Mohawk Solar

Case No. 17-F-0182

1001.5 Exhibit 5

Electric System Effects

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EXHIBIT 5 ELECTRIC SYSTEM EFFECTS

(a) System Reliability Impact Study

Mitsubishi Electric Power Products, Inc. (MEPPI) prepared a System Reliability Impact Study (SRIS) for the Facility on behalf of the New York Independent System Operator (NYISO). The SRIS is Appendix 5-A to this Application, but will be filed separately under confidential cover, as NYISO requires the SRIS to remain confidential due to Critical Energy Infrastructure Information (CEII) Regulations. The Facility is participating in the NYISO 2019 Class Year.

(b) Potential Reliability Impacts

The SRIS evaluated a number of power flow base cases, as provided by the NYISO, including 2020 Summer Peak, Winter Peak and Light Load system conditions. The study system included the Capital Zone (Zone F) and the Mohawk Zone (Zone E) in the New York ISO system. The SRIS indicates that there are no adverse reliability impacts caused by the Facility under N-0 and N-1 steady state analyses. Any adverse impacts initially identified in the N-1-1 steady state analysis can be managed through the normal operating procedures of the NYISO, therefore the Facility does not significantly impact any system elements with reliability criteria violations. The SRIS also concludes that the Facility does not adversely impact system reliability with respect to transient stability. The Facility meets the necessary voltage ride-through requirements and the Facility does not adversely impact critical clearing time (CCT). The short circuit analysis performed as part of the SRIS did not identify the need to replace any circuit breakers due to the addition of the Facility.

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

The SRIS did not identify any detriments of the Facility on Ancillary Services. The only system upgrades required are directly related to the connection of the facility to the system; those upgrades are limited to protection system changes at the remote substations.

(d) Reasonable Alternatives to Mitigate Adverse Reliability Impacts

The SRIS did not identify any adverse reliability impacts caused by the project.

(e) Estimated Change in Total Transfer Capacity

The SRIS studied the following interfaces: Central East, Total East and UPNY-SENY. The addition of the Facility reduces the thermal transfer capacity of the Central East and Total East interfaces by 75 MW and 93 MW, respectively. The addition of the Facility increases the transfer capacity of the UPNY-SENY interface by 90 MW. The degradation of the thermal transfer limit is not considered by NYISO to violate reliability criteria as the interface is internal and interface limits are expected to be managed in the day to day operation of the power system. Management of the internal interfaces may include such mitigation as a reduction in the output of the Facility, dependent on the system conditions at any given point in time.

(f) Criteria, Plans, and Protocols

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

The Facility will be designed in accordance with applicable standards, codes, and guidelines. For portions owned by the Applicant (e.g., collection system), best industry practices will be used, along with any standards/preferences set by the companies designing the Facility. For the point of interconnection (POI) switchyard, National Grid requirements will be followed.

<u>115 kV Overhead Transmission System</u>

The proposed location for overhead lines in the Facility are limited to a span of 115 kV line between the Facility collection substation and the National Grid POI station (see Appendix 5-B for typical details). This system will be designed and operated in accordance with the Interconnection Agreement, approved tariffs and applicable rules and protocols of National Grid, NYISO, New York State Reliability Council (NYSRC), Northeast Power Coordinating Council (NPCC), North American Electric Reliability Corporation (NERC) and successor organizations. In addition, the Facility will be designed in accordance with (but not limited to):

- RUS Bulletin 1724E-200
- National Electric Safety Code (NESC)
- ANSI – American National Standards Institute
- ASTM – American Society of Testing and Materials
- OSHA – Occupational Safety and Health Administration
- IEEE – Institute of Electrical and Electronic Engineers
- ASCE – American Society of Civil Engineers
- NEC – National Electric Code

The span will be supported on the steel H-frame in each of the stations and will consist of:

- Conductor - 795 kcmil ACSR ‘Drake’ (26/7 Stranding) or similar
- OPGW Shield Wire - 24 fiber single mode cable or similar
- Shield Wire - ½” diameter 7-stranded EHS Steel wire or similar

The limits for the tension of the conductor and shield wires will be based on NESC standards.

The insulator selection will take into consideration the design BIL of the line and substation. Consideration of mechanical and electrical properties of the insulators is critical to ensure that insulators can withstand the mechanical loads and electrical stresses on them. For both suspension and dead-ends, the percentage of strength rating is 50% of specified mechanical load as per the NESC mechanical properties requirement.

