# Feasibility Study Report: North Ridge Wind Project

## NYISO Interconnection Queue #354


Prepared By:

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# Executive Summary

Atlantic Wind LLC. (The "Developer") is proposing to connect the North Ridge Wind Project (the "Project") to the New York State Transmission System. The Point of Interconnection ("POI") will be on the Niagara Mohawk Power Corporation d/b/a National Grid ("NM-NG") 115 kV Colton – Malone Line #3 transmission line approximately 4 miles from Nicholville Substation. National Grid is the Connecting Transmission Owner (CTO) for this Project. The Project will be located in St. Lawrence County, New York. The Project is expected to have a maximum potential generating capacity of approximately 100.0 MW and has a proposed in-service date of December, 2014.

New York Independent System Operator (NYISO) has conducted a Feasibility Study for this Project to satisfy the NYISO tariff requirement under NYISO OATT attachment X.

This Feasibility Study included a power flow analysis and a short circuit analysis, both without and with the Project, to determine the incremental impact of the Project on the system. The Study also included performing the NYISO Test Procedure for Evaluating Power Factor Requirements for the Project according to NYISO Technical Bulletin 148. These analyses were conducted in accordance with the applicable NERC, NPCC, NYSRC, and NM-NG reliability and design standards; and in accordance with applicable New York Independent System Operator ("NYISO"), NM–NG and Affected Systems (if applicable) study guidelines, procedures and practices.

The results of the study indicate that with the 100.0 MW North Ridge Wind Project in service, all facilities (transmission lines, transformers, etc) within the Study Area were found to be within their thermal ratings under normal as well as under contingency conditions. There is one exception of Lawrence 115/13.2 kV transformer overloads near the POI that were caused by the Project for the contingency loss of 115 kV branches near the transformer. These overloads can be mitigated by slightly modifying generation dispatch for the pre-contingency condition. The generation modification to alleviate the overloading included reducing generation at the SUGAR IS units by 0.8 MW and increasing the same amount of generation at LAWRENCE units. With this modified dispatch, the Project does not cause any new overload in the contingency condition. No other adverse system thermal impacts were found as a result of addition of this Project. It is also important to note that the Project reduces the overloading on the same transformer for a contingency (colton 1) as noted in table 4-3.

The over voltages that existed pre-project post contingency remained to exist in the post-project post contingency conditions at Malone 3 and Nicholville 34.5 kV buses. No detrimental voltage impacts were found as a result of this Project. Therefore, the Project is considered as having no negative impact on the voltage violations within the Study Area.

The power factor test results show that the Project passed Step 1 of the NYISO Test Procedure for Evaluating Power Factor Requirement for Wind Generation Interconnection Projects, according to Tech Bulletin # 148. Therefore, the reactive capability proposed for the Project is adequate.

Short Circuit analysis was performed in accordance with the NYISO guideline for fault current assessment and the results indicate that the Project increases fault duties at nearby buses within the vicinity of the Project POI, but does not cause any breaker over duty at the Substations studied.

Attachment Facilities (AFs) and System Upgrade Facilities (SUFs) are required to make it physically possible to interconnect the Project from its switchyard station to the point of interconnection. The project will interconnect to the NGRID System via a 3 Breaker Ring Bus Station ("Point of Interconnection Station" or "POI Station"), and protective relay modifications are required at the Colton and Malone Substations. A non-binding good faith cost estimate of National Grid's Attachment facilities and System Upgrade Facilities (transmission line protection, transmission line modification, circuit breakers, relays, bus structures, etc.) and associated labor to accommodate the Project is $7,711,000 dollars ($7.711 million), plus or minus 40%, and the estimated time to construct these facilities is about 8 to 10 months, not including engineering, equipment procurement and weather delays.

# 1. Introduction

Atlantic Wind LLC. (The “Developer”) is proposing to connect the North Ridge Wind Project (the “Project”) to the New York State Transmission System. The Point of Interconnection (“POI”) will be on the Niagara Mohawk Power Corporation d/b/a National Grid (“NM-NG”) 115 kV Colton – Malone Line #3 transmission line approximately 4 miles from Nicholville Substation. National Grid is the Connecting Transmission Owner (CTO) for this Project. The Project will be located in St. Lawrence County, New York. The Project is expected to have a maximum potential generating capacity of approximately 100.0 MW and has a proposed in-service date of December, 2014

According to the Standard Large Facility Interconnection Procedures (Attachment X of the NYISO OATT), a Feasibility Study (FES) is required (unless waived by a three-party agreement) to assess the impact of the project on the base case electrical system, and to determine a good-faith non-binding cost estimates and time to construct the facilities needed to interconnect the Project in the New York State Transmission System. The facilities include any System Upgrade Facilities (SUFs) and the Transmission Owner’s Attachment Facilities (AFs) that are needed solely due to the Project.

This Feasibility Study included a power flow analysis and a short circuit analysis, both without and with the Project, to determine the incremental impact of the Project on the system. The Study also included performing the NYISO Test Procedure for Evaluating Power Factor Requirements for the Project according to NYISO Technical Bulletin 148. These analyses were conducted in accordance with the applicable NERC, NPCC, NYSRC, and NM-NG reliability and design standards; and in accordance with applicable New York Independent System Operator (“NYISO”), NM–NG and Affected Systems (if applicable) study guidelines, procedures and practices.

This report documents the results and findings of this Feasibility Study.

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# 2. Project Description

The North Ridge Wind Project will be located in St. Lawrence County, New York. The Project will be comprised of 50 Gamesa 2 MW wind turbines for a maximum output of 100.0 MW. Each turbine has a reactive power capability corresponding to a power factor of 0.95 lagging (overexcited) to 0.95 leading (underexcited). Power from each wind turbine will be stepped up to 34.5 kV through a 34.5/0.69 kV delta-wye, 2.35 MVA generator step-up transformer. The 34.5 kV feeder collection system will bring the combined power output to a single collection substation where the power will be further stepped up to 115 kV through a 115/34.5 kV, 60/80/100 MVA non-regulated transformer. The transformer connection is wye-grounded on the 115 kV and wye-grounded on the 34.5 kV, with a 13.2 kV buried delta tertiary winding.

The proposed Point of Interconnection ("POI") for the Project is on the National Grid 115kV Colton-Malone Line #3, approximately 14.3 miles from the Colton Station and 24.1 miles from the Malone Station, and is to be comprised of a three (3) breaker ring bus substation ("POI Station"). Figure 2-1 shows a conceptual one line diagram of the interconnection and figure 2-2 shows an electrical one-line diagram for the Project.

The Project was modeled using information provided by the Developer as shown in Figure 2-3. The Project wind turbines were modeled using 4 equivalent wind turbines (20, 10, 10, 10 turbines in total) as shown in Figure 2-3. The Project was dispatched at 100% of rated output and set to regulate voltage at the terminals of the wind turbine generators.

