EXHIBIT A.1
SCOPE OF WORK SOLAR, WIND, BESS

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EXHIBIT A.1
SCOPE OF WORK SOLAR, WIND, BESS

1.0 EXHIBIT INFORMATION

1.1 Purpose

1.1.1 Without limiting the information summarized herein, the purpose of this document is (a) to summarize the minimum scope of work requirements for Contractor, which generally include the development, engineering, procurement, and construction of the generation and balance-of-plant infrastructure for the Project, as well as the installation; and (b) to summarize the minimum performance specifications, quality standards, and other criteria required for the engineering, procurement, and construction of the Project.

1.2 Project Description

1.2.1 The [Project Name] may be a solar photovoltaic, wind, Battery Energy Storage System ("BESS"), or any combination of these technologies thereof. Definitions of what constitutes the Project for each technology are provided below. If the proposed project is a combination of one or more of the technologies below, the Project definition will include the Project components listed for each included technology below. Further size and location requirements can be accessed in Minnesota Public Utilities Commission Docket No. E002/CN-23-212.

1.2.2 Solar Projects: The Project includes the solar PV array, inverters, access roads, 34.5 kV energy collection system, collection substation, and interconnection line to the POI.

(1) For the purposes of initial project evaluation in Docket , PV array is to be designed based upon a DC to AC ratio of 1.3 (Array DC MW capacity rating / AC MW capacity rating at the POI = 1.3). If project is approved in Docket No. E002/CN-23-212, Contractor is to work with Owner to optimize the final DC to AC ratio to achieve the Lowest Cost of Energy (LCOE) for the Project during the design phase of the project.

1.2.3 Wind Projects: The Project includes the wind turbines, access roads, the Aircraft Detection Lighting System (ADLS), and 34.5 kV energy collection system, collection substation, and interconnection line to the POI.

1.2.4 Battery Energy Storage System: The BESS is capable of being charged from the transmission grid and provides stored energy to the transmission grid. The Project includes the batteries, battery enclosures, Power Conversion System, Energy Management System (EMS), 34.5 kV energy collection system, collection substation, and interconnection line to the POI.

1.2.5 For Photovoltaic solar power generation Project(s) that include Battery Energy Storage Systems (BESS), the BESS is to be capable of being charged from either the PV solar array or the transmission grid.

(1) Contractor to consider the BESS operational requirements as identified in Table 13-1 (Minimum Battery Operational Requirements) and Table 13-3 (Minimum PCS Functional Specifications) in its alternate design option. Contractor to include the technical details for the alternate design such as: the DC Array rating; DC to AC ratio; type and quantity of inverters; etc. Contractor is to work with Owner to optimize the final DC to AC ratio to achieve the Lowest Cost of Energy (LCOE) for the Project during the design phase of the project.

1.2.6 For wind power generation Project(s) that include Battery Energy Storage Systems (BESS), the BESS is to be capable of being charged from either the wind power generation or the transmission grid.

(1) Contractor to consider the BESS operational requirements as identified in Table 13-1 (Minimum Battery Operational Requirements) and Table 13-3 (Minimum PCS Functional Specifications) in its design.

1.2.7 Contractor to provide/perform all land use permitting, construction permitting, right-of-way permitting, land subdivisions (if necessary), interconnection agreement, engineering, labor, procurement of materials and equipment, and supervision required for the complete design and installation of a fully functional, and operational renewable power generation facility that is in full compliance with Company's requirements, applicable codes, standards, laws and regulations. The contractor shall enter into a Project Labor Agreement (PLA) with local unions capable of performing quality work on the project. The described facility, as further detailed in this specification, shall be designed for a 35-year operating life, unless explicitly stated otherwise, based on normal operation, and the performance of maintenance, repairs, and the replacement of parts according to manufacturers' recommendations and standard industry practices.

