PJM Generator Interconnection

W1-074 Ladysmith 230 kV

498 MW Capacity / 610 MW Energy

Feasibility Study Report

July 2010
DMS #604517v1

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Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue W1-074 is an IC 498 MW Capacity and 610 MW energy interconnection request consisting of two additional CT units at Remington station. The primary point of interconnection was the Remington CT 230kV bus, while the secondary point of interconnection was a tap point along the Loudoun – Meadowbrook 500kV line. Project W1-074 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

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Option 1: Remington CT 230 kV

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

1. The 6REMNGCT-6ELK RUN 230 kV line (from bus 314085 to bus 314110 ckt 1) loads from 72% to 122.31% (DC power flow) of its emergency rating (1045 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 525.72 MW to cause the thermal violation.

2. The 6ELK RUN-6GAINSVL 230 kV line (from bus 314110 to bus 314037 ckt 1) loads from 94% to 160.05% (DC power flow) of its emergency rating (796 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 525.72 MW to cause the thermal violation.

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)

3. The H.RDGE16-HOWARD32 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 111.22% to 111.69% (DC power flow) of its emergency rating (728 MVA) for the tower line contingency ('WCHPL_BRNDN'). This project contributes approximately 32.14 MW to cause the thermal violation.

4. The 6COHMIL-6PL VIEW 230 kV line (from bus 314170 to bus 314072 ckt 2) loads from 130.8% to 133.99% (DC power flow) of its emergency rating (470 MVA) for the single line contingency ('LN 558_W1-061B'). This project contributes approximately 35.92 MW to cause the thermal violation.

5. The 6BRAMBL-6COHMIL 230 kV line (from bus 314171 to bus 314170 ckt 2) loads from 133.81% to 137.01% (DC power flow) of its emergency rating (470 MVA) for the single line contingency ('LN 558_W1-061B'). This project

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contributes approximately 35.92 MW to cause the thermal violation.

Short Circuit

Option 1: Newly over-duty breakers

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w1-074 opt1	Duty Percent Without w1-074 opt1	Duty Percent Difference	Note
890	REMINGTON CT 230.kV	2077T2086	S	116.40%	99.80%	16.60%	New Over-duty
890	REMINGTON CT 230.kV	208662	S	116.40%	99.80%	16.60%	New Over-duty
890	REMINGTON CT 230.kV	H962	S	116.20%	99.60%	16.60%	New Over-duty
890	REMINGTON CT 230.kV	H9T299	S	116.20%	99.60%	16.60%	New Over-duty
80	REMINGTON 230.kV	280T2077	S	113.60%	94.60%	19.00%	New Over-duty
891	REMINGTON S1 230.kV	SX1262	S	113.20%	96.20%	17.00%	New Over-duty
892	REMINGTON S2 230.kV	SX3462	S	111.20%	96.20%	15.00%	New Over-duty
891	REMINGTON S1 230.kV	GT162	S	109.80%	93.00%	16.80%	New Over-duty
891	REMINGTON S1 230.kV	GT262	S	109.80%	93.00%	16.80%	New Over-duty
890	REMINGTON CT 230.kV	29962	S	109.70%	93.40%	16.30%	New Over-duty
890	REMINGTON CT 230.kV	207762	S	108.20%	93.40%	14.80%	New Over-duty
892	REMINGTON S2 230.kV	GT362	S	107.90%	93.00%	14.90%	New Over-duty
892	REMINGTON S2 230.kV	GT462	S	107.90%	93.00%	14.90%	New Over-duty
314061	LOUDOUN 230.kV	L252	S	100.50%	99.90%	0.60%	New Over-duty
3071	MARSH RUN 230.kV	29902	S	100.30%	90.90%	9.40%	New Over-duty
3071	MARSH RUN 230.kV	299T2040	S	100.30%	90.90%	9.40%	New Over-duty

Option 1 Existing over-duty breakers

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w1-074 opt1	Duty Percent Without w1-074 opt1	Duty Percent Difference	Note
314063	MORRISVILLE 230.kV	L1T2039	S	106.50%	101.30%	5.20%	Over 100%, > 3% contribution
314063	MORRISVILLE 230.kV	L1T2040	S	106.50%	101.30%	5.20%	Over 100%, > 3% contribution
314063	MORRISVILLE 230.kV	L2T2039	S	106.50%	101.30%	5.20%	Over 100%, > 3% contribution
314063	MORRISVILLE 230.kV	L2T2040	S	106.50%	101.30%	5.20%	Over 100%, > 3% contribution

System Stability Analysis

Dynamic studies are part of the System Impact Study.

