Hoffman Falls Wind Project

Matter No. 23-00038

900-2.22 Exhibit 21

Electric System Effects and Interconnection

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EXHIBIT 21 ELECTRIC SYSTEM EFFECTS AND INTERCONNECTION

(a) Proposed Electric Interconnection

Interconnection of the proposed Facility to the electrical grid will be achieved using multiple systems. The wind turbines produce power at a low voltage, which will be stepped up to a medium voltage (34.5 kilovolts [kV]) at the output of each turbine. A medium voltage collection system comprised of underground cables and the collection substation will transmit the power to the point of interconnection (POI) switchyard. The POI will be on the National Grid Cortland to Fenner Wind 115 kV line and will be located approximately 1.2 miles southwest of the Fenner substation.

(1) Design Voltage and Voltage of Initial Operation

The Facility is grouped into 5 different three-phase collection circuits, each with their own wind turbine and 34.5 kV cable network, which will terminate at the collection substation feeder circuit breakers. The collection substation will step up the voltage to 115 kV and deliver power to the adjacent POI switchyard. The POI switchyard will be constructed by the Applicant, in accordance with the design specifications provided by National Grid. The POI switchyard will be a 115 kV 3-CB ring bus with three-line terminals; two of them are for two National Grid 115 kV lines cut-in and cut-out, one is for linking to the collection substation. Two short parallel cut-in/out lines, each approximately 148 feet in length, will connect the POI switchyard to the National Grid transmission system, allowing power to be delivered from the Facility to the grid.

(2) Type, Size, Number, and Materials of Conductors

Between the collection substation and the POI switchyard, there will be one approximately 125-foot-long 795 kilo circular mils (kcmil) aluminum conductor steel reinforced (ACSR) 115 kV overhead generation tie (gen-tie) line. Between the POI switchyard and National Grid existing lines, there will be two approximately 148-foot-long 115 kV overhead cut-in/out lines. The conductor for these lines will be determined by National Grid.

The collection system is comprised of 34.5 kV underground medium voltage (MV) cables. The total length of the collection lines is approximately 30 miles,[1] and the lines will be aluminum cables composed of sizes of 4/0 AWG to 1250 kcmil and will be direct buried or cable conduits inside station, under road path and wind turbine pads. Please see Exhibit 5 and Appendix 5-B for additional details.

(3) Insulator Design

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[1] In many areas, multiple circuits will be buried in parallel; in such cases, each circuit was summed separately to arrive at the total of 30.4 miles. The linear distance where one of more circuits will be installed consists of approximately 18.3 miles.

The insulators proposed to be used at the collection substation and POI switchyard will be station post type porcelain insulators with minimum 550kV basic insulation level (BIL) for 115 kV and 200kV BIL for 34.5 kV.

(4) Length of the Transmission Line

As described in Exhibit 21(a)(2), three short 115 kV overhead lines (gen-tie and cut-in/out, with a total length of less than 500 feet), will connect the new 115/34.5 kV collection substation to the new 115 kV POI switchyard then to the existing National Grid 115 kV transmission line.

Through the POI switchyard, the Facility will connect to the existing Cortland to Fenner Wind 115 kV transmission line owned and operated by National Grid, allowing power to be delivered from the Facility to the grid.

(5) Typical Dimensions and Construction Materials of the Towers

Three types of single-circuit steel poles will be utilized for the short lengths of overhead gen-tie and cut-in/out lines between the collection substation and POI switchyard and between the POI switchyard and the existing transmission line:

1. Dead-End single-phase poles for making horizontal turns from the existing line into the POI switchyard toward Fenner
2. Dead-End single-phase poles for making horizontal turns from the existing line into the POI switchyard toward Fenner and attachment of a shield wire
3. Dead-End single-phase poles for making horizontal turns from the existing line into the POI switchyard toward Cortland
4. Dead-End single-phase poles for making horizontal turns from the existing line into the POI switchyard toward Cortland and attachment of a shield wire
5. Dead-End three phase poles for making a vertically oriented turn from the POI switchyard to the collection substation.

Table 22-1. Overhead Tower Details

Tower Details	115 kV Line Poles				
	Dead End 1	Dead End 2	Dead End 3	Dead End 4	Dead End 5
Pole Length	82ft	95ft	77ft	90ft	70ft
Pole Height Above Ground	83ft	96ft	78ft	91ft	71ft
Vertical Phase Spacing	0ft	0ft	0ft	0ft	11ft
Horizontal Phase Spacing	11ft	11ft	11ft	11ft	0ft
OHSW to Top Phase Spacing	N/A	12ft	N/A	12ft	N/A
Foundation Type	Concrete	Concrete	Concrete	Concrete	Concrete
Overhead Shielding Wire	No	Yes	No	Yes	No

All 115 kV steel poles have been custom designed and will be galvanized steel. For typical details of the proposed tower structures, see Appendix 5-C.

