700 feet of new transmission line and associated poles and load sectionalizing air breaks. The tap will be designed for double-circuit 138 kV operation, although it initially will be constructed as a double-tap, single feed tap operated at 69 kV. The Fountain Hill Tap and the Substation will be constructed, on land currently owned by the County. PPL Electric and the County have reached an agreement in principle under which PPL Electric will acquire a right-of-way for the Fountain Hill Tap and a tract of land in fee for the Fountain Hill Substation.

PPL Electric provided information describing the Project to Salisbury Township and Lehigh County, and neither the Township nor the County objects to the Project. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 6.

B. LAND USE

The proposed tap line and substation will be located on a 1.9-acre parcel in Salisbury Township, Lehigh County that PPL Electric is in the process of purchasing. The proposed lot is presently part of a larger 123-acre lot owned by Lehigh County and zoned CR for Conservation – Residential use. The entire 123-acre tract has been placed into a conservation easement. Due to the existing conservation easement on the property which PPL Electric plans to purchase, PPL

Electric is required to mitigate impacts by replacing the land on a one to one basis. Thus, in order to terminate the conservation easement, PPL Electric is required to transfer ownership of an equal sized lot to the County in exchange for the tract of land on which the Fountain Hill Tap and Substation will be constructed. As part of the agreement, PPL Electric will transfer to the County ownership of a 2.1 acre parcel within the center of the park.

The property which PPL Electric will purchase is partially traversed by the existing Elliot Heights #1 & #2 138/68 kV Transmission Tap Line. The property is bordered by county owned property to the north and east. Residential properties are located to the south and west of the subject property. To the south the property is bordered by Long Lane and to the west by Tillage Road. Due to the existing transmission lines and the proposed substation facilities on this parcel, the incremental visual impacts of the proposed tap line will be minimal.

No communication towers, pipelines, or other utilities will be affected by the proposed Project. Lehigh Valley International Airport in Allentown, PA, located approximately 3.1 miles north of the Project site, is the nearest airport to the Project. Impact to this airport is not expected due to the distance between the Project and the airport. Nonetheless, the appropriate notifications will be filed with the Federal Aviation Administration and PennDOT Bureau of Aviation to confirm that the proposed tap line will not be a hazard to the airport's flight operations.

C. CULTURAL RESOURCES

The Project was reviewed by the Pennsylvania Historical and Museum Commission (PHMC). The PHMC has identified no significant archeological sites in the proximity of the proposed Project and has determined that additional studies are not warranted (File No. ER 2011-1917-077A).

D. NATURAL FEATURES

The Project will not affect any unique geological, scenic, or natural areas. The nearest public recreational areas are Dodson Park and Lehigh Mountain Park (Upland Section) which are both located immediately adjacent to the proposed Project site. Dodson Park is a small 5-acre park that is utilized by local youth sport groups. The park contains two baseball fields, soccer field, and volleyball area. The proposed Project is not anticipated to have a significant impact to Dodson Park because the proposed substation and tap line will not interfere with the park's current uses. Additionally, PPL Electric will work with Lehigh County to install measures to mitigate impacts.

Lehigh Mountain Park (Upland Section) is an approximately 230-acre tract comprised of relatively undisturbed second growth forest that is used primarily for hiking and mountain biking. The #1 and #2 Elliot Heights 138/69 kV Transmission Tap Line, a PPL Electric distribution line and underground gas pipeline all traverse the park adjacent to the site that PPL Electric will purchase for the substation.

As a result of the land exchange described above, it not anticipated that the proposed Project will have a net adverse impact on this park since the size of the park will remain substantially the same and a lower value area is being replaced with a higher value area.

Tree clearing is not required for this Project since the property is presently being utilized for agricultural uses. PPL Electric will apply its "Specifications for Initial Clearing and Control of Vegetation on or Adjacent to Electric Right-of-Way Through Use of Herbicides, Mechanical, and Hand Clearing Techniques" if minor tree or brush clearing is required along the edges of the property..