The vertical clearance requirements for the transmission line have been calculated based on NESC C2 requirements. The clearances will be checked for the following weather conditions:

1. Maximum Conductor Operating Temperature; for the final Sagging and Clearances of 212º F with no wind.
2. Facility-specific condition as per NESC table 230-1, Zone 1 with radial ice thickness of 0.5" at 32º F with no wind.
3. Clearance between the crossing line and other utility facilities (existing distribution or communication lines, in order to minimize impact or interference with those facilities) will confirm the requirements of owning utility. Clearance will be computed with the upper conductor at 212º F, final condition with the lower conductor or wire at 32º F unloaded.

The Facility falls within the isokeraunic level of 20-40 (RUS Bulletin 1724E-200, page E-4, Figure 1). RUS recommends the use of shield wire in all locations where the isokeraunic level is above 20 with the shield angle of 30 degree for structure height 92 ft. above ground.

The ground resistance value at each structure will be measured after the ground rod has been installed, but prior to bonding any interconnection wires such as static wire(s). The resistance will be 25 ohms or less. If the measured value cannot meet the requirements, then another method of grounding as described in NESC Rule 94B will be used to meet the requirement of NESC Rule 96A.

All suspension and deadend structures will be designed to meet or exceed various applicable loadings outlined per the NESC C2.

Horizontal deflections at the top of angle and deadend vertical members will be limited, by camber if necessary, to less than five percent (5%) of the total structure height above ground, at a temperature of 60º F, with no wind and no ice. If the deflection is six inches or greater at the top of the structure, and camber is not required by the above criteria, the final design drawings will furnish a construction rake offset distance. Horizontal and vertical deflections of the horizontal members will be limited to be less than 0.5% of the span distance.

Collection substation

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

- NESC - National Electric Safety Code.
- NFPA 70 - National Fire Protection Association - National Electric Code
- NFPA 850 - National Fire Protection Association – Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
- ACI - American Concrete Institute
- ANSI - American National Standard Institute
- ASCE - American Society of Civil Engineers
- ASTM - American Society for Testing and Materials
- IBC - International Building Code
- IEEE 80 - IEEE Guide for Safety in AC Substation Grounding
- IEEE C37.2 - IEEE Standard Electrical Power System Device Function Numbers and Contact Designation
- IEEE C37.90 - IEEE Standard for Relays and Relay Systems Associated with Electrical Power Apparatus
- IEEE C37.110 - Guide for the Application of Current Transformers Used for Protective Relaying Purposes
- IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers
- IEEE 485 - IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
- IEEE C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers
- IEEE 998 - IEEE Guide for Direct Lightning Stroke Shielding of Substations
- IEEE C37.119 - IEEE Guide for Breaker Failure Protection of Power Circuit Breakers
- IEEE 605 - IEEE Guide for Design of Substation Rigid-Bus Structures
- IEEE 693 - IEEE Recommended Practices for Seismic Design of Substations
- IEEE 980 - IEEE Guide for Containment and Control of Oil Spills in Substations

The substation grading will be done in the most economical and efficient manner and will be slightly elevated in relation to the surrounding ground levels in order to give it positive drainage and ensure that water does not pond at or inside the substation. Grading slopes inside the substation fence 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 substation fence 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 Stormwater Pollution Prevention Plan (SWPPP) (see Appendix 21-B for the Preliminary SWPPP).

Design of the collection substation will consider various environmental data such as:

- Altitude
- Maximum wind speed
- Normal ambient temperature
- Extreme ambient temperature
- Precipitation
- Humidity
- 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 substation 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 American Institute of Steel Construction (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:

- Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50 or multi-certification A36/A572, Grade 50
- Tubular – a structure composed of closed sections (tubes) of circular, multi-sided, or elliptical cross section and tapered or untapered: 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 design 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 station 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 following basis: Fault Current, 50 kg 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 substation bus and equipment using statistical methods and will not exclude all strikes from the protected area.

The collection substation 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 the IEEE standards to protect the equipment, detect the minimum fault current flows, and coordinate as possible with adjacent protective relay devices.

34.5 kV Underground Collection System

The underground line design shall 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 400 - 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 5kV 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 (NESC)
- IEEE C57.12.10 - American National Standards for Transformers
- NFPA 70 - National Electric Code (NEC)
- TIA/EIA - Telecommunications Industry Association/Electric Industry Alliance
- NEMA - National Electrical Manufacturer's Association

Solar power projects commonly employ medium voltage (MV), AC cables to connect dispersed PV panel module inverters to the collection substation. Determining the configuration and sizing of the cable runs requires balancing 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 3 feet below grade (4 feet in agricultural areas). Unique installation configurations may be required where the cables cross public roads, utility easements, etc.

