SUBSTATION DESIGN CRITERIA DOCUMENT

East Point Collector Station
Schoharie Co, NY

Prepared for

NextEra Energy

Prepared by

TRC
10 Maxwell Drive
Clifton Park NY 12065
Project # 327851

June 2019
# REVISION INDEX

**Written by:** Andrew Dion, PE - TRC  **Date:** April 1, 2019

**Revised by:**  **Date:**

**Reviewed by:** D. R. Gilman  **Date:** April 17, 2019

**Approved by:**  **Date:**

<table>
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<tr>
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<th>Description</th>
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<td>June 20, 2019</td>
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Design Criteria Document
Substation Systems

Project: East Point Collector Substation
Client: NextEra Energy
Project Location: Schoharie Co, NY
Date: June 2019
Revision: 0

General Description

Summary
East Point Collector Substation will be designed and built to collect roughly 50MW of PV solar power located in upstate New York and transmit to a nearby 69kV interconnection point. The 110’ x 144’ substation yard will consist of two (2) incoming 34.5kV collector line feeders, each with circuit breaker protection feeding onto the substation bus and through a 69-34.5kV Power Transformer with associated 69kV high voltage circuit breaker, disconnect switches, instrument transformers and revenue metering.
Standards and Reference Documents

Applicable federal, state, and local codes and standards shall also be observed. A summary of the industry codes and standards to be used are as follows:

Industry References

- ANSI: American National Standards Institute
- NEMA: National Electrical Manufacturers Association
- NESC: National Electrical Safety Code
- NEC: National Electrical Code
- AISC: American Institute of Steel Construction
- ASTM: American Society for Testing and Materials
- ACI: American Concrete Institute
- AWS: American Welding Society
- IEEE: Institute of Electrical and Electronics Engineers
- CSI: Construction Specifications Institute
- NFPA: National Fire Protection Association
- IES: Illuminating Engineering Society
- ASCE: American Society of Civil Engineers
- NPCC: Northeast Power Coordinating Council
## Design Criteria & System Parameters

### System Parameters – 69kV System

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Nominal Voltage</td>
<td>69kV Line to Line</td>
</tr>
<tr>
<td>Maximum Design Level Voltage</td>
<td>72kV</td>
</tr>
<tr>
<td>Basic Impulse Level</td>
<td>350kV</td>
</tr>
<tr>
<td>Design Continuous Amperage</td>
<td>1200 Amps</td>
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<tr>
<td>Fault Current Level (Equipment)</td>
<td>40kAIC (RMS Symmetrical)</td>
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<tr>
<td>Grounding</td>
<td>Grounded Wye</td>
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<tr>
<td>Post Project 3 Phase-Fault Current</td>
<td>20kA (3L-Gnd)</td>
</tr>
<tr>
<td>3 Phase Fault Current for Bus Design</td>
<td>30kA</td>
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<tr>
<td>Post Project 1 Line to Gnd. Fault Current</td>
<td>17.5kA</td>
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<td>L-Gnd. Fault Current for Ground Grid Design</td>
<td>20kA</td>
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<td>Min. Withstand Fault Capability:</td>
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<tr>
<td>• Short Time</td>
<td>38kA</td>
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<tr>
<td>• RMS Asymmetrical (Momentary)</td>
<td>61kA</td>
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<tr>
<td>• Peak Asymmetrical</td>
<td>99kA</td>
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<td>Post Project Line-Line Fault Current</td>
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### System Parameters – 34.5kV System

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<td>Fault Current Level (Equipment)</td>
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<tr>
<td>Grounding</td>
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<tr>
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<tr>
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<td>L-Gnd. Fault Current for Ground Grid Design</td>
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<td>Min. Withstand Fault Capability:</td>
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<tr>
<td>• Short Time</td>
<td>38kA</td>
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<tr>
<td>• RMS Asymmetrical (Momentary)</td>
<td>61kA</td>
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<tr>
<td>• Peak Asymmetrical</td>
<td>99kA</td>
</tr>
<tr>
<td>Post Project Line-Line Fault Current</td>
<td>30kA</td>
</tr>
</tbody>
</table>

Listed design values to be validated and updated during detail engineering based on System Impact Study (SIS) and corresponding Aspen fault model for the collector substation.
Electrical Clearances

Yard Clearances

The substation shall be designed to provide at a minimum, the yard clearances and spacing in Table 1-1. Equipment spacing shall be in accordance with the applicable codes.

