



Peach Bottom to Raphael Road 230kV
New Transmission Line and Reconductoring
February 28, 2017

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Table of Contents

- 1. *Executive Summary* 4
- 2. *Company Evaluation* 5
 - 2.1. Contact Information 5
 - 2.1.1. Primary Contact 5
 - 2.1.2. Secondary Contact 5
 - 2.1.3. Headquarters 5
 - 2.2. Pre-Qualification 5
 - 2.3. Company Information 5
- 3. *Constructability Information* 12
 - 3.1. Scope of Project 12
 - 3.2. Cross-Border Issues 12
 - 3.3. Proposal Elements 12
 - 3.3.1. General Description 12
 - 3.3.2. Geographic Description 13
 - 3.3.3. Route Description 13
 - 3.3.4. Physical Characteristics 24
 - 3.3.5. Map and Supporting Diagram 24
 - 3.3.6. Interconnection Location 27
 - 3.3.7. Outage Requirements 27
 - 3.3.8. Cost 27
 - 3.3.9. Construction Responsibility 29
- 4. *Analytical Assessment* 30
 - 4.1. Analysis 30
 - 4.2. Equipment Parameters and Assumptions 31
 - 4.3. PSS/E IDEV Files 31
 - 4.4. Supporting Documentation 31
 - 4.5. Technical Analysis 32
 - 4.6. Proposal Template Spreadsheet 33
 - 4.7. Market Efficiency 33
- 5. *Cost* 35
 - 5.1. Cost Estimate 35
 - 5.1.1. Total Cost 35
 - 5.1.2. Yearly Cash Flow 35
 - 5.1.3. Escalation Rates 35

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

5.2. Detailed Breakdown of Cost	35
5.2.1. Planned Return on Equity	37
5.2.2. Estimated Monthly AFUDC	37
5.2.3. Annual O&M Cost	37
5.3. Cost Commitment	37
5.3.1. Estimated Annual Transmission Revenue Requirement (ATRR)	37
5.3.2. Estimated ATRR Calculations with Assumptions	38
6. Schedule	39
7. Operations/Maintenance	41
7.1. Overview	41
7.1.1. Previous Experience	41
7.1.2. Inspection and Maintenance Approach	41
7.1.3. Intentions for Control Center	42
7.1.4. Maintenance Contracts	42

Note: Supporting files identified in Section 4.4 Supporting Documentation have been submitted via Axway Secure Transport: <https://sftp.pjm.com/>

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

1. Executive Summary

Public Service Electric and Gas Company (PSE&G) is pleased to provide this proposal to PJM in response to the PJM’s 2016/2017 RTEP Long-term Window. PSE&G seeks Designated Entity Status to construct, own, operate, and maintain the proposed Project.

PSE&G proposes to construct, own, operate, and maintain the “Peach Bottom – Raphael Road 230kV Project” (the “Project”) in Pennsylvania and Maryland to address market congestion on the Conastone-Graceton and Graceton-Bagley flowgates in response to PJM’s 2016/2017 RTEP Long-term Window. The Project is located within the PECO and BGE zones. The Project should be evaluated as a whole, inclusive of the following components:

- New Peach Bottom – Raphael Road 230kV circuit: approximately 30-miles of a new single circuit 230kV overhead transmission line with 48-strand OPGW, between Peach Bottom Switching Station and Raphael Road Substation. PSE&G seeks Designated Entity Status to construct, own, operate, and maintain this proposed component.
- Expansion of Peach Bottom 230kV Switching Station to accommodate the new 230kV circuit.
- Expansion of Raphael Road Substation to accommodate the new 230kV circuit.
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PSE&G estimates the total Project cost is \$84.2 million, in 2017 dollars,

PSE&G modeled this solution extensively and has optimized it to provide the following Project benefits:

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-
-
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New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

2. Company Evaluation

2.1. Contact Information

2.1.1. Primary Contact

Name: Gregory A. Player
Title: Senior Project Manager
Email Address: gregory.player2@pseg.com
Phone: (732) 710-5287
Address: 4000 Hadley Road
South Plainfield, New Jersey 07080

2.1.2. Secondary Contact

Name: Qamar Arsalan
Title: Manager Transmission Planning, Electric Delivery
Email Address: qamar.arsalan@pseg.com
Phone: (973) 430-7821
Address: 80 Park Plaza
Newark, New Jersey 07102

2.1.3. Headquarters

PSEG
80 Park Plaza
Newark, New Jersey 07102
(973) 430-7000

2.2. Pre-Qualification

PSE&G's pre-qualification document was submitted June 21, 2013 under PJM ID# 13-07.