Interconnection Facility Diagram

North Ridge Windfarm (100 MW)
St. Lawrence, NY

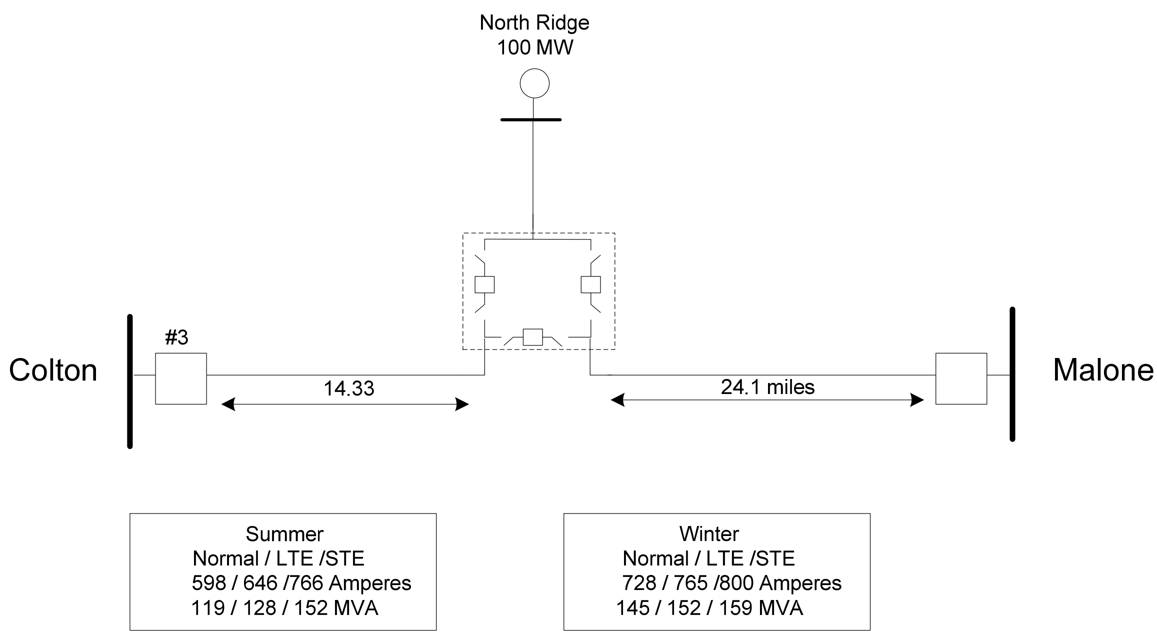


**Figure 2-1: Conceptual One-Line Diagram of POI**

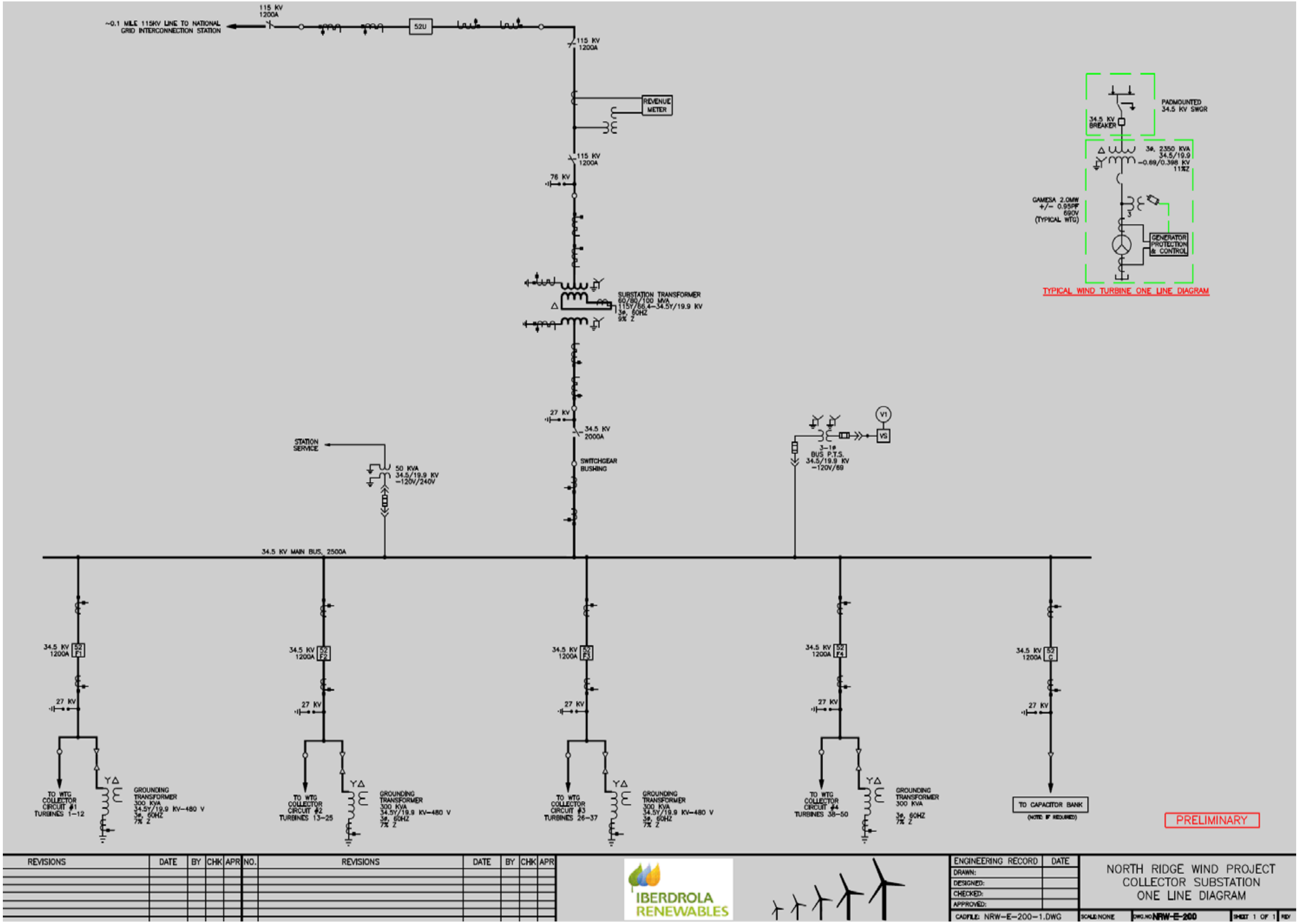


**Figure 2-2: One-Line Diagram Showing Connection of Project to the 115 kV System**

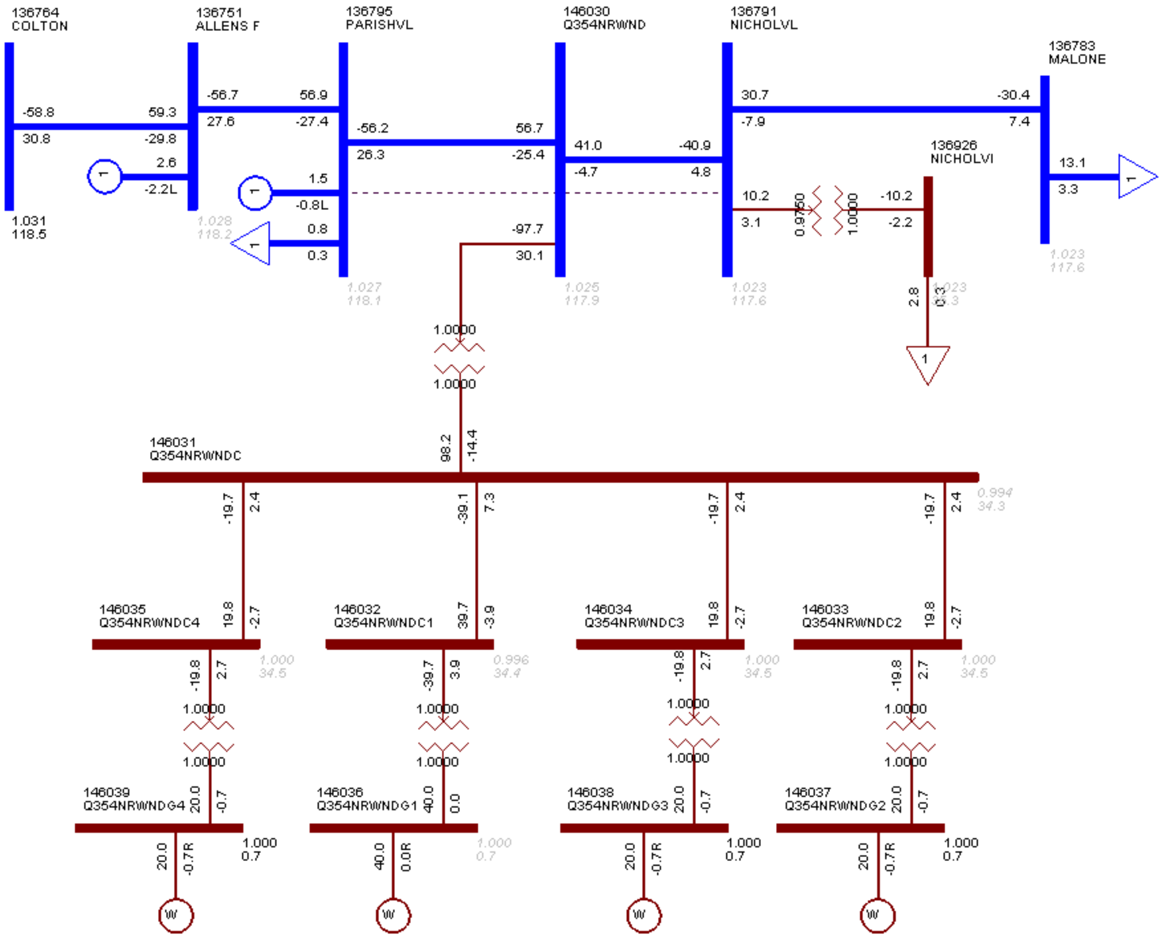


**Figure 2-3: Power Flow Model of the Project**

# 3. Study Assumptions

The following key assumptions were used in performing this Study. These assumptions were according to the Scope of the Feasibility Study (see Appendix A).

**Study Period:** NYISO staff created the power flow and short circuit base cases for the summer 2015 peak load conditions from the NYISO Class Year 2009 ATBA cases to be used in this Study. All proposed projects that have been cost allocated up to and including Class Year 2008 as listed in Appendix A of the Feasibility Study Scope were modeled in these base cases.

**Study Area:** The Study was focused on the impact of the Project on the local 230, 115, and 34.5 kV transmission systems at, and in proximity to the POI and the bulk power system in the northern portion of the Mohawk Valley Region (Zone E) and the northeastern portion of the North Region (Zone D) in upstate New York which are most likely to be affected by the Project (the "Study Area").

The preliminary impact of the proposed Project was evaluated for summer peak load conditions for the following base case conditions.

**Case 1 –** Base case without the Project. The base case will include the proposed projects listed in Appendix A. The Short Circuit base case will model all the projects as in-service. The Power Flow base case will normally model all projects in-service at full output, but may model some projects as out-of-service or less than full output as necessary to establish a feasible base dispatch. Generation will be dispatched in accordance with NYISO practices.

**Case 2 –** Case 1 with the Project modeled. The Project was modeled as in-service at full output (100.0 MW). Unit and facility reactive resources for the Project were represented. Generation was re-dispatched in the Power Flow case in accordance with NYISO practices. Table 3-1 shows generation dispatch of the Project.

**Modeling:**

- Phase Angle Regulators (PARs), switched shunts, and LTC transformers were modeled as regulating pre-contingency and non-regulating post-contingency. The PAR schedules used in the study were those modeled in the NYISO 2015 power flow base cases.

- New York SVCs and FACTS devices were set to zero pre-contingency and allowed to operate to full range post-contingency.

**Table 3-1: North Ridge Wind Project Dispatch in Summer Peak Case**

| Bus Number | Bus Name | Case 1 without Project (MW) | Case 2 with Project (MW) | Change (MW) |
|---|---|---|---|---|
| 146036 | Q354NRWNDG1 | 0.0 | 40 | 40 |
| 146037 | Q354NRWNDG2 | 0.0 | 20 | 20 |
| 146038 | Q354NRWNDG3 | 0.0 | 20 | 20 |
