Dominion
High Voltage
MidAtlantic℠

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Public Version

Detailed Evaluation and Constructability Report

PJM RTEP 2014 Window 1 – Proposal 1
28 July 2014

Dominion®

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A. Executive Summary

A.1. Name and address of proposing entity

Dominion High Voltage MidAtlantic, Inc. (DHVM)

701 East Cary Street

Richmond, Virginia 23139

Dominion Contact

Ronnie Bailey

Ronnie.Bailey@dom.com

804-771-3155

A.2. General description of proposed project

This proposal submitted by Dominion High Voltage MidAtlantic, Inc. (DHVM), in response to the 2014 PJM RTEP Reliability Open Window 1, proposes to build the following greenfield transmission elements to resolve the reliability violations identified in section A.3 below, and requests Designated Entity status for these elements. The greenfield elements include:

1. A new 500/230kV substation at the intersection of the Sunbury-Susquehanna 500kV transmission line and Montour- Columbia-Frackville 230kV transmission line, interconnecting the two voltage levels.
    a. 500kV ring bus arrangement
    b. 500/230kV transformer
    c. 230kV ring bus arrangement

The proposed solution also includes upgrades that the incumbent Transmission Owner will perform. These upgrades include:

1. Upgrade the Montour-Columbia-Frackville 230kV transmission circuit such that the rating of that line is no less than 900 MVA for Rating B (see Section C.5); and
2. Tie the 500kV and 230kV transmission lines into the new 500/230kV transformation substation.

A.3. Reliability problem(s) proposed to resolve

The proposed solution provides a long-term solution to the violations reported in the RTEP Proposal Window 1 Results provided during the RFP process. Specifically, it addresses the following common mode outage of 'PL100484', which causes the following violations:

1. FG #797: "208040 MONT – 208034 MILT" 230kV overload of approximately 109%
2. FG #801: "208034 MILT – 208109 SUNB" 230kV overload of approximately 107.6%

The proposed solution mitigates these flowgate violations, as defined in the materials provided for the RFP process for this Open Window. It meets the reliability requirements in addition to a robust improvement to the overall reliability of the bulk electric system by providing a closer outlet to the 500kV EHV network for 1550 MW of generating capacity at Montour Generating Plant. The 500/230kV transformation at the proposed Greenfield substation offloads the lower voltage networks for both the N-0 and post-contingency operating conditions in this area, potentially deferring future reliability upgrades.

A.4. Total proposed project cost

Component	Estimated Cost
DHVM new 500/230kV substation	[redacted]
Transmission line work by DHVM	[redacted]
Incumbent transmission upgrades	[redacted]
TOTAL PROPOSAL COST	**$31.8 million**

A.5. Overall schedule duration

The expected schedule duration is 48 months from receipt of approval from PJM.

A.6. Designated Entity

A.6.a. Status/pre-qualification

DHVM received Pre-Qualification status from PJM on April 11, 2014 under PJM ID 13-03a indicating satisfaction of the pre-qualification requirements for Designated Entity status as defined in the PJM Amended and Restated Operating Agreement ("PJM OA") in Section 1.5.8(a). Consequently, DHVM is eligible as a Designated Entity to construct, own and operate facilities within PJM's footprint. The information as posted on PJM's website reflects the Company's current qualifications.

A.6.b. Statement of intent

For this proposal, DHVM seeks to be the designated entity to construct, own, operate, maintain and finance the proposed project.

B. Company Evaluation Information

B.1. Technical and engineering qualifications

DHVM's parent Dominion Resources, Inc. (Dominion) is one of the nation's largest producers and transporters of energy, with a portfolio of approximately 27,500 megawatts of generation, 11,000 miles of natural gas transmission, gathering and storage pipeline and 6,400 miles of electric transmission lines. Dominion operates one of the nation's largest natural gas storage systems with 947 billion cubic feet of storage capacity and serves retail energy customers in 15 states.

Dominion's existing electric transmission facilities are all within the PJM footprint. Dominion has an Electric Transmission staff of over 800 engineers, technicians, operators, and other construction and support personnel dedicated to develop, construct, maintain, and operate these facilities. Dominion has over 80 years' experience in developing, constructing, maintaining and operating transmission facilities, including the most recent nine years as a PJM member.

DHVM would be supported by Dominion, which includes a fully-staffed Substation Engineering team inclusive of Physical Design, System Protection Design, Communications support, Site Plan Development; and Transmission Line Engineering inclusive of overhead and underground design, Civil Engineering support and Geotechnical support. Dominion is fully-staffed for engineering support activities inclusive of siting/routing transmission lines, site development for substations as well as all real estate-related activities.

B.2. Experience

B.2.a. Types of facilities proposed

The types of facilities in this proposal are those that Dominion has an extensive experience developing, operating and maintaining on a daily bases. Dominion designs, maintains and operates a transmission system that has over 6400 miles of transmission lines. The line voltages that make up this 6400 miles include 500kV, 230kV, 138kV, 115kV and 69kV. Additionally, the Dominion system has several hundred transmission substations that include ones similar to the 500 – 230kV substation proposed. As of this proposal, Dominion in the PJM Southern zone has approximately 127 active baseline projects under construction. Some examples of PJM baseline projects currently under construction that are similar to this proposal include;

- B1503.2 Construct a new 230kV line from Brambleton to BECO substation
- B1698 Install a 500 – 230kV transformer at Brambleton substation
- B1696 Install a 230kV breaker and half scheme at Idylwood Substation
- B1905 Skiffes Creek which consists of the following
    - Surry to Skiffes Creek 500kV transmission line
    - Skiffes Creek 500-230kV switching station
    - New Skiffes Creek to Whealton 230kV transmission line

B.2.b. Standardized construction, maintenance, and operating practices

All work and design meets and adheres to the PJM Transmission and Substation Design Technical Requirements and PJM Manual 7 - PJM Protection standards.

Dominion has established a long record of constructing, owning and operating transmission assets. Dominion participates in many PJM committees and industry forums to maintain best practices in transmission operations and maintenance practices. Dominion also operates a 24-hour system operations center staffed with North American Electric Reliability Corporation (NERC) and PJM certified operators.

The Electric Transmission Department of Dominion has over 800 personnel dedicated to standardized construction, maintenance and operating practices. To accomplish this, Electric Transmission is organized in groups with specific responsibilities.

Transmission Construction

Transmission Construction is responsible for supporting the growth of transmission assets, maintaining the electric transmission lines, and the vegetation management of transmission rights of ways.

Transmission Construction is organized in these business groups:

- Electric Transmission & Substation Construction
- Electric Transmission Lines
- Electric Transmission Forestry

Field Operations

Transmission Field Operations is committed to safely and efficiently maintaining the Electric Transmission System, and insuring asset compliance, reliability, and performance. The department consists of the following groups: Electrical Equipment, System Protection, T&S Nuclear, and Operational Engineering Support.

Planning & Communications

Transmission Planning oversees the development of the company's long-range transmission expansion plan through the PJM Planning process to assure compliance with NERC Reliability Standards. Transmission Planning also performs stability studies of generation within the Dominion Virginia Power service territory, and participates on various regional and inter-regional planning study groups and committees. The Project Marketing Managers help communicate the technical content as project plans are shared with internal and external stakeholders.

Substations

The Substation group:

- Is responsible for the operation, maintenance, and installation of all substation electrical equipment in over 790 substations in Virginia, North Carolina, and West Virginia.
- Provides investigative and diagnostic tests to establish health assessment and operational integrity of the substation equipment.
- Administers strategic modernization plan which focuses on the replacement of aging infrastructure to improve operational reliability.
- Provides technical support to Dominion’s environmental regulatory review process and supports compliance with environmental programs.
- Develops work methods and procedures for the operation and maintenance of substations with emphasis on improved safety, training, and productivity; and maintains adequate spare major equipment and mobile units in order to limit extended outages due to equipment failure.

Transmission Reliability

The Transmission Reliability group:

- Performs highly technical functions in support of transmission and distribution operations and analysis.
- Is responsible for circuit calculations and protective relay settings, as well as fault analysis.
- Is responsible for reliability metrics and statistics, and recommendations to improve the reliability of the electric transmission and distribution systems.
- Serves as the primary liaison to key transmission customers such as large industrials and government agencies.

System Operations

The System Operations Center (SOC) is responsible for the safe and reliable operation of Dominion's electric transmission system or "grid" in Virginia and North Carolina for its vertically integrated utility operations. This grid includes approximately 6,300 miles of transmission lines and 245 substations that perform a power transformation for the transmission network of 500kV, 230kV, and 115kV facilities.

The staff in the SOC monitors each transmission facility around the clock and continuously assesses the potential impacts on system reliability that could result from an unplanned loss of any single facility. The SOC's system operators also authorize and direct all transmission switching in order to support construction and maintenance needs, or to facilitate system restoration in the safest manner possible. They work in close coordination with the system operators of PJM, the Regional Transmission Operator (RTO) of which Dominion has been a member since 2005.