(6) Design Standards for Each Type of Tower and Tower Foundation

The overhead 115 kV gen-tie and cut-in/out lines will be constructed in accordance with:

1. ASCE/SEI 48-11, Design of Steel Transmission Pole Structures
2. ACI 318-19, Building Code Requirements for Reinforced Concrete
3. ACI 336.3R-14, Report on Design and Construction of Drilled Piers
4. ACI 305 Specification for Hot Weather Concreting
5. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
6. ASCE 74, Guidelines for Electrical Transmission Line Structural Loading, American Society of Civil Engineers, 3rd Edition, 2010
7. New York State Department of Transportation (NYSDOT) Geotechnical Design Manual, State of New York Department of Transportation
8. American Institute of Steel Construction (AISC) 360-15, Steel Construction Manual (LRFD), 15th Edition
9. National Grid Structural Design Criteria.

(7) Type of Cable System and Design Standards for Underground Construction

From the transformer at each wind turbine, underground power cables and fiber optic communication cables, which comprise a single circuit, will collect the electricity produced by wind turbine generators. Where direct burial is not possible or not preferred, an open trench will typically be excavated. During open trenching, topsoil and subsoil will be segregated and stockpiled adjacent to the trench for use in site restoration. As utility trenches can provide a conduit for groundwater flow, trenches will be backfilled with material that approximately matches the permeability characteristics of the surrounding soil. Direct burial methods, through use of a rock saw, rock wheel trencher and/or similar equipment, will be used during the installation of underground electrical collection systems whenever possible.[2] If a rock saw is used, water or other nonhazardous compounds would be used as a lubricant. Direct burial will involve the installation of bundled cable (electrical and fiber optic bundles) directly into the "rip" in the ground created by the saw blade or rock wheel. The rip will disturb an area up to 60 inches wide. The 34.5 kV collection system will be buried below the depth of 48 inches in all areas. Side cast material will be sieved, replaced, and compacted with a small excavator or bulldozer. All direct burial areas will be returned to approximate pre-construction grades and restored per the Preliminary Stormwater Pollution Prevention Plan (Preliminary SWPPP; Appendix 13-C).

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[2] Direct burial construction methods will not be utilized in active agricultural lands.

Trenchless technologies, as described below, may be utilized to install underground collection lines in or near sensitive areas (e.g., wetlands, streams, etc.) or as needed (e.g., to cross roadways, utilities, etc.).

Jack and Bore

The jack and bore installation method involves digging a bore pit and receiving pit on each side of the obstacle. The underground crossing is installed by setting up a drilling or auguring machine in the bore pit. The bore or augured path is typically installed horizontally but at an angle; upward or downward is allowable. The contractor will augur the hole for a distance roughly equal to the length of one section of conduit. The augur is then removed from the hole and a length of conduit is jacked through the hole. This process of auguring then jacking length of conduit through the hole is repeated until the conduit protrudes into the receiving pit. Afterwards, the auguring equipment is recovered, and the open trench can be joined to the crossing. The auguring bit is cooled by drilling fluid which is typically a bentonite clay solution. The spoils are collected by pumping the drilling fluid and spoils into a tanker truck and transporting them to an authorized disposal facility or area.

Horizontal Directional Drilling (HDD)

HDD involves having a surface-launched carrier pipe that is pushed/drilled into the ground to go underneath obstructions. It can be "steered" to guide the drill head down and then to arc back up to the surface on the other side of the crossed facility. Small pits are required at either end of the bore to send and receive the drill head, as well as to hold drilling fluid. The cable is then pulled through the installed carrier pipe, and direct burial using the "rip" method can resume. Additional information regarding HDD is provided in Exhibit 10. HDD under wetlands, waterbodies, and streams, will be performed in accordance with the approved Inadvertent Return Flow Plan required pursuant to Section 900-10.2(f)(5).

The 34.5 kV collection system will use cross-linked polyethylene (XLPE) medium voltage cables with a 100% insulation rating. Design of the system will comply with:

1. ANSI – American National Standards Institute.
2. ASTM – American Society for Testing and Materials.
3. OSHA – Occupational Safety and Health Administration.
4. IEEE – Institute of Electrical and Electronic Engineers.
5. NEC – National Electric Code.

(8) Profile of Underground Lines

Refer to the Electrical Design Drawings (Appendix 5-B) for depth of the underground collection cables, typical spacing of parallel circuits, and associated material. As stated above, the 34.5 kV cable will be 100% insulation with 7#7 concentric neutral. The cables will be buried to a minimum depth of 48 inches in all areas.