| 146039 | Q354NRWNDG4 | 0.0 | 20 | 20 |
| 146840 | BOW2 20G | 551.1 | 516.1 | -35.0 |
| 146841 | BOW1 20G | 528.6 | 493.6 | -35.0 |
| 125192 | ROSGN2 24 | 565 | 535 | -30.0 |

# 4. Power Flow Analysis

Power flow analysis was conducted to determine the impact of the Project (overloading, voltage violations, etc.) within the Study Area under normal and contingency conditions. The analysis was first done without the Project and then with the Project to identify the incremental impact of the Project.

For this Feasibility Study, the power flow analysis was limited to only Thermal and Voltage analysis, as defined in the Scope of the Feasibility Study (Appendix A). All projects that have been cost allocated up to and including Class Year 2008 were modeled in the base cases. These modeled projects are also described in the Scope of the Feasibility Study. Generation dispatch was done in accordance with NYISO operating practices. For dispatching the Project at full output (100.0 MW), an equal amount of generation was reduced from the Bowline and Roseton units located in the Hudson Valley Region (Zone G).

New York ISO used Siemens PTI's PSS™E and PSS™MUST Programs to conduct the Thermal and Voltage analysis for pre-contingency and design criteria contingency conditions, focusing on the Study Area. The monitored facilities for thermal and voltage violations included the local 230 kV, 115 kV, and 34.5 kV transmission systems at, and in proximity to, the POI (on the Nicholville – Parishville 115 kV transmission line) and the bulk power system in the northern portion of the Mohawk Valley Region (Zone E) and the northeastern portion of the North Region (Zone D) in the upstate New York. The tested contingencies included outages of single lines, transformers, tower contingencies and a bus outage at, and in proximity to, the POI that were developed by National Grid and NYISO. The contingency list is included in Appendix B1.

Thermal limits were assessed using normal ratings for pre-contingency conditions and applicable emergency ratings (Long Term Emergency, LTE, or Short Term Emergency, STE, ratings) for post- contingency conditions. In this thermal analysis, the LTE rating was used for post-contingency conditions. Voltage limits were assessed, pre and post contingency, using NYISO voltage limits for the Bulk Power System and 0.95 – 1.05 pu for other system buses, unless specified otherwise.

## 4.1 Impact on Base System Conditions

The thermal and voltage impacts of the Project near the POI in the base system conditions for the summer peak cases are summarized in Table 4-1 and Table 4-2.

The branch loadings and bus voltages in the Study Area are compared between pre- and post-Project conditions. The Project impacts loadings and voltages in the base case conditions in the summer peak cases but the Project does not cause any thermal or voltage violations in the base case conditions.

