Final Report

Independent Engineering Evaluation
Constructability Analysis
of
PSE&G 345kV Conversion Alternative

Prepared for

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December 6, 2013
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To avoid sections being taken out of context, the report should be read in its entirety.
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Final Report

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1.0 Executive Summary

Burns and Roe has performed a constructability analysis of the double circuit 345kV alternative for the upgrading of the PSE&G electrical transmission system in northern New Jersey.

The purpose of the constructability analysis is to identify overall constructability of the project as proposed within the cost and schedule identified.

Burns and Roe’s evaluation was based on preliminary information of conceptual designs developed to date by PSE&G and on information provided by both PSE&G and PJM. This review takes into account permitting issues, constructability, schedule, and the cost of the construction of substations and transmission lines. Burns and Roe has identified factors that could potentially affect the implementation of the 345kV conversion alternative.

As a result, the conclusions drawn in this report are based on past experience and good engineering and construction practices; and not necessarily on the detailed designs or in depth requirements for construction of substation and transmission lines upgrade and/or new construction.

2.0 Project Overview

The 345kV conversion alternative includes the upgrade of ten (10) substations and associated transmission circuits. Burns and Roe has evaluated the constructability of the substation expansion and modifications and the transmission line upgrades. This study provides constructability assessment of the substations and transmission lines with respect to environmental impacts, project schedule and capital cost estimates. The findings and recommendations for the 345kV conversion alternative are presented as part of the constructability analysis for PJM.
2.1 Overall Description of Proposed Project

2.1.1 Scope of Work

In order to alleviate increasing fault duty of the existing PSE&G 230kV system, PSE&G has proposed a major upgrade project to multiple switching stations in the northeast area of the PSE&G system. This upgrade project will add a new voltage level of 345kV for multiple switching stations and associated interconnecting transmission lines. This upgrade to 345kV will replace some stations and lines presently operating at 138kV, and will reduce the present magnitude of power transmission at 230kV, shifting transmission and load to the new 345kV system. As such, the increasing energy level of the 230kV system will be alleviated.

2.1.2 Summary of New and Upgrade Transmission Lines

This 345kV conversion alternative project involves upgrading existing 138kV and 230kV transmission infrastructure to operate at 345kV. For overhead lines, the existing Rights-of-Way will be re-used. For underground circuits, some new pipe-type circuits will be installed, and some existing pipes will be reused with re-conductoring of the transmission circuit. An overall summary of the transmission modifications is presented in this section of the report. Detailed descriptions for each transmission line portion of the overall project are described in Sections 2.1.3 (Overhead) and 2.1.4 (Underground) of this report.

2.1.2.1 Bergen to Marion

[Redacted]

2.1.2.2 Marion to Bayonne

[Redacted]
2.1.2.3 PVSC to Bayonne

2.1.2.4 North Ave to PVSC

2.1.2.5 North Ave to Airport

2.1.2.6 Airport and North Ave to Bayway

2.1.2.7 Bayway to Linden

2.1.2.8 Linden to Goethals
2.1.3 Overhead Transmission Details

2.1.3.1 Bergen – Marion
2.1.3.2 Bayway - Linden

2.1.4 Underground Transmission Details

The construction activities in this 345kV project include conversion of 138kV underground oil-cooled transmission lines as follows: 1) the re-conductor projects utilizing the existing pipe, 2) the upgrade of termination structures and 3) the installation of new pipe-type circuits running parallel with existing pipes.
2.1.4.1 *Underground Transmission – Re-conductoring*

For the underground transmission lines being upgraded to 345kV, re-conductoring will require the removal of existing conductors, and the cleaning and the inspection of the existing pipes. Existing pipes in good condition will require less road closures and traffic disruptions. However, if extended repair work is needed, construction time may become a public issue due to the need for road closures while excavation is performed.

Re-conductoring of existing underground pipe circuits will be performed for the following circuits:

- [List of circuits]

2.1.4.2 *Underground Transmission – Termination Upgrades*

2.1.4.3 *Underground Transmission – New*

This project includes the following new underground 345kV transmission circuits:

- Bayonne to PVSC
• PVSC to North Avenue

Interface with the NJ DOT may be needed since excavation will be required across the NJ DOT easement, even though the highway is significantly elevated in this area.