No oil pumping stations, or manholes are proposed for the Facility. Each parallel trench will be spaced 3 feet or more apart. The layout consists of one, two, three, four, and five trenches in parallel which can be seen in the typical details provided in the __ Drawings (Appendix 5-__).

(9) Equipment to be Installed in Substations or Switchyards

The collection substation will include one 115 kV line dead-end terminal, one 115 kV circuit breaker, disconnect switches, lightning masts, the 115 kV/34.5 kV main power transformer, a 34.5 kV bus, metering/relaying instrument transformers, two 34.5kV circuit breakers, 34.5kV capacitor banks, and one control building for power control and protection equipment. The equipment for the collection substation will be installed on concrete foundations.

The POI switchyard and overhead 115 kV cut-in/out lines and associated land rights will ultimately be transferred to National Grid, in accordance with the Large Generator Interconnection Agreement (LGIA). This parcel will undergo a subdivision to successfully transfer the POI switchyard to National Grid (see Exhibit 24). It will include three 115 kV line dead-end terminals, three 115 kV circuit breakers, with the ability to add one future circuit breaker associated disconnect switches, lightning masts, 115 kV buses, metering/relaying instrument transformers, and one control building for power control and protection equipment.

Refer to the Substation Design Drawings (Appendix 5-C) in Exhibit 5 for plan/overview of the collection substation and the POI switchyard. Equipment in the POI switchyard is necessary for connecting the Facility to the existing National Grid transmission system and delivering power to homes and businesses.

(10) Any Terminal Facility

The only terminal facilities expected are the POI switchyard and collection substation. These components are described in Exhibit 21(a)(9).

(11) Need for Cathodic Protection Measures

There are no cathodic protection measures expected to be required for installation of the underground systems, as no third-party metallic pipelines are known in the Facility Site. Therefore, cathodic protection measures are not discussed further in this Application.

(b) System Reliability Impact Study

PowerGEM has performed a System Reliability Impact Study (SRIS) on behalf of the Applicant to determine the impact of the Facility to the reliability of the New York State Transmission System. The SRIS is included as Appendix 21-A to this Application, but will be filed separately under confidential cover, as required by Critical Energy Infrastructure Information Regulations.

(c) Potential Reliability Impacts

A thermal and voltage steady state analysis was conducted for N-0 conditions to assess the impact of the Facility under summer peak load and light load scenarios. It was observed that the Facility did not have an adverse impact on thermal and voltage criteria violations under base case (N-0) conditions for the summer peak and light load study periods.

The summer peak and light load cases were tested under N-1 contingency conditions for pre- and post-Facility cases. The Facility did not have an adverse impact on thermal and voltage criteria violations under contingency (N-1) conditions for the summer and light load study periods.

The summer peak case was tested under N-1-1 contingency conditions for pre- and post-Facility cases Using preventive system adjustments, the Facility did not cause any N-1-0 and N-1-1 thermal overloads in the summer peak case except for N-1-0 thermal violations, based on Normal or Base ratings, on Delphi-Q1335 POI 115 kV and Cortland-Q276 POI 115 kV lines. The Facility is to be limited to 90 MW dispatch to mitigate the N-1-0 thermal overloads. If the Facility is not to be limited to 90 MW dispatch, elective System Upgrade Facilities may be identified on the affected two 115 kV elements.

In accordance with "NYISO Guidelines for Fault Current Assessment", the short circuit analysis applied three-phase, double-line to ground, and single-line to ground faults at all buses in the Study Area. Those buses with short circuit current increase by 100 Amperes or more were identified. The assumed 40 kilo-Amperes Lowest Breaker Rating ("LBR") at the identified buses is then compared to the observed highest short circuit current. Based on the assumed LBRs, no circuit breakers were found to be over-dutied as a result of interconnecting the Facility.

Stability analysis was performed for summer peak and light load conditions to determine the impact of the Facility on system performance within the Study Area for the selected system design contingencies. This analysis evaluated the performance of the system for selected local and design criteria contingencies, and addressed issues including, but not limited to, transient stability and critical clearing time. The stability analysis was conducted for local and design contingencies with the Facility for summer peak and light load conditions. The results indicated that the system remained stable with the Facility for all the simulated local and design contingencies.

In order to determine Facility impacts on Critical Clearing Time (CCT), a three-phase bus fault was simulated at the Facility Point of Interconnection (POI), Fenner, Cortland, and Oneida 115 kV buses. The CCT tests were conducted on both the summer peak and light load cases. The clearing times of the simulated bus faults gradually increased until one of the monitored generators begin to show instability. The results of the assessment found that the CCTs were not degraded by the Facility.

The CCT results show that the Facility will ride-through 50 cycle faults at the POI. These results show that the Facility complies with applicable Post-Transient Period LVRT requirements.