## Table 4-1: Base Case Branch Loadings near POI

| ** From bus ** ** To bus ** CKT "Monitored Element" | Rating MVA | Pre-Project MVA | Pre-Project Loading % | Post-Project MVA | Post-Project Loading % | delta % |
|---|---|---|---|---|---|---|
| 136751 ALLENS F 115 136764 COLTON 115 1 | 119.0 | 8.3 | 7.0 | 64.6 | 54.3 | 47.3 |
| 136751 ALLENS F 115 136795 PARISHVL 115 1 | 128.0 | 6.9 | 5.4 | 61.5 | 48.0 | 42.6 |
| 136795 PARISHVL 115 146030 Q354NRWND 115 1 | 128.0 | 6.7 | 5.3 | 60.6 | 47.3 | 42.0 |
| 136791 NICHOLVL 115 146030 Q354NRWND 115 1 | 128.0 | 7.0 | 5.5 | 40.3 | 31.5 | 26.0 |
| 136791 NICHOLVL 115 136926 NICHOLVI 34.5 1 | 14.0 | 7.7 | 55.4 | 10.7 | 76.4 | 21.0 |
| 136783 MALONE 115 136791 NICHOLVL 115 1 | 129.0 | 5.0 | 3.9 | 31.0 | 24.0 | 20.1 |
| 136759 BRNS FLS 115 136771 FLAT RCK 115 1 | 102.0 | 35.0 | 34.3 | 45.1 | 44.2 | 9.9 |
| 136759 BRNS FLS 115 136775 HIGLEY 115 1 | 102.0 | 33.8 | 33.2 | 44.0 | 43.1 | 9.9 |
| 136759 BRNS FLS 115 136807 TAYLORVL 115 1 | 102.0 | 35.4 | 34.7 | 45.2 | 44.3 | 9.6 |
| 136759 BRNS FLS 115 136807 TAYLORVL 115 2 | 105.0 | 35.4 | 33.7 | 45.2 | 43.1 | 9.4 |
| 136764 COLTON 115 136771 FLAT RCK 115 1 | 114.0 | 33.8 | 29.7 | 43.9 | 38.5 | 8.8 |
| 136764 COLTON 115 136775 HIGLEY 115 1 | 128.0 | 35.5 | 27.7 | 45.5 | 35.6 | 7.9 |
| 136764 COLTON 115 136780 LTL RV-G 115 1 | 76.0 | 14.7 | 19.3 | 20.4 | 26.8 | 7.5 |
| 136780 LTL RV-G 115 136798 PYRITE-8 115 1 | 76.0 | 14.4 | 18.9 | 20.1 | 26.4 | 7.5 |
| 136785 MCINTYRE 115 136812 MC ADOO2 115 1 | 76.0 | 14.0 | 18.4 | 19.7 | 25.9 | 7.5 |
| 136798 PYRITE-8 115 136812 MC ADOO2 115 1 | 76.0 | 14.2 | 18.7 | 19.9 | 26.2 | 7.5 |
| 136778 LOWVILLE 115 136807 TAYLORVL 115 1 | 102.0 | 53.3 | 52.2 | 58.8 | 57.6 | 5.4 |
| 137221 BOONVL 115 146651 Q197_TUGHILL 115 1 | 106.0 | 36.8 | 34.7 | 42.4 | 40.0 | 5.3 |
| 136778 LOWVILLE 115 146651 Q197_TUGHILL 115 1 | 106.0 | 37.0 | 34.9 | 42.5 | 40.1 | 5.2 |
| 136758 BREMEN 115 136807 TAYLORVL 115 1 | 105.0 | 44.4 | 42.3 | 49.7 | 47.4 | 5.1 |
| 136783 MALONE 115 136918 MALONE 3 34.5 2 | 12.0 | 6.6 | 54.9 | 6.2 | 52.0 | -2.9 |
| 136216 LTHSE HL 115 136755 BLACK RV 115 1 | 116.0 | 19.6 | 16.9 | 16.0 | 13.8 | -3.1 |
| 136216 LTHSE HL 115 136768 E WTRTWN 115 1 | 116.0 | 24.4 | 21.0 | 20.8 | 17.9 | -3.1 |
| 136750 ALCOA-NM 115 136767 DENNISON 115 1 | 176.0 | 20.0 | 11.4 | 12.8 | 7.3 | -4.1 |
| 147849 MOS 115 115 147863 GR-TAP2 115 2 | 238.0 | 99.3 | 41.7 | 89.5 | 37.6 | -4.1 |
| 136757 N.O-BRG 115 136760 BRADY 115 1 | 193.0 | 18.8 | 9.7 | 10.6 | 5.5 | -4.2 |
| 147849 MOS 115 115 147862 GR-TAP1 115 1 | 238.0 | 100.4 | 42.2 | 90.2 | 37.9 | -4.3 |
| 147848 ALCOA S 115 147849 MOS 115 115 3 | 218.0 | 97.6 | 44.8 | 87.8 | 40.3 | -4.5 |
| 147848 ALCOA S 115 147863 GR-TAP2 115 2 | 218.0 | 93.5 | 42.9 | 83.6 | 38.3 | -4.6 |
| 147847 ALCOA N 115 147862 GR-TAP1 115 1 | 218.0 | 94.5 | 43.4 | 84.3 | 38.7 | -4.7 |
| 136757 N.O-BRG 115 136785 MCINTYRE 115 1 | 159.0 | 18.3 | 11.5 | 10.2 | 6.4 | -5.1 |
| 147864 REYN T#1 115 148010 GM T#1 115 1 | 40.0 | 16.4 | 40.9 | 14.0 | 35.1 | -5.8 |
| 136750 ALCOA-NM 115 136760 BRADY 115 1 | 128.0 | 24.5 | 19.2 | 16.5 | 12.9 | -6.3 |
| 147845 WILLIS E 230 147856 WILL 115 115 1 | 150.0 | 33.1 | 22.1 | 23.2 | 15.5 | -6.6 |
| 147846 WILLIS W 230 147856 WILL 115 115 1 | 150.0 | 33.2 | 22.1 | 23.3 | 15.5 | -6.6 |
| 135593 AWKESANS 115 135594 AWKESA34 34.5 1 | 26.0 | 7.8 | 30.0 | 5.1 | 19.6 | -10.4 |
| 136750 ALCOA-NM 115 147847 ALCOA N 115 1 | 206.0 | 44.4 | 21.5 | 5.8 | 2.8 | -18.7 |
| 136783 MALONE 115 147856 WILL 115 115 1 | 129.0 | 57.1 | 44.3 | 29.6 | 22.9 | -21.4 |