• North Avenue to Airport
Permitting for this HDD will likely involve the NJ DOT in addition to other agencies, and a railroad crossing east of the Turnpike will also be made. Installation of new pipes is faster than draining, cleaning, and re-conductoring old pipes.

- **North Avenue to Bayway**

2.1.5 **Description of New and Upgrade Substations**

This project will partially replace 138kV systems with 345kV substations at many stations, and will add completely new 345kV substations at some stations, and will include new transformers for interconnections to existing 138kV and 230kV transmission systems, new 69kV subtransmission system, as well as lower voltage distribution systems.

The available substation sites have been examined using satellite aerial views to determine the feasibility of installing 345kV equipment at each site. At this time, the level of detail for this project is preliminary.
2.1.5.1 Bergen (Expansion of Substation)

2.1.5.2 Bayonne (Modifications within Substation)

The continued development of the Bayonne station must be addressed during the design phase of the project.
2.1.5.3 *Marion (Modifications and Expansion of Substation)*

The Marion site is under development as part of the Northeast Grid Project. The 138kV substation yard and the 26kV distribution subdivision occupy the Hudson Generator property. The 138kV substation is presently a single bus AIS connected to seven (7) transformers. The preliminary plan involves decommissioning an existing oil tank and using the additional property for the construction of a new 345kV five (5) or six (6) bay breaker-and-a-half GIS substation. The available area as noted on the PSE&G presentation is approximately 630 ft. by 580 ft. The six (6) bay GIS would require an area approximately 150 ft. by 125 ft. excluding transformers. Without an actual layout of the site with all the projects accounted for, the available space is not definite and coordination with PSEG Power may be needed to purchase additional property.

2.1.5.4 *Newark Airport*

2.1.5.5 *North Ave (Expansion of Substation)*

2.1.5.6 *Bayway (Modifications within Substation)*
2.1.5.7 Linden (Modifications within Substation)

The Linden substation contains a 138kV single bus AIS and a distribution section with

Presently, there is a 230kV interconnection from PSE&G at Linden to Con Edison
Goethals Substation, Circuit A-2253.

2.1.5.8 PVSC

The PVSC substation is a 138kV single bus AIS with two transformers for distribution.
2.1.5.9 Other Substations (Modifications within Substations)

Homestead Substation and North Bergen Substation are substations connected to the overhead lines from Bergen to Marion, F-1306 and E-1305. These substations are used for distribution.

2.2 Milestone Schedule

An overall milestone schedule for this project has not yet been developed. As described by PSE&G, the overall project is expected to require 48 months. The first phase of the project is to construct and commission the Marion 345kV substation, so that the connections to Con Edison Farragut can be removed from the 230kV system, thereby partially alleviating the short circuit duty problem.

2.3 Overall Estimated Project Cost

PSE&G has provided a conceptual level overall cost estimate for this project. The PSE&G total is $1,180,300,000.
2.4 Potential Risks to Successful Project Completion

The 345kV Double Circuit project is a large and complex undertaking.
• Some wetland acquisition may be needed to support additions of overhead structure foundations and expansion of substations.

• Submittals to the FAA will be needed for modifications of overhead transmission lines in proximity to Newark and Linden airports.

• Temporary construction activities will require development of measures to protect the environment including spill prevention planning, stormwater management and sediment control.
2.5 Executive Summary of Findings

Burns and Roe performed Internet-based field surveys\(^1\) of all substations and transmission routes. The transmission routes were visually followed to inspect any visible problems with the route. The aerial views of the substations and routes of the underground pipe circuits are provided in Attachment 6. The transmission lines and substations have been reviewed based on preliminary information from both PJM and PSE&G and the typical engineering of substations and transmission system construction activities.

The overall project is considered feasible. Permitting for the multiple substations and the multiple transmission lines will be complex and time consuming, involving interface with

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\(^1\) Google Maps Labs' Distance Measurement Tool was used to estimate the allocated space available at each substation. This distance was compared against the Google provided scale to verify the accuracy of the tool.
multiple agencies as well as all the municipalities where the substations are located and where the transmission lines traverse. In addition to the local municipalities, permitting submittals may be required by the US Army Corps of Engineers, NJ DOT, FAA, NJ DEP, NJ DCA, owners/operators of railroads, and the Port Authority of NY/NJ. The permitting process will need to be broken down into specific segments and detailed planning and scheduling for interface with agencies and submittals is critical to allow the project to proceed.

