# *Generation Interconnection Feasibility Study Report – Web Version*

***For***

# *PJM Generation Interconnection Request Queue Position AA2-161*

# *Yukon - Robbins 138 kV Project*

August 2015

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# Feasibility Study Report

# Yukon - Robbins 138 kV Project

## Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by FirstEnergy (FE) in response to a request made the Interconnection Customer (or IC) for the connection of a 541 MW Natural Gas Combined Cycle Generation (AA2-161) facility to the West Penn Power (WPP) System. The IC has proposed a commercial operation date of June 2020 for the proposed facility.

## Connection Facilities

In compliance with the RTEP protocol, Interconnection Customer has submitted a "Generation Interconnection Feasibility Study Agreement" to PJM (see Attachment 8) that identifies its plan to construct a combined cycle natural gas generation facility connected to a common bus with a total capability of 541 MW (513 MW capacity.) For purposes of this report, it has been designated as the "Yukon – Robbins 138 kV Project". The IC has requested the study of a single point of interconnection (POI) for the Project. The POI is the Yukon – Robbins and Springdale – Yukon 138 kV double circuit line.

Point of Interconnection: Yukon – Robbins/Springdale - Yukon 138 kV lines
The POI will be accomplished by looping in the Yukon – Robbins and Springdale – Yukon 138 kV lines into a six breaker 138 kV substation. Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct both the new 138 kV line and the associated attachment facilities. A summary of the direct connection facilities and cost estimates, and a one-line drawing for the POI are shown in Attachment 3 and Attachment 2 respectively.

## PJM Interconnection Study Results

The following is the report describing the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

## Network Impacts

The Queue Project AA2-161 was evaluated as a 541.0 MW (Capacity 513.0 MW) injection tapping the Yukon-Robbins 138kV and Wycoff-Springdale 138kV lines in the APS area. Project AA2-161 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-161 was studied with a commercial probability of 53%. Potential network impacts were as follows:

# Summer Peak Analysis - 2019

## Generator Deliverability

*(Single or N-1 contingencies for the Capacity portion only of the interconnection)*

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1. (AP - AP) The 01AL&D6T-01KITTAN 138 kV line (from bus 235139 to bus 235204 ckt 1) loads from 83.26% to 109.84% (**DC power flow**) of its emergency rating (151 MVA) for the single line contingency outage of 'AP_B2_531'. This project contributes approximately 40.14 MW to the thermal violation.

CONTINGENCY 'AP_B2_531' / KISKI VALLEY-SHAFFERS CORNER
OPEN BUS 235137
OPEN BUS 235131
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

2. (AP - AP) The 01AL&D6T-01KITTAN 138 kV line (from bus 235139 to bus 235204 ckt 1) loads from 73.97% to 101.65% (**DC power flow**) of its emergency rating (151 MVA) for the single line contingency outage of 'APS_B_G144'. This project contributes approximately 41.8 MW to the thermal violation.

CONTINGENCY 'APS_B_G144' / 235137 01AL 2J 138 235202 01KISKIV 138 1
OPEN BRANCH FROM BUS 235137 TO BUS 235202 CKT 1
END

3. (AP - AP) The 01YUKON-01SMTH62 138 kV line (from bus 235277 to bus 235252 ckt 1F) loads from 96.83% to 107.06% (**DC power flow**) of its emergency rating (332 MVA) for the single line contingency outage of 'APS_B_G693'. This project contributes approximately 33.96 MW to the thermal violation.

CONTINGENCY 'APS_B_G693' / 200011 KEYSTONE 500 235118 01SOBEND 500 1
OPEN BRANCH FROM BUS 200011 TO BUS 235118 CKT 1
END

**Multiple Facility Contingency**

*(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)*

1. (AP - AP) The AA2-161 TAP-01ROBBIN 138 kV line (from bus 920570 to bus 235238 ckt 1) loads from 12.86% to 101.36% (**DC power flow**) of its emergency rating (287 MVA) for the tower line contingency outage of 'AP_C5_113_B'. This project contributes approximately 254.0 MW to the thermal violation.

CONTINGENCY 'AP_C5_113_B' /YU-SP_YU-ROB
OPEN BRANCH FROM BUS 920570 TO BUS 235277 CKT 1 /AA2-161_TAP-YUKON 138KV
OPEN BUS 235275
OPEN BUS 235283
END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (AP - AP) The AA2-161 TAP-01YUKON 138 kV line (from bus 920570 to bus 235277 ckt 1) loads from 6.47% to 107.41% (**DC power flow**) of its emergency rating (287 MVA) for the tower line contingency outage of 'AP_C5_113_A'. This project contributes approximately 326.82 MW to the thermal violation.