1.3 References

1.3.1 In addition to anything summarized herein, all Work related to the Project shall conform to the latest version of the following Owner standards as included in Exhibit E.2 (*Owner Specifications*):

(1) EEC 7.970W01 Drawing Deliverables Standard

(2) NSP Title Block Standard

(3) XEL-POL-Facility Rating Methodology

(4) EPR 5.200 – Facility Rating and Reporting Policy

(5) EPR 5.201S – Stability Modeling Data Maintenance and Reporting Requirements

(6) EPR 5.202S – NERC Protection Systems Coordination Relay Setting Reporting Requirements

(7) EPR 5.220P01 – Facility Rating Methodology

(8) EPR 5.704S – Battery Maintenance Standard

(9) EPR 5.714S – Protective Relay

(10) EPR 4.200 – Plant Process Network Security Policy

1.3.2 This exhibit shall also be used in conjunction with the documents in Exhibit D.3 (*Preliminary Design Documents*), which shall be used as the basis for developing quantities for the Proposal. The specifications provided herein and the documents in Exhibit D.3 (*Preliminary Design Documents*) are intended to supplement, but not necessarily duplicate, each other; any Work exhibited in one and not in the other shall be executed as if it had been set forth in both. In the event of any conflicts between the information in Exhibit D.3 (*Preliminary Design Documents*) or this exhibit, the more stringent requirement shall prevail.

1.3.3 In the event the Work indicated or specified herein is increased or decreased, which shall occur at Owner's sole discretion and direction, the Contract Price shall be adjusted in accordance with the unit rates set forth in Exhibit TBD (*Exhibit Name*) to the Agreement. For the avoidance of doubt, deviations in quantities shall not constitute a Change Order unless dictated by Owner, such as through a Wind Turbine location change, and only deviations in linear quantities (e.g., Site Access Road length, collection system length) shall be included in such Change Order; all other changes shall be at Contractor's sole risk and reflected in the Contract Price.

1.4 Definitions

1.4.1 Unless defined in this exhibit, terms that begin with an upper case shall have the meaning defined in the Agreement.

1.4.2 For purposes of only this exhibit, the following words shall have the respective meanings set forth below.

(1) "**AC**" or "**ac**" shall mean alternating current.

(2) "**AC Rated Plant Capacity at the POI**" shall equal the total net export capability at the Point of Interconnection as defined by the Interconnection Agreement.

(3) "**AC System Losses**" shall mean the resistance losses (I^2R) through the AC cabling and magnetization and winding losses associated with the inverter step-up transformers and is exclusive of auxiliary loads

(4) "**ADLS**" means aircraft detection lighting system.

(5) "**Agreement**" shall mean the Development, Engineering, Procurement and Construction Agreement to which this Exhibit A.1 is attached.

(6) "**AHJ**" Shall mean any Authority Having Jurisdiction for the Facility.

(7) "**Applicable Law**" has the meaning set forth in the Agreement.

(8) "**Applicable Permits**" has the meaning set forth in the Agreement.

(9) "**Applicable Standards**" means the minimum standards and industry codes by Contractor, including those set forth in Exhibit A.2.

(10) "**As-Built Drawing**" means a complete set of drawings prepared by Contractor or a subcontractor using Owner's drawing standard which accurately and completely represents the Work as constructed and installed.

(11) "**Auxiliary Loads**" shall mean power consumption not directly associated with power generation or transmission losses. These include, but are not limited to, inverter power. Communications System power, HVAC, and communications Equipment loads.

(12) "**BESS**" means the battery energy storage system and includes the batteries, battery racks, power conversion system, a battery management system, and a site controller with pre-programmed BESS operating modes.

(13) "**BMS**" means battery management system.

(14) "**BTU**" shall mean British Thermal Unit

(15) "**C**" or "**°C**" shall mean degrees Celsius.

(16) "**Capacity Guarantee**" shall mean the guarantee by the Contractor for the total Power Rating of the Facility. It shall be verified by the Capacity Test in which the guaranteed Minimum Power Rating, as calculated with the Contractual Energy Model at the Reporting Conditions, is compared to the Power Rating, as measured by the AC power meter at the Point of Interconnection. The Capacity Guarantee shall be achieved if the Performance Criteria is greater than or equal to 98%.

(17) "**Circuit**" shall mean all Equipment associated with medium-voltage AC loop (PV modules, trackers, combiner boxes, ISAs, MET Station, SCADA, cabling, etc.).

(18) "**Collection System Circuit**" is one or more AC feeder cables with its own breaker connected to the Project Substation.

(19) "**Communications System**" or "**SCADA**" means the supervisory, control, and data acquisition system for the Project equipment (including all inverters, transformers, breakers, switches, relays, and meters) and permanent meteorological towers / Met Stations, as well as all fiber optic cabling and supporting devices within the Collection System Circuits.

(20) "**Contractor**" means the person, firm, or corporation with whom Owner has entered into the Agreement.

(21) "**Contractor Permit**" means any permit that the Contractor is responsible for obtaining and maintaining, as more particularly described in Exhibit A.6 (*Applicable Permits*).