The System Operations Engineering group performs a technical support role for the SOC as well as providing its back-office functions. This group is responsible for regulatory review and standards development, compliance monitoring and reporting, engineering support of the computer model of the transmission system, documentation of SOC procedures and references, training support, and miscellaneous projects. They also serve as the primary liaison to the operations support functions of PJM and other industry groups.

B.2.c. Working in the geographical region of the proposal

Working outside Dominion’s tradition transmission footprint is something this organization already does in support of other facilities. This is accomplished by a fully-staffed Substation Engineering team inclusive of Physical Design, System Protection Design, Communications support, Civil Engineering support, Site Plan Development; and Transmission Line Engineering inclusive of overhead and underground design, Civil Engineering support and Geotechnical support. Dominion is fully-staffed for engineering support activities inclusive of siting/routing transmission lines, site development for substations as well as all real estate-related activities.

This support would also rely on a various contractors to help facilitate this construction support of which Dominion has a long historical relationship. Below are examples of Transmission and Substation support that Dominion currently provides for Facilities in various states.

Location: Kewaunee Nuclear Power Station, Kewaunee Wisconsin

- Date of beginning support: 2004
- History: Operation performance was improved and significant improvements were made to the substation by both Dominion Technical Solutions and ATC.
- Contractor – L.E. Meyer, North American Substation Services

Location: Elwood Generation facility, Elwood, Illinois

- Date of beginning support: 2003
- History: Combined cycle facility designed by Dominion. The substation is supported by Dominion Technical Solutions for critical issues and problem resolution.
- Contractor when requested - North American Substation Services

Location: Fairless Energy Works, Philadelphia, PA.

- Date of beginning support: 2003
- History: Combined cycle facility designed by Dominion. Dominion Technical Solutions provides transmission line maintenance / response oversight using local contractor for generator leads to Emily Substation. Dominion Technical Solutions provides substation and transmission line engineering support as needed. Dominion Technical Solutions provides Electrical Equipment and System Protection maintenance oversight of annual maintenance activities including any capital improvements that may be required. Plant continues to be a top performing plant.
- Contractor – Henkels & McCoy (Generator leads), North American Substation Services (substation)

Location: Millstone Nuclear Power Station, Millstone, Conn.

- Date of beginning support: 2004
- History: Dominion Technical Solutions provide substation engineering and transmission line engineering support as required. Dominion Technical Solutions Electrical Equipment and System Protection personnel provide critical support during maintenance outages and provide emergent support as required to insure plant reliability. Dominion Technical Solutions coordinates with CL&P and Dominion Nuclear to insure specific modifications can be coordinated and managed successfully. Close coordination and technical resolutions are coordinated with New England ISO to insure high reliability. Plant substation modifications identified are being addressed proactively including replacement of all GSUs (complete), replacement of generator output leads to insure reliability during recurring weather conditions (completed) and coordinating on-going improvements – station service replacements, relay upgrades, isophase modeling and modifications, etc.
- Contractors – North American Substation Services, OEMs service groups – Siemens, Mitsubishi, McPhee for Transmission Line work

Additional information and sites references can be provided if requested.

B.2.d. Rights of way in geographical region of project

Burns & McDonnell has a team of best-in-class specialists that will successfully assist DHVM in routing and siting and environmental permitting projects in Pennsylvania. Burns & McDonnell has performed similar studies on a number of long 345kV, 500kV, and 765kV lines, most of which were highly contentious and in developed areas, specifically 5 projects in Pennsylvania including a new 500kV substation. Burns and McDonnell is one of the most experienced transmission line planning, siting, design, and construction firms in the United States and have successfully routed and permitted approximately 17,000 miles of transmission lines nationwide. Burns and McDonnell's capabilities include: planning and feasibility studies, full routing studies, environmental permitting and associated studies, in-house transmission design and civil engineering, right-of-way acquisition, and environmental monitoring during construction. This level of involvement in all facets of transmission line development gives Burns & McDonnell an unparalleled understanding of how transmission lines are sited, designed, and constructed providing society with the greatest infrastructure achievements while assuring the least impact on the community.

B.3. Financing plan

DHVM has received Pre-Qualification status from PJM under ID 13-03a and is eligible as a Designated Entity to construct, own and operate facilities within PJM's footprint. DHVM will rely upon Dominion for financial and credit support.

B.4. Cost containment and adherence to construction schedules

DHVM will assign a dedicated Project Manager (PM) who will be responsible from start to energizing of the Transmission Project. The Dominion Project Managers have a vast amount of experience implementing Projects to build or improve new substations and transmission lines. The PM will be responsible for leading a multi-disciplined team representing all groups involved to manage the project process which includes schedule and budget. The team will be responsible for acquiring all right of way, securing necessary permits, engineering and overall project management with supply chain and construction support provided within the project teams.

Since joining PJM on May 1, 2005, Dominion has completed approximately $3 billion of transmission construction projects with this process, including the following examples:

- Line #580 to Loudoun 500kV line (Part of 502 Junction-Loudoun) – Obtained right-of-way (ROW) and Certificate of Public Convenience and Necessity (CPCN) approval in Virginia and constructed line by the PJM target date of 6/01/2011;
- Carson to Suffolk 500kV line - Obtained ROW and CPCN in Virginia and constructed line by the PJM target date of 6/01/2011; and
- Mt Storm to Doubs 500kV rebuild project – Project is to wreck and rebuild Dominion's 96.4 miles portion of this line. Project is currently underway and is on track to be completed in advance of the PJM required target date.

B.5. Assumptions in developing proposal

The proposed solution also includes upgrades that the incumbent Transmission Owner will perform. These upgrades include:

- Upgrade the Montour-Columbia-Frackville 230kV transmission circuit such that the rating of that line is no less than 900 MVA for Rating B (see Section C.5); and
- Tie the 500kV and 230kV transmission lines into the new 500/230kV transformation substation.

Some assumptions around the incumbent performing these upgrades are identified in section C.5 of this report.

C. Proposed Project Constructability Information

C.1. Component scope

C.1.a. Greenfield transmission line element detail

The proposed solution does not include any greenfield transmission line elements.

C.1.b. Greenfield substation/ switchyard facility element detail

C.1.b.1. General description of the proposed location(s)

The proposed solution includes a greenfield 500/230kV substation that will be located in the vicinity of:

[redacted]

This substation will consist of:

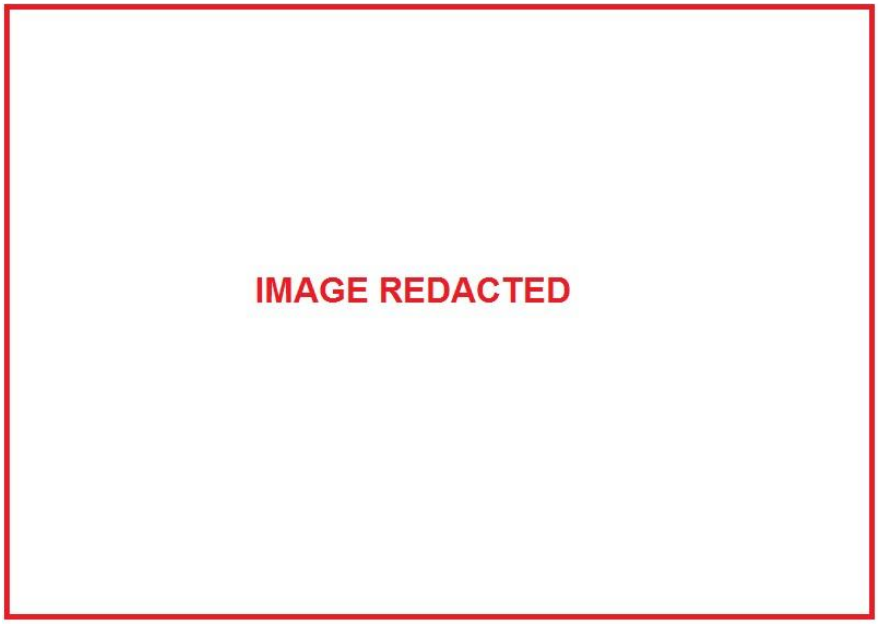
1. 500kV 3-breaker ring bus arranged in a breaker-and-a-half configuration to facilitate potential future expansion with minimal incremental cost;
2. 500/230kV transformer with the following approximate ratings:
   a. Rate A = 937 MVA
   b. Rate B = 967 MVA
   c. Rate C = 1036 MVA
3. Transformer high side breaker
4. 230kV 3-breaker ring bus

The Columbia County GIS database indicates that the site parcels are privately owned. The parcels are a mix of farmland and forest. The substation would be mainly sited in the forested portion of the eastern parcel. The combined parcels would total 250 acres and the portion to be developed with the substation is approximately 11 acres.