CONTINGENCY 'AP_C5_113_A' /YU-SP_YU-ROB
OPEN BRANCH FROM BUS 235238 TO BUS 920570 CKT 1 /ROBBIN 138KV-AA2-161_TAP 138KV
OPEN BUS 235275
OPEN BUS 235283
END

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

3. (AP - AP) The AA2-161 TAP-01YUKON 138 kV line (from bus 920570 to bus 235277 ckt 1) loads from 10.86% to 103.02% (**DC power flow**) of its emergency rating (287 MVA) for the tower line contingency outage of 'AP_C5_100'. This project contributes approximately 326.82 MW to the thermal violation.

CONTINGENCY 'AP_C5_100' /YU-HN_YU-SP
OPEN BRANCH FROM BUS 235195 TO BUS 235238 CKT 1
OPEN BUS 235275
OPEN BUS 235283
END

**Contribution to Previously Identified Overloads**

*(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)*

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1. (AP - AP) The 01YUKON-01SMTH62 138 kV line (from bus 235277 to bus 235252 ckt 1F) loads from 107.97% to 113.97% (**DC power flow**) of its emergency rating (332 MVA) for the tower line contingency outage of 'AP_C5_80'. This project contributes approximately 44.19 MW to the thermal violation.

CONTINGENCY 'AP_C5_80' /CH-YU_WTR-YU
OPEN BRANCH FROM BUS 235161 TO BUS 235277 CKT 1
OPEN BRANCH FROM BUS 235270 TO BUS 235277 CKT 1
END

Please refer to Appendix 4 for a table containing the generators having contribution to this flowgate.

2. (AP - AP) The 01YUKON-01SMTH62 138 kV line (from bus 235277 to bus 235252 ckt 1F) loads from 106.52% to 112.52% (**DC power flow**) of its emergency rating (332 MVA) for the tower line contingency outage of 'AP_C5_78'. This project contributes approximately 44.19 MW to the thermal violation.

CONTINGENCY 'AP_C5_78' /CH-YU_CH-WTR
OPEN BRANCH FROM BUS 235161 TO BUS 235270 CKT 1
OPEN BRANCH FROM BUS 235161 TO BUS 235277 CKT 1
END

**Steady-State Voltage Requirements**

*(Results of the steady-state voltage studies should be inserted here)*

To be determined

**Short Circuit**

*(Summary of impacted circuit breakers)*

To be determined

## Affected System Analysis & Mitigation

**Delivery of Energy Portion of Interconnection Request**

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection

Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

## Light Load Analysis - 2019

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

## System Reinforcements

### Short Circuit

*(Summary form of Cost allocation for breakers will be inserted here if any)*

To be determined

### Stability and Reactive Power Requirement

*(Results of the dynamic studies should be inserted here)*

To be determined

## Summer Peak Load Flow Analysis Reinforcements

### New System Reinforcements

*(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)*

**Generator Deliverability**

1. (AP - AP) The 01AL&D6T-01KITTAN 138 kV line:
Reinforcement: Re-conductor the Allegheny Dam 6 Tap to Kittanning 138kV line, an approx. 6.1 mile section, with 795 kcmil 26/7 ACSR
Cost: $6,241,500
Time: 19 Months

2. (AP - AP) The 01AL&D6T-01KITTAN 138 kV line:
Same reinforcement as Generator Deliverability #1

3. (AP - AP) The 01YUKON-01SMTH62 138 kV line:

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Reinforcement 1: Re-conductor 2.6 mile Yukon to Smithton tap section of the Layton Jct. (Allen-Iron Bridge-Yukon) 138kV line with 795 kcmil ACSS conductor, replacing the existing 954 kcmil ACSR ($2,368,700)
Reinforcement 2: Replace line risers on Layton Jct line with double 954 ACSR ($21,000)
Cost: $2,659,700
Time: 14 Months

**Multiple Facility Contingency**

1. (AP - AP) The AA2-161 TAP-01ROBBIN 138 kV line:
Same reinforcement as Generator Deliverability #3

2. (AP - AP) The AA2-161 TAP-01ROBBIN 138 kV line:
Same reinforcement as Generator Deliverability #3