(22) "**Contract Price**" means an amount to be paid to Contractor by Owner as full and complete payment for all Work to be performed by Contractor under the Agreement.

(23) "**Contractual Energy Model**" shall mean the PVsyst model which characterizes the Facility's energy performance inclusive of all modeling files (.MET, .PRJ, .PAN, .OND, etc.), DC and AC losses, soiling losses, auxiliary loads, etc. to accurately characterize the Facility. This model represents the project design and assumptions as of Agreement execution. In the event the Facility is modified by mutual agreement between the Contractor and Owner, the Contractual Energy Model inputs may be modified to match the constructed Facility if agreed upon by Owner and Contractor.

(24) "**DC**" or "**dc**" shall mean direct current.

(25) "**DC/AC ratio**" shall mean the ratio of DC power from the Array to nameplate AC real power capacity of the Project at the POI.

(26) "**DCP**" means dynamic cone penetrometer.

(27) "**ECP**" means the electrical connection point.

(28) "**Equipment**" means all of the parts, components, equipment, materials, apparatus, structures, tools, supplies, consumables, goods, and other items required or appropriate for a complete, fully-functional Project or that otherwise form or are intended to form part of the Work or the Project, *including* all equipment, materials, apparatus, structures, tools, supplies and other goods provided and used by Contractor and the subcontractors for performance of the Work, but that are not incorporated into the Project, and *excluding* all Owner-Supplied Equipment.

(29) "**F**" or "°**F**" shall mean degrees Fahrenheit.

(30) "**Facility**", "Site", or "site" shall mean all Equipment and systems outlined in this Exhibit A.1 including any Exhibits. The Facility shall meet all requirements as defined in the Agreement and the Exhibits.

(31) "**FERC**" shall refer to the Federal Electric Reliability Council.

(32) "**Final Completion**" means that each of the following has occurred: (a) the Substantial Completion Date has occurred; (b) all documents which are to be delivered to Owner by Contractor on or before the Final Completion Date pursuant to this Agreement have in fact been delivered to Owner, including, but not limited to, the As-Built Drawings and all manuals for the Work; (c) all of Contractor's supplies, personnel and rubbish have been removed from the Project Site; (d) all items on the Punch List and Final Punch List have been completed; (e) Contractor has delivered all final Lien waivers; (f) Contractor has performed all Work such that the Project may be operated as a fully-integrated wind energy project; (g) all Owner Furnished Equipment has been constructed in accordance with the Requirements and is capable of being operated in a safe and proper manner; (h) [intentionally deleted]; (i) Contractor has delivered the Job Books; and (j) Contractor has issued a Certificate of Final Completion to Owner and such certificate has been accepted or deemed accepted pursuant to Section TBD of the Agreement.

(33) "**GHI**" means Global Horizontal Irradiance.

(34) "**FNTP**" shall mean Full Notice to Proceed.

(35) "**HMI**" shall mean Human Machine Interface and shall refer to the user interface for the Owner, Contractor, and operator to interface with the Facility Communications System. The SCADA HMI shall be located in the Project Substation control building.

(36) "**HVAC**" shall mean heating, ventilation, and air conditioning.

(37) "**Hertz**", or "**Hz**" shall mean hertz.

(38) "**Interconnection Line**" means the 115-kV to 345-kV transmission line connecting the Project Substation with the Point of Interconnection as more particularly described in Section 7.0 herein.

(39) "**Irradiance Band**" shall mean the range of irradiance values which are eligible to be included in the data analyses. Should be no less than the reference irradiance (Irr0) +/- 15%, and no greater than Irr0 +/- 40%.

(40) "**ISO**" means Independent System Operator.

(41) "**Job Book**" means a manual to be prepared by Contractor and approved by Owner, which will include all Contractor engineering, design, purchasing, and other information relating to the Work.

(42) "**kV**" shall mean kilovolts.

(43) "**kW**" shall mean a measure of instantaneous power as measured in kilowatts. If not specified in particular it shall be assumed to be in Alternating Current (AC).

(44) "**kWh**" shall mean kilowatt-hours. If not specified in particular it shall be assumed to be in Alternating Current (AC).

(45) "**LV**" shall mean low-voltage, generally referring to equipment and materials below 34.5kV.

(46) "**Measured Data**" shall mean the meteorological data measured during the Capacity Test and used as inputs into the Contractual Energy Model to calculate the Predicted Energy.

(47) "**MESA-ESS**" means the Modular Energy System Architecture Energy Storage System Specification Open Standards for Energy Storage.