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Option 2: Loudoun – Meadowbrook 500kV line

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No problems identified.

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. The H.RDGE16-HOWARD32 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 111.25% to 111.70% (DC power flow) of its emergency rating (728 MVA) for the tower line contingency ('WCHPL_BRNDN'). This project contributes approximately 30.67 MW to cause the thermal violation.

2. The 6COHMIL-6PL VIEW 230 kV line (from bus 314170 to bus 314072 ckt 2) loads from 130.78% to 133.71% (DC power flow) of its emergency rating (470 MVA) for the single line contingency ('LN 558_W1-061B'). This project contributes approximately 34.42 MW to cause the thermal violation.

3. The 6BRAMBL-6COHMIL 230 kV line (from bus 314171 to bus 314170 ckt 2) loads from 133.80% to 136.73% (DC power flow) of its emergency rating (470 MVA) for the single line contingency ('LN 558_W1-061B'). This project contributes approximately 34.42 MW to cause the thermal violation.

Short Circuit

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w1-074 opt2	Duty Percent Without w1-074 opt2	Duty Percent Difference	Note
314061	LOUDOUN 230.kV	L252	S	100.70%	99.90%	0.80%	New Over-duty
0	CLIFTON 230.kV	201182	S	100.10%	99.40%	0.70%	New Over-duty
0	CLIFTON 230.kV	265T266	S	100.10%	99.40%	0.70%	New Over-duty
0	CLIFTON 230.kV	26682	S	100.10%	99.40%	0.70%	New Over-duty

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BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w1-074 opt2	Duty Percent Without w1-074 opt2	Duty Percent Difference	Note
0	CLIFTON 230.kV	XT2011	S	100.10%	99.40%	0.70%	New Over-duty
890	REMINGTON CT 230.kV	2077T2086	S	100.00%	99.80%	0.20%	New Over-duty
890	REMINGTON CT 230.kV	208662	S	100.00%	99.80%	0.20%	New Over-duty

System Stability Analysis

Dynamic studies are part of the System Impact Study.

ITO Assessment Results

ITO assessed the impact of the proposed 498MW generation capacity on the ITO transmission system. The system was assessed using the summer 2014 RTEP case provided to ITO by PJM. The primary point of interconnection was the Remington 230kV bus at the Remington CT site, while the secondary point of interconnection was a new Remington 500kV Substation, located adjacent to the existing Remington CT site, and tapped into the 500kV Trail Line between Loudoun and Meadowbrook Substations. This analysis did include the impacts of the generation capacity for all higher order queue generators within the ITO transmission system. To consider the impact of queue W1-073, ITO used option 2 (Ladysmith 500kV) for that queue for the assessment of W1-074. When performing a generation analysis, ITO main analysis will be load flow study results under base case and single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO planning criteria and interconnection requirements can be found in the ITO Facility Connection Requirements which are publicly available at: http://www.dom.com.

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Option 1: Remington 230kV

As part of its generation impact analysis ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the W1-074 evaluation three different assessments were conducted.

1) The first being when local generation including the proposed W1-074 Facility is operated at their maximum capability. The result of this study is shown below.

   No Problems Identified for Base Case or Single Contingency Conditions.

ITO verified PJM's analysis of the Double Circuit Tower Line Contingency with W1-074 capacity output under maximum generation conditions. The AC analysis results are shown below.

1. The 6REMNGCT-6ELK RUN 230 kV line (from bus 314085 to bus 314110 ckt 1) loads from 82.7% to 124.1% (AC power flow) of its emergency rating (1045 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 433 MW to cause the thermal violation.

2. The 6ELK RUN-6GAINSVL 230 kV line (from bus 314110 to bus 314037 ckt 1) loads from 108% to 162.4% (AC power flow) of its emergency rating (796 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 433 MW to cause the thermal violation.

2) The second being a stressed system condition where the largest generator in the area is unavailable. With the W1-074 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of W1-074 was studied with the outage of Possum Point Unit #5. The result of this study is shown below.

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No Problems Identified for Base Case or Single Contingency Conditions.

ITO verified PJM’s analysis of the Double Circuit Tower Line Contingency with W1-074 capacity output under stressed system conditions. The AC analysis results are shown below.