The ampacity of all cable configurations (standard single circuit, or unique configurations such as multiple circuits in parallel, circuits crossing each other, etc.) will be determined based on Neher-McGrath methods. The analysis will include the effects of various parameters, including soil thermal resistivity, shield grounding connections, mutual heating from parallel cables, and special thermal backfill resistivity (if used). The calculations will ensure that all cables can carry the expected loads without overheating and damaging components of the cables.

Estimated electrical losses will be calculated as a percentage of the expected energy production of the Facility. Losses will be determined for all cables and transformers.

(2) Generation Facility Type Certification

The PV solar panel models currently under consideration by the Applicant have received an Underwriters Laboratories (UL) certification. The equipment specifications of these UL-certified panels are included in Appendix 5-C of this Application. The Applicant will ultimately select a solar PV panel that has a UL certification.

(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 Siting Board and stored at the Facility Site for easy review/access in the future.

<u>115 kV Overhead Transmission System</u>

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

All material received for construction of the overhead lines will be visually inspected for defects and compatibility with the design/specifications. This includes, but is not limited to anchors, poles, conductor, fiber, insulators, hardware, and grounding material.

The Applicant will be sure to number and verify structures/poles locations/coordinates, elevation, embedment, height, plumbness, rotation, etc. per the design. Anchors/guy wires will be verified for location, angle to pole, embedment, etc.

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

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 the overhead lines or substation described above. All material received for construction of the underground lines will be visually inspected for defects and compatibility with the design/specifications. This includes, but is not limited to, cables, transformers, 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 (see Appendix 5-D for typical details). 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.

Collection Substation

The substation 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 substation 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
- Capacitor bank or reactor banks
- 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:

- 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

Concrete foundations will only be utilized for the collection substation. Visual/dimensional inspections will be performed on reinforcing steel/rebar (for bar size, configuration, tie/welds, etc.), anchor bolts (size, location, elevation, plumbness, etc.), 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.

PV Panels

Panel commissioning will occur once the PV panels and substation are fully installed and the NYISO is ready to accept transport of power to the New York electrical grid. Commissioning and operation of the Facility relies on consistent systems monitoring and testing. Systems monitoring includes the following strategies and considerations:

- DC array inspection through manual electrical testing and/or aerial thermal imaging. Manual electrical testing is used to detect faults in the DC system that the monitoring system was unable. This type of monitoring provides the defects currently causing module failures. Manual inspection requires that wiring enclosures, combiner boxes, and module junction boxes be opened to access the currents. Aerial thermal imaging inspection strives to detect string, module, and sub-module faults as well as the racking and balancing of the system (e.g. racking shifts, systemic shading, major erosion) in arrays by monitoring thermal variations between modules (NREL, 2016).
- Equipment required: Support trucks will be driven to the construction site for manual inspections. Aerial thermal imaging is typically conducted by manned survey aircraft or unmanned aerial vehicles (UAVs) (NREL, 2016).
- 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 (NREL, 2016).

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

The Applicant has prepared a Preliminary Operations and Maintenance Plan (O&M Plan), which is included in this Application as Appendix 5-E. This Plan, which is intended to be the foundation of the Final O&M Plan, will be implemented at the Facility once it becomes operational, and is based on the Applicant's experience and typical O&M maintenance requirements for solar power projects. Ultimately the Applicant's Facility Operators will be responsible for the O&M Plan's implementation. The objective of the O&M 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.

Solar energy projects typically consist of multiple solar-to-energy inverters that are electrically connected to produce the desired project output. Each internal inverter requires periodic, preventative maintenance as well as corrective maintenance in the event of a malfunction within the individual inverter. Typically, solar energy facilities maintenance cycles occur semi-annually and on an as-needed basis. These manual maintenance cycles can last from days to weeks (NREL, 2016). During maintenance activities, solar arrays will remain in-service to the greatest extent practicable. The Applicant is an experienced manager of renewable energy services and is currently responsible for the production of 50 MW of solar energy

115 kV Overhead Transmission System

The overhead 115 kV lines are passive systems that do not require active operation activities. They generally do not have the direct ability to notify or alarm an operator or technician in the event of any material problems or developing problems, such as excessive conductor sag or insulator damage. 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. While not common, fault detectors could be installed to assist in locating problems with the line.

The 115 kV transmission line span, will be visually inspected at regular intervals (two to three times per year), as well as after any significant weather events such as extremely high winds, severe snow and ice, etc. Inspections can be done at ground level (using binoculars or magnifying devices, as necessary) and will locate and identify any:

- Changes in wire location that could result in clearance violations
- Damaged insulators, including signs of arcing/tracking/flashover
- Encroaching vegetation (see Section (i)(2) below for vegetation maintenance)
- Foreign objects on or near conductors and insulators
- Broken or damaged structures, guy wires or grounding system
- Damaged conductor or fiber
- Damaged or missing hardware, fittings, dampers or spacers
- Discharged surge arresters
- Evidence of animal activity/nesting

Any damage to equipment/material or changes in the wire configuration will either be repaired/replaced, or presented for engineering review of adequacy/impacts.