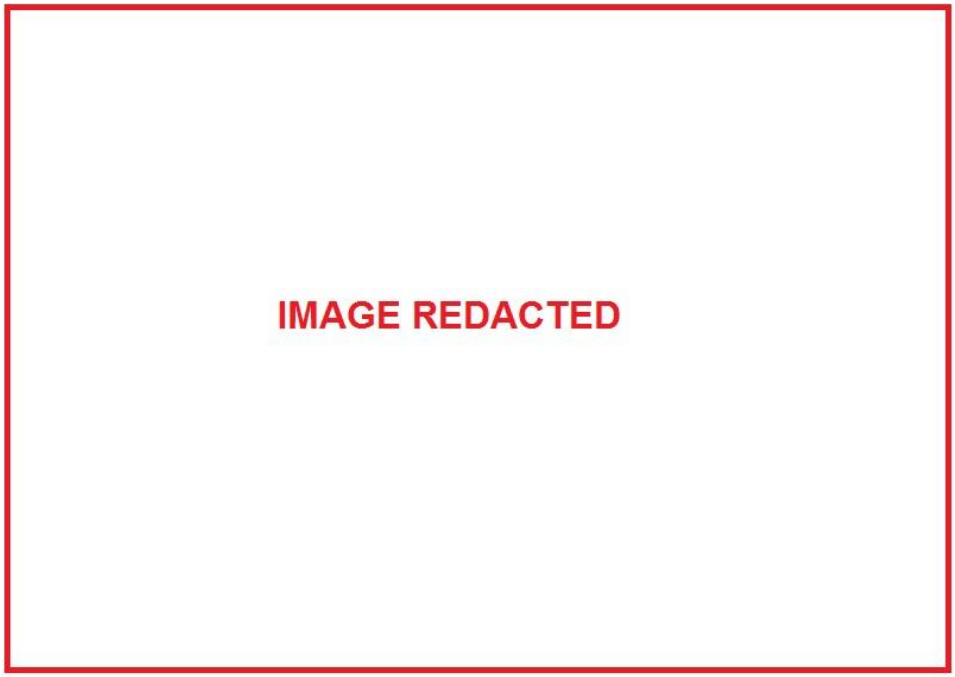
The land adjacent to the parcel is generally farmland and rural development.

The following screenshots show the land explored in the vicinity of the 500kV & 230kV crossings.

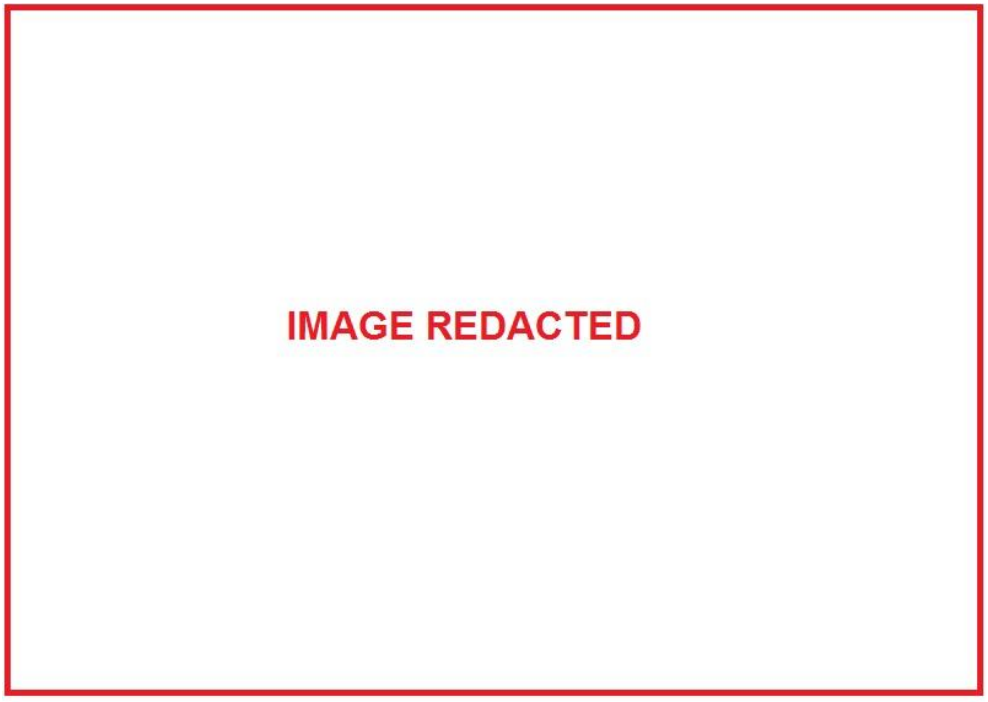
Parcel 1:



Parcel 2:



Parcel 3:



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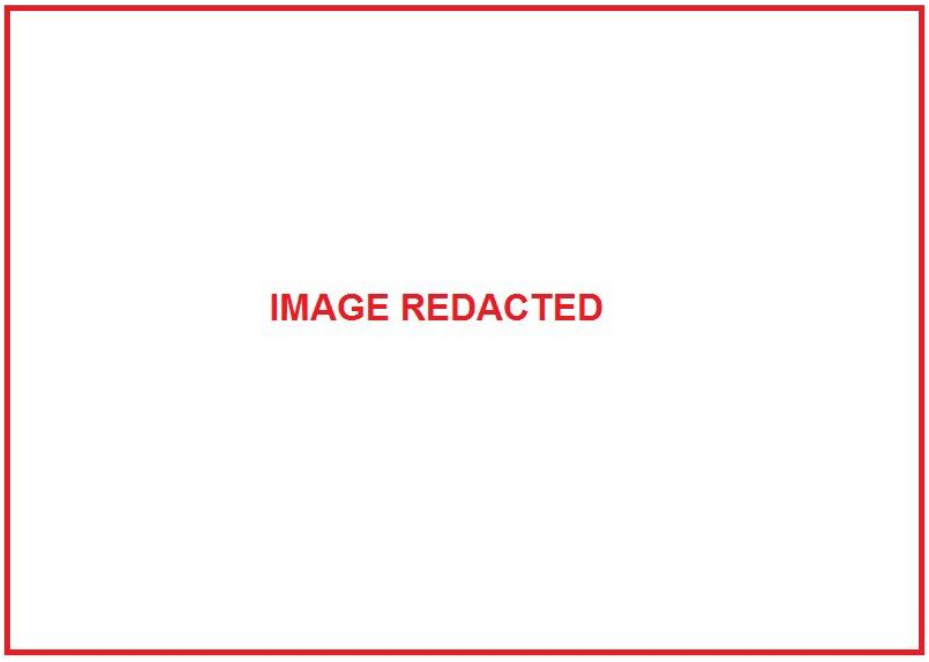

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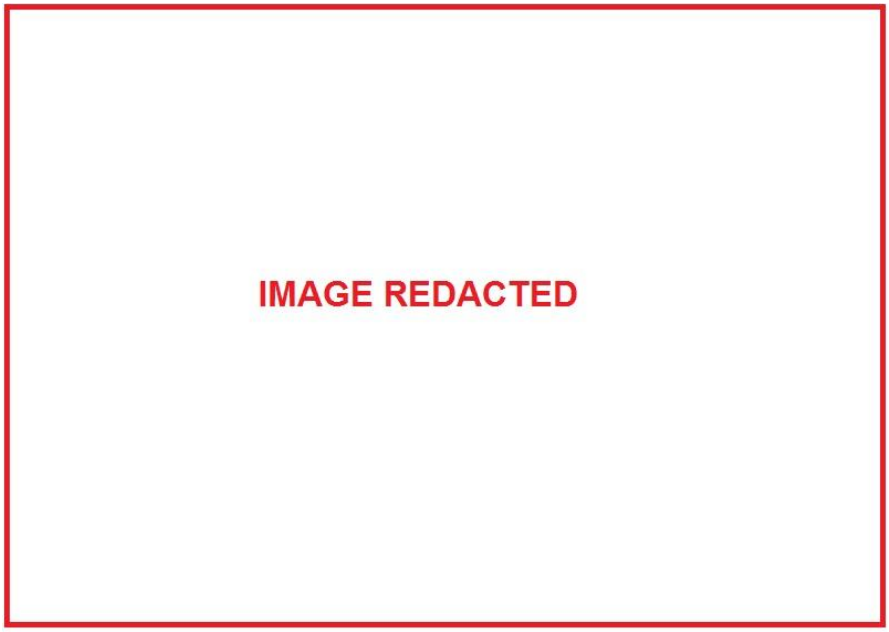
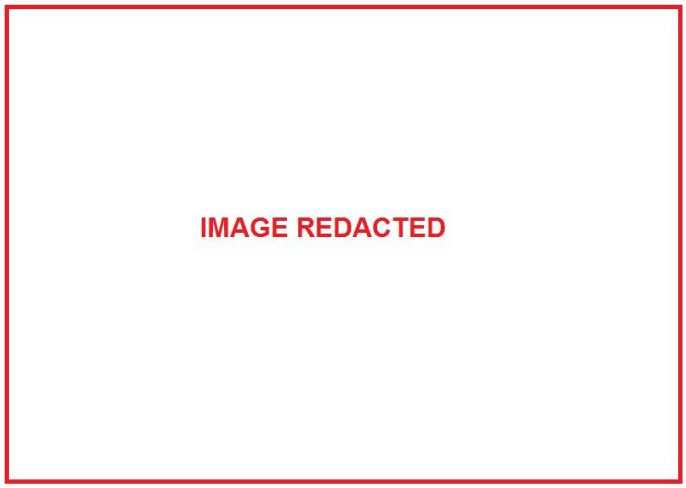


C.1.b.2. One-line diagram and general arrangement drawing

A high level one line diagram of the proposed substation is shown below:



A general arrangement drawing is provided as Attachment 1.