(d) Benefits and Detriments of the Facility on Ancillary Services

The Facility's turbine will each have a two winding (High – Delta, Low – Wye,) fixed tap transformer (GSU) stepping the voltage from 0.72 kV to 34.5 kV. The reactive capability of each machine is within the limits of

0.947 capacitive and 0.981 inductive power factor, translating into a Q range of 1.53 MVAr capacitive to 0.9 MVAr inductive.

Since the turbines are connected to full scale converters, the turbines can fully control their reactive power output. As a result, the Facility can potentially provide Voltage Support ancillary service in the NYISO system.

(e) Estimated Change in Total Transfer Capacity

Transfer limit analysis for Volney East interface was conducted under summer peak load for pre- and post-Facility scenarios. It was observed that the Facility did not degrade the thermal, voltage and stability transfer limits of Volney East interface for the summer peak condition.

(f) Criteria, Plans, and Protocols

(1) Applicable Engineering Codes, Standards, Guidelines, and Practices

Substation Engineering Codes, Standards, Guidelines and Practices

The Facility collection substation and POI switchyard design will incorporate, but is not limited to, the following standards and codes when applicable:

1. NESC – National Electric Safety Code.
2. NFPA 70 – National Fire Protection Association – National Electric Code.
3. NFPA 850 – National Fire Protection Association – Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations.
4. ACI – American Concrete Institute.
5. ANSI – American National Standard Institute.
6. ASCE – American Society of Civil Engineers.
7. ASTM – American Society for Testing and Materials.
8. IBC – International Building Code.
9. IEEE 80 – IEEE Guide for Safety in AC Substation Grounding.
10. IEEE C37.2 – IEEE Standard Electrical Power System Device Function Numbers and Contact Designation.
11. IEEE C37.90 – IEEE Standard for Relays and Relay Systems Associated with Electrical Power Apparatus.
12. IEEE C37.110 – Guide for the Application of Current Transformers Used for Protective Relaying Purposes.
13. IEEE C57.13 – IEEE Standard Requirements for Instrument Transformers.
14. IEEE 485 – IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
15. IEEE C57.12.10 – IEEE Standard Requirements for Liquid-Immersed Power Transformers.
16. IEEE 998 – IEEE Guide for Direct Lightning Stroke Shielding of Substations.
17. IEEE C37.119 – IEEE Guide for Breaker Failure Protection of Power Circuit Breakers.

18. IEEE C37.605 – IEEE Guide for Design of Substation Rigid-Bus Structures.
19. IEEE 605 – IEEE Guide for Design of Substation Rigid-Bus Structures.
20. IEEE 693 – IEEE Recommended Practices for Seismic Design of Substations.
21. IEEE 980 – IEEE Guide for Containment and Control of Oil Spills in Substations.
22. Utility Standard Requirements (POI Switchyard/Facility Substation).

The Facility collection substation and POI switchyard grading will be done in the most economical and efficient manner and will result in a collection substation and POI switchyard that is elevated in relation to the surrounding ground levels on the north side of these facilities, and being buffered by retaining walls on 3 of the 4 sides. The proposed retaining walls have been reviewed by engineers and the design has been determined to be feasible. Prior to construction, detailed engineering specific to the retaining wall will be completed and structural plans will be designed in accordance to ASTM standards. Grading slopes inside the Facility collection substation and POI switchyard fences will preferably be between 0.5 to 1% but under no conditions will the slope be more than 2%. The graded area will extend a minimum of 5 feet beyond the collection substation and POI switchyard fences to allow for yard stone and the perimeter loop of the ground grid. All clearing, grubbing, excavation, and cut/fill will conform to geotechnical report recommendations and the SWPPP.

Design of the Facility collection substation and POI switchyard will consider various environmental data such as:

1. Altitude
2. Maximum wind speed
3. Normal ambient temperature
4. Extreme ambient temperature
5. Precipitation
6. Humidity
7. Seismic hazard (acceleration as percent of gravity).

The foundation design will be based on the maximum load (both static and dynamic) that will be applied to the steel structures and/or the equipment. Either drilled piers or spread footing will be used to support steel structures as per geotechnical report recommendation. Cast-in-place headed anchor rods with leveling nuts will be used/designed to connect the collection substation and POI switchyard structures/equipment to their foundations.

Oil containment will be designed/installed for the main transformer as required by federal, state and local regulations. The oil containment will have an oil capacity of no less than 110% of equipment total oil capacity.

