

ATTACHMENT “1”
MARTINS CREEK – SIEGFRIED #2 230 kV TRANSMISSION LINE REPLACEMENT
NECESSITY STATEMENT

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
A.	INTRODUCTION.....	1
B.	OVERVIEW OF VINTAGE CONDUCTOR PROGRAM.....	2
C.	PROPOSED SOLUTION.....	5

LIST OF TABLES

TABLE 1	VINTAGE CONDUCTOR PROGRAM.....	4
TABLE 2	PPL ELECTRIC ANALYSIS OF REBUILD VS REHABILITATE.....	7

ATTACHMENT “1”
MARTINS CREEK – SIEGFRIED #2 230 kV TRANSMISSION LINE REPLACEMENT
NECESSITY STATEMENT

A. INTRODUCTION

PPL Electric is requesting Commission approval to rebuild the PPL Electric-owned portion of the eighty-five year-old Martins Creek – Siegfried #2 230 kV Transmission Line. The proposed replacement involves a section of transmission line which begins at the Siegfried Substation adjacent to the Lehigh River in Allen Township, Northampton County, and terminates at a point near the intersection of Katellen Road and Old Grace Road in Moore Township, a distance of approximately 10.7 miles.¹ This project is part of PPL Electric’s Vintage Conductor Program, which was developed to address deteriorated facilities in PPL Electric’s transmission system. Like the existing line, the proposed Project will be designed for a single 230 kV circuit. As explained in detail below, reconstruction of the transmission line is required to maintain system reliability.

The estimated cost to design and replace the transmission line is \$17,100,000. Construction is scheduled to begin in the fall of 2012 in order to meet the in-service date of November 2013. PPL Electric is proposing an in-service date of November 2013 in order to coordinate this project, the other Vintage Conductor Program projects², and system reinforcement projects planned for the eastern region of the PPL Electric territory. Also, all construction projects must be coordinated with Transmission Operations and PJM system operations to minimize any adverse impacts of line outages, which these projects require, on service to PPL Electric customers.

A PPL Electric system map showing the existing transmission facilities with design voltage of 35 kV or greater is included in the Attachment “1” map pocket. Although this Necessity

¹ The other terminus of the Line is located at the Martins Creek Steam Electric Station. The total length of the Line is 26.10 miles. However, only a 10.7-mile long portion of the line will be rebuilt and is included within this filing. The remaining portion of the line was rebuilt in the early 1970s.

² Manor-Graceton 230 kV Line; Otter Creek-Conastone 230 kV Line; Whitpain – Buxmont 230 kV Line, and Hosensack-Wescosville #3 230 kV Line.

Statement provides a broad discussion of the Vintage Conductor Program, this filing addresses only the Martins Creek – Siegfried #2 230 kV Transmission Line, which is located in Northampton County, Pennsylvania.

B. OVERVIEW OF VINTAGE CONDUCTOR PROGRAM

The PPL Electric transmission system includes multiple 230 kV line segments that are over 80 years old. These line segments were installed in the mid-1920s through the 1930s. Lines that operate at 230 kV are part of the bulk electric system. These lines serve as major pathways for the flow of large amounts of electrical power: (a) from one bulk substation or switchyard to other bulk stations within the electric utility’s territory, or (b) between electric utilities. At the bulk substations, power is transformed to lower voltage levels for delivery to residential, commercial, or industrial customers. PPL Electric owns approximately 1,000 miles of transmission lines that operate at 230 kV.

The Vintage Conductor Program began when, as a result of a review process, PPL Electric’s Transmission Engineering group informed the Transmission Planning group of deteriorated facilities on the 230 kV line located between the Bushkill 230 kV switchyard and Wallenpaupack hydroelectric plant. The Transmission Engineering group subsequently identified other 230 kV lines dating to the same construction era with similarly designed structures and conductors.³ Conversations between the Planning and Engineering groups resulted in the identification of eleven line segments that contained similarly aged facilities. Subsequent inspections revealed that some of these facilities had deteriorated significantly. The identified segments, totaling approximately 140 miles, were grouped into a program that PPL Electric named the Vintage Conductor Program. The process of identifying aged and deteriorated facilities is on-going.