Significant procurement is required for major engineered equipment, including large quantities of transformers, 345kV dead tank circuit breakers, multiple 345kV GIS substation systems, LPP insulated conductors, and transmission structures; and bulk materials such as steel pressure pipes, aluminum bus tubing, bare transmission conductors, suspension and post insulators, air insulated disconnect switches and substation steel structures. Similarly to the statement above for the permitting process, the procurement process for this project must be broken down into specific segments, with detailing planning and scheduling, in order to obtain engineered equipment and bulk materials at the needed times during the overall 48 month project duration.

Major risks for this project have been summarized. The most significant risks include:
The cost estimates for this project have been examined, and estimates for the 345kV AIS and GIS stations are considered conservative. The costs for the transmission modifications have not been reviewed in detail at this time, however, those cost estimates have been prepared by PSE&G based on their on-going experience with transmission upgrades. Overall, the total project cost should be less than the total present estimate with contingency; this should be carefully monitored during the next phase of project planning effort.
The overall conclusion is that this project, although large and complex, can be achieved in accordance with the preliminary concepts that have been put forth at this time. As more detail is prepared covering cost, schedule, land acquisition, and specific planning of each station and line upgrade, further review should be performed.

3.0 Regulatory Risk

Regulatory risks can be categorized against overhead transmission, underground transmission, and substation projects, as follows:

Overhead Transmission
- Some wetland acquisition may be required to support possible expansion of transmission tower bases as well as construction vehicle access. This is a minor issue as the amount of potential disturbance is small.
- FAA hazard notification filing is likely required due to proximity of towers to take-off and landings at Newark and other local airports (Linden Airport). No likely hazard due to existence of taller structures in area.

Underground Transmission
- Permitting will be required for roadway closures and excavation for installation of new underground transmission circuit pipes and manholes. This does not present a major risk for the majority of the routes for new pipe circuits.
- Permitting will be required for placement of new pipes using horizontal directional drilling under waterways, railroads and highways. Since there will be no disturbance of the seabed, railroad or highway, obtaining necessary permits is mostly a formality with minimal risk, but the paperwork effort and multiple agencies involved can cause this topic to be burdensome. For the excavation at the terminals of each end of the horizontal directional drill locations, permitting for the excavation, including soil erosion and sediment control, will be required.

Substations
- For substation modifications that do not involve expansion outside the present fence line, permitting and submittals to NJ DCA are somewhat routine and do not present any appreciable risk.
- For substation expansions outside the present fence line, permitting and submittals to NJ DCA will likely be more complex, and may involve consideration of wetlands, flood elevations and remediation if required. These risks will require further assessment when more detailed information is available concerning the properties to be acquired.
- Where contaminated soil is discovered, remediation efforts will require documentation and acceptance by appropriate agencies. Risk will need to be assessed after such discovery of contamination is confirmed.
3.1 General Path Feasibility

Therefore, Burns and Roe developed "typical" layout footprints for similar substations to support this evaluation for approximation of real estate requirements. In addition, budgetary information from major vendors was obtained and used for Burns and Roe's independent conceptual cost estimate evaluations.

At this point in the study, there are no major barriers to the proposed 345kV conversion alternative.

3.2 Public Opposition

Most of the 345kV conversion alternative project affects substations and transmission lines located in highly populated areas, industrial areas and wetlands. Removing existing conductors and inspecting the existing underground pipes and associated manholes can result in extended delays for re-opening roadways. In the case that underground pipes are damaged, replacing these pipes can result in unplanned environmental permitting efforts.

3.3 Permitting and Environmental

New Jersey Department of Environmental Protection (NJDEP) freshwater wetlands permitting is required for each area where more than one acre of wetlands will be permanently disturbed as a result of this project. In accordance with NJDEP's "No Net Loss Policy", wetlands permitting will require creation of two acres of wetlands for every one acre of disturbed land. Joint U.S. Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Services review will be required if more than five (5) acres are disturbed. Approximately 1.5 years is anticipated for the NJDEP freshwater wetlands permitting planning, submittal, and review and approval process.