The steel structure design will conform to the provisions and requirements of the AISC and ASCE “Substation Structure Design Guide, Manual of Practice 113.” Materials for structural steel and miscellaneous steel will conform to the following requirements of the ASTM:

1. Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50 or multi-certification A36/A572, Grade 50
2. Tubular – a structure composed of closed sections (tubes) of circular, multi-sided, or elliptical cross section and tapered or un-tapered: ASTM A595 or A500 Grade B
   - Pipe: A53, Grade B
   - M shapes, S shapes, HP, Channels, and Angles: ASTM A36
   - Structural Plates and Bars: ASTM A36.

All structures will be galvanized conforming to the requirements of ASTM A123, ASTM A143, and ASTM A153 as applicable. All structural welding designs will conform to the requirements of AWS D1.1. All high strength bolts, nuts, and washers will conform to ASTM A325, A394 or A490, ASTM A563, and ASTM F436, respectively, and will be galvanized in accordance with ASTM A153.

The collection substation and POI switchyard will maintain voltage-dependent electrical clearances per ANSI/IEEE requirements.

All necessary associated overhead bus, conductors, supports, insulators, terminations etc. will comply with IEEE 605 and all other relevant standards. All connections from the tubular bus to equipment will be made using flexible conductor. Busses will be designed to carry the maximum load possible, including full load capability (highest name plate rating) of all the transformers feeding off of or supplying the bus.

Design will incorporate schedule 40, 6063-T6 seamless aluminum bus tube and stranded all aluminum conductor (AAC) flexible conductor. Bus tube will include internal damping cable to reduce Aeolian vibration in accordance with methods given in IEEE 605. Bus calculations considering bus diameter, span length and short circuit forces will be provided in accordance with the methods given in IEEE 605.

Grounding design study will be performed in accordance with IEEE 80. The study will ensure that the ground grid is designed to maintain safe touch and step voltages within IEEE tolerable limits. The ground grid analysis will have the following basis: Fault Current, 50-kilogram body weight, a fault current split factor, soil resistivity and fault duration of 0.5 seconds.

The lightning protection will be designed by using the rolling sphere method per IEEE 998, which will reduce the probability of a direct lightning strike to the station. A constant radius sphere will be used in conjunction with flashover probability calculations to design an efficient and economical shielding system. The shielding calculations will provide shielding for the collection substation and POI switchyard bus and equipment using statistical methods and will not exclude all strikes from the protected area.

The collection substation and POI switchyard will be designed with adequate, secure, reliable and redundant protective and control schemes. The protection zones will be overlapped to maintain redundancy while ensuring that the major equipment will be protected. The applicable utility protection practices will be incorporated into the protection and control settings as necessary in the design.

A protective device coordination study will be performed to develop the necessary calculations to select protective relay characteristics and settings, ratio and characteristic of associated current transformers. The coordination study will include time current curves (TCC), which will be showing the various protective devices settings and the time margin between settings. Relay settings are set to protect equipment and detect abnormal conditions. The settings will be chosen according to IEEE standards to protect the equipment, detect the minimum fault current flows, and coordinate as possible with adjacent protective relay devices.

Overhead Transmission Lines Engineering Codes, Standards, Guidelines and Practices

The Facility overhead line design will incorporate, but is not limited to, the following standards and codes when applicable:

- ASCE/SEI 48-11, Design of Steel Transmission Pole Structures.
- ACI 318-19, Building Code Requirements for Reinforced Concrete.
- ACI 336.3R-14, Report on Design and Construction of Drilled Piers.
- ACI 305 Specification for Hot Weather Concreting.
- ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- ASCE 74, Guidelines for Electrical Transmission Line Structural Loading, American Society of Civil Engineers, 3rd Edition, 2010.
- NYSDOT Geotechnical Design Manual, State of New York Department of Transportation.
- AISC 360-15, Steel Construction Manual (LRFD), 15th Edition.
- ANSI C2, National Electric Safety Code (NESC).
- National Grid Structural Design Criteria.

34.5 kV Underground Collection System Engineering Codes, Standards, Guidelines and Practices

The underground line design will incorporate, but is not limited to, the following standards and codes when applicable:

- ANSI – American National Standards Institute.
- ASTM – American Society for Testing and Materials.
- IEEE 48 – Standard Test Procedures and Requirements for Alternating Current Cable Terminations 2.5 kV through 765 kV.
- IEEE 80 – Guide for Safety in AC Substation Grounding.
- IEEE Std. 835-2012, "IEEE Standard Power Cable Ampacity Tables".
- IEEE400 – Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

- IEEE 400.1 – Guide for Field Testing of Laminated Dielectric, Shielded Power Cable Systems Rated 5 kV and Above with High Direct Current Voltage.
- IEEE 400.3 – Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment.
- IEEE C2 – National Electric Safety Code.
- IEEE C57.12.10 – American National Standards for Transformers.
- NFPA 70 – National Electric Code.
- NEMA – National Electrical Manufacturer's Association.