The transmission tap line will not cross any wetlands or areas designated as "Waters of the U.S." or "Waters of the Commonwealth." PPL Electric will acquire and comply with any required soil erosion and sedimentation control permit conditions. Additionally, any required permits will be obtained from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers prior to construction and PPL Electric will comply with all conditions placed on the permits.

E. THREATENED AND ENDANGERED SPECIES

PPL Electric has coordinated with different state and federal agencies to obtain information regarding threatened and endangered species in close proximity to the Project area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicates the potential presence of threatened and endangered species and/or special concern species and resources (PNDI Search ID: 20111007320187). Based on the initial PNDI response, PPL Electric contracted Mellon Biological Services to conduct a survey of the entire property to determine whether the identified species were present. Based on this survey, the identified species was not found on the portion of the property where these proposed facilities will be constructed. The results of the survey were submitted to Pennsylvania Fish and Boat Commission (PFBC) for its review, along with a recommendation that no further investigation be conducted on this portion of the property. On October 26, 2011 PFBC issued a letter concurring with the recommendations of the report and agreeing that the proposed Project would not have an adverse impact on the identified species.

Attachment
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ATTACHMENT "4"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACICES

The National Electrical Safety Code (NESC) is a set of rules to safeguard people during the installation, operation, or maintenance of electric power lines. The NESC contains the basic provisions considered necessary for the safety of employees and the public. Although it is not intended as a design specification, its provisions establish minimum design requirements. PPL Electric has developed design specifications and safety rules which meet or surpass all provisions specified by the NESC.

Engineering Design Criteria and Parameters

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

PPL Electric transmission line design standards meet or surpass the NESC standards. For example, the relative order of grades of construction for conductors and supporting structures is B, C, and N; Grade B being the highest. According to the NESC standards, construction Grades B, C, or N may be used for transmission lines (except at crossings of railroad tracks and limited access highways where Grade B construction is specified). However, PPL Electric designs all of its transmission lines for Grade B construction. The use of Grade B design and construction specifies such things as larger-minimum 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	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. Numerous helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

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

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

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

Personnel Safety Rules

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

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

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

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:

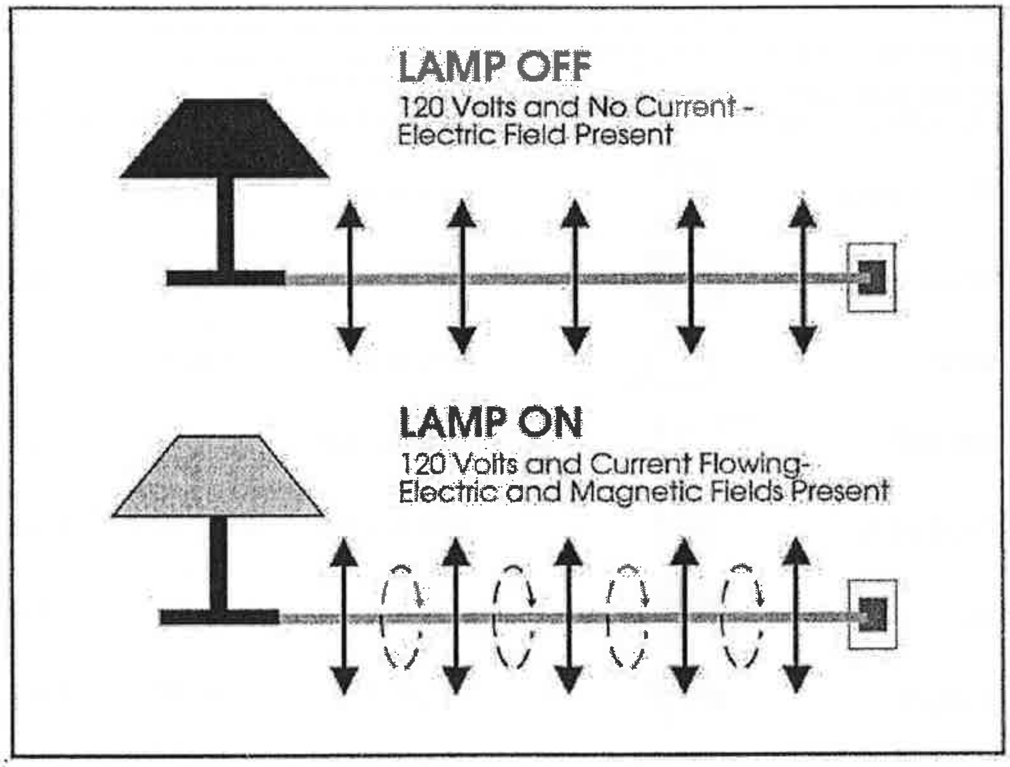
Electric Fields

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	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

Source: "EMF In Your Environment", U.S. Environmental Protection Agency 1992

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

Measuring Magnetic Fields

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

Figure 3

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

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

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

VARIABLES THAT AFFECT MAGNETIC FIELDS

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

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

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

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

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

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

Effect of Conductor Configuration on Magnetic Fields

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

Effect of Distance From the Magnetic Field Source

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

SUMMARY OF PPL EU's
MAGNETIC FIELD MANAGEMENT PROGRAM

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

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

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

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

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

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

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

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

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

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

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

Chart VI illustrates the compact design structure.

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

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

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

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

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

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

138/69 kV Transmission Lines

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

230 kV Transmission Lines

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

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

500 kV Transmission Lines

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

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

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

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

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

DISTRIBUTION LINES

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

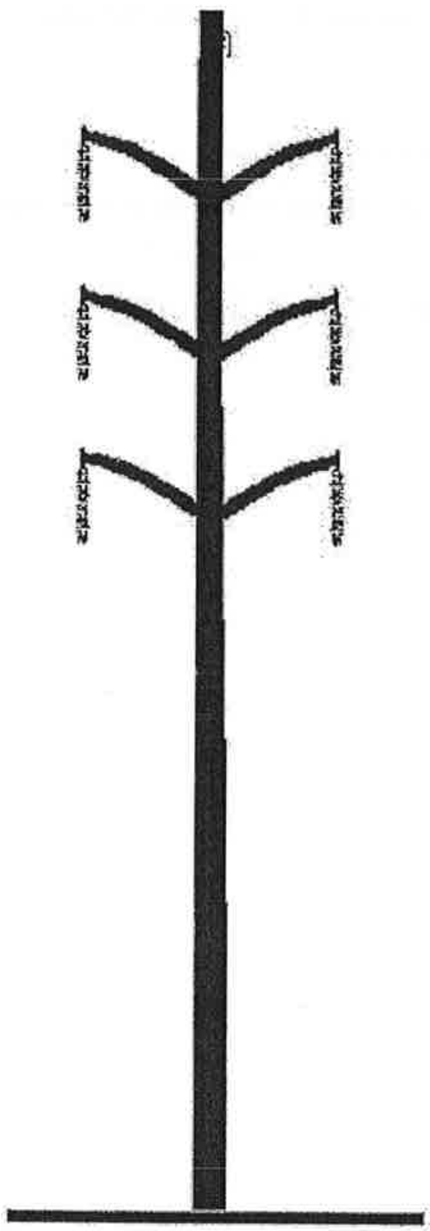
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These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