<table>
<thead>
<tr>
<th>Nominal Operating Voltage (Ph-Ph)</th>
<th>Basic Impulse Level (BIL)</th>
<th>Minimum Phase-to-Phase, Metal-to-Metal, Inches</th>
<th>Phase-to-Ground, Metal-to-Metal, Inches</th>
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<tr>
<td>(kV Nom)</td>
<td>(kV Peak)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>350</td>
<td>31</td>
<td>25</td>
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<tr>
<td>34.5</td>
<td>200</td>
<td>18</td>
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1 ANSI C37.32  
2 NESC, Section 12

Outdoor Bus Clearances & Spacings

Standard Phase Spacings

<table>
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<tr>
<th>Voltage</th>
<th>Spacing</th>
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<tr>
<td>69kV</td>
<td>8’ – 0”</td>
</tr>
<tr>
<td>34.5kV</td>
<td>3’ – 0”</td>
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</table>

The substation bus shall be designed to maintain the clearances and spacing in Table 1-2. The values given below shall be treated as the minimum allowed.

<table>
<thead>
<tr>
<th>Nominal Operating Voltage (Ph-Ph), kV Nom</th>
<th>Basic Impulse Level (BIL)</th>
<th>Vertical Clearance of Unguarded Parts, Inches</th>
<th>Horizontal Clearance of Unguarded Parts, Inches</th>
<th>Vertical Break Disconnecting Switches, Inches</th>
<th>Side Break Disconnecting Switches, Inches</th>
<th>All Horn Gap Switches (Vertical and Side Break), Inches</th>
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<tr>
<td>72.5</td>
<td>350</td>
<td>125</td>
<td>59</td>
<td>60</td>
<td>72</td>
<td>84</td>
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<tr>
<td>34.5</td>
<td>200</td>
<td>114</td>
<td>48</td>
<td>36</td>
<td>48</td>
<td>60</td>
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</tbody>
</table>

1 ANSI C37.32  
2 NESC, Section 12

High & Medium Voltage Bus System & Hardware

Bus

Tubular bus fittings shall be 360 degree circumferential swage 2 piece compression type with NEMA configured equipment terminal pad configurations as manufactured by DMC or approved equal. All tubular bus spans exceeding 20’ shall include 795KCM AAC dampening cable for Aeolian vibration control. Bus supports shall be bolted aluminum two piece ring type - capable of either slip of fixed
support with anti-chatter springs. The 34.5kV tubular aluminum bus will be 2 or 4 inch I.P.S., and will transition to 1272KCM or 795KCM AAC to 69kV and 34.5kV yard equipment.

**Conductors**

69kV conductor leads for the yard equipment will be (1) 1272KCM AAC. Transformer conductor leads will be (1) 1272KCM AAC.

34.5kV conductor leads for the cable terminators and surge arresters will be (1) 1272KCM AAC. Transformer conductor leads will be (1) 1272KCM AAC.

**Insulators**

The load on the insulator (cantilever, tension, compression, torsion) shall not exceed the respective insulator strength published in ANSI C29.9, Tables 1 or 2. All insulators for the rigid bus system and disconnect switches shall be porcelain station post, standard creep, and shall be ANSI 70 gray in color. Standard strength, High strength or Extra-high strength insulators will be specified according to project criteria resulting from three phase symmetrical bus design fault current.