2.3. Company Information

Public Service Electric and Gas Company (PSE&G) is a direct wholly owned subsidiary of Public Service Enterprise Group. PSE&G is among the nation's largest investors in transmission infrastructure in the United States. PSE&G provides electric and gas service to customers in New Jersey in an area consisting of 2,600-square-miles. PSE&G serves 2.2 million electric customers and 1.8 million gas customers in more than 300 urban, suburban, and rural communities, including New Jersey's six largest cities. PSE&G owns and maintains approximately 900-miles of transmission right-of-way with 1,540-miles of transmission lines over 100kV and more than 480-miles of 500kV transmission lines.

Financial Strength

PSE&G maintains grade credit ratings and has positive and stable outlooks from the rating agencies.

PSE&G's strategy is to maintain a focus on operational excellence, financial strength and disciplined investment. Our balance sheet has remained one of the strongest in the industry. Generally, PSE&G uses either secured medium-term notes or first mortgage bonds to raise long-term capital. PSE&G's mortgage bond credit ratings are as follows:

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

PSE&G's Credit Ratings	2016*	2015	2014
Standard and Poor's	A	A	A
Moody's	Aa3	Aa3	Aa3

Table 1. PSE&G Credit Ratings

For more on PSE&G's financial strength and latest information, see the link for the Investor Relations page at the PSE&G website: <http://investor.pseg.com/>

Industry Recognition—A proven track record of reliability, customer satisfaction, and emergency response and restoration

PSE&G continually earns industry recognition for operational excellence in key operating areas. In 2017, PSE&G ranked in the top 10 of Electric and Gas Utilities on Fortune's World's Most Admired Companies list. PSE&G was named Electric Light & Power's 2015 Utility of the Year for its high ranking performance in customer satisfaction, leadership in employing state-of-the-art technology, and capital investment programs designed to enhance reliability and system resiliency.

PSE&G has also won several awards for reliability which were driven by its design, operation and maintenance practices for the most reliable utility. PSE&G was recognized as the most reliable utility in the Mid-Atlantic region for the 15th year in a row by PA Consulting, a national industry benchmarking group. The company also received the Outstanding Outage Response Time award for restoring customers 30 percent faster than any other large investor owned utility. In addition, PSE&G received the Outstanding Customer Engagement award for its proactive approach to communications—using Twitter, Facebook, LinkedIn, customer emails, corporate website, and blog, among other channels, to keep customers, regulators, government officials and the media informed during both blue-sky days and major events. PSE&G was also named by PA Consulting as America's Most Reliable Electric Utility five out of past 10 years and ranks highest in customer satisfaction with business large business electric service and natural gas service in the east, according to J.D. Power.

PSE&G was named to the Dow Jones Sustainability North America Index for the 8th consecutive year. The Dow Jones Sustainability Indices (DJSI) recognize forward thinking companies based on an appraisal of the company's strategy, management and its performance in dealing with opportunities and risks deriving from economic, environmental and social developments.

PSE&G was named to the 2014 FORTUNE List of Most Admired Companies, ranking fourth among electric and gas companies in the United States.

PSE&G earned the Edison Electric Institute Award for outstanding restoration efforts after Superstorm Sandy in 2012 and Hurricane Irene in 2011 for restoring power and for outstanding storm management practices, including effective communications with the public.

As in the case of Superstorm Sandy, PSE&G emergency preparations and responses included the following:

- Available personnel ready to respond.
- Contractors to assist the utility's own skilled workforce.
- Additional supplies, such as poles, transformers and other pole-top equipment were on hand.
- Vehicles were fueled and ready to go.
- Tested generators at utility locations.
- Checked locations for potential flooding and took precautions such as using sandbags to help divert water from substation equipment.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

- Coordinated with county Office of Emergency Management for updates on outages and restoration efforts.
- Communicated with the public regarding anticipated storm conditions.
- Both the Primary and Back-Up transmission control centers were fully staffed starting a day before the storm arrived and the Primary control center was staffed with extra personnel.
- PSE&G requested more than 1,300 linemen and 600 tree contractors from utilities in other states to assist our crews.
- PSE&G's call center was fully staffed to handle calls from customers. Other employees assisted with assessing storm damage, keeping the public away from any downed power lines and other functions that supported restoration efforts.