UNDERGROUND TRANSMISSION LINES

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

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

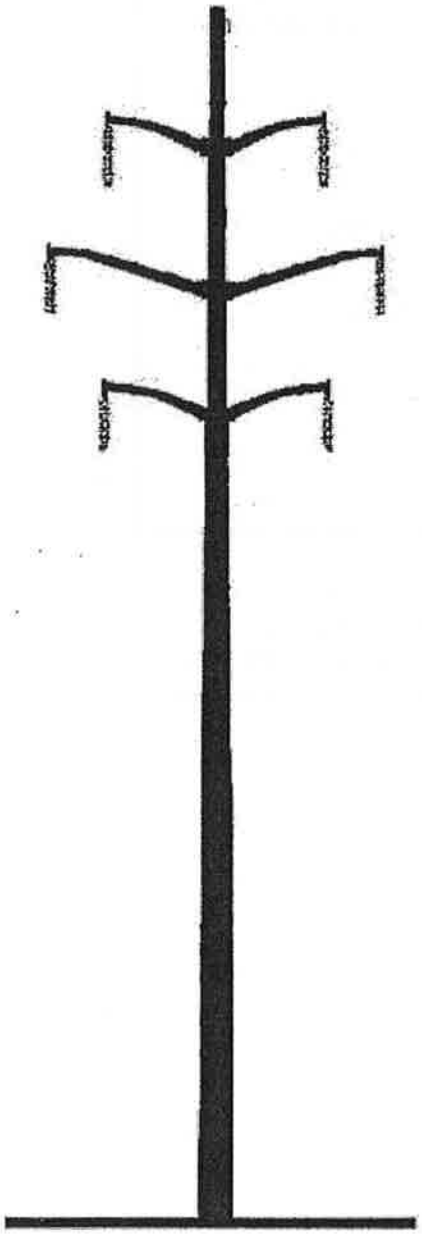
Short-Span Construction



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

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

Long-Span Construction Remains PPL EU 138 kV Standard



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

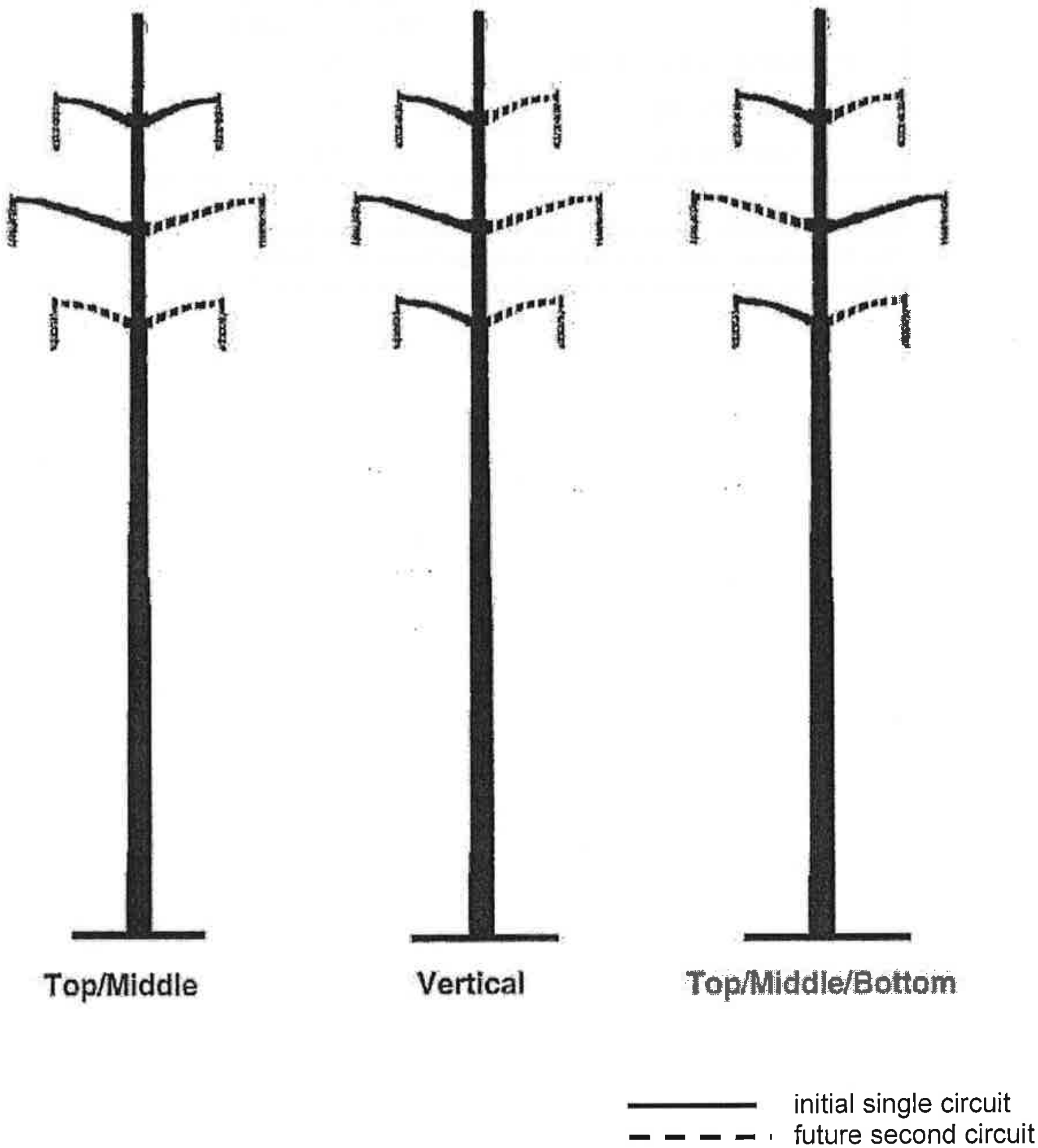
1 3/8" HS steel overhead ground wire - 17.3 feet sag
6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
Average span - 600 feet