**Apparatus Insulators (69kV):**

- Nominal Voltage 69kV
- Type Station Post
- BIL 350kV
- Color ANSI-70
- Cantilever Strength 1500/3000 lbs standard/high strength
- NEMA TR No. 216/278

**Apparatus Insulators (34.5kV):**

- Nominal Voltage 34.5kV
- Type Station Post
- BIL 200kV
- Color ANSI-70
- Cantilever Strength 2000 lbs minimum (standard strength)
- NEMA TR No. TR-210
Major Equipment

(1) - 69/34.5/13.8kV Power Transformer
- Vendor: TBD
- High Voltage: 69kV Grounded-Wye
- Low Voltage: 34.5kV Grounded-Wye
- Ter. Voltage: 13.8kV Delta (Buried)
- MVA: 36/48/60

34.5kV Switch
- Vendor: TBD
- Type: Vertical Break
- Voltage: 38kV
- BIL: 200kV
- Cont. Current: 1200A
- kA Mom.: 61kA

69kV Operated Line Switch
- Vendor: TBD
- Type: Vertical Break
- Voltage: 69kV
- BIL: 350kV
- Cont. Current: 1200A
- kA Mom.: 61kA
- Control Volt.: 125VDC

69kV Transformer Switch
- Vendor: TBD
- Type: Center Break
- Voltage: 69kV
- BIL: 350kV
- Cont. Current: 1200A
- kA Mom.: 61kA

69kV Ground Switch
- Vendor: TBD
- Type: Vertical Break
- Voltage: 69kV
- BIL: 350kV
- kA Mom.: 61kA
AC Station Service

Design Criteria
The AC station service system shall be sized to accommodate all new and known future substation AC power requirements. AC Station service will be established from two independent sources.

The Primary station service will originate from the 34.5kV bus and feed a single phase 25kVA transformer. A 240/120V grounded-wye, 1 phase, 3 wire secondary will be derived and used as the Primary station service.

The Alternate station service will originate from a nearby distribution line or emergency generator and will be selected during the detailed design process.

An automatic transfer switch (ATS) will be installed and fed from the two independent station service sources.

Substation Lighting

Design Criteria
All interior building and exterior yard lighting will be designed per NextEra Energy or applicable industry standard. Outdoor Yard lighting designed to a 2.4 foot-candle average, and will be building wall, and pole structure mounted. Light fixture maintenance can be accomplished with equipment / bus in service by qualified personnel.

Materials
- Building Entry Light, Wallpack, 70W, HPS, with Full Visor
  - Lithonia TWA-70S
- Floodlight, 250W, HPS
  - Lithonia TFLU-250S

Direct Stroke Protection

Design Criteria
A three (3) 60ft. lightning mast will be utilized for the direct stroke protection. The analysis of then lightning protection for the substation yard will employ IEEE-998 “Rolling Sphere method” for the 69kV voltage level and “Fixed Angle method” for the voltages below 69kV.

Grounding

Design Criteria
The fault current that will be used for grounding system design will be based on 20 kA. IEEE-80 Standard current split factor will be used to determine the return ground current.
Subgrade Grounding
A 4/0 (19 strand) copperweld conductor will be installed 18” below finish yard grade. The 4/0 conductor will be arranged throughout the yard in an overlapping rectangular grid pattern, extending 3 feet beyond the fenceline (including gate swing radius), with 20 foot by 20 foot spacing as determined by design software. The grid spacing will be closer in the proximity of electrical equipment, and will be connected at all conductor intersections. Two (2) steel copper clad ground rods ¾” x 10’, with threaded couplings will be installed as dictated by design software and client standards throughout the yard area connected to the 4/0 grid, to enhance the grid system’s effectiveness, by penetrating into stable & lower resistivity unfrozen soil layers. The sub-grade ground grid connectors will be the “Hyground irreversible compression system” type - as manufactured by Burndy. All group operated airswitch mechanisms will have personnel protection mats below grade (installed with 4” of crushed stone cover) at each operating mechanism location. This protection mat will be connected to the operating handle, and to the ground grid to maximize personnel protection from touch potentials. Connected pigtails (4/0) extending from the subgrade grid to the base of equipment structures, and stands will bond all above grade facilities. The below grade grounding conductor will loop around yard structures. The substation yard finish grade will consist of a 4 inch layer of coarse crushed rock (3,000 OHM-meter), which is considered for safe yard step and touch potentials.

Structure & Equipment Grounding
Ground grid pigtails will connect to the base of structure legs using bronze bolted or copper compression clamps as required at each leg for single and double leg structures, or at diagonally opposite legs for four leg structures and stands. Bronze mechanical connectors will also support jacketed 4/0 copper conductor to be run along structures and stands for grounding of equipment casings, surge arresters, ground switches, and overhead shield wires.