Immediately after a storm or outage event has passed, PSE&G deploys its crews to restore the system as quickly as possible. Over the years, PSE&G operations and maintenance personnel have had substantial experience in restoring the system after major events.

Experienced and Qualified Teams Providing Lifecycle Services

PSE&G has developed a team of experienced professionals to support the entire life cycle of a transmission project which include: environmental and permitting, project engineering, project management, project controls, procurement, construction, public affairs and community outreach, commissioning, operations and maintenance, and regulatory compliance. PSE&G has over 1,400 in-house personnel engaged in transmission line project implementation and/or transmission facility operations and maintenance.

PSE&G's transmission engineering team has the experience and capabilities to design transmission line projects from 69kV to 765kV of various line configurations. Configurations include: wood, tubular steel, lattice tower, laminated wood H-frame or single pole structures. The engineering team's design approach anticipates and mitigates project risks, including for example design challenge and uncertainties. The engineering team's experience in the latest industry recognized line design software tools includes work with - PLS-CADD, PLS-Pole, PLS-Tower, EPRI TL Workstation, STAAD, LPILE, FAD Tools, and others. The engineering staff actively attends external and internal training sessions to stay current on industry standards and to expand their technical skill set.

PSE&G's Comprehensive Services

Project Management

Environmental

Permitting

Engineering

Project Controls

Procurement

Construction

Public Affairs

Community Outreach

Commissioning

Operations and

Maintenance

Regulatory Compliance

Consistent Project Delivery

As an infrastructure company, PSE&G has an outstanding record of consistently delivering challenging projects within schedule and on budget. We have the experience and confidence to develop the technical scope, detailed cost, and achievable schedules for new transmission and substation projects. PSE&G successfully manages and executes every project within the established performance metrics and goals.

PSE&G has substantial experience owning and constructing transmission projects. PSE&G's ability to manage projects effectively and to deliver consistent, high quality services lies in its standardized procedures and balanced scorecard. PSE&G currently has 20 project management procedures addressing topics ranging from scope management through contractor safety, which all closely model the Project Management Body of Knowledge, published by the Project Management Institute. There are also 14 reference manuals (playbooks), for critical project functions including project manager, and project control engineer (cost and schedule). Key metrics measured in the balanced scorecard include key project milestones, forecasting accuracy, and project cost and schedule performance index.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

PSE&G project teams develop work sequences that make sense, manage procurement so that needed materials arrive on time, and flexibly deploy resources when and where they are needed to increase efficiency, cost effectiveness, and reliability. PSE&G has the experience and capability to adhere to standardized construction, maintenance and operating practices. As a transmission infrastructure company—we do it every day.

PSE&G has a comprehensive Lessons Learned and Continuous Improvement process where we transfer and build upon the knowledge obtained from each project. Once the installation is complete, we effectively manage and operate the infrastructure. Our system is recognized as highly reliable and well maintained to meet the customer needs for the long-term.

PSE&G is currently executing a \$4.1 billion transmission capital investment program through 2019.

PJM approved PSE&G's Metuchen-Trenton-Burlington (MTB) 230kV project, which will replace and upgrade two 138kV transmission facilities from Metuchen to Brunswick, from Brunswick to Trenton and from Trenton to Burlington. The towers and transmission equipment along these three corridors were nearing end of life based on age and system condition. In addition, this upgrade will help maintain system reliability by strengthening ties between northern and central New Jersey. The MTB project will traverse 55 miles spanning three counties (Middlesex, Mercer, Burlington), and will involve work in 17 municipalities. MTB will be constructed in three phases, with all work expected to be completed by June 2022.