(48) "**MET Station**" shall mean the meteorological station/(s) installed within the solar field to measure critical weather data such as wind speed and direction, ambient temperature, solar irradiance, etc.

(49) "**Minimum Capacity Guarantee**" shall be achieved if the Performance Criteria is greater than or equal to 98%.

(50) "**Minimum Power Rating (PMIN)**" shall mean the expected power output of the Facility as calculated with the Contractual Energy Model at the Reporting Conditions.

(51) "**MPH**" or "**mph**" shall mean miles per hour.

(52) **"MPPT**" shall mean maximum power point tracking. It is the point on the output of the solar cell where the current and voltage output results in the maximum power output of the solar cell.

(53) "**MV**" shall mean medium-voltage, generally referring to 34.5kV equipment and materials.

(54) "**NERC**" shall refer to the North America Electric Reliability Corporation.

(55) "**NRTL**" shall mean Nationally Recognized Testing Laboratory.

(56) "**NTP**" shall mean Notice to Proceed.

(57) "**O&M Building**" means the Project operations facility, as further described in Section 13.0 herein.

(58) "**Owner**" means Northern States Power Minnesota (NSPM) or Northern States Power Wisconsin (NSPW).

(59) "**Owner Permit**" means those Applicable Permits that shall be acquired by Owner, as specifically set forth in Exhibit A.6 (*Applicable Permits*).

(60) "**Owner-Supplied Equipment**" means the work, services, and equipment Owner is to provide (or cause to be provided) as expressly set forth in Exhibit B (*Owner-Scope of Work*).

(61) "**PCC**" means the point of common coupling.

(62) "**PCS**" means power conversion system and includes the bi-directional inverter, harmonic filters, step-up transformer, AC and DC fault and overcurrent protection devices, and instruments and devices to interface with the Communications System. Bi-directional inverters are required on BESS inverters.

(63) "**Performance Criteria**" shall mean the Power Rating (PRC) divided by the Minimum Power Rating (PMIN) for the Facility during the Capacity Test, expressed as a percentage.

(64) "**Perimeter Fence**" shall mean a physical security fence that surrounds the property allocated for the Project. The fence shall be contiguous without interruption (except for personnel and vehicle gates).

(65) "**POA**" means "plane of array" as in 'plane of array irradiance'.

(66) "**Point of Interconnection**" or "**POI**" shall mean the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider as defined in the Interconnection Agreement.

(67) "**Power Rating (PRC)**" shall mean the actual power output of the Facility at the Reporting Conditions, per ASTM E2848.

(68) "**Predicted Energy**" shall mean the energy output from the Contractual Energy Model after inputting the Measured Data.

(69) "**Primary Measurement Device**" shall mean an instrument which provides a measurement or reading that is used in calculating output power in the Capacity Test.

(70) "**Progress Reports**" means the plan of the day, weekly, and monthly progress reports as prepared by Contractor detailing the actual progress of the Work in comparison to the Project Schedule.

(71) "**Project**" means the Project as defined in the Agreement. The Project shall include all equipment and systems producing / storing energy, from the renewable generation technology / BESS up to the POI, including the collector system, and collector substation and interconnection line.

(72) "**Project Schedule**" means the schedule of Project activities as more particularly described in Section 2.5.1(1) herein.

(73) "**Project Site**" means the location of the Project.

(74) "**Project Substation**" shall mean the interconnection facility(ies) which collect the feeders from the PCS / Wind Turbines / medium-voltage transformers / BESS and transforms the voltage (as required) for electrical interconnection to the Transmission Provider.

(75) "**Prudent Wind Industry Practices**" means:

(a) those practices, methods, equipment, specifications and standards of safety, performance, dependability, efficiency and economy as are acceptable for construction and professional engineering firms performing design, engineering, procurement and construction services in North America on facilities of the type and size similar to the Project, which in the exercise of reasonable judgment and in the light of the facts known at the time the decision was made, are considered good, safe and prudent practice in connection with the design, construction and use of electrical and other equipment, facilities and improvements, with commensurate standards of safety, performance, dependability, efficiency and economy, are in accordance with generally accepted national standards of professional care, skill, diligence and competence applicable to design, engineering, construction and project management practices, and are consistent with Applicable Laws; and

(b) those practices, methods, standards and acts that at a particular time in the exercise of reasonable judgment would have been acceptable to those engaged in, or approved by a significant portion of, the wind power industry for similar facilities in similar geographic areas as a reasonable effort to accomplish the desired result in a manner consistent with Applicable Laws, Applicable Standards, safety, environmental protection, economy and expedition.