Where aluminum structures are used, bolted connections will be used and connections will be plated to accept copper conductors. Copper conductors shall be covered in solid dielectric insulation to avoid dissimilar metal corrosion from the contact of aluminum and copper.

All above grade equipment will be properly bonded to the station ground grid using a continuous conductor path.

Fence Grounding
The substation perimeter fence posts will be bonded using 4/0 copperweld pigtails from the station ground grid at regular intervals, and where each overhead transmission phase conductor (if applicable) crosses the fenceline with bolted bronze pipe-type mechanical connectors. Fence corner and gate posts shall be bonded directly to a ground rod. Gate frames and top rails will be bonded with 1/0 stranded copper, with the gate frame using a high strand 600V welding cable for maximum flexibility. Grounding of the chain-link fence, barbs, and bottom tension wire will be completed with a #2 stranded bare copper conductor and tinned bronze split bolt mechanical connectors.
1. THIS DESIGN ASSUMES EACH WIND-TURBINE GENERATOR STEP-UP OPERATES WYE-WYE WITH FOUR WIRE COLLECTOR LINES TO COLLECTOR SUBSTATION FOR A SOLIDLY GROUNDED FACILITY AT 34.5KV. NO GROUND BANK IS SHOWN UNDER THIS ASSUMPTION.

2. VOLTAGE WILL BE REGULATED AT EACH COLLECTOR LINE BY FEEDER NETWORK INVERTERS.
ADJUST DIRECTION OF NORTH ARROW AS NEEDED

51'-0"

REFERENCE DRAWINGS:
- 327851-100 - EAST POINT POWER ONE LINE DIAGRAM
- 327851-102 - EAST POINT ELEVATIONS & SECTIONS A-A, B-B
- 327851-103 - EAST POINT SECTIONS C-C, D-D
- 327851-104 - EAST POINT YARD LIGHTING PLAN
- 327851-105 - EAST POINT FENCE & GROUNDING PLAN
- 327851-106 - EAST POINT FENCE & GROUNDING DETAILS
- 327851-107 - EAST POINT CONTROL HOUSE ELECTRICAL LAYOUT PLAN
ELEVATION A-A

REFERENCES:
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327851-101 - EAST POINT GENERAL ARRANGEMENT PLAN
327851-103 - EAST POINT SECTIONS C-C, D-D
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327851-106 - EAST POINT FENCE & GROUNDING DETAILS
327851-107 - EAST POINT CONTROL HOUSE ELECTRICAL LAYOUT PLAN

NOTES:
1. BUS SUPPORTS PROVIDED AND INSTALLED AS SHOWN FOR THE FOLLOWING TYPES:
   - F - FIXED BUS SUPPORT
   - S - SLIP BUS SUPPORT
   - EX - EXPANSION BUS SUPPORT
2. CLEARANCES FOR ALL BUS & CONDUCTOR TO BE PER VALUES PUBLISHED IN ANSI C37.32 TABLE 5:
   - 69KV-PHASE TO PHASE 7'-0" (CENTERLINE-CENTERLINE)
   - 69KV-PHASE TO GROUND 2'-1" (METAL TO METAL)
   - 34.5KV-PHASE TO PHASE 3'-0" (CENTERLINE-CENTERLINE)
   - 34.5KV-PHASE TO GROUND 1'-3" (METAL TO METAL)
3. WIRE CONDUCTOR MINIMUM BEND RADIUS TO BE INSTALLED NO LESS THAN:
   - 1272KCM-20 INCHES
   - 336KCM-10 INCHES
   - 4/0 COPPER-8 INCHES
   - 2/0 COPPER-6 INCHES
   - 1/0 AMC-5.5 INCHES
   - #2 COPPER-4 INCHES

REFERENCE DRAWINGS:
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NOTE 4

1. BUS SUPPORTS PROVIDED AND INSTALLED AS SHOWN FOR THE FOLLOWING TYPES:
   - F - FIXED BUS SUPPORT
   - S - SLIP BUS SUPPORT
   - EX - EXPANSION BUS SUPPORT