In 1983, PPL Electric tested portions of certain transmission conductors that have since been included in the Vintage Conductor Program. Specifically, PPL Electric tested portions of the line segments connecting the Wallenpaupack, Blooming Grove, Bushkill, and Siegfried electric stations. At that time, the steel core of the 795 kcmil ACSR conductors was showing

³ The identified conductors are 795 thousand circular mils (kcmil), aluminum conductor steel reinforced (ACSR), 54/7 stranding, and variations of that stranding. A circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².

deterioration, but the greatest concern to PPL Electric was the deterioration occurring at the conductor splices.

Consequently, most splices in the line segments located between the Wallenpaupack and Siegfried stations were replaced. The Transmission Engineering group determined that the line conductor was expected to last another 10 to 15 years. The 15-year time frame has been exceeded, and no follow up examination or similar major repair work has been performed on the other line segments. PPL Electric, however, continues to perform aerial inspections of these facilities every four years, on average. Specific maintenance tasks are identified from the inspections. PPL Electric prioritizes, schedules, and completes these tasks in a timely manner.

In early 2010, PPL Electric hired an outside engineering consultant, DiGioia Gray and Associates,⁴ to perform an independent field investigation and assessment of the line segments.⁵

The engineering consultant reported on the degree of deterioration of the structural components, foundations, insulators, line hardware, shield wire, grounding, signage, paint, and galvanizing. Right-of-way encroachments and adjacent land features were also reported.

Overhead line conductor between tension towers was not tested to determine its physical condition or its tensile strength. Tensile strength testing would have required a line outage in order to physically remove multiple samples from the span (i.e., conductor located between two adjacent towers) at numerous locations along the identified line segments. Furthermore, an examination of the conductor would be an unnecessary initial step if the other tower-line components (i.e., structures, foundations, etc.) were found to be significantly deteriorated, as was expected from the findings in 1983. Sampling of overhead conductor would only be initiated if deteriorated tower-line components could be remedied by rehabilitation.

⁴ DiGioia Gray & Associates of Monroeville, PA 15146

⁵ Two of the line sections, specifically the Bushkill – Blooming Grove and Blooming Grove – Wallenpaupack line segments, were excluded from the field investigation performed by the engineering consultant because those segments are to be completely rebuilt as part of the proposed Susquehanna – Roseland 500 kV line project. A recent Commission decision approved the Susquehanna – Roseland project, and the associated rebuilding of these two line segments.

DiGioia Gray & Associates identified a statistically significant number of structures for each line segment. For the Martins Creek – Siegfried #2 230 kV Transmission Line, DiGioia Gray & Associates identified 10 of 52 structures. The identified structures, and associated foundations and line equipment, were then inspected in the field by DiGioia Gray & Associates. Results of the evaluations were summarized in line-specific assessment reports.

Based upon the issues that were identified in 1983, and the recent findings of the independent external engineering consultant, these identified line segments are now at an increased exposure to failing, thus creating a safety concern for both the public and PPL Electric field personnel. Further, if this issue is left unresolved, the potential for degradation in grid reliability will exist, due to an increased risk of line equipment outages. PPL Electric determined that a program to systematically upgrade these line segments was required, and established the Vintage Conductor Program to perform the necessary upgrades.

The original nine segments included in the Vintage Conductor Program, which total approximately 90 miles, and the two projects that are included in the Susquehanna-Roseland 500 kV project are identified in Table 1. Review of PPL Electric’s transmission system to determine whether additional segments need to be replaced is on-going.

TABLE 1
Vintage Conductor Program

Project No.	Project Name / Line Segment	Line Segment Miles	Original In-Service Date
9056	Manor – Graceton	14.52	1937
9057	Otter Creek – Conastone	11.98	1933
9054	Martins Creek – Siegfried # 2	10.69	1926
9049	Hosensack – Wescosville # 3	8.7	1928
9053	Whitpain – Buxmont	7.72	1928
9050	Shawnee – Bushkill	2.20	1926
9051	Fox Hill – Shawnee	8.27	1926
9052	Martins Creek – Monroe	16.14	1926
9055	Hummelstown – Middletown Junction # 1	7.00	1954
N/A	Bushkill – Blooming Grove ⁶	21.80	1926
N/A	Blooming Grove – Wallenpaupack ⁶	29.40	1926

N/A – not applicable.

⁶ Line segments to be upgraded as part of the Susquehanna-Roseland 500 kV Line project.