A Notice of Proposed Construction or Alteration approval from the FAA is required for any structure greater than 200 feet above ground level or for a structure within 20,000 feet of a large airport or seaplane base with a height in excess of the slope criteria, i.e., 1 foot vertical per 100 feet horizontal.

Other permits may include:
• NJDEP Wetlands General Permit for aboveground utility work (tower installations and footings)
• NJDEP Wetlands General Permit for underground utility work
• NJDEP Stormwater Discharge Permit
• NJDEP Stream Encroachment Permit

The requirements of the NJDEP wetlands general permit for aboveground utility line work limits the temporary disturbance of wetlands during construction for vehicle and equipment access, if necessary, to no more than 60 feet wide from the Right-of-Way boundary with a requirement for the wetlands to revert to their natural condition. For any permanent disturbances of wetlands equal to or greater than one acre, a NJDEP freshwater wetlands permit application will be required and involve extensive permit preparation, planning, and possible review by the U.S. Fish and Wildlife Service.

Permitting for underground circuit re-conductoring is expected to be a minor issue because most of the existing underground infrastructure including piping systems and manholes are expected to be re-used. For new underground pipe circuit installations, permitting will be required for excavation and for the horizontal directional drill installations.

For modifications of overhead transmission lines, permitting is expected to be a minor issue because the existing ROW will be reused. Similarly, most of substation expansions will be done on existing and new PSE&G property, without adverse impacts to surrounding communities.

3.3.1 Wetlands

The level of effort required to obtain approval for wetland disturbance will depend on the nature of the disturbance. A project with the potential to disturb a larger quantity of wetlands will require a different level of review than for a project with minimal impact. The 345kV upgrades are located in areas with a large presence of freshwater wetlands.

In order to determine whether or not an area of freshwater wetlands, transition areas or State open waters may be disturbed by any proposed activity, detailed information about that wetlands and the site must be obtained, and an inspection of the property by a representative of the Department is required. The Department offers a “Letter of Interpretation” (LOI), which is a document that describes the location of wetlands on the proposed property.

3.3.1.1 Transmission Lines - Above Ground

Regulatory agencies recognize the unique nature, in terms of environmental impact, of certain project types. Specific to the PJM Constructability evaluation, the upgrades of
existing above ground utility lines can be permitted via General Permits offered by the
NJDEP for the class of projects defined as “Above Ground Utility Lines”. Requirements
are addressed under “General Permit 21 or GP-21. To be eligible for a GP-21, the
temporary disturbance during construction cannot be more than 60 feet wide, and the
permanent disturbance at the conclusion of the project cannot be more than a 1/2 acre or
wider than 20 feet.

Activities under this general permit must not interfere with the natural hydrologic
characteristics of the freshwater wetland (FWW), transition area (TA), or State Open
Water (SOW). If the applicant has to place the utility line on pilings to avoid this issue,
that may be a requirement to satisfy this condition. The main concern here is the
inadvertent creation of a "French drain" or other type of structure that would act to drain
or otherwise alter the FWW, TA or SOW.

The Permittee is also required to mitigate for all permanent loss and/or disturbance of 0.1
acres or greater of freshwater wetlands and/or State open waters.

3.3.1.2 Transmission Lines - Below Ground

General Permit 2 or GP-2 covers underground utility lines. GP-2 authorizes activities in
freshwater wetlands, transition areas, and/or State open waters, necessary for the
construction and/or maintenance of an underground utility line. This could be anything
from a gas line to placement of fiber optic telecommunication cable; generally any linear
disturbance intended for a utility line.

If a utility line is jacked or directionally drilled underground, so that there is no surface
disturbance of any freshwater wetlands, transition areas, or State open waters and there is
no draining or dewatering of freshwater wetlands, then NJDEP approval is not required.
Directionally drilled utility lines, if improperly constructed, have the potential to act as
"French drains", in essence creating a conduit for water to flow. As such, it is important
to implement measures such as anti-seep collars to prevent movement of water. In
addition, perched water on which a wetland system may depend could be the result of a
"clay lens" which, if punctured by construction of a utility line, can alter a wetland
system.

A GP-2 may be combined with other general permits or permits provided the total
disturbance of all GPs do not exceed the one acre threshold for multiple general permits.