**Table 4-2: Base Case Bus Voltages near POI**

| Bus # | Bus Name | KV | Pre Project BaseVolt | Post Project BaseVolt | Delta V |
|---|---|---|---|---|---|
| 136765 | DE KALB | 115.0 | ***1.0201*** | ***1.0128*** | -0.0073 |
| 136784 | MC ADOO | 115.0 | ***1.0244*** | ***1.0173*** | -0.0071 |
| 136787 | CORNING | 115.0 | ***1.0249*** | ***1.0179*** | -0.0070 |
| 136753 | BALMAT | 115.0 | ***1.0132*** | ***1.0063*** | -0.0069 |
| 136774 | GVNR TLC | 115.0 | ***1.0132*** | ***1.0063*** | -0.0069 |
| 136789 | N GOUVNR | 115.0 | ***1.0133*** | ***1.0064*** | -0.0069 |
| 136810 | ZINCO | 115.0 | ***1.0133*** | ***1.0064*** | -0.0069 |
| 136794 | OGDENSBG | 115.0 | ***1.0323*** | ***1.0254*** | -0.0069 |
| 136812 | MC ADOO2 | 115.0 | ***1.0337*** | ***1.0269*** | -0.0068 |
| 136754 | BATTL HL | 115.0 | ***1.0147*** | ***1.0079*** | -0.0068 |
| 136785 | MCINTYRE | 115.0 | ***1.0332*** | ***1.0264*** | -0.0068 |
| 136798 | PYRITE-8 | 115.0 | ***1.0349*** | ***1.0284*** | -0.0065 |
| 136797 | PYRITE-7 | 115.0 | ***1.0252*** | ***1.0190*** | -0.0062 |
| 136757 | N.O-BRG | 115.0 | ***1.0321*** | ***1.0261*** | -0.0060 |
| 136780 | LTL RV-G | 115.0 | ***1.0356*** | ***1.0296*** | -0.0060 |
| 136779 | LTL RV-F | 115.0 | ***1.0264*** | ***1.0205*** | -0.0059 |
| 136791 | NICHOLVL | 115.0 | ***1.0284*** | ***1.0226*** | -0.0058 |
| 136751 | ALLENS F | 115.0 | ***1.0334*** | ***1.0277*** | -0.0057 |
| 136795 | PARISHVL | 115.0 | ***1.0327*** | ***1.0270*** | -0.0057 |
| 136775 | HIGLEY | 115.0 | ***1.0343*** | ***1.0287*** | -0.0056 |
| 136771 | FLAT RCK | 115.0 | ***1.0271*** | ***1.0215*** | -0.0056 |
| 136759 | BRNS FLS | 115.0 | ***1.0266*** | ***1.0211*** | -0.0055 |
| 136764 | COLTON | 115.0 | ***1.0363*** | ***1.0308*** | -0.0055 |
| 136790 | NEWTON F | 115.0 | ***1.0266*** | ***1.0211*** | -0.0055 |
| 146030 | Q354NRWND | 115.0 | ***1.0302*** | ***1.0249*** | -0.0053 |
| 136803 | SANDST-4 | 115.0 | ***1.0345*** | ***1.0293*** | -0.0052 |
| 136804 | SANDST-5 | 115.0 | ***1.0353*** | ***1.0302*** | -0.0051 |
| 136806 | SUGAR IS | 115.0 | ***1.0334*** | ***1.0284*** | -0.0050 |
| 136781 | LWRNCE-A | 115.0 | ***1.0319*** | ***1.0272*** | -0.0047 |
| 136782 | LWRNCE-B | 115.0 | ***1.0331*** | ***1.0285*** | -0.0046 |
| 136796 | POTDM PA | 115.0 | ***1.0304*** | ***1.0261*** | -0.0043 |
| 136802 | S COLTON | 115.0 | ***1.0430*** | ***1.0389*** | -0.0041 |
| 136770 | FIVE FLS | 115.0 | ***1.0444*** | ***1.0406*** | -0.0038 |
| 136760 | BRADY | 115.0 | ***1.0283*** | ***1.0246*** | -0.0037 |
| 136799 | RAINBOW | 115.0 | ***1.0453*** | ***1.0416*** | -0.0037 |
| 136792 | NORFOLK | 115.0 | ***1.0284*** | ***1.0249*** | -0.0035 |
| 136801 | RAYMD HY | 115.0 | ***1.0283*** | ***1.0248*** | -0.0035 |
| 136756 | BLAKE | 115.0 | ***1.0461*** | ***1.0427*** | -0.0034 |
| 137928 | CHASES L | 230.0 | ***1.0454*** | ***1.0421*** | -0.0033 |
| 136758 | BREMEN | 115.0 | ***1.0110*** | ***1.0077*** | -0.0033 |
| 136778 | LOWVILLE | 115.0 | ***1.0045*** | ***1.0012*** | -0.0033 |
| 136918 | MALONE 3 | 34.5 | ***1.0588*** | ***1.0555*** | -0.0033 |
| 136926 | NICHOLVI | 34.5 | ***1.0238*** | ***1.0227*** | -0.0011 |

## 4.2 Impact on Contingency Conditions

### 4.2.1 Thermal Analysis

Table 4-3 summarizes branch loadings near the POI caused by the Project under the contingency conditions. The addition of Project caused the overloading of Lawrence 115/13.2 kV transformers for the contingency loss of 115 kV branches near the proximity of the transformer. The Project does not cause any other overload in the contingency analysis.

To mitigate these transformer overloads, the generation dispatch was slightly modified for the pre-contingency condition in the summer peak power flow case with the Project. This involved reducing generation at the SUGAR IS units by 0.8 MW and increasing the same amount of generation at LAWRENCE units. With this modified dispatch, the Project does not cause any new overload in the contingency condition. No other adverse system thermal impacts were found as a result of addition of this Project. It is also important to note that the Project reduces the overloading on the same transformer for a contingency as noted in table 4-3. Appendix B.1 contains the contingency descriptions for all the simulated contingencies.

Therefore, the Project is considered as having no significant adverse impact on the branch loadings within the Study Area. A more detailed summary table of the thermal analysis within the Study Area, without and with the Project, is included in Appendix B2.

**Table 4-3: Contingent Branch Loadings near POI with Original Generation Dispatch**

| ** From bus ** **To bus ** CKT "Monitored Element" | MVA Rating | Post Project Cont MVA | Post Project Loading% | Contingency Description* | Pre Project Cont MVA | Pre Project Loading % | Delta % |
|---|---|---|---|---|---|---|---|
| 136791 NICHOLVL 115 136926 NICHOLVI 34.5 1 | 17.0 | ***20.9*** | ***123.0*** | Malone | ***17.0*** | ***100.1*** | 22.9 |
| 136782 LWRNCE-B 115 137153 LAWRENCE 13.2 1 | 10.0 | 9.7 | 97.3 | Colton 1 | 7.7 | 76.8 | 20.5 |
| 136781 LWRNCE-A 115 137153 LAWRENCE 13.2 1 | 10.0 | ***10.3*** | ***103.0*** | COLTON-SANDST-5 | 8.4 | 84.5 | 18.5 |
| 136791 NICHOLVL 115 136926 NICHOLVI 34.5 1 | 17.0 | 15.5 | 91.3 | 136911 FRANK TA 34.5 136918 MALONE 3 34.5 1 | 13.3 | 78.1 | 13.2 |
| 136791 NICHOLVL 115 136926 NICHOLVI 34.5 1 | 17.0 | 14.9 | 87.4 | 135593 AWKESANS 115 135594 AWKESA34 34.5 1 | 13.6 | 80.1 | 7.3 |
| 136791 NICHOLVL 115 136926 NICHOLVI 34.5 1 | 17.0 | ***29.4*** | ***173.0*** | 135593 AWKESANS 115 148010 GM T#1 115 1 | ***28.4*** | ***167.2*** | 5.8 |
| 147764 MOS17-20 13.8 147839 MOSES E 230 5 | 258.0 | 215.7 | 83.6 | 147828 MASS 765 765 147838 MASS230B 230 1 | 222.9 | 86.4 | -2.8 |
| 147764 MOS17-20 13.8 147839 MOSES E 230 5 | 258.0 | 215.7 | 83.6 | Massena 765 | 222.9 | 86.4 | -2.8 |
| 147764 MOS17-20 13.8 147839 MOSES E 230 5 | 258.0 | 215.2 | 83.4 | TWR:MAP13&12 | 223.5 | 86.6 | -3.2 |
| 147764 MOS17-20 13.8 147839 MOSES E 230 5 | 258.0 | 213.9 | 82.9 | 147852 PLAT T#3 115 147922 PLAT 115 115 3 | 223.3 | 86.6 | -3.7 |
| 136782 LWRNCE-B 115 137153 LAWRENCE 13.2 1 | 10.0 | 7.8 | 78.2 | COLTON-SANDST-5 | 9.7 | 97.3 | -19.1 |
| 136781 LWRNCE-A 115 137153 LAWRENCE 13.2 1 | 10.0 | 8.41 | 84.1 | Colton 1 | ***10.7*** | ***107.0*** | -22.9 |

*Appendix B.1 has detailed contingency descriptions

### 4.2.2 Voltage Analysis

The results of voltage analysis for contingency conditions show that the addition of Project at the full output (100.0 MW) does not cause any voltage violation under contingencies in the Study Area and its impacts on voltage are insignificant. All monitored voltages are within the 0.95 – 1.05 pu voltage criteria. Several 34.5 kV bus over voltages that existed pre-project post contingency remained to exist in the post-project post contingency conditions at Malone 3 and Nicholville 34.5 kV buses as shown in Table 4-4, these over voltages are not exacerbated by the addition of the North Ridge Wind Project.