(76) "**PSF**" or "**psf**" shall mean pounds per square foot.

(77) "**PV**" shall mean photovoltaic.

(78) "**PV Array**" shall mean the collection of solar modules connected in series and parallel via DC system, all tying into centralized inverters or PCS.

(79) "**Raceway**" means all conduit (rigid and flexible), underground duct, wireway, cabinets and boxes, and all materials and devices required to install, support, secure, and provide a complete system for support and protection of electrical conductors.

(80) "**Reporting Conditions**" shall mean the reference irradiance (Irr0), the reference temperature (T0), and the reference wind speed (WS0) as determined by the procedures outlined in the Capacity Test and referred to in ASTM E2848.

(81) "**Requirements**" means the Specifications in this Exhibit A.1, Prudent Solar / Wind / BESS Industry Practices, Applicable Law, Applicable Permits, Applicable Standards, the Project Schedule, the Interconnection Agreement, the preliminary designs in Exhibit D.3 (*Preliminary Design Documents*), the Transmission Provider Specifications, Turbine Supplier requirements, all manufacturer recommendations, and the other requirements of the Agreement.

(82) "**Roads**" and "**roadways**" means all Site Access Roads, spur roads, Site Maintenance Roads, perimeter roads, substation roads, transmission line service roads, maintenance building roads, and temporary construction roads to be constructed for the Project by Contractor.

(83) "**ROW**" shall mean Right of Way or Rights of Way.

(84) "**Secondary Measurement Device**" shall mean an instrument which provides a measurement or reading that is not used in calculating the Power Rating (PRC) but is used as check on primary measurements in the Capacity Test.

(85) "**Site Access Roads**" shall mean the Roads used to access the solar PV facility, Project Substation, or other Project Facility (excluding the O&M Building) that extends from the state or county road to immediately within the perimeter fencing of the Project Substation or to the inverters at the solar PV facility / or to each Wind Turbine / or to the BESS area.

(86) "**Site Maintenance Roads**" shall mean the Roads in the corridors within the solar PV Array / BESS perimeter fence and between solar arrays / BESS used to maintain the equipment.

(87) "**Special Tools**" means those tools as specifically set forth in Exhibit B (*Owner Scope of Work – Not Applicable*).

(88) "**Standard Error**" or "**SE**" shall be defined per ASTM E2848.

(89) "**STC**" shall mean standards test conditions, which is 1000 watts per square meter insolation, 25°C module temperature, 1.5 AM (air mass).

(90) "**Submittal Schedule**" means the schedule for Contractor's delivery of submittals, as set forth in Exhibit G.1 (*Submittal Schedule*).

(91) "**Substantial Completion**" means [TBD: Update with definition from the Agreement.]

(92) "**Test Period**" shall mean the "data collection period" referred to in ASTM E2848 and utilized during the Capacity Test.

(93) "**Transmission Provider**" shall mean the public utility (or its designated agent) that owns, controls, or operates transmission or distribution facilities used for the transmission of electricity in interstate commerce and provides transmission service under the Tariff.

(94) "**Turbine SCADA System**" means the SCADA system provided by the turbine manufacturer for control and monitoring of the Wind Turbines.

(95) "**Turbine Foundation**" means each Wind Turbine foundation to be completed in accordance with the Agreement.

(96) "**Turbine Supplier**" means Vestas or General Electric.

(97) "**Turbine Supply Agreement**" or "**TSA**" means the agreement between Contractor and Turbine Supplier for the supply of the Project Wind Turbines and associated equipment and work.

(98) "**Transmission Provider Specifications**" means the requirements of the interconnecting utility, transmission provider, and regional transmission organization.

(99) "**UCS**" means unconfined compressive strength.

(100) "**Wind Turbine**" means a wind turbine generator, including the following components: the tower sections, nacelle, hub, rotor blades, controller, control panels, wind vanes and anemometers, and associated accessories, in each case, to the extent provided by a Turbine Supplier under the terms of the applicable Turbine Supply Agreement.

(101) "**Wind Turbine Pads**" means both crane pads and hardstands, where (a) "**crane pads**" refer to a hardstand area in connection with the erection or service of a Wind Turbine and (b) "**hardstands**" refer to any area where Wind Turbine components, Wind Turbine equipment, transport equipment, or storage equipment are stored, placed, or parked, and including parking areas, laydown areas, and other such working areas.