Wind power projects commonly employ medium voltage, low voltage, and fiber optic cables to connect dispersed wind turbine generators to the collection substation (see Appendix 5-B for typical details). Determining the configuration and sizing of the cable runs (commonly called feeders) is a complex task, requiring a balance of a variety of considerations, including land use restrictions, cable characteristics, soil conditions, equipment and construction constraints, cost, reliability, maintainability, and efficiency. The design process incorporates these considerations in order to provide the client with the most robust, flexible, and cost-effective design possible.

The standard installation configuration is for the cables to be bundled and directly buried in the native soil, approximately 4 feet below grade. Unique installation configurations may be required where the cables cross public roads, utility easements, etc.

The underground cable ampacity calculation is based on the model proposed by Neher and McGrath assuming no variation in any geometrical or thermal parameter along the length of the entire cable route. This assumption reduces the formulation from a three-dimensional analysis to one of two-dimensions. The two-dimensional formulation is then further reduced to a one-dimensional heat transfer problem by using the principle of superposition which utilizes a fictitious heat sink of equal strength above the cable at a distance above the earth surface equal to the burial depth. This mathematical approach is the one used to provide values in the ampacity tables and accepted as the standard thermal ratings of most underground cable systems. If any changes in the thermal environment exist along the length of a cable installation, the ampacity tables are unable to provide guidance for determining the ampacity of this more complex situation. If the thermal conditions exist for a relatively long segment of the route, it would be prudent to rate the entire circuit based on the worst combination of thermal environments. However, when the poor thermal conditions exist for only a short length of the route (which is often the case in the field where the cable frequently requires to share its underground space with other utilities or must be routed through a relatively short segment of conduit, pipe or duct bank), the calculation of the reduced ampacity is not as simple and the thermal model must account for the fact that the heat transfer into the surrounding soil is a complex three-dimensional heat transfer problem that none of the commercially available software in our disposal address this situation. Some utilities choose not to model different cable configurations unless it has reached a certain distance in length due to assumed axial cooling in the cables that would have minimal effects on the ampacity. The cable ampacity for those configurations (direct buried, conduits, duct bank) in each routing that exceed the typical 50 feet in length to be determined by Neher-McGrath method.

(2) Generation Facility Type Certification

The wind turbines installed at the Facility will meet applicable requirements and standards to facilitate reliable operation of the Facility. Ultimately, the wind turbines under consideration will receive certification prior to installation. The equipment specifications of these wind turbines are included in the wind turbine technical manuals (Appendix 5-G).

(3) Procedures and Controls for Inspection, Testing, and Commissioning

The various aspects of the Facility will have a written inspection, testing, and commissioning plan, as summarized below, that is adhered to during all stages of construction as well as a post-construction inspection and testing phase. When completed, all documentation will be provided to the Office of Renewable Energy and Siting (ORES) and stored at the Facility Site for easy review/access in the future.

Collection Substation and POI Switchyard

The collection substation and POI switchyard will be inspected, tested and commissioned in accordance with various ANSI, IEEE, NFPA, IETA, ASTM, etc. requirements, as necessary. All tests shall be performed with the equipment de-energized, except where specifically required for it to be energized for functional testing.

All material received for construction of the collection substation and POI switchyard will be visually inspected for defects and compatibility with the design/specifications. Various industry standard electrical and mechanical tests are performed on equipment before leaving the manufacturers' facilities. Some tests are performed on a "class" of equipment, such that the passing tests results apply to all specific equipment produced. Other tests are required to be performed on each individual piece of equipment. Additional tests will be performed on specific equipment after installation at the Facility site to ensure that there was no damage during handling including, but not limited to:

- Main transformer.
- High/medium voltage circuit breakers.
- Disconnect switches.
- Instrument transformers (current transformer, voltage transformer, etc.).
- Surge arresters.
- Station service transformer.
- High/medium voltage cables.
- DC battery bank and charger.

Other standard tests will be performed on "installations" or "systems" to ensure that the components of a design were constructed/installed at the Facility Site in the correct manner. These include, but are not limited to:

- High/medium voltage bus connections and hardware.
- Grounding grid (including electrical resistivity of surface stone).
- Low voltage protection, control and instrumentation wiring.
- Protective relaying systems.

- System Control and Data Acquisition (SCADA)/communication systems.

All circuits will be energized and verified for functional operation. Each control circuit shall be functionally tested and documented. This will include operation of all equipment, verification of each interlock and trip function. Each alarm device/point shall also be verified and documented. This shall include the actual operation of the alarm whenever possible.