No detrimental voltage impacts were found as a result of this Project. Therefore, the Project is considered as having no negative impact on the voltage violations within the Study Area.

A detailed summary table of the voltage analysis results is included in Appendix C

**Table 4-4: Contingent Voltages near POI**

| | | | Post - Project | | Pre - Project | | | |
|---|---|---|---|---|---|---|---|---|
| **Bus #** | **Bus Name** | **KV** | **BaseVolt** | **ContVolt** | **BaseVolt** | **ContVolt** | **Contingency Description*** | **Delta V** |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0064** | **1.0238** | **0.9990** | Malone 1 | 0.0074 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0252** | **1.0588** | **1.0204** | Malone 1 | 0.0048 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **0.8532** | **1.0588** | **0.8505** | Malone | 0.0027 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **0.9680** | **1.0238** | **0.9660** | Malone | 0.0020 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0220** | **1.0238** | **1.0215** | ALCOA-N ALCOA | 0.0005 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0206** | **1.0238** | **1.0203** | Colton-Stark | 0.0003 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0251** | **1.0238** | **1.0249** | 4+5 | 0.0002 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0211** | **1.0238** | **1.0209** | Colton-S Colton | 0.0002 |
| 136815 | LYMETP | 115.0 | **1.0044** | **1.0056** | **1.0051** | **1.0066** | BRM-TAY-LOWV | -0.0010 |
| 136816 | LYME | 115.0 | **1.0028** | **1.0039** | **1.0035** | **1.0049** | BRM-TAY-LOWV | -0.0010 |
| 136825 | RCKLDG_ | 115.0 | **1.0028** | **1.0039** | **1.0035** | **1.0049** | BRM-TAY-LOWV | -0.0010 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0238** | **1.0238** | **1.0248** | 147865 REYN T#2 115 148019 REYNLD B 13.8 1 | -0.0010 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0238** | **1.0238** | **1.0248** | Dennison | -0.0010 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0406** | **1.0588** | **1.0551** | ALLENS-Parishvl | -0.0145 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0400** | **1.0588** | **1.0541** | PARISHVILLE-NORTHRIDGE | -0.0141 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0422** | **1.0588** | **1.0550** | Colton | -0.0128 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0425** | **1.0588** | **1.0550** | Colton 2 | -0.0125 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0426** | **1.0588** | **1.0550** | COLTON-Allen | -0.0124 |
| 136918 | MALONE 3 | 34.5 | **1.0555** | **1.0325** | **1.0588** | **1.0423** | 136783 MALONE 115 136918 MALONE 334.5 2 | -0.0098 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0092** | **1.0238** | **1.0177** | ALLENS-Parishvl | -0.0085 |
| 136926 | NICHOLVI | 34.5 | **1.0227** | **1.0083** | **1.0238** | **1.0162** | PARISHVILLE-NORTHRIDGE | -0.0079 |
| 136827 | STLAW115 | 115.0 | **1.0029** | **1.0029** | **1.0036** | **1.0039** | Dennison | -0.0010 |
| 136816 | LYME | 115.0 | **1.0028** | **1.0028** | **1.0035** | **1.0038** | Dennison | -0.0010 |
| 136825 | RCKLDG_ | 115.0 | **1.0028** | **1.0028** | **1.0035** | **1.0038** | Dennison | -0.0010 |
| 136826 | RCKLEDG | 115.0 | **1.0028** | **1.0028** | **1.0035** | **1.0038** | Dennison | -0.0010 |

*Appendix B.1 has detailed contingency descriptions

# 5. Power Factor Evaluation

FERC has designated a power factor requirement for wind farms which states that the wind farm must have the capability to operate across the full power factor range from 0.95 lagging (injecting) to 0.95 leading (absorbing) at the POI. However, this requirement only goes into effect if the transmission provider shows that it is needed. NYISO has created a test procedure (*NYISO Test Procedure for Evaluating Power Factor Requirements for Wind Generation Interconnection Projects (Technical Bulletin #148)* to determine if a proposed wind farm needs to meet this requirement. NYISO requires that the proposed wind farm be capable of maintaining the POI and adjacent bus voltages within 0.005 per unit of their pre-project levels, for both normal and contingency conditions. The full set of requirements is identified in NYISO Technical Bulletin #148.

For the purpose of this Test Procedure, a change in voltage at the POI or the adjacent buses of greater than +/- 0.5% of nominal voltage (+/- 0.005 Per Unit) were considered significant. Three critical contingencies were identified for the test:

- Loss of Parishville – North Ridge 115 kV Line
- Loss of Nicholville – North Ridge 115 kV Line
- Loss of Colton – Allens F 115 kV line

Voltage was monitored at the following buses, including the POI bus.

- Nicholville 115 kV (NICHOLVL)
- Parishville 115 kV (PARISHVL)
- Q354 North Ridge Wind POI 115 kV (Q354NRWND)

The test results show that the Project passed Step 1 of the Procedure identified in NYISO Technical Bulletin #148. Therefore, the reactive capability proposed for the Project is adequate.

The detailed test results are included in appendix E.

# 6. Short Circuit Analysis

A short circuit analysis was performed to assess the impact of the Project on the adequacy of existing circuit breakers and related equipment in the Study Area. This analysis was performed in accordance with the NYISO Guideline for Fault Current Assessment.

## 6.1 Methodology

Short circuit analysis was performed in accordance with the "NYISO Guideline for Fault Current Assessment" (SC Guideline) using the ASPEN One-Liner Program. Three-phase-to-ground, two-phase-to-ground, and single-phase-to ground faults were simulated on the case without the Project and repeated on the case with the Project to identify project impact.

In accordance with the SC Guideline, the short circuit calculation assumed that all currently existing facilities (lines, transformers, feeders, series reactors, generators and synchronous condensers) within and outside New York State and all higher queued interconnection projects specified in the SIS Scope (Appendix A) are in service. The calculation further assumed the following system conditions:

**1)** All loads, shunts and transformer magnetizing branches are ignored.

**2)** LTC Transformer tap ratios are set to 1:1, and 30 degree phase shifts in delta-wye transformer connections are modeled.

**3)** Generators are modeled using subtransient saturated reactance and internal voltages of all generators are set to one per unit, with the angle set by the reference bus (Marcy 345 kV).

## 6.2 Criteria

Three-phase-to-ground, two-phase-to-ground, and single-phase-to-ground faults were simulated at 34.5 kV and above substations in the Study Area to identify substations where the impact of the Project exceeds 100 A. At each substation, the highest of these three fault currents was compared against the lowest circuit breaker rating in the respective substation to determine if circuit breakers might be overdutied. The impact at a substation is deemed to be significant if the fault current exceeds the lowest circuit breaker rating or the Project increases fault current by more than 100 A.