C.1.b.3. Electrical design

The transformer has the following specifications and ratings:

Parameter	Value
Winding 1 Turns Ratio (500kV)	1.025
Winding 2 Turns Ratio (230kV)	1.000
Series Resistance (R) [pu]	0.00016
Series Reactance (X) [pu]	0.01513
Series Susceptance (B) [pu]	0.000
Control Mode	None
Rate A [MVA]	937.7
Rate B [MVA]	967.2
Rate C [MVA]	1036.4

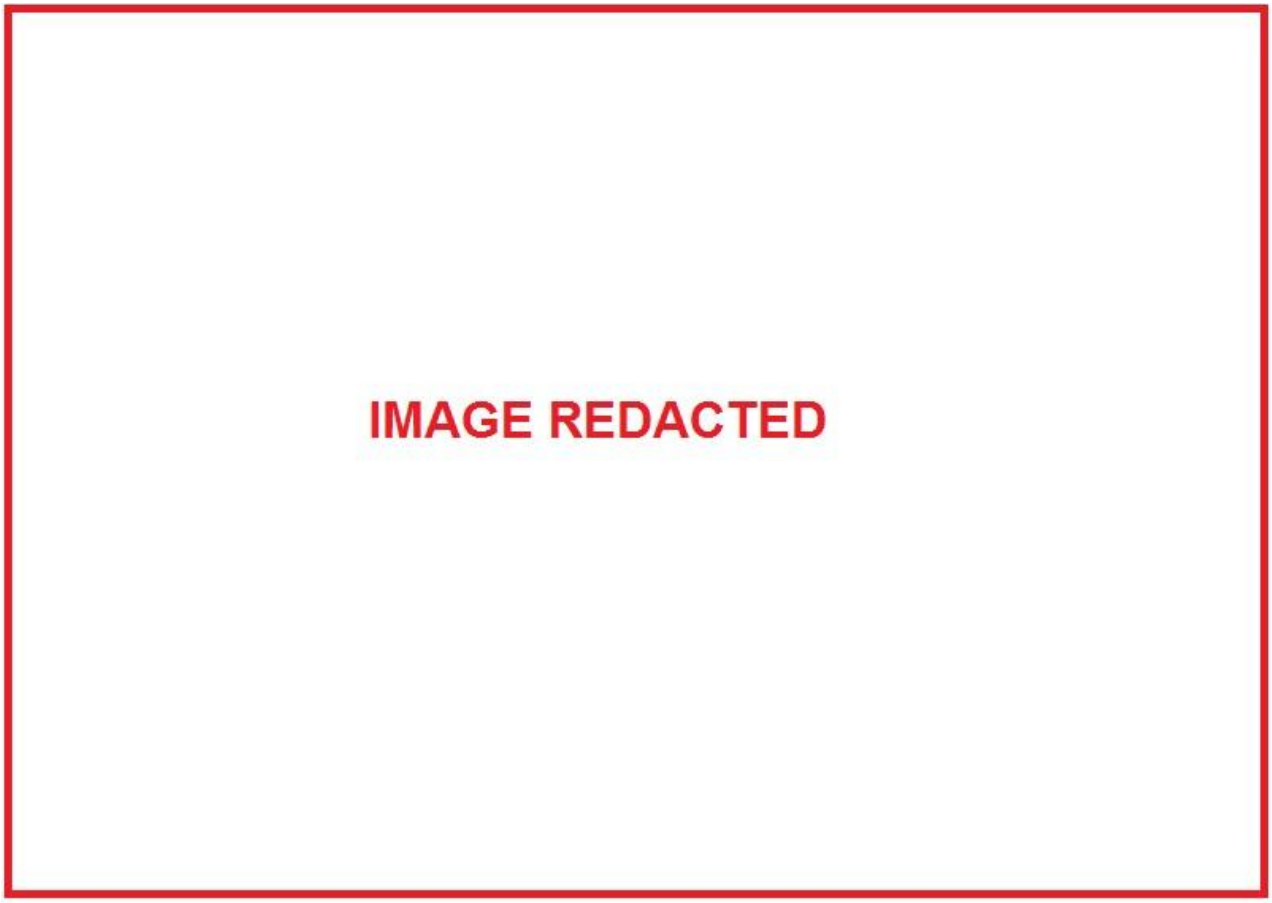
C.1.b.4. Relay communications plan

DHVM has made the following assumptions in regards to relaying communications with the remote incumbent substations:

1. There is compatible protective relaying on opposite ends of the affected transmission lines that work with SEL Relays.
2. Power Line Carrier communications is used at the opposite ends of the affected transmission lines using a frequency selected by the incumbent.

If the assumptions are incorrect, modifications can be made at either the DHVM new substations or the remote incumbent substations. The expected cost to perform this work is not expected to exceed $350,000.

C.1.b.5. Geographic map



C.1.c. Transmission facilities to be constructed by others

DHVM proposes that the incumbent Transmission Owner construct and/or upgrade the facilities identified below. A description of assumptions used is located in Section C.5.

C.1.c.1. Transmission line upgrades

Transmission line segment upgrades

The incumbent utility owning the 230kV transmission circuit from Montour-Columbia-Frackville will reconductor or upgrade the existing transmission line segments as described in the table below. The upgrades for the line segments shall achieve an overall line rating of no less than 900 MVA for Rate B.

Line Segment	Existing Rating [MVA]		Required Upgrade Rating [MVA]	
	Rate A	Rate B	Rate A	Rate B
Montour-Columbia 230kV	647.8	752.5	N/A	900
Columbia 230kV Station (COLU TR1-COLU TR2)	650.0	752.0	N/A	900
Columbia-Frackville 230kV	647.8	739.4	N/A	900

The full extent to these upgrades is not certain unless information such as line and tower design diagrams is provided to fully understand the limiting element in the circuit. However, preliminary analysis of the towers, described in Section C.5, shows the following lengths that could require upgrading.

Line Segment	Approximate Length of Upgrade [mi]
Montour-Columbia 230kV	1
Columbia 230kV Station (COLU TR1-COLU TR2)	< 0.2
Columbia-Frackville 230kV	0.8

Upgrading these line segments facilitates the addition of the transformer to carry sufficient capacity from the Montour 230kV substation to the new proposed 500/230kV transformation station for identified contingencies.

As described in Section C.5 regarding the segments, it appears that the majority of transmission line is constructed with sufficient structure and line strength to carry a higher rating. However, segments near the termination points of the line transition from bundled conductor to single conductor, and it is deduced that these segments are the limiting elements. Refer to Section C.5 for snapshots of these segments. It is expected that this work can be completed within the existing Right of Way of the transmission circuit, minimizing cost and maximizing constructability.

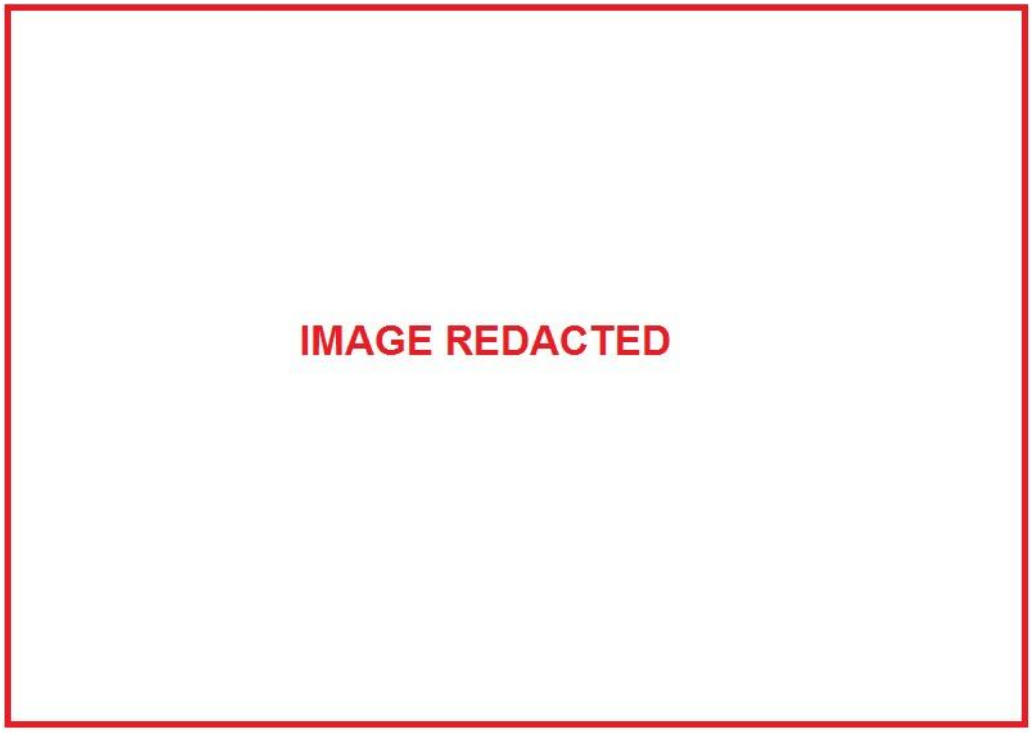
Substation interconnection upgrades

The new substation will interconnect the existing Montour-Columbia-Frackville 230kV transmission line and the Sunbury-Susquehanna 500kV transmission line at their intersection. These cut-ins will require the existing circuits to be tied into the new substation. It is expected that the incumbent will modify their existing transmission towers to drop these lines into the new substation. Refer to Attachment 1 for the general arrangement of the new substation.