1. The 6REMNGCT-6ELK RUN 230 kV line (from bus 314085 to bus 314110 ckt 1) loads from 78% to 119.2% (AC power flow) of its emergency rating (1045 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 430 MW to cause the thermal violation.

2. The 6ELK RUN-6GAINSVL 230 kV line (from bus 314110 to bus 314037 ckt 1) loads from 101.9% to 155.9% (AC power flow) of its emergency rating (796 MVA) for the tower line contingency ('2039&2040'). This project contributes approximately 430 MW to cause the thermal violation.

3) The third being import and export conditions into and out of the ITO system. Any new facility that is interconnected with the ITO system should not significantly decrement FCITC between utilities. The results of these studies can be found in Tables C and D.

Table C: Import Study Results (1)

Import Study Results			
Area	**Summer 2014**	**Summer 2014 with W1-074**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Table D: Export Study Results (1)

Export Study Results			
Area	**Summer 2014**	**Summer 2014 with W1-074**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

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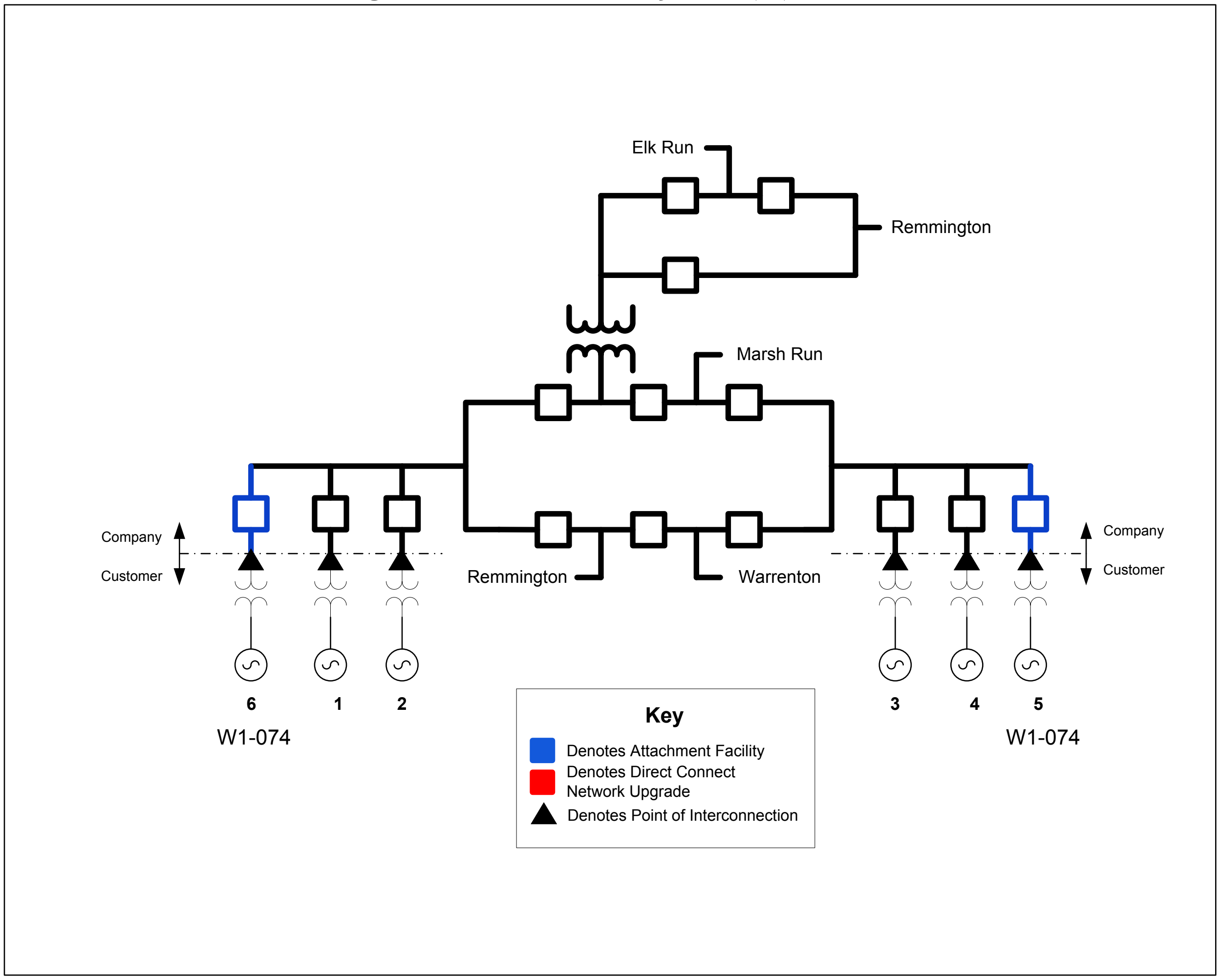
ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