Bergen-Linden Corridor Project

PSE&G is currently building the \$1.2 billion 345kV Bergen-Linden Corridor Project and recently completed four (230kV and above), large infrastructure projects totaling over \$2 billion ahead of PSE&G's schedule and under budget.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV



Mickleton-Gloucester-Camden Project



Susquehanna Roseland Project



Burlington-Camden Upgrade



North Central Reliability Project

Clockwise from top left: stringing conductor on the Mickleton-Gloucester-Camden Project; using the air crane to set tower sections on the Susquehanna Roseland Project; overview of the North Central Reliability towers and right-of-way; and overlooking the new Burlington station from the Burlington-Camden Project.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

Below is a list of representative projects that PSE&G owns, is constructing/has constructed, maintains, and operates.

Project	Circuit Miles	Voltage (kV)	Cost	Scope	In-Service Date
Bergen-Linden Corridor Upgrade Project	30	345	Up to: \$1.2B	1 new station; 9 station upgrades; new overhead and underground lines	Phase 3: 2018 Target Completion Phase 2: 2017 Target Completion Phase 1: May 2016
Underground Transmission Upgrade Program	113	138/230/345	\$440M	Upgrade underground transmission lines in 5 counties in New Jersey	December 2016
Sewaren-Metuchen 230kV Conversion Project	14	230	\$125M	Convert existing lines to 230kV; 4 station upgrades	August 2016
Northeast Grid Reliability Project	69	138/230	\$975M	11 stations, upgrade overhead transmission line (50 miles) and underground transmission lines (19 miles)	July 2016
Mickleton-Gloucester-Camden	16	230	\$435M	Two new 230kV overhead lines; three new 230kV underground lines, upgrade 5 stations	2015
Susquehanna-Roseland	45	500	\$790M (PSE&G's portion)	New 500kV overhead lines, construct new 500kV GIS station and expand an existing station	2014 (PSE&G's portion); Energized 2015
North-Central Reliability Project	55	230	\$390M	Upgrade existing 138kV transmission line to 230kV; convert 7 existing stations to 230kV	2014
Burlington-Camden Network Reinforcement Project	37	230	\$399M	Reconfigure overhead transmission lines and upgrade	2014
Bayonne 3 rd Source	5.5	230	\$123M	New underground transmission line from Bayonne to Marion stations	2013

Table 2. PSE&G's Representative Project Experience

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

A Strong Commitment to Health and Safety

PSE&G's vision is to be increasingly recognized as "a leader for People providing Safe, Reliable, Economic and Green Energy." People come first—and so does their health and safety.

"Our Commitment to Health and Safety" statement unites PSE&G employees, company leaders, and our contractors in achieving an accident free environment where no one gets hurt.

Health & Safety Councils are the backbone of the PSE&G Health and Safety System. Today, a system of employee-led councils at the local, business and company level dedicate their time, effort, and expertise to achieving a culture built on:

Trust—We respect and trust each other's opinions and decisions and follow through on all health and safety concerns.

Care—We approach each day with the determination to care for ourselves, co-workers, contractors, and the communities we serve.

Knowledge—We have the knowledge and skills to be healthy and safe.

Communication—We communicate in a clear, open and honest manner.

At PSE&G, we believe that safety is a way of life both on and off the job. PSE&G is fully committed to protecting the health and safety of our employees, contractors, and the communities we serve. We believe that operational excellence—with safety first— is the key to long-term success.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

3. Constructability Information

3.1. Scope of Project

PSE&G proposes to construct, own, operate, and maintain the Project, inclusive of the following components:

- New Peach Bottom – Raphael Road 230kV circuit: Approximately 30-miles of a new single circuit 230kV overhead transmission line, between Peach Bottom Switching Station and Raphael Road Substation. The circuit will be arranged in a

Construction of the new circuit will include installation of two (2) 48-strand fiber OPGW. PSE&G seeks Designated Entity Status to construct, own, operate, and maintain this proposed component.
- Expansion of Peach Bottom 230kV Switching Station to accommodate the new 230kV circuit.
- Expansion of Raphael Road Substation to accommodate the new 230kV circuit.
-
-

3.2. Cross-Border Issues

The following proposal is not a solution to Cross-Border issues.