Foreign objects can be assessed depending on size, location, or material. It may be beneficial to remove the object as quickly as possible or it may be deemed to be a low risk. Depending on the type and location of the object, a line outage may be needed to remove it, or it could be removed while the line is energized by a qualified contractor familiar with, and trained in, energized work and safety procedures.

Insulator tracking could be the result of a material/equipment issue, and could be the result of naturally occurring environmental conditions, such as dirt or moisture deposits on the insulator surface. If determined to be the result of contaminants/deposits, insulator cleaning can be performed either during a line outage or while energized by a qualified contractor (as noted above).

Periodic infrared scanning will be performed on hardware/connections to confirm continued low resistance of all current carrying connections. Concentrated areas of high temperatures could be an indication of a poor electrical and mechanical connection. The high temperatures ("hot spots") could lead to early failure of material/equipment. If hot spots are identified in connections, inspection and/or repair should be performed during an outage condition. Re-testing of the transmission line grounding system will be performed every one to two years to ensure that the integrity and effectiveness of this system has not changed. These changes could occur due to deterioration of materials, changes in soil properties, etc.

34.5 kV Underground Collection System

The underground collection system is also passive such that it does not require active operations. As with the overhead lines, 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:

- Transformers – there is generally a transformer associated with each inverter and, if desired, it could be designed/installed with high/low temperature or oil level alarms;
- Fault locators – 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;
- 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 actually 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 be worn/used at all times. Hazards such as arc flash will be present, but are mitigated to the extent practical during detailed design. In accordance with industry standards, hazard labels will be installed on electrical equipment that can be operated/accessed to provide guidance for additional PPE required for operational activities.

The majority of the underground collection system is not 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, and junction boxes that combine multiple cable sections or splices. 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 partial discharge testing during a maintenance outage each year in order to identify and locate any cable damage or impending failures.

Some equipment provided by manufacturers will have 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 transformers or metal-enclosed switchgear.

<u>Collection Substation</u>

The collection substation will have a SCADA (System Control and Data Acquisition) system that will send status and alarm signals to the overall Facility SCADA system. These signals will notify the operators of items such as breaker trips, transformer high/low temperature or oil level, battery charger trouble, etc. The SCADA system will also allow for remote operation of electrically-operated equipment. The operations team will be able to open and close circuit breakers, motor-operated disconnect switches, the transformer tap changer, etc. The details of this system will be determined during the design phase after certification by the Siting Board, but is generally accomplished using a communications line (T1, POTS, etc.) to transfer signals from an operator station to the substation equipment.

Since many items in the substation are large pieces of equipment supplied by major manufacturers, these items will be inspected and maintained in accordance with the manufacturers' O&M manual, which will be stored at the substation. The requirements will differ depending on which manufacturer is used. These items may include, but are not limited to:

- Main power transformer
- High and medium voltage circuit breakers
- Instrument transformers
- Disconnect switches
- Capacitor banks
- Metal-clad switchgear
- Standby generators
- Station service transformers
- Stationary battery and charger

Many of these items will be designed to send preventative alarm signals to the SCADA system to notify operators of problems before they become more significant or costly.

The substation will be visually inspected at regular intervals, as well as after any significant weather events such as extremely high winds, severe snow and ice, etc. Substation design adequacy will be monitored during the operations period of the Facility to ensure changes in environmental circumstances, utility changes, or equipment changes are evaluated for impact to the Facility.

(g) Heat Balance Diagrams

Since there will be no thermal component to the Facility, this requirement is not applicable to the proposed Facility.

(h) Interconnection Substation Transfer Information

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

National Grid is the interconnecting transmission owner for this Facility. The interconnection of the Facility will be accomplished via a POI with the National Grid St. Johnsville-Marshville 115kV transmission line. See Appendix 5-F for a General Arrangement Plan View drawing of the POI substation. The details of the arrangement with National Grid will not be known until the Facilities Study is complete.

(2) Transmission Owner's Requirements

Design and construction of the POI switchyard may be done by National Grid or by the Applicant. If by the Applicant, National Grid will be responsible for design reviews, construction oversight, and commissioning. The description of the design will not be known until the Facilities Study is complete.