Geographic map

The figure below shows a geographic map of the Montour-Columbia-Frackville 230kV line, with the Sunbury-Susquehanna 500kV line (orange) and major roads and highways (purple and yellow) also shown as reference.

The nature of these upgrades does not require any additional ROW to be acquired, new line crossings, or river crossings.



Relay communications & protection upgrades

DHVM has made the following assumptions in regards to relaying communications with the remote incumbent substations:

1. There is compatible protective relaying on opposite ends of the affected transmission lines that work with SEL Relays.
2. Power Line Carrier communications is used at the opposite ends of the affected transmission lines using a frequency selected by the incumbent.

If the assumptions are incorrect, modifications can be made at either the DHVM new substations or the remote incumbent substations. The expected cost to perform this work is not expected to exceed $350,000.

C.1.d. Environmental, permitting and land acquisition

C.1.d.1. Environmental impacts

The following environmental constraints were reviewed using GIS and other information available electronically:

- Wetlands: A review of the National Wetland Inventory did not indicate the presence of Wetlands on the proposed site.
- Endangered Species: Preliminary review of United States Fish and Wildlife Service database indicated two endangered species in the vicinity.
- Land clearing: Approximately 11 acres of forested area will be cleared for installation of the substation.
- Topography: The site is generally level according to United States Geological Survey topographical maps.
- Land disturbance will be required and soil and erosion controls will be put in place to prevent migrations of sediment off site. Stormwater management will be addressed.
- Conservation lands: The parcel is outside of all conservations lands and public use lands.
- National Register of Historic Places (NRHP): Several NRHP sites are located approximately 2 miles from the parcel.

C.1.d.2. Right of way and land acquisition

Installing the substation will require the purchase of privately-owned land. Dominion requires approximately 11 acres of land for a 500kV to 230kV switching station. The basic requirements for a substation site include adequate land for the facilities as well as landscaping, stormwater ponds, or buffer area around the site and road access to the site. The site should be reasonably level and have a viable route for the transmission lines to connect to the substation. The selection of a viable site for a substation requires the avoidance of the same environmental and cultural resources (e.g., wetlands, protected species habitat and cultural resource sites) or culturally sensitive areas that may require more stringent regulatory permitting requirements.

C.1.d.3. Permitting plan and approach

The project would qualify for review by the Pennsylvania Public Utility Commission (PaPUC). The following permits may be required.

- PA State Programmatic General Permit - 3 (SPGP-3)
- Section 404 Clean Water Act
- Endangered Species Act (ESA) - Federal Threatened & Endangered Species Consultation
- Federal Aviation Administration (FAA) Notification
- Section 401 WQC NPDES General Permit for Storm Water Discharges
- Floodplain Management Permit
- State Threatened and Endangered Species Consultation
- Section 106 - National Historic Preservation Act/ PHMC Compliance
- Other State Permits (i.e Road crossing permits, Blasting permits etc)
- Erosion and Sediment Control Permits
- Other Local Permits and Plans (i.e. zoning permit, Spill Prevention, Control and Countermeasure Plan)

The anticipated schedule for the siting, PaPUC process, and environmental permitting aspects of the project is shown on the Gantt chart included as Attachment 2.

C.1.d.4. Discussion of potential public opposition

The substation would be sited in a rural, farming area adjacent to the existing transmission right of way. The closest residence would be approximately [redacted] miles away. As part of the siting and permitting process, public meetings would be held to obtain feedback from key stakeholders.

C.1.d.5. [redacted]

C.2. Project Component Cost Estimates

The following tables summarize the estimated costs for each component. A Site Summary report with additional cost details is provided as Attachment 3.

C.2.a. Cost Estimate Table – New 500/230kV substation

Detail (required)	Estimated Cost
Engineering and design costs	[redacted]
Material and equipment costs	[redacted]
Construction and commissioning costs	[redacted]
Right of way and land procurement costs	[redacted]
Permitting costs	[redacted]
Construction management costs	[redacted]
Contingency	[redacted]
Other cost adders such as corporate overhead	[redacted]
TOTAL:	**$27,851,191**

C.2.b. Cost Estimate Table – Transmission line work by DHVM

Detail (required)	Estimated Cost
Engineering and design costs	[redacted]
Material and equipment costs	[redacted]
Construction and commissioning costs	[redacted]
Right of way and land procurement costs	[redacted]
Permitting costs	[redacted]
Construction management costs	[redacted]
Contingency	[redacted]
Other cost adders such as corporate overhead	[redacted]
TOTAL:	**$2,062,098**

C.2.c. Cost Estimate – Incumbent line upgrade and rearrangement

The estimated cost for the incumbent utility to perform the necessary line upgrade and cut in to the substation site is [redacted].

C.3. Schedule

C.3.a. Schedule – New 500/230kV Substation

See the Gantt chart included as Attachment 2 for the following schedule details:

- State and local siting approvals
- Site acquisition and/or Right of Way acquisition
- Engineering and design
- Long lead time equipment
- Construction activities
- Outage plan to support construction and energization
- Testing and commissioning

C.3.b. Schedule – Transmission line work by DHVM

The DHVM schedule for Transmission Line work is in conjunction with the DHVM substation construction.

C.3.c. Schedule – Incumbent line upgrade and rearrangement

Incumbent engineering and line work needs to support the 48-month construction schedule for the new 500/230kV substation.

C.4. On-going Transmission Facility Items

C.4.a. Operational Plan

Dominion's System Operations Center (SOC) and backup Emergency System Operations Center (ESOC) in the Richmond, Virginia area will monitor and operate the new facilities. The SOC and ESOC are currently certified to operate Dominion Virginia Power's transmission system in Virginia and North Carolina as a PJM Local Control Center (LCC). The primary SOC is staffed 24 x 7 with NERC and PJM certified system operators. The backup ESOC is staffed in the event of an emergency requiring an evacuation of the primary SOC site.

The SOC is equipped with a state-of-the-art Energy Management System (EMS) that includes SCADA and state estimation / security analysis application. The EMS currently exchanges operating data for the Dominion Virginia Power zone with PJM using both PJMnet and NERCnet. The ESOC is similarly equipped with redundant communications capabilities using physically diverse paths. The EMS computers perform SCADA functions as well as security analysis using a state estimator / contingency analysis application.

For the new facilities in this proposal, the EMS will be partitioned to provide dedicated displays for the area, and security analysis will be developed to analyze specific conditions for that area.

Specific experience operating facilities outside Dominion's transmission system

Dominion has the capability and expertise to manage and operate facilities remotely from the SOC (and ESOC). Dominion's SOC has operated a generation-only balancing area in Batesville, Mississippi from April 2001 until the generation facilities were sold on April 1, 2006. Under this arrangement, the Dominion EMS was partitioned so that the Batesville balancing area was monitored and managed from Dominion's System Operations Center in the Richmond, Virginia area. At the time, Dominion Virginia Power was a Reliability Coordinator (VACAR North), a Balancing Area, and a Transmission Operator for assets in Virginia and North Carolina, so in effect, the Dominion EMS was managing two separate balancing areas

Dominion also has experience in remotely managing generation to serve native load as with the Virginia City Hybrid Energy Center (VCHEC). VCHEC is a Dominion-owned generation facility that is interconnected with a third-party transmission owner. The output of this plant is used to serve Dominion Virginia Power load. Dominion's EMS is used to manage plant output that is delivered within the requirements of the interconnecting utility.

C.4.b. Maintenance Plan

Dominion has been supporting Transmission and Substation facilities through their Dominion Technical Solutions subsidiary since 2003. This same organization would support all maintenance activities for all facilities included in this proposal. Dominion's approach to off system support of these critical facilities has proven to provide reliable operational support, prompt problem identification and resolution and has improved operational performance of the facilities that have been purchased.