Concrete foundations will be inspected in various ways. Visual/dimensional inspections will be performed on reinforcing steel/rebar (for bar size, configuration, tie/welds, etc.), anchor bolts (size, location, elevation, plumbness, etc.), and formwork (size, dimensions, location, height/reveal, etc.) prior to pouring the concrete. Excavations, subgrade and compacted backfill will be verified to be in accordance with design requirements. The mix design of the concrete will be reviewed for conformance with the design requirements. During pouring of concrete, samples will be taken to ensure that the proper slump, air content, temperature and any additives are in accordance with design requirements. Numerous test cylinders will be obtained for future strength/compression testing at periodic points after pouring (7 days, 28 days, etc.). The cylinders will be tested to determine if the concrete is curing at the proper rate and will meet design strength prior to being loaded.

Any imported yard subbase, surface stone, etc. will be tested for proper sieve gradation, compaction, etc., as necessary. Adequate quantities/dimensions of imported material will be verified. A final survey of station benchmarks, elevations (overall pad and concrete foundations, etc.) will be performed.

Overhead Transmission Lines

The overhead lines will be inspected, tested and commissioned in accordance with following standards and documents:

- In accordance with ANSI, IEEE, NFPA, IETA, ASTM standard
- Construction Management Plan
- Quality Management Plan
- Testing and Commissioning Plan
- Material Specifications
- Material, Facility Inspection and Testing Plan (ITPs)
- Material Non-Confirming Product
- Non-Conformance Report (NCR)
- Post-construction/Installation Inspection Punch List and Punch List Sign-off
- Notice of Energization.
- Transmission line facility inspection including the following items:
- Structure
- Foundation, including guy anchor
- OH Wires, including conductor, shielding wire, OPGW, etc.
- Insulator Assembly
- Hardware Assembly, including guy wire hardware

- Structure Grounding, including grounding wire, rod, connection, and measurement of grounding resistant
- Circuit Phasing
- Line and Structure Identifications, including ID signs and tags
- Construction Site and ROW Restoration
- Clearance, including vertical/crossing clearance and horizontal/wind clearance.

34.5 kV Underground Collection System

The collection system will be inspected, tested and commissioned in accordance with various ANSI, IEEE, NFPA, IETA, ASTM, etc. requirements, as necessary. All tests shall be performed with the equipment de-energized, except where specifically required for it to be energized for functional testing.

Underground cables systems have comparatively less components than overhead lines or substations. All material received for construction of the underground collector system will be visually inspected for defects and compatibility with the design/specifications. This includes, but is not limited to, cables, fiber, splices/junction boxes and grounding material.

During installation, materials used for cable trench installation will be tested for conformance with the design, including backfill material (gradation, compaction, thermal resistivity, etc.). The cables themselves will be installed in the proper configuration, at the proper depth and the proper spacing. Care must be taken to ensure that the required/minimum/maximum bending radius or pulling tension (if installed in conduit/duct) of the cable is met to avoid damage.

Hardware/terminations at the ends of the cables will be installed in accordance with manufacturer requirements to ensure adequate mechanical strength and electrical continuity. Cable shields/neutrals will be installed per the design and solidly connected to the grounding system or surge arresters, or taped/insulated, where applicable. Phasing of the conductors will be checked to ensure that the end-to-end connection of each conductor is correct per the design of the station/equipment at each end of the cable.

Very Low Frequency (VLF), at a minimum, or Partial Discharge (PD) testing will be performed on cables, in accordance with IEEE recommendations, in order to identify any deficiencies or damage in the cable system that could result in outages or failure. Testing of transformers will be performed in accordance with applicable ANSI/IEEE specifications.

Wind Turbines

Turbine commissioning will occur once the wind turbines and substation are fully installed and the NYISO is ready to accept delivery of power to the New York grid. The commissioning activities will consist of testing and inspection of electrical, mechanical, and communications systems, as well as turbine foundations. Turbine foundation testing and inspection will be in accordance with guidance from the American Wind Energy Association (AWEA)/ASCE in the 2011 document entitled

Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures. These procedures are summarized below:

Equipment required: Support trucks, which will be driven to the construction site.

Materials brought on site: Gearbox oil, lubricating grease, and temporary portable generators. The only chemicals required for this phase are oils, gasoline, and grease used to operate construction equipment and portable generators, gearbox oil, and lubricants. Fuel-handling will be conducted in compliance with the Facility-specific Spill Prevention, Control, and Countermeasures (SPCC) Plan (see Appendix 13-__ for additional information on the SPCC).

Timing: Commissioning will preferentially be completed in late spring or summer to take advantage of typically drier weather. If necessary, this activity can be completed in the spring, fall, or winter depending on weather conditions.

Material generated: Some packing material waste will be generated. The recyclable material will be separated from the non-recyclable material on site. Both types of waste will be removed by a licensed sub-contractor.