3.3. Proposal Elements

3.3.1. General Description

The Project includes the installation of an approximately 30-mile 230kV overhead transmission line from the existing Peach Bottom Switching Station to the existing Raphael Road Substation.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

3.3.2. Geographic Description

3.3.3. Route Description

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

3.3.4. Physical Characteristics

- Line and shield conductor type and size:
- Overhead or underground/submarine: Overhead
- Single or double circuit towers: Single Circuit

3.3.5. Map and Supporting Diagram

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

3.3.6. Interconnection Location

3.3.7. Outage Requirements

Outages will be required for construction at the existing Peach Bottom and Raphael Road stations. PSE&G will coordinate with the incumbent transmission owners to determine the length and timing of the outages. The Project schedule assumes that outage requests will be submitted in accordance PJM's Outage Requirement Criteria, and will be available on-time support the construction and energization of the line.

Outages are also required to reconductor or rebuild BGE's Raphael Road to Northeast 230kV double circuit and BGE's Northeast to General Motors 115kV double circuit. The incumbent transmission owner will be responsible for determining the length and sequence of outages to complete the reconductor or rebuild scope of the Project.

3.3.8. Cost

The total Project cost is \$84.2 million.

The component costs of the new transmission line are provided in Table 3. Component Costs.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

3.3.9. Construction Responsibility

PSE&G seeks Designated Entity Status to construct, own, operate, and maintain the proposed Peach Bottom to Raphael Road 230kV transmission line.

4. Analytical Assessment

4.1. Analysis

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

4.2. Equipment Parameters and Assumptions

4.3. PSS/E IDEV Files

PSS/E IDEV files are submitted via Axway Secure Transport: <https://sftp.pjm.com/>. Refer to Section 4.4 Supporting Documentation.

4.4. Supporting Documentation

PSE&G provided supporting documentation required by PJM to perform verification review. The following files listed in the table below are submitted as separate files via Axway Secure Transport: <https://sftp.pjm.com/>.

File Description	File Names
Attachment 1 – Project One Line Diagram	B.1. Breaker Diagram Peach Bottom Raphael Rd.vsd
Attachment 2 – Route Diagram	B.2. Peach Bottom Raphael Road Route.jpg
Attachment 3 – Power Flow Results	B.3. Power Flow Results Peach Bottom Raphael Road.xls
Attachment 4 – Contingencies	B.4. Contingencies Peach Bottom Raphael Road.con
Attachment 5 – PSS/E IDEV files	B.5. PSSE Model Peach Bottom Raphael.idv
Attachment 6 – RTEP Proposal Spreadsheet	B.6. RTEP 2016 Peach Bottom Raphael Rd.xls
Attachment 7 – Event File	B.7. 201617ME MONCON v2016-10-31Peach Bottom Raphael Rd.eve
Attachment 8 – PROMOD Change Cases	B.8. branch 1.xls

Table 5. Peach Bottom to Raphael Road Supporting Documentation

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

4.5. Technical Analysis

PSE&G studied the Project according to various PJM Market Efficiency and RTEP analysis including:

- Production Simulation study
- N-1 Contingency Analysis (Thermal and Voltage)

PSE&G has completed extensive modeling efforts to evaluate the merits of proposed Project, including economic studies and reliability studies. The economic study included PROMOD simulations using the 2016 Market Efficiency base cases. The reliability study used the PJM provided PSSE files along with associated contingency data.

Market Efficiency Economic Study

PSE&G's modeling efforts utilized PJM's 2016 Market Efficiency Economic Models for the study years 2017, 2021, 2024, and 2027. Employing the modeling methods and procedures outlined in PJM's "PJM-2016-market-efficiency-procedure-for-executing-promod-simulations" Document, PSE&G conducted all market efficiency modeling runs using PROMOD. All inputs and assumptions came directly from the PJM as described in the problem statement; specifically the 2016 Market Efficiency Event files and 2016 Market Efficiency Analysis input assumptions.

In order to establish a baseline against which Project benefits would be calculated, PSE&G ran the model for each individual study year using the exact models and inputs provided by PJM. The results of these models runs established the base cases. PSE&G compiled several matrices from the base case including total congestion costs on constraints of interest and system wide congestion costs, production costs by zone and load energy payments by zone. PSE&G confirmed its base case congestion costs matched those provided by PJM in the Problem Statement.

All analysis results from the economic study have been attached and are referenced in Section 4.4 Supporting Documentation and are discussed in detail in Section 4.7 Market Efficiency.