2. CLEARANCES FOR ALL BUS & CONDUCTOR TO BE PER VALUES PUBLISHED IN ANSI C37.32 TABLE 5:
   - 115KV-PHASE TO PHASE 7'-0" (CENTERLINE-CENTERLINE)
   - 115KV-PHASE TO GROUND 2'-1" (METAL TO METAL)
   - 34.5KV-PHASE TO PHASE 3'-0" (CENTERLINE-CENTERLINE)
   - 34.5KV-PHASE TO GROUND 1'-3" (METAL TO METAL)

3. WIRE CONDUCTOR MINIMUM BEND RADIUS TO BE INSTALLED NO LESS THAN:
   - 1272KCM-20 INCHES
   - 336KCM-10 INCHES
   - 4/0 COPPER-8 INCHES
   - 2/0 COPPER-6 INCHES
   - 1/0 AAAC-5.5 INCHES
   - #2 COPPER-4 INCHES

4. BUS TIE VOLTAGE TRANSFORMERS TO BE INSTALLED H1-PHASE HZ-GROUND.

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SCALE (FEET)
0 5 10
1'-0" = 1'-0"
**YARD LIGHTING SCHEDULE**

<table>
<thead>
<tr>
<th>LIGHT NO.</th>
<th>TYPE DESCRIPTION</th>
<th>WATTAGE</th>
<th>ORIENTATION DEGREES</th>
<th>MOUNTING LOCATION</th>
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<td>YL1</td>
<td>TFLU 250W</td>
<td>250</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>YL2</td>
<td>TFLU 250W</td>
<td>250</td>
<td>320</td>
<td>60</td>
</tr>
<tr>
<td>YL3</td>
<td>TFLU 250W</td>
<td>250</td>
<td>220</td>
<td>60</td>
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<tr>
<td>YL4</td>
<td>TFLU 250W</td>
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<td>140</td>
<td>60</td>
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<td>YL5</td>
<td>TFLU 250W</td>
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<td>90</td>
<td>60</td>
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<tr>
<td>CHL1</td>
<td>TWA 70W</td>
<td>70</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>CHL2</td>
<td>TWA 70W</td>
<td>70</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
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**YARD LIGHT TILT ORIENTATION ANGLE**

- Tilt angle range: 0° to 60°

**NOTES:**

1. Yard flood fixtures YL-1, YL-2, YL-3, YL-4, YL-5 & YL-6 are mounted 30'-0" above finished grade.
2. Exterior control house fixtures are mounted 10'-0" above finished grade.
3. Incident light level points are spaced at 10' x 10'.
4. The average illumination in the substation yard is 3.4 footcandles.
5. Yard lighting control equipment is defined on DWG. 327851-XX.
6. Lighting calculations were performed using VISUAL 2016, Version 2.08.
7. Overall site layout includes proposed perimeter and proposed work lighting.
8. Perimeter lighting control options are On/Off/Auto.
9. Work lighting control options are On/Off.

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**REFERENCES REV DESCRIPTION DATE DES CHK APP**

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**PLAN VIEW**

- Scale: 1/8" = 1'-0"
- Preliminary
PRELIMINARY

EAST POINT
34 KV COLLECTION SUBSTATION
FENCE & GROUNDING PLAN

NOTE:

1. A FORMED PERIMETER GROUND CONDUCTOR MUST BE CONTINUOUSLY BURIED AT A MINIMUM DEPTH OF 2'-0" BELOW GRADE.
2. ALL TAPS SHALL EXTEND AT LEAST 6'-0" ABOVE FINISHED GRADE (AFG) AND FOR EVERY THIRD OR FOURTH LINE POST.
3. TAPS FROM MAIN GRID SHALL BE AT LOCATIONS INDICATED BURIED AT A MINIMUM DEPTH OF 2'-0" BELOW GRADE.
4. PROVIDE TAPS FOR FENCE GROUND AT EACH GATE POST, CORNER POST STRUCTURE COLUMNS, EQUIPMENT, ETC.
5. PERIMITER GROUND CONDUCTOR

LEGEND OF SYMBOLS:

FONT DESCRIPTION MATERIAL MARK