3. (AP - AP) The AA2-161 TAP-01YUKON 138 kV line:
Same reinforcement as Generator Deliverability #3

**Contribution to Previously Identified Overloads**
*(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)*

1. (AP - AP) The 01YUKON-01SMTH62 138 kV line:
Same reinforcement as Generator Deliverability #3

2. (AP - AP) The 01YUKON-01SMTH62 138 kV line:
Same reinforcement as Generator Deliverability #3

## Light Load Load Flow Analysis Reinforcements

**New System Reinforcements**
*(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)*

None

**Contribution to Previously Identified System Reinforcements**

*(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)*
*(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)*

Additional Interconnection Customer Responsibilities:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

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# PJM Report Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

## Appendix 1

(AP - AP) The 01AL&D6T-01KITTAN 138 kV line (from bus 235139 to bus 235204 ckt 1) loads from 83.26% to 109.84% (**DC power flow**) of its emergency rating (151 MVA) for the single line contingency outage of 'AP_B2_531'. This project contributes approximately 40.14 MW to the thermal violation.

CONTINGENCY 'AP_B2_531' / KISKI VALLEY-SHAFFERS CORNER
OPEN BUS 235137
OPEN BUS 235131
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *235134* | *01AL&D6* | *0.33* |
| *235580* | *01HATFD1* | *0.26* |
| *235581* | *01HATFD2* | *0.26* |
| *235582* | *01HATFD3* | *0.26* |
| *235610* | *01SPRGD1* | *0.61* |
| *235611* | *01SPRGD2* | *0.61* |
| *235612* | *01SPRGD3* | *2.32* |
| *235613* | *01SPRGD4* | *2.29* |
| *235614* | *01SPRGD5* | *2.41* |
| *914221* | *Y2-080* | *11.24* |
| *915951* | *Y3-092* | *29.39* |
| *916001* | *Z1-015* | *0.36* |
| *916321* | *Z1-088* | *0.26* |
| *916331* | *Z1-089* | *0.26* |
| *920571* | *AA2-161 C* | *40.14* |

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## Appendix 2

(AP - AP) The AA2-161 TAP-01ROBBIN 138 kV line (from bus 920570 to bus 235238 ckt 1) loads from 12.86% to 101.36% (**DC power flow**) of its emergency rating (287 MVA) for the tower line contingency outage of 'AP_C5_113_B'. This project contributes approximately 254.0 MW to the thermal violation.

CONTINGENCY 'AP_C5_113_B' /YU-SP_YU-ROB
OPEN BRANCH FROM BUS 920570 TO BUS 235277 CKT 1 /AA2-161_TAP-YUKON 138KV
OPEN BUS 235275
OPEN BUS 235283
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *920571* | *AA2-161 C* | *240.86* |
| *920572* | *AA2-161 E* | *13.15* |

## Appendix 3

(AP - AP) The AA2-161 TAP-01YUKON 138 kV line (from bus 920570 to bus 235277 ckt 1) loads from 6.47% to 107.41% (**DC power flow**) of its emergency rating (287 MVA) for the tower line contingency outage of 'AP_C5_113_A'. This project contributes approximately 326.82 MW to the thermal violation.

CONTINGENCY 'AP_C5_113_A' /YU-SP_YU-ROB
OPEN BRANCH FROM BUS 235238 TO BUS 920570 CKT 1 /ROBBIN 138KV-AA2-161_TAP 138KV
OPEN BUS 235275
OPEN BUS 235283
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *235610* | *01SPRGD1* | *0.57* |
| *235611* | *01SPRGD2* | *0.57* |
| *235612* | *01SPRGD3* | *2.17* |
| *235613* | *01SPRGD4* | *2.14* |
| *235614* | *01SPRGD5* | *2.26* |
| *916001* | *Z1-015* | *0.34* |
| *920571* | *AA2-161 C* | *309.91* |
| *920572* | *AA2-161 E* | *16.92* |

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# Appendix 4

(AP - AP) The 01YUKON-01SMTH62 138 kV line (from bus 235277 to bus 235252 ckt 1F) loads from 107.97% to 113.97% (**DC power flow**) of its emergency rating (332 MVA) for the tower line contingency outage of 'AP_C5_80'. This project contributes approximately 44.19 MW to the thermal violation.