The lowest circuit breaker ratings at the buses/substations studied were provided by the Transmission Owner/s.

## 6.3 Model Development

The NYISO developed short circuit models with and without the Project that include positive, negative and zero sequence parameters of the New York State power system and surrounding transmission networks. These models include the higher queued projects specified in the SIS Scope (Appendix A) and correspond to Case 1 and Case 2 as described in Section 3.

## 6.4 Results

Table 6-1 shows fault currents calculated at the substations in proximity to the POI. It is shown in the table that the Project increases fault duties at nearby buses but does not cause any breaker over duty at the Substations studied.

A full table showing a comparison of short circuit currents at all substations studied is included in Appendix D.

**Table 6-1: Substation Total Fault Duties (kA)**

| | | Case with Project | | | | Case with out Project | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bus Name** | **kV** | **3LG(kA)** | **2LG(kA)** | **1LG(kA)** | **Largest SC Current (kA)** | **3LG(kA)** | **2LG(kA)** | **1LG(kA)** | **Largest SC Current (kA)** | **Delta in Largest SC Current (kA)** | **Lowest Breaker Rating (kA)** |
| COLTON | 115 | 12.25 | 11.85 | 11.32 | 12.25 | 11.67 | 11.25 | 10.67 | 11.67 | 0.58 | **12.5** |
| COLTON GEN | 115 | 12.23 | 11.82 | 11.3 | 12.23 | 11.65 | 11.23 | 10.65 | 11.65 | 0.58 | N/A |
| ALLENS FALLS | 115 | 6.32 | 6.02 | 5.11 | 6.32 | 5.87 | 5.5 | 4.45 | 5.87 | 0.45 | N/A |
| MALONE | 115 | 6.56 | 6.07 | 4.83 | 6.56 | 6.3 | 5.79 | 4.46 | 6.3 | 0.26 | **40** |
| S COLTON | 115 | 7.2 | 7.17 | 6.94 | 7.2 | 7.03 | 7.02 | 6.8 | 7.03 | 0.17 | **40** |
| AHDC-POTSDAM | 115 | 7.89 | 7.17 | 5.22 | 7.89 | 7.75 | 7.05 | 5.14 | 7.75 | 0.14 | N/A |
| HEWITTVILLE | 115 | 7.81 | 7.09 | 5.16 | 7.81 | 7.68 | 6.97 | 5.08 | 7.68 | 0.14 | N/A |
| BROWNS F LOW | 115 | 7.45 | 6.72 | 4.45 | 7.45 | 7.38 | 6.65 | 4.43 | 7.38 | 0.07 | N/A |
| BROWNS F UPP | 115 | 7.45 | 6.72 | 4.45 | 7.45 | 7.38 | 6.66 | 4.43 | 7.38 | 0.07 | **12.5** |
| NORFOLK | 115 | 7.3 | 6.6 | 4.97 | 7.3 | 7.23 | 6.53 | 4.92 | 7.23 | 0.07 | **40** |
| LITTLE RIV 8 | 115 | 4.64 | 4.27 | 3.36 | 4.64 | 4.57 | 4.21 | 3.32 | 4.57 | 0.07 | N/A |
| BLAKE | 115 | 4.76 | 4.73 | 4.55 | 4.76 | 4.69 | 4.67 | 4.5 | 4.69 | 0.07 | 40 |
| RAYMONDVILLE | 115 | 6.09 | 5.49 | 4.03 | 6.09 | 6.04 | 5.45 | 4 | 6.04 | 0.05 | N/A |
| NEWTON FALLS | 115 | 5.55 | 5 | 3.34 | 5.55 | 5.51 | 4.96 | 3.33 | 5.51 | 0.04 | N/A |
| MCINTYRE | 115 | 4.51 | 4.53 | 4.25 | 4.53 | 4.48 | 4.5 | 4.23 | 4.5 | 0.03 | 40 |
| D-BENSN | 115 | 4.87 | 4.52 | 3.04 | 4.87 | 4.84 | 4.49 | 3.03 | 4.84 | 0.03 | N/A |
| OGDENSBURG | 115 | 4.01 | 3.96 | 3.62 | 4.01 | 3.98 | 3.93 | 3.6 | 3.98 | 0.03 | N/A |
| N OGDENSBURG | 115 | 4.43 | 4.78 | 4.71 | 4.78 | 4.41 | 4.75 | 4.69 | 4.75 | 0.03 | **40** |
| TAYL. BLACK | 115 | 10.47 | 9.58 | 7.35 | 10.47 | 10.45 | 9.56 | 7.34 | 10.45 | 0.03 | **40** |
| TAYL. WHITE | 115 | 10.47 | 9.58 | 7.35 | 10.47 | 10.45 | 9.56 | 7.34 | 10.45 | 0.03 | **40** |
| BENSONS1 | 115 | 4.52 | 4.21 | 2.84 | 4.52 | 4.49 | 4.18 | 2.83 | 4.49 | 0.02 | N/A |
| OEF | 115 | 4.21 | 4.67 | 4.64 | 4.67 | 4.19 | 4.65 | 4.62 | 4.65 | 0.02 | N/A |
| BENSONS2 | 115 | 4.42 | 4.12 | 2.8 | 4.42 | 4.4 | 4.1 | 2.79 | 4.4 | 0.02 | N/A |
| MALONE | 34.5 | 3.95 | 3.97 | 3.89 | 3.97 | 3.92 | 3.95 | 3.87 | 3.95 | 0.02 | N/A |
| NICHOLVIL UP | 34.5 | 2.58 | 2.59 | 2.49 | 2.59 | 2.55 | 2.57 | 2.47 | 2.57 | 0.02 | N/A |
| NICHOLV LO | 34.5 | 2.58 | 2.59 | 2.49 | 2.59 | 2.55 | 2.57 | 2.47 | 2.57 | 0.02 | N/A |
| BATTLE HILL | 115 | 3.01 | 2.99 | 2.62 | 3.01 | 2.99 | 2.97 | 2.61 | 2.99 | 0.02 | **12.5** |
| DEKALB | 115 | 2.93 | 2.8 | 2.37 | 2.93 | 2.92 | 2.78 | 2.36 | 2.92 | 0.02 | N/A |
| CAP 1 | 115 | 1.85 | 2.11 | 2.12 | 2.12 | 1.83 | 2.09 | 2.11 | 2.11 | 0.02 | N/A |
| LAKE COLBY | 115 | 1.85 | 2.11 | 2.12 | 2.12 | 1.83 | 2.09 | 2.11 | 2.11 | 0.02 | **20** |
| SW. X21-1 | 34.5 | 2.11 | 1.93 | 1.38 | 2.11 | 2.1 | 1.92 | 1.38 | 2.1 | 0.01 | N/A |
| | | | | | | | | | | | N/A |

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# 7. Preliminary Cost Estimates

This section provides a description and non-binding cost estimate of the Connecting Transmission Owner's (CTO) System Upgrade Facilities and Attachment Facilities required for the interconnection of the Project to the New York State Transmission System via the CTO's Line #3.

A non-binding good faith cost estimate of National Grid's Attachment facilities and System Upgrade Facilities (transmission line protection, transmission line modification, circuit breakers, relays, bus structures, etc.) and associated labor to accommodate the Project is $7,711,000 dollars ($7.711 million), plus or minus 40%, and the estimated time to construct these facilities is about 8 to 10 months, not including engineering, equipment procurement and weather delays.