3.3.1.3 Substation Installation or Expansion in Wetlands

NJDEP freshwater wetlands permitting is required for each project where more than one
acre of wetlands will be permanently disturbed as a result of an installation or expansion.
In accordance with NJDEP's “No Net Loss Policy”, wetlands permitting will require
creation of 2 acres of wetlands for every one acre of disturbed land. Joint U.S.
Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Services (FWS) review will be required if more than five (5) acres are disturbed.

### 3.3.2 Federal Aviation Administration (FAA)

A Notice of Proposed Construction or Alteration approval from the FAA is required for any structure greater than 200 feet above ground level or for a structure within 20,000 feet of a large airport or seaplane base with a height in excess of the slope criteria, i.e., 1 foot vertical per 100 feet horizontal. The design height of the new structures carrying the upgraded power lines is not known at this time. At certain locations, mainly above ground power lines along the Bayway to Linden substations, proximity to Newark Airport, and to the smaller Linden Airport, may trigger FAA notification requirements. Thus, towers in excess of 200 feet, or less high towers within the take-off and approach paths of Newark and Linden Airports, may trigger FAA filing requirements.

The use of helicopters for erecting new transmission towers would require FAA approval as well given the proximity of certain transmission line segments to Newark and Linden Airports.

### 3.3.3 Streams and Rivers


Unless properly controlled, development within flood hazard areas can exacerbate the intensity and frequency of flooding by reducing flood storage, increasing stormwater runoff and obstructing the movement of floodwaters. In addition, structures that are improperly built in flood hazard areas are subject to flood damage and threaten the health, safety and welfare of those who use them. Furthermore, healthy vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The indiscriminate disturbance of such vegetation can destabilize channels, leading to increased erosion and sedimentation that exacerbates the intensity and frequency of flooding. The loss of vegetation adjacent to surface waters also reduces filtration of stormwater runoff and thus degrades the quality of these waters.

The Flood Hazard Area Control Act rules therefore incorporate stringent standards for development in flood hazard areas and adjacent to surface waters in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development. Attachment 7 contains a copy of the NJDEP Stream Encroachment Administrative Checklist.

A utility line or substation that is proposed in a tidelands area may require a tidelands license if the activities are taking place at or below the mean high water line of a tidal waterway or a tidelands grant if any portion of the activities are taking place in an area
that is currently landward of the mean high water line but was, at some point, flowed by the tide.

3.3.4 Other Possible Permits / Requirements

Depending on the nature of the project, additional permits may be required, as noted below.

3.3.4.1 NJDEP Stormwater Discharge Permit

The stormwater discharge permit program is responsible for protecting New Jersey's ground and surface water quality by assuring the proper treatment and discharge of wastewater (and its residuals) and stormwater from various types of facilities and activities. With respect to the proposed transmission tower upgrades, this permit would mostly cover construction-related activities and would regulate stormwater discharge in terms of discharge volume and sediment/contaminant (i.e., oil and grease) loading. With respect to the expansion or installation of new substations, this permit would cover construction activities, as well as discharges during operation (which from a substation, would mostly involve assurance that vessels containing transformer oils and lubricants are properly operated, maintained) and inspection in terms of minimizing the chance of potential spill. A temporary operation such as a concrete batch plant to support tower foundation construction would be permitted under a General Permit for Concrete Products Manufacturing (CPM).

3.3.4.2 NJDEP Air Permit

The installation of a temporary concrete batch plant could also trigger a requirement for obtaining a NJDEP air permit for emissions associated with raw and final product material handling. Pollutants of concern would be dust from dry material handling (aggregate, sand, etc.). Use of fabric filter controls during material handling and transfer may need to be applied.

3.3.4.3 Local Noise Requirements

Local or overriding state noise requirements would need to be reviewed in determining acceptable construction practices (i.e., limits on evening construction activities that would generate noise or use of helicopters in erecting transmission line towers).