(3) Operational and Maintenance Responsibilities

National Grid, as the transmission owner, will define and perform the operational and maintenance responsibilities for the POI switchyard. The Applicant will assume such responsibilities, to be implemented in accordance with the transmission owner's standards, as directed by National Grid.

(i) Facility Maintenance and Management Plans

The Applicant will be responsible for the operation, inspection, and maintenance requirements of all Facility components, except for the POI switchyard. These activities can generally be classified as scheduled inspection/maintenance, unscheduled maintenance/repairs, or electrical system inspection/maintenance. Each of these is briefly described below.

(1) Electric Transmission and Collection Line Inspections

(i) Vegetation Clearance Requirements

Vegetation control will be required immediately adjacent to the overhead interconnect lines to ensure safe operation and prevent damage to the line. All vegetation within the clear-cut boundary, with the exception of low lying growth, will be completely cleared. Vegetation must be reviewed, inspected, and cleared/maintained as necessary to avoid faults, outages, and damages to the lines. These issues are generally due to vertical movement (sagging) in the wires caused by thermal and mechanical loads, as well as horizontal movement caused by wind (blowout). These issues can also be caused by uncontrolled growth of vegetation itself.

Included in Appendix 5-E is a drawing that illustrates the requirements for clearing vegetation around the overhead interconnect lines. All vegetation within the clear-cut boundary, with the exception of low lying growth as shown, will be completely cleared. In addition, vegetation extending above the danger tree clearance line (outside of the clear-cut boundary) will be cleared to prevent a potential tree from falling into the line.

(ii) Vegetation Management Plans and Procedures

Initial vegetation management prior to and during construction utilizes manual/mechanical methods such as chainsaws, pruners or other heavy machinery. Portions of trees and other vegetation that extend into the clearing regions are typically trimmed. Vegetation that is completely within the clearing regions may be trimmed down such that they are classified as low-lying growth, or may be removed completely (up-rooting, removal, etc.).

Continued maintenance may be through a variety of manual trimming methods, as well as environmentally friendly herbicide treatments used to inhibit vegetation growth (where permitted). The frequency of inspection and management will depend on the rate of growth at the particular location along the lines. Low-lying growth and vegetation extending into the clear-cut boundary will be checked regularly each year. See Appendix 5-E for typical details and information associated with vegetation management for the overhead interconnect.

(iii) Inspection and Maintenance Schedules

The electrical system will require periodic preventative maintenance. Routine maintenance will include condition assessment for aboveground infrastructure and protective relay maintenance of the substation, in addition to monitoring of the secondary containment system for traces of oil. See Section (f)(4) above for information on the maintenance schedule for the electrical system.

(iv) Notifications and Public Relations for Work in Public Right-of-Ways

If work is to be performed in a public right-of-way, notification and any permit(s) to conduct such work will be addressed with the appropriate agencies prior to starting the work.

(v) Minimization of Interference with Distribution Systems

The overhead transmission lines will comply with safety standards referenced in Section (f)(1), which provide for separation distances from existing electric and communication distribution lines. The underground collection lines will comply with safety standards referenced in Section (f)(1), which provide for separation distances from existing electric and communication distribution lines. In addition, the lines have been sited on private lands.

(j) Vegetation Management Practices for Substation Yards

Vegetation management around substations are similar to the practices and requirements discussed above for overhead lines. Appendix 5-E provides details related to clearing requirements for the areas outside of the substation fence.

Within the substation fence, and immediately surrounding, it is important to eliminate all above-ground growth. Vegetation in this area could come in contact with the substations below grade grounding grid. If the vegetation extends above ground, coming in contact with a person could put them in danger in the event of an electrical system ground fault, which energizes the below grade grounding grid with high voltages and currents. Normally, a person is protected by the crushed stone on the surface of the station, but the vegetation could bridge the safety gap created by the stone. Pre-emergent herbicide is preferred to prevent vegetation from becoming established, but post-emergent herbicide and/or manual weed removal will be used in the event vegetation does begin to show.

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

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

(l) Availability and Expected Delivery Dates for Major Components

The Applicant is not aware of any equipment availability restrictions. The Applicant currently plans to place the Facility in-service in Q4 of 2021. Based on this in-service time-frame, major Facility components would be expected to arrive onsite starting in Q4 of 2020 through Q4 of 2021

(m) Blackstart Capabilities

The Facility is not anticipated to have blackstart capabilities.

REFERENCES

National Renewable Energy Laboratory (NREL). 2016. *Best Practices in Photovoltaic System Operations and Maintenance: 2nd Edition.* NREL/Sandia/Suspec Alliance SuNLaMP PV O&M Working Group. Technical Report NREL/TP-7A40-67553.