Dominion Technical Solutions Operations personnel have expertise in EMTP, RTDS, PSSE, PSCAD and Ansys plus other computer software to support resolution of complex problems. This organization is active in developing the use of sophisticated monitoring / modeling tools with PJM on synchrophasors that will be used at these facilities.

Dominion Technical Solutions model for technical, management and engineering support uses the following model.

Local Response: Proven T&S contractors in the area of the facility are placed under contract to provide 24/7/365 response for critical alarms. Dominion Technical Solutions organization is notified of alarms through an advanced suite of monitors that query critical parameters at the facility and text or page response personnel typically before Operating Center response is required. Additional Security monitors and video coverage provide site assessment on a continuous basis. Electrical Equipment personnel are trained in the specifics of the facility for equipment that is unique to provide quick knowledgeable response. System Protection personnel are trained and have access to critical controls and protection information to respond to the facility when dispatched. Fault Analysis personnel provide 24/7/365 response and Transmission Forestry, Transmission Lines Specialist, Substation Specialist, Substation Engineering, and Transmission Lines Engineering support are dispatched as required to support local contract personnel in the operation / response activities required. (Dominion has a dedicated aircraft fleet that assist in reducing response time if the situation warrants).

For specialized equipment such as Series Capacitor banks and SVCs, Electrical Equipment and System Protection personnel will be trained and located at Dominion's facilities in Northern Virginia and West Virginia to provide timely response as required. These individuals will be the technical interface with equipment OEMs who will be under contract as part of the equipment purchase to provide technical support and technical maintenance services as required. Dominion Technical Solutions Operation Engineering group will provide technical support as needed in addition to modeling the facility using our Real Time Digital Simulator to insure responses and actions are understood and quickly resolved. Spare parts of critical equipment will be stored on site in a separate secure storage structure that has security controlled access. This spare equipment was included in the estimated cost for this. In particular, critical equipment includes but is not limited to the following examples:

- Spare transformer bank
- Spare Breaker

Maintenance: All maintenance will be performed using Dominion's SAP tracking and associated compliance programs to insure that timely and specific facility inspections plus maintenance are performed as required. Dominion Technical Solutions personnel will provide oversight of local contract personnel and specialized equipment OEMs in this work while working closely with the local transmission provider and PJM. Detailed maintenance plans and compliance processes can be demonstrated as they emulate those currently used by Dominion Virginia Power.

Transmission Lines Operational Engineering Support

Dominion Transmission Lines Operations Engineers are available on an on-call basis for all maintenance and restoration evaluation and/or assistance requests. Experienced personnel interact with the line inspection and maintenance forces on issues involving line repair options and requirements, line design, structure loading, structure design, foundations, line materials, and customer inquiries. Additional expertise is available from Dominion Electric Transmission Line Design personnel, Structural Design personnel and/or Dominion Contractors as needed.

Dominion Engineers routinely participate in various information exchange forums to stay current on industry design standards and maintenance issues. Programs to improve the safety, performance and reliability of existing lines are designed and implemented using the latest in materials and technological advances.

In the event of a catastrophic failure, Dominion Transmission Lines Operations Engineers perform the initial assessment of what is the extent of the damage and what can be done to restore service in the most safe and expedient manner considering material availability.. Dominion Engineers and/or Dominion Contractors will prepare the construction specifications and Dominion Construction personnel will manage the outside construction contractors.

Dominion maintains an extensive inventory of emergency materials for standard and site specific transmission line repair and restoration. They are stored in a secured environment and available upon request.

Substation Equipment and Relaying Maintenance Program

Electric Transmission Field Operations (ETFO) utilizes time-based maintenance intervals for protective relay based schemes on its system. The intervals are designed to ensure system stability without sacrificing system protection or equipment reliability. Factors considered in determining the appropriate maintenance interval for microprocessor relays may include: criticality and/or voltage level of primary equipment being protected; operating experience with the specific type of relay; internal studies; recommendations from regional and industry relay committees, manufacturers, and regulatory or regional operating entities. Electric Transmission Field Operations also tries to accommodate operating and scheduling constraints imposed on protection system maintenance activities by both internal and external entities.

The ETFO System Protection Personnel perform the following pertinent roles:

- ETFO Relay Technicians install new assets and perform commissioning activities in order to ensure the integrity and proper functionality testing of new devices. Asset management questions are answered through Enoserv to aid in the documentation of asset and firmware upgrades, which are continuously monitored through an internal share point site.
- ETFO Compliance group handles the Asset management process through the Share Point site. This group reviews and processes asset modifications, to ensure maintenance plans and compliance periods are assigned accordingly in the SAP Plant Maintenance module. Share point routes the notifications from field to office personnel for asset integration, while Power Base is the storage location for all historical documents. This enhanced level of documentation is vital for our record keeping and provides a strong system of evidence for audit purposes and historical reference.
- ETFO Cyber group manages cyber security controls through complex password changes, shared account reviews and ports and services evaluations; helping to reduce potential threats to the reliability of our Bulk Electric System. The CIP laptops and relay technicians' computer software implementation and hardware support are serviced by this group. All cyber security incident reviews from Corporate Security are assessed, recovery plans for critical cyber assets and annual field reviews of communication devices for vulnerability assessments are documented using Team Track.
- ETFO Lab handles all new relay scheme testing, relay troubleshooting, evaluations of failed devices from the field, and the Critical Cyber Asset Reconditioning Process, documented in Team Track for reference. They develop the Enoserv RTS test plans based on the settings from circuit calculations and offer Enoserv support. Interruption reports are reviewed and investigated for any related misoperations and specialized testing is performed for future reference and enhancements.

The specific protection and relaying maintenance schedule is as follows:

Requirement	Description	Cycle
Bus Relay Maintenance	• Routine maintenance and tests of microprocessor protective relays associated with bus differential and bus overload relays, and other bus protection relays. Also includes bus protection scheme operational tests to verify that relay(s) trip the lockout and initiate a lockout alarm.	Not to exceed 6 years
Transformer Relay Maintenance	• Routine maintenance and tests of microprocessor protective relays associated with differential, overcurrent relays, and other transformer protection relays. Also includes transformer protection scheme operational tests which include operation of all protection and associated auxiliaries to ensure proper primary equipment operation. Also includes protection scheme operational tests to verify that relay(s) trip the lockout and initiate a lockout alarm.	Not to exceed 6 years
Power Line Carrier Relay Maintenance	• Power Line Carrier Relay Maintenance consists of routine maintenance and tests of carrier blocking and transfer trip equipment including channel frequency verification, receiver margin adjustment, trip output, transmitter/ receiver level calibrations and other associated checks. Also includes protection scheme operational tests to measure, observe, and verify reflected power, signal strength, check back functions, and the correct operation of the carrier blocking and transfer trip schemes.	Not to exceed 4 years

Additional maintenance to be completed by this support organization for other equipment within the substation is as follows:

Cycle Unit	MeasUnit	ItemDesc
1	YR	Battery Cell Corder Test Review
1	YR	Battery Test, Impedance
5	YR	Battery Performance Test
1	MON	Initial Battery Cell Corder Test Review
1	MON	Initial Battery Impedance Test
1	MON	Initial Battery Performance Test
2	YR	Compressor Maintenance
Varies	FLT	Duty Inspection
8	YR	Maintenance Inspection
8	YR	Performance Profile
8	YR	Maintain Circuit Switcher
12	MON	Environmental Assessment
3	MON	Major Substation Inspection
6	MON	Station Heat-Scan
8	YR	Station High Current Ground Test
1	YR	Get LTC Syringe for DGA-All Compartments
8	YR	Get Oil Sample-Furan Test(see long text)
1	YR	Get Transformer Oil Sample - DGA Test
4	YR	Spare Transformer Oil Sample-ScreenTest-AL
8	YR	Maintain & Calibrate TX Gauges
4	YR	Spare Transformer Maintenance & Testing
8	YR	Maintain 500kV NLTC, 1 Phase

C.5. Assumptions

The following section identifies all assumptions used in the electrical and constructability analyses performed for this proposed solution, as well as any uncertainties that could significantly impact cost or schedule.

C.5.a. Simulation assumptions

DHVM, in its analysis for this RTEP Open Window, has identified violations that are not identified by PJM. When developing solution options, these contingencies are considered but violations in the solution case are ensured to either improve or mitigate these violations. There are rare cases where the Gen Deliverability analysis produces different violations between the root case and the solution case which do not appear to be credible with regard to adding the solution. For example, contingencies 'CNSTN_C_PJM500', 'PJM8BG', and 'PEACH245' create violations in our TARA analysis that are not in the root case but show up in the solution case. These contingencies and their respective monitored elements are not electrically close to the solution and are not expected to be affected by the solution. DHVM has identified these issues to maintain transparency, but does not believe they are actual violations caused by the solution. Additional information can be provided upon request.