C. **PROPOSED SOLUTION**

The Martins Creek – Siegfried #2 230 kV line is one of two 230 kV circuits that connect the Martins Creek 230 kV switchyard and the Siegfried 230-138-69 kV Substation. The Martins Creek 230 kV switchyard serves as the outlet for the two generating units at Martins Creek Steam Electric Station (approximately 850 MW each). It also serves as the outlet for three generating units at the Lower Mount Bethel Energy Plant, which combine to produce 600 MW of power.

Also, the Martins Creek – Siegfried #2 line is one of seven 230 kV circuits that terminate into the Martins Creek switchyard and one of five 230 kV circuits that terminate into the Siegfried Substation. PPL Electric relies on the Martins Creek – Siegfried #2 230 kV line to uphold the integrity of the transmission system (Bulk Electric System). Not rebuilding this circuit would leave the remaining 230 kV system in a vulnerable state, particularly under unplanned outage (contingency) situations.

The North American Electric Reliability Corporation (“NERC”) requires that the Bulk Electric System remain stable and within applicable thermal and voltage limits under contingencies (unplanned outage) defined under Category C of the NERC Transmission Planning (TPL) Standards. A Category C contingency is an event on the transmission system resulting in the loss of two or more elements. An element is a generator, single circuit transmission line, double circuit transmission line, bus section, breaker, or power transformer. An N-1-1 contingency is a specific Category C event where one element of the transmission system incurs an outage, followed by a period of system readjustment, and then a second element is unexpectedly interrupted. Without the Martins Creek – Siegfried #2 Line, an outage of the Martins Creek – Siegfried #1 line and the subsequent outage of either the Susquehanna-Wescosville-Alburtis 500 kV line or the Siegfried – East Palmerton # 3 / Siegfried – Harwood 230 kV double-circuit line would result in 230 kV bus voltages at Siegfried substation dropping more than the five percent deviation allowed by PPL Electric planning guidelines. Therefore, abandoning the Line is not a reasonable option as it would compromise the integrity of the Bulk Electric System and cause PPL Electric to be in violation of NERC Transmission Planning Standards.

The Siegfried Substation has five transformers. For a 2012 summer peak load scenario, using approximately 200 customers per MW of load, the Substation supports electric service to approximately 125,000 customers. If the Martins Creek – Siegfried #2 230 kV line were not rebuilt, the reliable supply that these customers have come to expect would be compromised. For these reasons, the Martins Creek – Siegfried #2 230 kV Transmission Line must not be removed from the 230 kV system.

Technical solutions to resolving the deteriorated components inherent to the “Vintage Conductor” line segments would be to either:

- (a) rehabilitate the components (i.e., structures, foundations, conductors, insulators, and line hardware), or
- (b) completely rebuild those line segments.

PPL Electric prepared a cost analysis and determined that a complete rebuild of the Martins Creek – Siegfried #2 230 kV Transmission Line would be slightly more expensive than rehabilitation. Specifically, the PPL Electric cost analysis, summarized in Table 2, concluded that rehabilitation costs would be 81 percent of the total rebuild cost for the Martins Creek – Siegfried #2 230 kV Transmission Line. In its assessment report, Digoia Gray & Associates stated that it would be prudent to rebuild a deteriorated line if the cost to rehabilitate exceeded 50 percent of the cost to rebuild the line.⁷ Also, considering the extended lifetime that new steel structures would provide, along with other technical improvements gained by using new structures as described below, PPL Electric determined that a total rebuild would be the more cost effective and best technical option.

⁷ For lines that have provided many years of service, and where reliability is important, DiGoia Gray & Associates lowered the “breakpoint” to 30 to 40 percent.

**TABLE 2
PPL Electric Cost Analysis of Rebuild vs. Rehabilitation**

Scope	Labor & Material Cost (x 1000)		Ratio of Costs; Rehabilitation to Rebuild
	Rebuild	Rehabilitation	Percent
Labor and materials related to structures, foundations, insulators, line hardware and paint.	\$9,005	\$5,702	63
Common elements (includes labor and materials related to conductor, design and engineering, project management, acquisition of additional right-of-way, permitting, siting, PUC certification, environmental, and general overhead costs).	\$8,131	\$8,131	100
Total	\$17,137	\$13,834	81

In addition, Burns & McDonnell (“B&McD”), a consulting engineering firm, prepared an independent cost evaluation on eight of the nine⁸ line segments in the Vintage Conductor Program and compared the cost of a rehabilitation of conductors, structures, foundations, and associated line equipment against the cost of a complete rebuild. The results of the B&McD evaluation for the Martins Creek – Siegfried #2 Line were consistent with the PPL Electric cost evaluation.