All cost estimates presented herein were provided by the CTO and exclude:

- Property acquisition;
- Property, income, and use taxes;
- Future operation and maintenance costs;
- Legal fees;
- Adverse field conditions such as rock, water, matting, road construction, weather, and Developer electrical equipment obstructions;
- POI Station site grading beyond normal clearing, rough grading and topsoil removal;
- Telecommunications circuits;
- Costs associated with the engineering review and acceptance of the Interconnection Customer's Interconnection Facilities;
- Access road;
- Landscaping;
- Costs associated with permitting and licensing;
- Preparation, inspection or construction necessary to meet stormwater compliance requirements;
- Extended construction hours to minimize outage time or National Grid's public duty to serve;
- The cost of any temporary construction service, or any required permits; and
- Distribution station service"

## 7.1 Description of System Upgrade Facilities (SUFs)

### 7.1.1 POI Station

The North Ridge Wind Project shall be interconnected to the National Grid 115kV Colton-Malone Line #3 via a three breaker ring bus station ("Point of Interconnection Station" or "POI Station"). This station shall include, but not be limited to, the following:

- Three (3)- 3 phase, 115 kV, 2000 amp, gang-operated line disconnect switches;
- Minimum 2000 amp rated tubular aluminum bus conductors;

- Three (3)- 115 kV, 2000 amp, 40 kA, 550 kV BIL, SF6 insulated, dead tank circuit breakers, with provision for a future 4th breaker and isolation switches in the ring bus;
- Six (6)- 3 phase, 115 kV, 2000 amp gang-operated isolation switches;
- Nine (9) single-phase capacitive voltage transformers (CVTs) for protection and control);
- Three (3)- 120 kV duty rated (98 kV MCOV) surge arresters;
- All required foundations and structures to support the above equipment;
- All required conduit and/or cable trench for protection and control wiring;
- A relay and control building of adequate size to contain the National Grid protection and control equipment, station battery banks, telecommunications and metering equipment;
- Protective relaying per National Grid requirements with both primary and backup protection packages. This includes the local interface equipment for protective relay communications (DTT & POTT) to the remote National Grid line protection relays;
- Station service voltage transformers tapped from each of the incoming transmission lines or local distribution, with automatic transfer capability, to provide two independent sources of station power;
- Station lightning protection, ground grid and grounding, security fence, and lighting; and
- Remote Terminal Unit to provide SCADA equipment.

The non-binding, good faith, cost estimate for the POI Station is $4,865,000 +/-40%.

### 7.1.2 Remote Stations

To provide proper line protection, protective relay modifications are required at the Colton and Malone Substations, as follows:

a) Colton Substation

The transmission line protection equipment at the Colton Substation shall be upgraded as follows:

1. Implementation of a pilot communication scheme between the Colton Substation and the POI Station. The telecommunications medium (e.g., leased phone line, digital microwave, fiber optic) shall be determined during preliminary engineering;
2. RFL9745 audio tone equipment shall be added to convert the ‘A’ scheme to a POTT scheme;
3. Dual channel DTT receive, a new SEL-351 relay, and associated telecommunications shall be installed for the detection of breaker failure at the POI Station;
4. Engineering, design, construction, and testing/commissioning labor for the above; and
5. Development, implementation, and testing of new settings for the existing ‘A’ and ‘B’ Line #3 protection relay packages.

The non-binding, good faith, cost estimate for the SUFs at the Colton Substation is $648,000 +/-40%.

b) Malone Substation

The transmission line protection equipment at the Malone Substation shall be upgraded as follows:

1. Implementation of a pilot communication scheme between the Colton Substation and the POI Station. The telecommunications medium (e.g., leased phone line, digital microwave, fiber optic) shall be determined during preliminary engineering;
2. RFL9745 audio tone equipment shall be added to convert the ‘A’ scheme to a POTT scheme;
3. Dual channel DTT receive, a new SEL-351 relay, and associated telecommunications shall be installed for the detection of breaker failure at the POI Station;
4. Engineering, design, construction, and testing/commissioning labor for the above; and
5. Development, implementation, and testing of new settings for the existing ‘A’ and ‘B’ Line #3 protection relay packages.

The non-binding, good faith, cost estimate for the SUFs at the Malone Substation is $648,000 +/-40%.

### 7.1.3 Colton - Malone #3 Line Interconnection

Assuming the POI Station is approximately 200 ft. from the Line #3 POI, the physical interconnection of the POI Station to the existing 115kV Colton-Malone #3 Line is to be near Structure 77 and will be a 115kV loop tap with 200 ft loop segments. Between Structures 76 and 77, two steel 3 pole dead end pull off structures will be installed on the #3 line, and 200 ft. of 795 kcmil 26/7 ACSR “Drake” conductor and 3/8” EHS shieldwire will be strung to the POI Station.

The non-binding, good faith, cost estimate for the Line #3 interconnection is $1,250,000 +/-40%, assuming the POI Station is approximately 200 ft from the Line #3 POI.

## 7.2 Connecting Transmission Owner Attachment Facilities(CTO AFs)

The CTO AFs shall consist of revenue metering, including three (3) 115kV combination CT/VT metering transformers, and a 115kV, 2000 Amp continuous, 100kA momentary capability, 550kV BIL gang operated disconnect switch with manual operators with associated structure and minimum 2000 Amp rated tubular aluminum bus conductors.

The estimated non-binding, good faith cost estimate for the CTO AFs is approximately $300,000 +/-40%, excluding telecommunications circuits.

# 8. Conclusions

From the overall results of this Feasibility study, the following conclusions can be drawn:

**Power flow analysis:**

1) All facilities (transmission lines, transformers, etc) within the Study Area were found to be within their ratings under normal and under contingency conditions with the exception of Lawrence 115/13.2 kV transformers which, with the addition of the Project, overloads for the contingency loss of 115 kV branches in the vicinity of the transformer. These overloads can be eliminated by slightly modifying generation dispatch for the pre-contingency condition. The generation modification included reducing generation at the SUGAR IS units by 0.8 MW and increasing the same amount of generation at the LAWRENCE units. With this modified dispatch, the Project does not cause any new overloads under normal and contingency condition. No other adverse system thermal impacts were found as a result of this Project.

2) The over voltages that existed pre-project post contingency remained to exist in the post-project post contingency conditions at Malone 3 and Nicholville 34.5 kV buses. No detrimental voltage impacts were found as a result of this Project. Therefore, the Project is considered as having no negative impact on the voltage violations within the Study Area.

**Power factor evaluation:**

The power factor test results show that the Project passed Step 1 of the NYISO Test Procedure for Evaluating Power Factor Requirement for Wind Generation Interconnection Projects. Therefore, the reactive capability proposed for the Project is adequate.

**Short circuit analysis:**

The short circuit currents on circuit breakers at the substations near the POI were found to be within the lowest substation breaker rating with the addition of the Project. The Project increased the fault currents at the nearby Substations but did not cause the fault current exceed the available maximum breaker rating at the Sub-stations studied.

**Preliminary cost estimates and Construction Times:**

A non-binding good faith cost estimate of National Grid's Attachment facilities and System Upgrade Facilities (transmission line protection, transmission line modification, circuit breakers, relays, bus structures, etc.) and associated labor to accommodate the Project is $7,711,000 dollars ($7.711 million), plus or minus 40%, and the estimated time to construct these facilities is about 8 to 10 months, not including engineering, equipment procurement and weather delays.