3.3.4.4 Spill Prevention Control and Countermeasure (SPCC)

Under 40 CFR 110 & 112, and the legal authority of the Clean Water Act, the Discharge of Oil regulation, more commonly known as the "sheen rule", provides the framework for determining whether an oil spill to inland and coastal waters and/or their adjoining
shorelines should be reported to the federal government. In particular, the regulation requires the person in charge of a facility or vessel responsible for discharging oil that may be "harmful to the public health or welfare" to report the spill to the federal government. The regulation establishes the criteria for determining whether an oil spill may be harmful to public health or welfare, thereby triggering the reporting requirements, as follows:

- Discharges that cause a sheen or discoloration on the surface of a body of water;
- Discharges that violate applicable water quality standards; and
- Discharges that cause a sludge or emulsion to be deposited beneath the surface of the water or on adjoining shorelines.

Because the Oil Pollution Act of 1990, which amended the Clean Water Act, broadly defines the term "oil," the sheen rule applies to both petroleum and non-petroleum oils (e.g., vegetable oil).

Oil contained within a substation (i.e., transformers) or within underground piping would likely be regulated under the SPCC regulations provided minimum applicability threshold quantities are exceeded (aggregate above ground capacity of 1,320 gallons, including the totals of all material stored in containers greater than 55 gallons in volume). An interpretation of whether oil contained in underground piping would or would not be counted in the 1,320 gallons above ground capacity applicability threshold once the pipe is brought above ground to change out the cable would need to be made. Regardless of applicability, it is recommended that a standard operating procedure governing safe handling of oil contained in the underground pipes during cable change-out should be developed and implemented to minimize the risk of an accidental spill.

3.3.5 Permitting and Environmental Review Conclusions

The double circuit 345 kV conversion project was reviewed with respect to potential regulatory issues. The above ground portion of the project was evaluated as this portion of the project was visible for regulatory interpretation via line tracing using Google Maps. Two segments were evaluated as follows:

The routes were reviewed specific to potential impacts to wetlands, potential FAA issues and the crossing of streams (stream encroachment). The results of the reviews are
presented in Attachment 8 for Wetlands, Attachment 9 for FAA and Attachment 10 for Stream Encroachment.

A preliminary review was performed for potential environmental and regulatory implications associated with the proposed upgrade of transmission lines. The review was based on a desktop assessment, using Google Maps, of wetlands, FAA limitations and stream encroachments along the portions of the right-of-way that are elevated. Further, an overview of other state and federal regulations that may apply in upgrading the subsurface transmission lines was performed. These regulations could include, but not be limited to, stormwater management/sediment control, spill prevention, noise limits and NJDEP air permitting.

At this point, nothing was found that could be considered a fatal flaw to the project. The review indicated:

- Wetlands may be impacted, however, for the transmission line upgrades, the increase in footprint to accommodate larger towers will likely be minimal. Use of the NJDEP General Permit for Above Ground Utility lines would expedite the approval process, although wetland issues will pose the greatest challenge in terms of project schedule owing to typical long-lead times in gaining approvals.

- The FAA may need to be notified specific to taller towers; however, many of the tower sites are in areas where taller structures, relative to the towers, abound. The existence of taller structures in the vicinity of the towers would lessen FAA concern.

- Stream encroachment permits may need to be filed to the NJDEP, again general permit are available. Since the project involves upgrades rather than new installations, footprints and stream encroachments have already been established with minimal impacts.

Spill planning may be necessary during execution of the replacement of the cable in underground piping as well as updating plans to accommodate additional oils at expanded substations.
4.0 Schedule Analysis and Assessment

Underground transmission line modifications to replace conductors in existing oil-filled pipe circuits will require outages of extended duration for each transmission line. For each line, dielectric fluid must be drained, conductors removed, piping and manholes inspected and modified if necessary, piping cleaned, new conductors pulled and spliced, and dielectric fluid filled. Testing and inspections during these processes will add time to each construction activity. The termination of each existing pipe circuit, above-ground in the substations at each end, will also need modification for the increased voltage.