Figure A: W1-074 Layout (1)



Attachment Facilities

The proposed layout and attachment facilities are illustrated below in Figure A. The estimated cost of these facilities which includes metering, protection equipment along with two 230kV breakers is $2 Million and is estimated to take 24 to 30 months to complete.

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Non-Direct Connection Network Upgrades

Upgrade substation wire limitations at Howard. The cost for this Howard work is $100,000 and it will take 6 months to complete. This assumes that the High Ridge baseline work is completed in 2012. The resultant new rating normal & emergency become 670 & 844 MVA respectively.

The construction of the Remington CT to Gainesville Line #2114 (project 99-2217, RTEP # b0453) will result in an emergency line rating of 1047MVA for the entire line from Remington CT to Gainesville. This will reduce the Double Circuit Tower Line Contingency overloads to below 130% for the Elk Run to Gainesville segment for this NERC category C5 event. Generation re-dispatch at Remington after the contingency event will reduce loading to below 100% on this line.

1) The estimated cost to replace the sixteen newly overdutied breakers is $3,217,000 and will take about 15.5 months to complete (2 weeks for each replacing breaker and 8 months for equipment order time).

2) The estimated cost to replace the four previously overdutied breakers is $840,000 and will take about 10 months to complete (2 weeks for each replacing breaker and 8 months for equipment order time). The projects allocation to these breakers will be determined at the System Impact Study.

Total cost estimated to be $4.2 million dollars and maximum duration is 15.5 months.

Direct Connection Network Upgrades

None required for this addition.

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Option 2: Loudoun to Meadowbrook 500kV

As part of its generation impact analysis ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the W1-074 evaluation three different assessments were conducted.

1. The first being when local generation including the proposed W1-074 Facility is operated at their maximum capability. The result of this study is shown below.

   No Problems Identified for Base Case or Single Contingency Conditions.

ITO studied PJM's analysis of the Double Circuit Tower Line Contingency with W1-074 capacity output under maximum generation conditions. The AC analysis results are shown below.

   1. The 6REMNGCT-6ELK RUN 230 kV line (from bus 314085 to bus 314110 ckt 1) load is reduced from 82.7% to 82.5% (AC power flow) of its emergency rating (1045 MVA) for the tower line contingency ('2039&2040'.

   2. The 6ELK RUN-6GAINSVL 230 kV line (from bus 314110 to bus 314037 ckt 1) load is reduced from 108% to 107.8% (AC power flow) of its emergency rating (796 MVA) for the tower line contingency ('2039&2040').

2. The second being a stressed system condition where the largest generator in the area is unavailable. With the W1-074 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of W1-074 was studied with the outage of Possum Point Unit #5. The result of this study is shown below.

   No Problems Identified for Base Case or Single Contingency Conditions.

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ITO verified PJM’s analysis of the Double Circuit Tower Line Contingency with W1-074 capacity output under stressed system conditions. The AC analysis results are shown below.

1. The 6REMNGCT-6ELK RUN 230 kV line (from bus 314085 to bus 314110 ckt 1) load is reduced from 78% to 77.6% (AC power flow) of its emergency rating (1045 MVA) for the tower line contingency ('2039&2040').

2. The 6ELK RUN-6GAINSVL 230 kV line (from bus 314110 to bus 314037 ckt 1) load is reduced from 101.9% to 101.4% (AC power flow) of its emergency rating (796 MVA) for the tower line contingency ('2039&2040').

3. The third being import and export conditions into and out of the ITO system. Any new facility that is interconnected with the ITO system should not significantly decrement FCITC between utilities. The results of these studies can be found in Tables C and D.