CONTINGENCY 'AP_C5_80' /CH-YU_WTR-YU
OPEN BRANCH FROM BUS 235161 TO BUS 235277 CKT 1
OPEN BRANCH FROM BUS 235270 TO BUS 235277 CKT 1
END

| *Bus Number* | *Bus Name* | *Full Contribution* |
|---|---|---|
| *236578* | *01GRABLE* | *-0.59* |
| *914221* | *Y2-080* | *56.67* |
| *915731* | *Y3-109* | *-2.24* |
| *920571* | *AA2-161 C* | *41.91* |
| *920572* | *AA2-161 E* | *2.29* |

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## Transmission Owner's Analysis

The following is the report generated by the Transmission Owner (TO) based upon its analysis of the project's impacts on the lower voltage system and the costs and schedules for any transmission and distribution system upgrades.

## Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the IC's proposed project on the WPP transmission system. This included the performance of a contingency analysis to identify any FE Planning Criteria violations. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report with a least cost plan identified to mitigate them.

The power flow analysis was performed using a 2019 summer peak load base case provided by the PJM staff. This base case included a detailed representation of the WPP system. A simulation of all single and common mode contingencies within the NERC and FE Planning Standards that are impacted by the IC's proposed project was conducted to test for criteria compliance.

FE Planning Criteria violations identified are included in Attachment 4. Network upgrades necessary to mitigate the identified criteria violations, including cost estimates, are included in Attachment 5.

## Short Circuit and Dynamics Analysis

A short circuit analysis has been performed by PJM and the findings were confirmed by FE. No new breakers exceed their interrupting rating.

## System Protection Analysis

A system protection analysis will be performed during the System Impact Study.

## Metering

Interconnection Customer will be required to comply with all FE revenue metering requirements for generation interconnection customers. These FE requirements are detailed at the link on Attachment 7 of this report.

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**Compliance Issues**

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE "Requirements for Transmission Connected Facilities" document[1]. While voltage analysis is not performed for the feasibility study, any voltage criteria violations that would require the plant to provide reactive power will be determined in the system impact study.

Interconnection Customer must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required for standards compliance. For example, the IC will need to properly locate and report the over and under-voltage and over and under-frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the WPP system.

**FE Facility Upgrades and Costs**

Results from the power flow analysis (Attachment 4) show that there are FE Planning Criteria violations directly attributable to the capacity of the Project. Therefore in accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, Interconnection Customer is responsible for network upgrades (see Attachments 5 and 6).

The Project contributes and/or causes overloads (line loading exceeding 100% of applicable rating) of the following facilities:

- Yukon - Smithton 138 kV line
- Kittanning – All Dam 6 Tap 138 kV line
- Yukon – AA2-161 Tap 138 kV line

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to revision. More accurate estimates will be determined as a part of the System Impact Study. Interconnection Customer will be responsible for the actual cost of the direct connection that is implemented. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission system.

[1] https://www.firstenergycorp.com/content/dam/feconnect/files/Requirements-for-Transmission-Connected-Facilities.pdf

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**Interconnection Customer Requirements**

In addition to the WPP facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FE "Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of a fully rated circuit breaker on the high side of the AA2-161 step-up transformer.

2. The purchase and installation of a lockable load-break switch at the point of interconnection. This switch must be accessible by FirstEnergy.

3. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

4. The purchase and installation of a 138 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

5. The purchase and installation of a revenue class meter for each unit to measure the power delivered in compliance with the FE standards.

6. The purchase and installation of supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FE Transmission System Control Center. The RTU, the communications channel and all related equipment will be furnished and maintained by Interconnection Customer. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

7. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.

8. A compliance with the FE and PJM generator power factor and voltage control requirements.

9. The execution of a back-up service agreement to serve the customer load supplied from the AA2-161 138 kV interconnection substation when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

The above requirements are in addition to any metering required by PJM.

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**Summary**

The IC's proposed project direct connection will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the direct connection facilities is $11,193,700. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $2,556,900. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. The Project does require network upgrades as defined in Attachment 5. As shown, the total estimated cost for the required network upgrades is $11,536,100. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $2,634,900. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Based on the scope of the direct connection, it is expected to take a minimum of 21 months from the signing of a fully executed Interconnection Construction Service Agreement to complete the installation required for the Project. This includes a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the AA2-161 138 kV interconnection substation. It also assumes that the Interconnection Customer will provide the property for the AA2-161 138 kV interconnection substation and all right-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested.