Overall, Burns and Roe considers that the project can be completed in 48 months as long as the following critical issues are implemented:

- Careful planning and a strong project management group is assembled
- Procurement of engineered equipment must commence quickly
- Land acquisition and remediation where required must commence quickly
- Expansion at Bergen presents a schedule risk because the land to be acquired is separated from the existing station by wetlands. Creating a larger contiguous station by removal of the present east fence line along the existing 230kV area (to be coupled with the new area for the 345kV system) will require bridging of the wetlands, which could impact the schedule. Acquiring the expansion property at Bergen and associated wetlands remediation is required before construction activity can commence.
5.0 Cost Analysis and Assessment

5.1 345kV AIS Switching Stations

The PSE&G project concept includes construction of six (6) new 345kV AIS stations:
- Bergen
- North Avenue
- Linden
- PVSC
- Homestead
- North Bergen

PSE&G has provided preliminary cost estimates for these 345kV AIS stations. Initial PSE&G estimates include the AIS substation with associated transformer costs. At Burns and Roe’s request, PSE&G provided a separate tabulation of the transformer costs, to allow better comparison of the substation costs. The substation costs include dead tank circuit breakers, disconnect switches, buswork, structures, and control house (with protective relays, batteries and other controls).

Using the basis described above, Burns and Roe has prepared a conceptual cost estimate for each 345kV AIS substation, as shown on Table 1. In order to provide an overall cost estimate assessment, the PSE&G transformer costs were then added to the Burns and Roe conceptual substation costs, as shown on Table 1 (comparison of Column 3 to Column 9).

Examination of Table 1 yields the following comments:
- The PSE&G estimated costs of the 345kV AIS substations appear to be high, in comparison to the Burns and Roe estimate. For example, Bergen and Linden will each be a 12-breaker (4-bay, breaker and a half) AIS substation. The Burns and Roe cost estimate, including allowance for new control house and station

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In summary, the total estimated AIS costs provided by PSE&G are considered conceptual and conservative, and further assessment of PSE&G cost estimates should be performed when preliminary station designs are prepared. It is expected that overall costs of the 345kV AIS stations will decrease when more accurate estimates are prepared.

5.2 345kV GIS Switching Stations

The PSE&G project concept includes construction of four (4) new 345kV GIS stations:
- Bayonne
- Marion
- Newark Airport
- Bayway

PSE&G has provided preliminary cost estimates for these 345kV GIS stations. Initial PSE&G estimates included the GIS substation with associated transformer costs; at Burns and Roe request, PSE&G provided a separate tabulation of the transformer costs, to allow better comparison of the substation costs. The substation costs include GIS substation with circuit breakers, gas insulated disconnect and grounding switches, gas insulated buswork, gas insulated potential transformers, gas insulated current transformers, GIS
control cabinets, support structures, access platforms, with a building with overhead crane and an adjoining control house area (with protective relays, batteries and other controls).

In order to assess validity of the PSE&G cost estimates, Burns and Roe obtained budgetary pricing of a 9-breaker, 3-bay, 345kV GIS breaker-and-a-half substation from two suppliers. One supplier provided pricing that included installation of the GIS. The other supplier's price was for supply of the GIS only, and an allowance was added (by Burns and Roe) to account for GIS installation.

Using the basis described above, Burns and Roe has prepared a conceptual cost estimate for each 345kV GIS substation, as shown on Table 2. In order to provide an overall cost estimate assessment, the PSE&G transformer costs were then added to the Burns and Roe conceptual substation costs, as shown on Table 2 (comparison of Column 4 to Column 9).

Examination of Table 2 yields the following comments:
In summary, the total estimated GIS costs provided by PSE&G are considered conceptual and conservative, and further assessment of PSE&G cost estimates should be performed when preliminary station designs are prepared. It is expected that overall costs of the 345kV GIS stations will decrease when more accurate estimates are prepared.

5.3 Transmission Lines

Transmission line cost estimates provided by PSE&G are based on a global allocation per mile (described in Section 2.3). These costs are considered conservative and have not been evaluated in detail. However, these costs are considered valid based on PSE&G's ongoing projects. Further evaluation can be performed by Burns and Roe if required.

5.4 Overall Cost Analysis

Since the detailed planning and scheduling, as well as detailed cost estimates, have not yet been prepared, the risk and contingency amount should be considered adequate to cover the "known unknowns," such as extra costs for land acquisition and remediation, expediting of engineered equipment, overtime labor and additional materials to complete specified upgrades without schedule impact, and other factors that can be solved with additional funding.
6.0 Attachments

6.1 List of Attachments
7.0 Outside References

Burns and Roe has utilized the latest information provided by PJM, which includes the PSE&G responses to PJM questions, PSE&G Cost Estimates (Inside Plant and Outside Plant), PSE&G Powerpoint slides, and the PSE&G Existing and Proposed single line diagrams.