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

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

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

Typical Single-Circuit Structure Designs

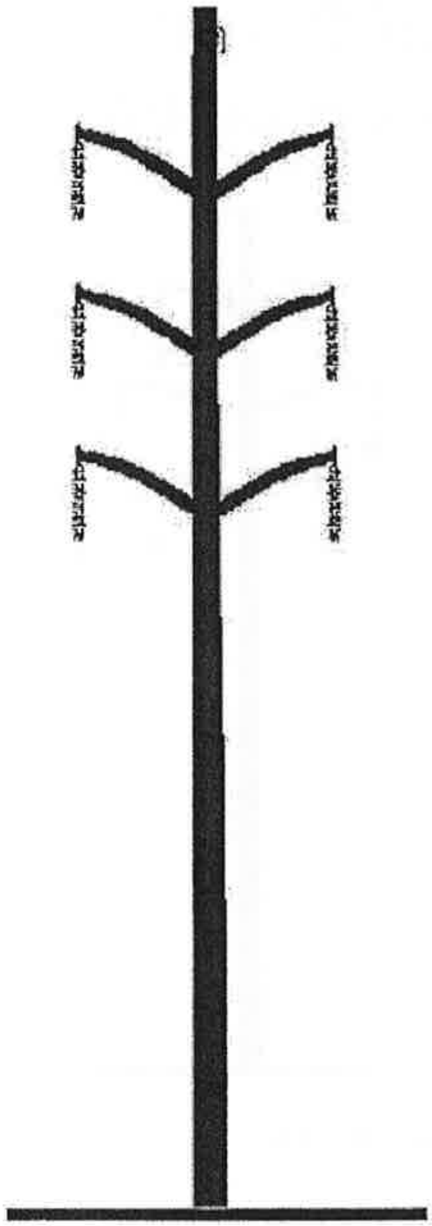


138/69 kV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES

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

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

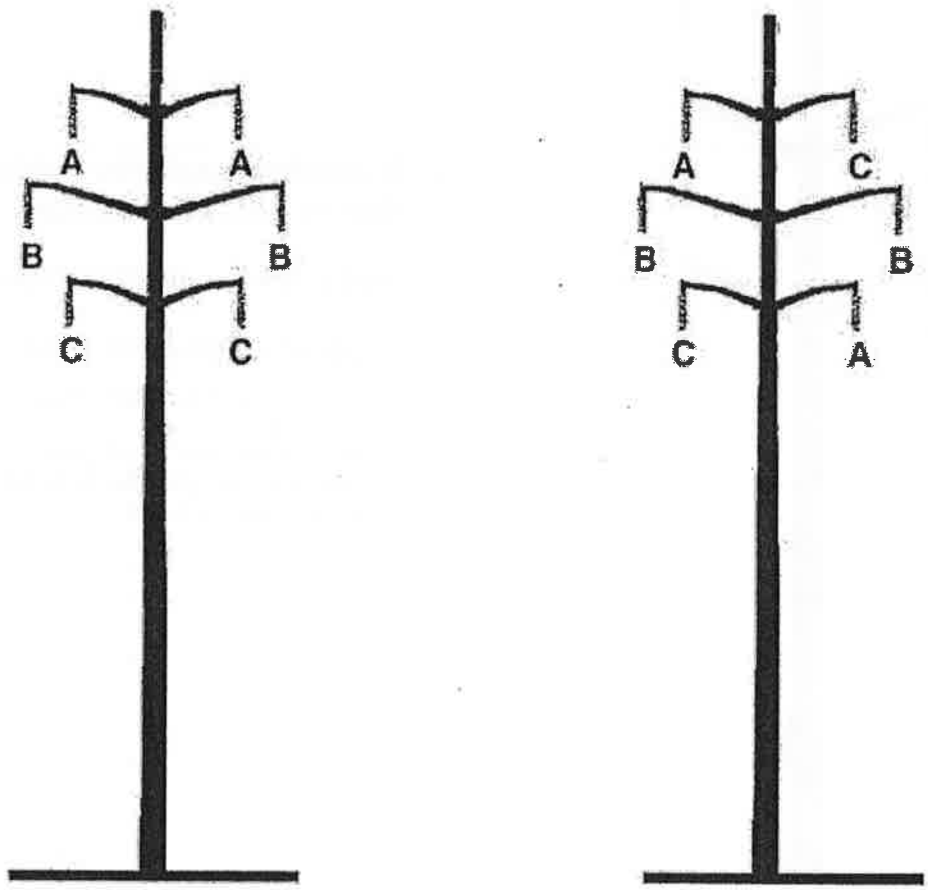
Compact Design Structure



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

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

Reverse Phasing of Double-Circuit Transmission Lines



From: ⟶ ⟶ ⟶ ⟶ To:

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

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

CHART VIII

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

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

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

CHART IX

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

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

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

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

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

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

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

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

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

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

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

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

CHART XIII

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"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND OTHER PUBLIC ENTITIES

Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building
400 North Street, 2nd Floor
Harrisburg, PA 17120
Attn: Mr. Douglas C. McLearen, Chief

Honorable Barry Schoch, P.E., Secretary
Pennsylvania Department of Transportation
c/o Office of Chief Counsel
Commonwealth Keystone Building
400 North Street, 9th Floor
Harrisburg, PA 17120
Attn: Andrew Gordon

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

Lehigh County Commissioners
17 S. Seventh Street
Allentown, PA 18101
Attn: Mr. Dean N. Browning, Chairman

Lehigh Valley Planning Commission
961 Marcon Boulevard, Suite 310
Allentown, PA 18103
Attn: Steven L. Glickman, Chairman

Salisbury Township Board of Commissioners
2900 South Pike Avenue
Allentown, PA 18103
Attn: James Brown, President

Salisbury Township Planning Board
2900 South Pike Avenue
Allentown, PA 18103
Attn: Charles Beck, Chairperson

Attachment

7

ATTACHMENT "7"

FOUNTAIN HILL #1 & #2 138/69 kV TAP LINE

LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT OF WAY

County of Lehigh
17 S. Seventh Street
Allentown, PA 18101