Table C: Import Study Results (2)

Import Study Results			
Area	**Summer 2014**	**Summer 2014 with W1-074**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

Table D: Export Study Results (2)

Export Study Results			
Area	**Summer 2014**	**Summer 2014 with W1-074**	**Limiting Element**
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicates a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

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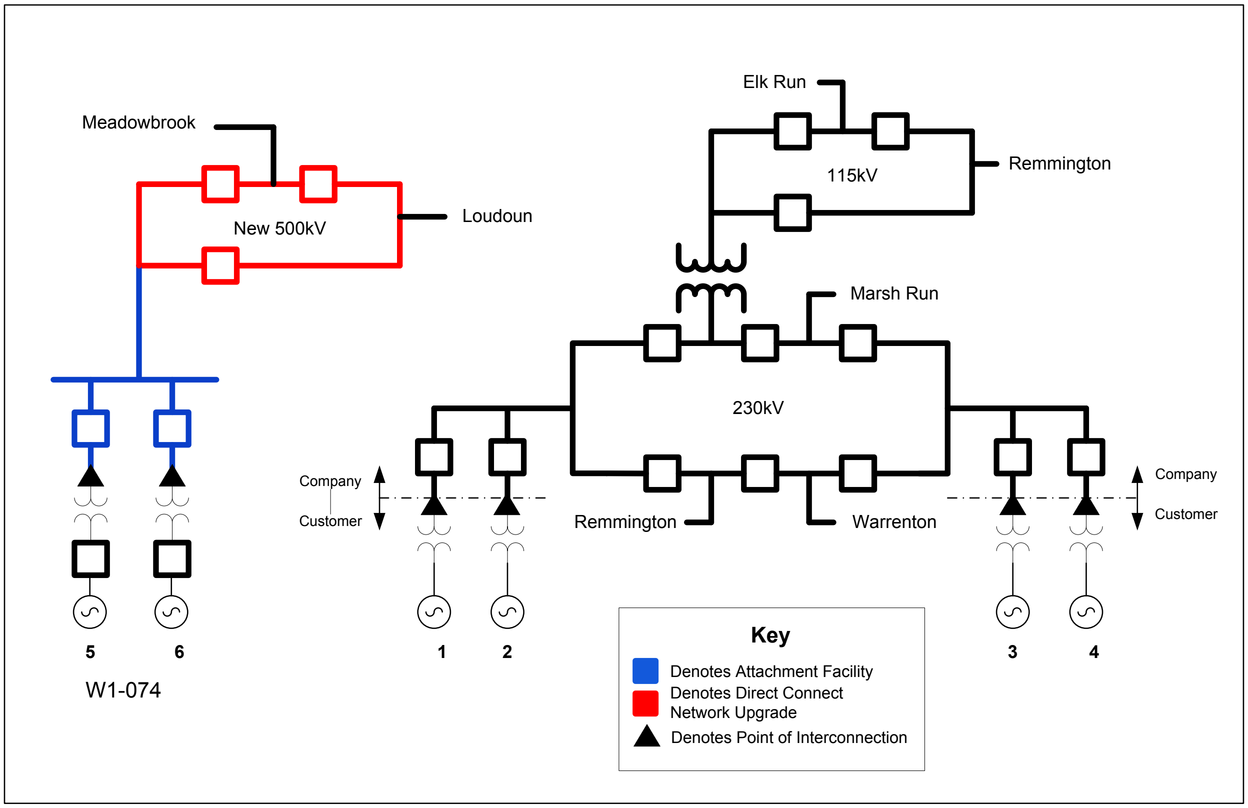
Figure B: W1-074 Layout (2)



Attachment Facilities

The proposed layout and attachment facilities are illustrated below in Figure B. The estimated cost of these facilities which includes metering, protection equipment along with two 230kV breakers is $2 Million and is estimated to take 24 to 30 months to complete.

Direct Connection Network Upgrades

To reliably interconnect the proposed generation with the ITO transmission system it will be necessary to install a 500kV ring bus at the new Remington 500kV terminal as shown below in Figure B. The estimated cost of this work is $6 Million and is estimated to take 36 to 48 months to complete. This includes obtaining all necessary SCC permits.

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Non-Direct Connection Network Upgrades

The construction of the Remington CT to Gainesville Line #2114 (project 99-2217, RTEP # b0453) will result in an emergency line rating of 1047MVA for the entire line from Remington CT to Gainesville. This will reduce the Double Circuit Tower Line Contingency overloads to below 100% for the Elk Run to Gainesville segment for this NERC category C5 event.

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