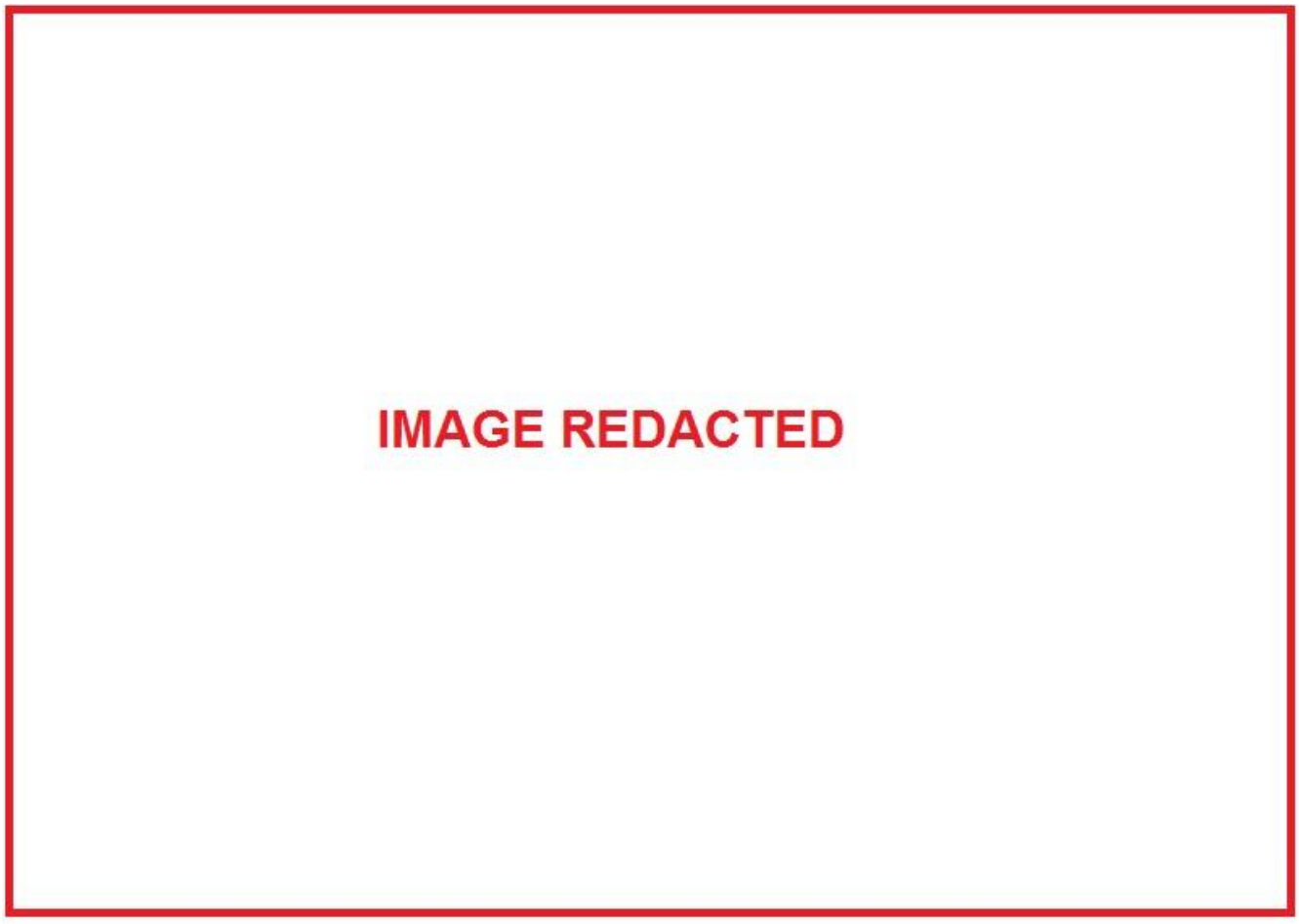
C.5.b. Incumbent transmission owner upgrades

It is assumed that the incumbent Transmission Owner for the Montour-Columbia-Frackville 230kV transmission circuit can and will upgrade their existing facilities to a Rating B greater than 900 MVA.

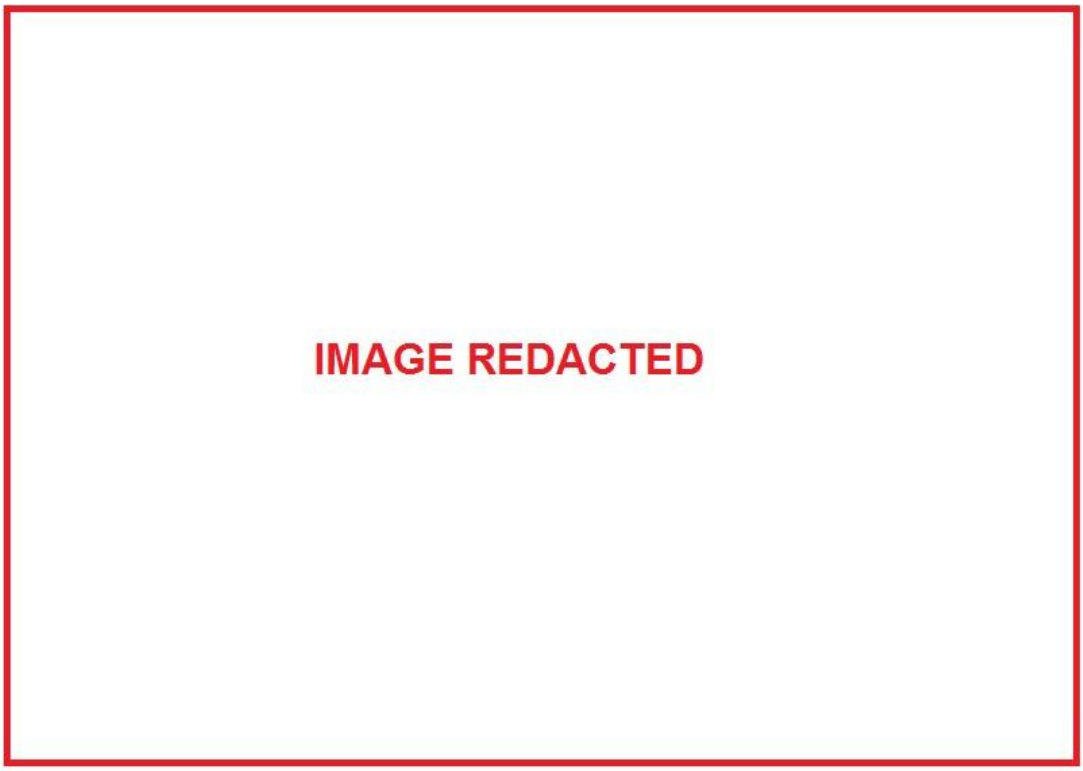
It is assumed that these upgrades are related to the transmission circuit itself, where the bundled conductor transitions to single conductor prior to entering the terminating stations at Montour 230kV, Columbia 230kV, and Frackville 230kV. The figures below show a visual representation of what is described.

Montour End:

The location of the structure where the line appears to transition from bundled conductor to single conductor is shown in the aerial view below.