In further support of the decision to completely rebuild rather than rehabilitate the Martins Creek – Siegfried #2 230kV Transmission Line, PPL Electric also considered the following additional issues that are more efficiently and effectively addressed by rebuilding:

- Bent steel components on the existing towers require removal and/or replacement, or the installation of additional bracing, to correct the structural deficiency. Depending on the number of crews assigned to the project, that work would either be done one tower at a time or multiple towers grouped together for the repair work. On the other hand, the rebuild option will require only the erection of a single monopole structure after a new concrete foundation has been poured and cured.

⁸DiGioia Gray & Associates determined that the Hummelstown – Middletown Junction #1 Line only required rehabilitation.

- All insulator sets at the top of each tower should be replaced due to their age, the condition of the insulating material within the insulator, and the heavy contamination with pollutants from long-term exposure.
- Line hardware and related attachment steel on each tower should be removed and replaced, due to wear on the material at the connecting points. Metal against metal degradation was observed during the field inspections.
- Splices in the conductor should be replaced, due to their age, outdated design, and early manufacturing processes that were used to make these devices in the 1920s and 1930s.
- The conductor should be replaced based on its age.
- Grounding at each structure or tower leg must be upgraded by adding counterpoise in order to meet current safety standards.
- The overhead shield wires require replacement due to their age and condition. In addition, they may require repositioning in order to bring the tower-line structure up to current lightning standards. In its assessment report, the independent external engineering consultant noted that some line segments do not have the appropriate shielding angle, which makes the tower-line more susceptible to lightning strikes.

Rebuilding the line will result in addition benefits that are explained below.

- Rebuilding the Martins Creek – Siegfried #2 230 kV Transmission Line will result in new structures that are capable of supporting a single-circuit line that would meet current National Electrical Safety Code (“NESC”) standards with regard to mechanical loading, including improved ground clearances.

- New structures will have an expected life that will exceed that of reconditioned structures.
- The new structures will enable PPL Electric to comply with its modern magnetic field policy, and will improve the magnetic field values within and at the edge of the right-of-way.⁹
- The new single circuit line will use 1590 kcmil ACSR conductors. These conductors will have a greater capacity than the conductors currently in use on the line.
- Rehabilitation of the Martins Creek – Siegfried #2 230 kV Transmission Line would require longer construction periods to perform the numerous repairs on a tower by tower basis. Most of the structures on the Martins Creek – Siegfried #2 230 kV Transmission Line have four foundations, due to the use of steel lattice towers. Most of the existing structures would require major foundation repairs if they were being rehabilitated. Such repairs would necessitate temporary structural support while each foundation is replaced. To preserve the structural integrity of the structures, only one foundation can be replaced at a time. Therefore, a period of weeks would be needed for removal of the old concrete and pouring and curing of each of four new concrete foundations prior to placing the mechanical load of the lattice tower structure onto the new foundations. Foundation replacement would impede the speed at which crews could move from one structure and its associated foundations to the next. In contrast, replacing the lattice tower structures with steel monopoles will require pouring and curing of only one foundation per structure.
- PPL Electric’s current practice in rebuilding or reconductoring of lines is to install optical ground wire (“OPGW”) instead of steel ground wire. The OPGW provides a relaying and communication path with improved reliability. OPGW consists of non-conductive strands of optical fiber material that are surrounded by one or more layers of steel and/or aluminum wire to create the OPGW. The optical fiber material is used to carry communications related to the operation of the transmission system. OPGW is used so

⁹ PPL Electric’s Magnetic Field Management Program is explained in Attachment 5 to this Letter of Notification.

that protective relay schemes do not depend on less reliable hard-wired telephone circuits, or on power line carrier equipment that uses the line conductors for the communication path.

The completion date for each specific Vintage Conductor Program will be coordinated with the timing of the overall Asset Optimization Strategy (“AOS”) Program, which is scheduled to conclude by 2020. Due to the physical condition of the Martins Creek – Siegfried #2 line segment, its in-service date has been established as November 2013. The in-service date of November 2013 will enable PPL Electric to coordinate budgeting, acquiring of resources, and scheduling the rebuild of the Martins Creek – Siegfried #2 Line segment with an outage schedule approved by PPL Electric’s and PJM’s system operators, and will enable PPL Electric to coordinate the construction among the other line segments in the Vintage Conductor Program that also require rebuilding to minimize any effects of the projects on service to customers.