(4) Maintenance and Management Plans, Procedures, and Criteria

The Applicant will prepare a Facility Maintenance and Management Plan prior to construction of the Facility, based on the Applicant's experience and typical operations and maintenance requirements for wind projects. The objective of the Facility Maintenance and Management Plan is to optimize the Facility's operational capacity and availability through best-in-class maintenance guidelines and inspections that are designed to pro-actively detect any significant safety or maintenance issues.

Each wind turbine will require periodic, preventative maintenance as well as corrective maintenance in the event of a malfunction. Typically, wind turbine maintenance cycles occur semi-annually and on an as-needed basis. During maintenance activities, wind turbines will remain in-service to the greatest extent practicable.

<u>34.5 kV Underground Collection System</u>

The underground collection system is passive such that it does not require active operations. The underground lines generally do not have the ability to notify or alarm operators of a problem, unless it manifests itself as an electrical fault that can be sensed by equipment in the substation. Depending on detailed design, there could be some equipment that could provide remote indication or control which includes, but is not limited to:

Fault indicators – the devices are installed at certain intervals through the collection system to assist in locating faults on underground cables (that cannot be verified visually). There are options for these detectors to have remote signaling capabilities.

Most of the underground collection system will not be able to be inspected visually. There will be "access points" that will allow for a limited amount of visual verification such as riser poles that transition to the collection substation, junction boxes that combine multiple cable sections or splices, link boxes, and entrances to the wind turbines. While terminations and cable ends can be inspected at these points, they are more valuable as a point to connect electrical testing equipment. As with the initial testing/commissioning phase described above, the underground cables will be subject to testing during a maintenance outage in order to identify and locate any cable damage or impending failures.

115 kV Overhead Gen-Tie and Cut-In/Out Lines

The overhead lines are passive systems that do not require active operation activities. Any serious issues with the line will likely manifest themselves as an electrical fault, in which case the protection system in the collection substation would sense and clear the fault.

All overhead line spans are anticipated to be visually inspected at regular intervals, as well as after any significant weather events such as extremely high winds, severe snow and ice, etc. Additional details regarding the maintenance of all overhead lines will be provided as final selection of components information for this component becomes available.

Metal-enclosed switchgear

Unless any switchgear is ordered with remote control capabilities, operation of the collection system will be performed manually by qualified operators. Main operation of the collection system is performed at the collection substation by opening or closing the circuit breaker that protects each cable circuit. Sectionalizing/disconnection of circuit section can be accomplished at junction boxes or switchgear. These activities will be performed by personnel familiar with and trained in the operation and safety hazards of high-voltage electrical equipment. Personal protective equipment (PPE) appropriate for the activities being performed will always be worn/used. Hazards such as arc flash will be present but will be mitigated to the extent practical during detailed design. In accordance with industry standards, hazard labels will be installed on electrical equipment to provide guidance for additional PPE required for operating and accessing such electrical equipment once the Facility is operational.

Equipment provided by manufacturers typically includes operation and maintenance (O&M) manuals specific to that product, similar to the substation equipment described below. These maintenance intervals and procedures will be used where applicable and can apply to equipment such as pad-mount transformers or metal-enclosed switchgear.

(g) POI Switchyard Transfer Information

(1) Description of Substation Facilities to be Transferred and Timetable for Transfer

National Grid is the connecting transmission owner for this Facility. The POI switchyard will be a new National Grid 115 kV ring bus station with three (up to four) terminals. See Appendix 5-B for a drawing of the POI substation. The exact future arrangement and timetable related to POI switchyard engineering and construction will not be known until the Facilities Study is complete.

(2) Transmission Owner's Requirements

Construction of the POI switchyard may be done by the Applicant, in accordance with design specifications provided by National Grid. National Grid will be responsible for design reviews, construction oversight, relay settings and commissioning.

(3) Operational and Maintenance Responsibilities for the POI Switchyard

National Grid, as the transmission owner, will define and perform the operational and maintenance responsibilities for the POI switchyard.

(h) Criteria and Procedures for Sharing Facilities with Other Utilities

The Applicant does not anticipate sharing facilities with other utilities at this time.

(i) Availability and Expected Delivery Dates for Major Components

Availability and delivery times for major Facility components may vary depending on selected equipment, inventory, manufacturer, and market conditions. The Applicant is not aware of any equipment availability restrictions but will monitor availability to guide the final selection of equipment. The Applicant currently plans to place the Facility in service by the end of 2026. Based on this in-service timeframe, major Facility components would be expected to arrive onsite starting approximately in the first or second quarter of 2026 but will depend on timing of final permit issuance.

Note that the equipment procurement strategy will be firmed up during the final engineering and planning stage of the Facility, prior to construction. As needed, adjustments to equipment procurement may be made after starting Facility construction.