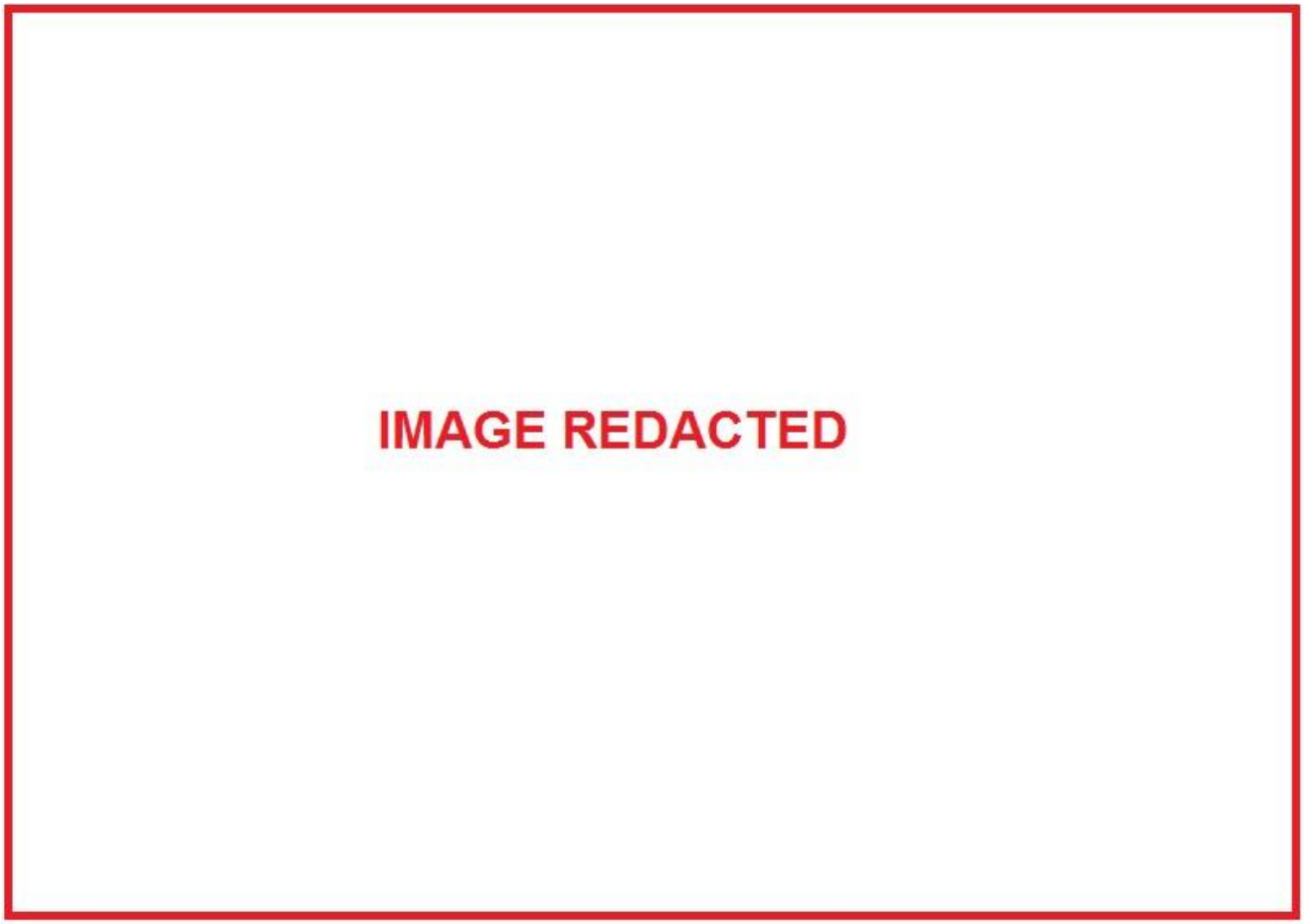


Zooming in on this tower structure shows the following – it is observed that the conductor bundling stops at this double deadend tower.



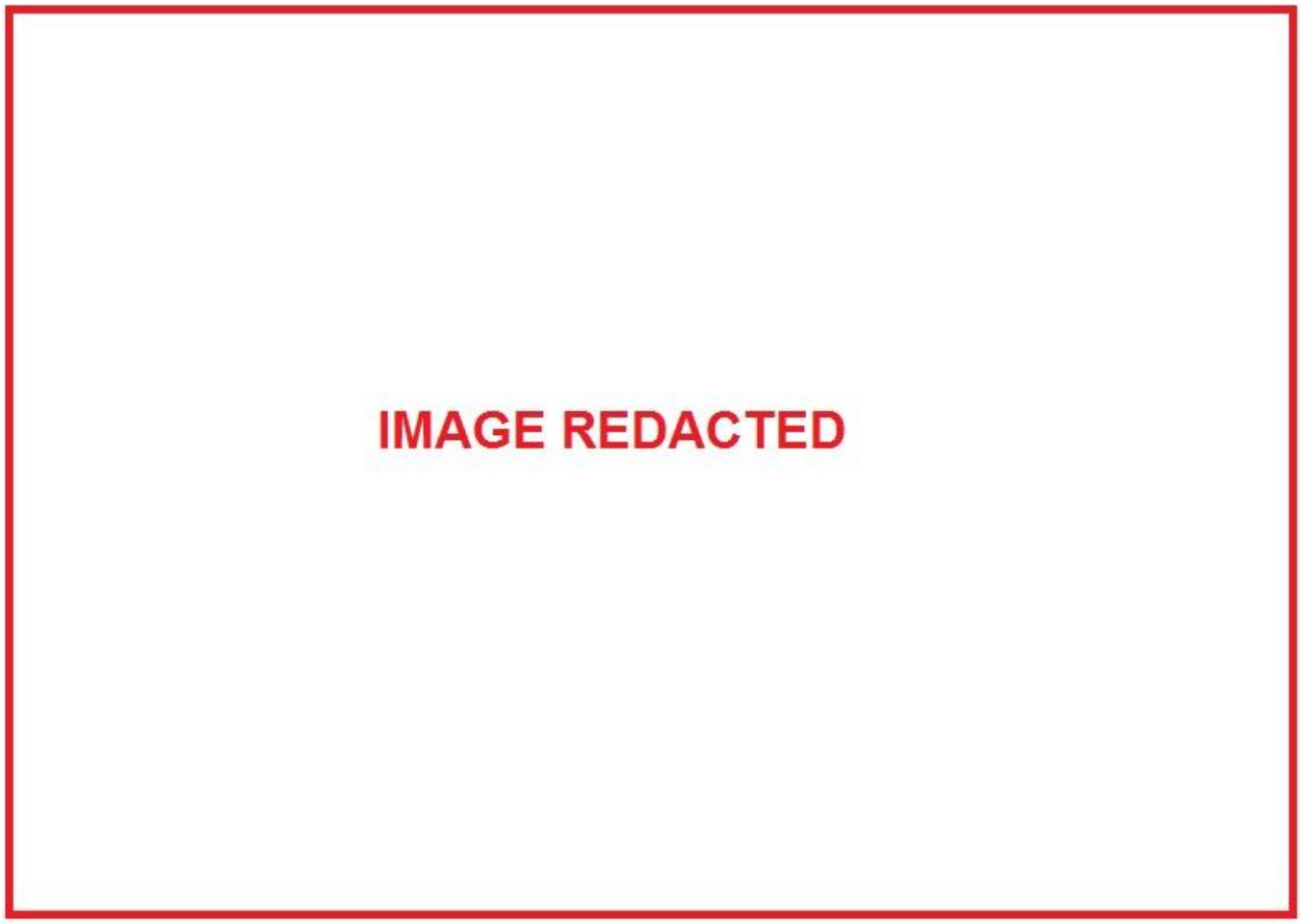
Columbia End:

At the Columbia 230kV station, the bundling stops at the tower structures prior to entering the station.

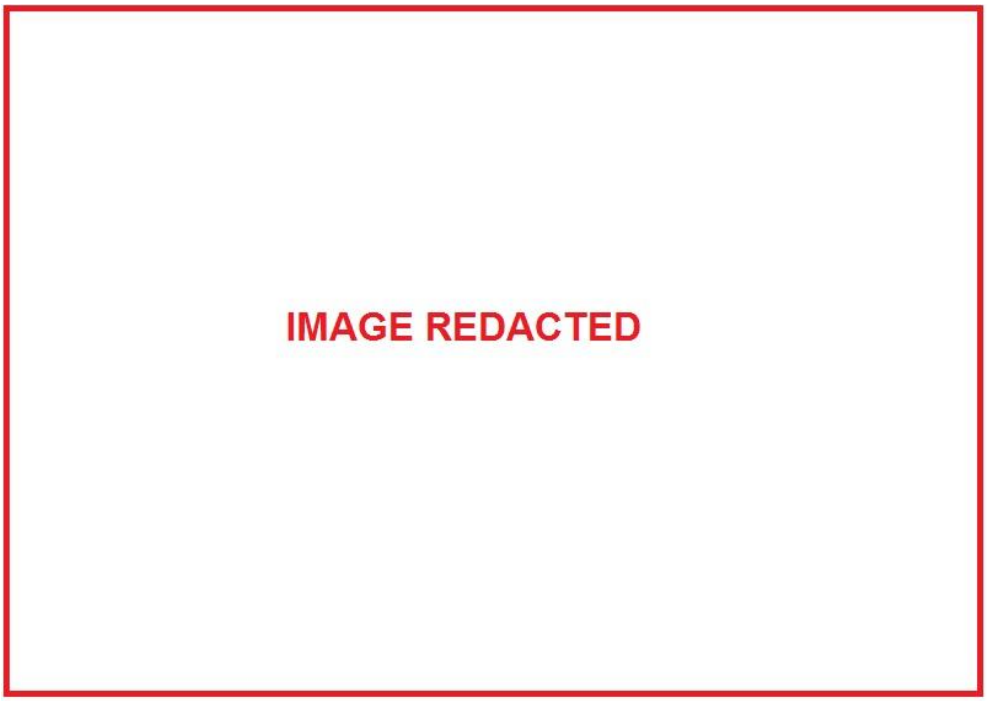


Frackville End:

The location of the structure where the line appears to transition from bundled conductor to single conductor is shown in the aerial view below.



Zooming in on this tower structure shows the following – it is observed that the conductor bundling stops at this double deadend structure.



C.5.c. Uncertainties Impacting Cost or Schedule

There are no significant uncertainties and/or qualifiers that could impact estimated costs and schedules for the DHVM Greenfield proposed solution elements.

The only significant uncertainty around the incumbent upgrades is whether the assumptions made regarding the limiting elements of the Montour-Columbia-Frackville 230kV circuit are correctly assumed in this section.

Attachments Redacted