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# Attachment 1
## Project Location

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# Attachment 2
# Direct Connection Facilities

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# Attachment 3
## Direct Connection Requirements

| Number of Months to Complete --- 21 Months. | | | |
|---|---|---|---|
| **Description** | **Total with Tax** | **Tax** | **Total Cost** |
| Buena Vista SS. Construct 6-breaker ring bus substation. See notes tab for details. | 9,209,300 | 2,103,800 | 7,105,500 |
| Huntingdon-Yukon 138kV, Loop to Proposed 6-Breaker Ring Bus. Install a loop to the proposed 6-breaker ring bus. Coordinate with estimate WP-T-76. | 537,500 | 122,100 | 415,400 |
| Springdale-Yukon 138kV, Loop to Proposed 6-Breaker Ring Bus. Install a loop to the proposed 6-breaker ring bus. Coordinate with estimate WP-T-75. | 462,600 | 105,100 | 357,500 |
| **DC Sub-Total.** | **10,209,400** | **2,331,000** | **7,878,400** |
| Yukon SS. Install new relay panels and carrier equipment on the Huntingdon and Springdale 138kV lines AA2-161 Interconnection Project. | 467,300 | 107,300 | 360,000 |
| Springdale SS. Install new relay panels and carrier equipment on the Yukon 138kV line for the AA2-161 Interconnection Project. | 258,500 | 59,300 | 199,200 |
| Huntingdon SS. Install new relay panels and carrier equipment on the Yukon 138kV line for the AA2-161 interconnection project. | 258,500 | 59,300 | 199,200 |
| **NDC Sub-Total.** | **984,300** | **225,900** | **758,400** |
| **Totals** | **11,193,700** | **2,556,900** | **8,636,800** |

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# Attachment 4
# Contingency Analysis Results

| Overloaded Element | Contingency Description | Rating (MVA) | % Loading | Network Upgrades |
|---|---|---|---|---|
| AA2-161 Tap – Yukon 138 kV Line | Common Structure Yukon – Robbins/Yukon – Springdale 138 kV Lines | 287 | 107 | See Attachment 5 (Thermal) |
| AA2-161 Tap – Yukon 138 kV Line | Common Structure Yukon – Huntingdon/Yukon – Springdale 138 kV Lines | 287 | 103 | See Attachment 5 (Thermal) |
| Yukon – Smithton 138 kV Line | Common Structure Yukon – Charleroi/Yukon – Wycoff 138 kV Lines | 376 | 114 | See Attachment 5 (Thermal) |
| AA2-161 Tap – Robbins 138 kV Line | Common Structure Yukon – Robbins/Yukon – Springdale 138 kV Lines | 287 | 101 | Relay Thermal Violation Mitigated by Direct Connection |
| All Dam 6 Tap – Kittanning 138 kV Lines | Loss of Kiski Valley – Shaffers Corner 138 kV Line | 151 | 110 | See Attachment 5 (Thermal) |

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# Attachment 5
## Network Upgrade Conceptual Cost Estimates

Number of Months to Complete --- 14 Months.

| Description | Total with Tax | Tax | Total Cost |
|---|---|---|---|
| **Layton Jct. (Allenport-Iron Bridge-Yukon) 138kV, Reconductor Yukon-Smithton Section (2.6 Miles)** - Reconductor the 2.6 mile Yukon to Smithton tap section of the Layton Jct. (Allenport-Iron Bridge-Yukon) 138kV line with 795 kcmil ACSS conductor, replacing the existing 954 kcmil ACSR. | 3,419,800 | 781,100 | 2,638,700 |
| **Yukon SS** - Replace line risers on the Layton Jct 138kV line with double 954 ACSR. | 27,300 | 6,300 | 21,000 |
| **Totals** | **3,447,100** | **787,400** | **2,659,700** |

Number of Months to Complete --- 19 Months.

| Description | Total with Tax | Tax | Total Cost |
|---|---|---|---|
| **All Dam 6 Tap-Kittanning 138kV, Reconductor 6.4 Mile w/ 795 kcmil ACSR Conductor.** Reconductor the Allegheny Dam 6 Tap to Kittanning 138kV line, an approx. 6.1 mile section, with 795 kcmil 26/7 ACSR. | 8,089,000 | 1,847,500 | 6,241,500 |
| **Totals** | **8,089,000** | **1,847,500** | **6,241,500** |

# Attachment 6

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# Network Upgrade Concept One Line Diagrams

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