Reliability Analysis

PSE&G conducted a detailed reliability assessment which included a power flow contingency analysis of the PJM system with the Project as directed in the Problem Statement. Using the RTEP 2021 base case as provided by PJM, PSE&G performed a thermal overload analysis using PSSE.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

Before incorporating the Project in the model, PSE&G solved the model in order to identify any thermal violations and voltage violations in the base model. After compiling a list of base thermal and voltage violations, the Project was added and the analysis rerun. Any new or exacerbated overloads were identified. As previously described the addition of the Project creates no new thermal or voltage overloads.

4.6. Proposal Template Spreadsheet

The 2016/17 RTEP Proposal Template spreadsheet (in Excel format) is provided electronically as a separate file via Axway Secure Transport: <https://sftp.pjm.com/>. Refer to Section 4.4 Supporting Documentation.

4.7. Market Efficiency

The Peach Bottom to Raphael Road 230kV Project specifically proposes to address the following market efficiency constraints identified by PJM and shows substantial relief across the study years on the congested elements shown in Table 6. Flowgates of Interest below.

Facility Name	AREA	2017 Market Congestion (\$ Millions)	2021 Market Congestion (\$ Millions)	2024 Market Congestion (\$ Millions)	2027 Market Congestion (\$ Millions)
GRACETON TO CONASTON 230kV ckt 1 due to loss of GRACETON TO CONASTON ckt 2	BGE	\$51.80	\$58.26	\$72.10	\$68.88
BAGLEY TO GRACETON 230kV due to loss of BAGLEY to GRACETON ckt 2	BGE	\$23.59	\$33.01	\$49.55	\$59.57

Table 6. Flowgates of Interest

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

The benefit/cost ratio for the Project in the base scenario is . The present value of benefit is million relative to the present value of the cost of , over the 15 years life of the Project.

A detailed reliability analysis was performed with the proposed Project in place and no additional thermal or voltage violations were found due to the proposed Project.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

5. Cost

5.1. Cost Estimate

5.2. Detailed Breakdown of Cost

The total Project cost is \$84.2 million.

New Transmission Line and Reconductoring

Peach Bottom to Raphael Road 230kV

6. Schedule

PSE&G prepared a detailed schedule and construction sequence and expects the schedule duration is from the PJM Board of Directors' approval of the RTEP – 2016/17 RTEP Long Term Proposal Window. This proposal assumes a Project award in by January 1, 2018

7. Operations/Maintenance

PSE&G will operate and maintain the project with consistent, internal procedures in line with PSE&G's normal business practices.

7.1. Overview

As an infrastructure company, PSE&G follows Operations and Maintenance procedures and practices. The purpose of these procedures and practices is to implement the necessary operations and maintenance activities that help ensure the safe, reliable and cost-effective operation of electrical equipment. PSE&G utilizes standard time and condition-based practices, along with constant focus on safety, customer service and cost control, to optimize the utilization and minimize the down time of equipment that is critical to the delivery of electric power. PSE&G monitors equipment condition and applies the resources to improve the condition and extend the useful life of electric equipment, thereby maximizing the value of its investment in these facilities.

7.1.1. Previous Experience

PSE&G owns, operates, and maintains approximately 900 miles of transmission right-of-way with 1,540 miles of transmission lines over 100kV and more than 480 miles of 500kV transmission lines.

PSE&G's Transmission Construction and Maintenance organization is responsible for planning and performing all required Corrective Maintenance (CM) and Preventative Maintenance (PM) on PSE&G transmission facilities. The specific work performed by this organization includes:

- Overhead maintenance
- Underground maintenance
- Live line work
- Inspections

The group is responsible for:

- Inventorying existing transmission assets and assessing maintenance needs
 - Maintaining database of all transmission assets
 - Ensuring that all transmission assets are scheduled for periodic maintenance according to the correct schedule
 - Assessing the condition of existing assets
 - Identifying the CM and PM requirements for current maintenance period
- Prioritizing the CM and PM maintenance work for the current period
- Identifying and securing required resources (e.g., labor, materials, funding)
- Developing a detailed work plan and assigning resources required to accomplish all CM and PM
- Scheduling the CM and PM work to be performed and coordinate labor, equipment, material, vendor, outages, and support services availability
- Preparing labor work orders, material, outside services, purchase orders, and arrange outages, if required
- Performing and completing all scheduled CM and PM work in accordance with the work plan and established standard practices and procedures
- Finalizing all project documentation, completing related internal and external reports