(102) "**Work**" means all actions, contracts, labor, equipment, and materials necessary to construct the proposed Project and furnish the energy and any environmental attributes to Owner at the specified delivery point.

1.5 Interpretation

1.5.1 References herein to requirements to perform and/or provide work, services, equipment, or other similar items shall be understood to be the responsibility of Contractor, unless explicitly noted as being a responsibility of Owner.

1.5.2 Unless expressly noted otherwise, any requirement to "provide", "supply", or "furnish" goods or services herein shall be considered equivalent.

1.5.3 The headings of sections and subsections herein are for convenience only and shall be ignored in construing this exhibit.

1.5.4 Unless expressly noted otherwise, any number in decimal form herein shall not refer to the precision or significant digits of that number.

2.0 GENERAL SERVICES

2.1 General Provisions

2.1.1 Contractor shall perform and/or provide all work, design services, procurement services, construction services, permitting services, land development, land acquisition, Interconnect Agreement development, scheduling, supervision, management, labor, equipment, materials, parts, apparatus, tools, consumables, temporary structures, temporary utilities, storage, quality control and other items necessary or appropriate to complete the Work described herein, unless explicitly stated otherwise, and all such Work shall be included in the Contract Price.

2.1.2 Contractor shall perform all Work in conformance with the Requirements. In the event of any conflict or discrepancy between this exhibit and any Requirement, the more stringent or higher quality Requirement shall take precedence over the less stringent or lesser quality Requirement.

2.1.3 Contractor shall provide supervision, inspection, and quality control of the Work to ensure it is completed safely, competently, and efficiently. Contractor shall devote attention, skills, and expertise as is necessary to perform the Work in accordance with the Requirements. All materials shall be new, unused, of the highest quality, free of defects and irregularities, and consistent for use in solar generation facilities / wind] generation facilities and battery energy storage facilities. All equipment and materials shall be installed, assembled, and tested in strict compliance with the manufacturer's drawings, code markings, and instructions, and any proposed materials, structures, and/or assemblies shall be maintainable in the simplest and most cost-effective manner possible.

2.1.4 All Work, including construction, materials storage, grading, landscaping, cut/fill, erosion control, and other similar or related activities, shall not extend beyond the designated disturbance limits shown on the Project Site Plan. Unnecessary disturbance of the existing Project Site conditions shall be minimized, and under no circumstance may Contractor perform any Work or cause any disturbance beyond these corridors without explicit written confirmation from Owner.

2.1.5 Contractor shall not construct any portion of the Work until the applicable issued-for-construction drawings have been approved by Owner. Turbine Foundations shall not be constructed until (a) the Turbine Foundation drawings and calculations have been approved by Owner, including its independent engineer; and (b) until pre-determined hold points have been approved by Owner, including inspection of rebar placement prior to pouring concrete.

2.1.6 Contractor shall design all aspects of the Project based on verifiable criteria that are specific to the Project and the Project Site, including elevation, corrosivity, precipitation, frost depth, seismic loads, and subsurface conditions. All such design criteria shall be clearly displayed on the design drawings.

2.1.7 Notwithstanding any reference to specific codes or standards herein, all Work shall comply with the latest revision of the Applicable Standards, including those set forth in Exhibit A.2 (*Applicable Standards*). The method for handling conflicts between Applicable Standards shall be as set forth therein.

2.1.8 Exhibit A.3 (*Approved suppliers*) contains a list of approved materials, equipment suppliers, and subcontractors. If Contractor is considering the selection of a material, equipment supplier, or subcontractor that is not listed herein, Contractor shall request approval from Owner prior to executing any contract for the procurement of such material or with such equipment supplier or subcontractor. Equipment catalog cut sheets shall be submitted for Owner review and approval prior to procurement.

2.1.9 Unless explicitly stated otherwise, the minimum design working life of the Work shall be 35 years.

2.1.10 Requirements for rigging, tooling, and testing equipment:

(1) All rigging shall be rated; inspected daily; and load tested in accordance with the Applicable Standards or other more rigorous requirements set forth in the HSSE Plan. The manufacturer-rated capacities shall be legible and permanently affixed. Inspection reports shall be maintained at the Project Site and available for review by Owner.

(2) All tooling and testing equipment shall be calibrated, at a minimum, in accordance with the manufacturer's recommendations. Copies of testing certificates and calibration records for all tooling and testing equipment shall be maintained at the Project Site, available for review by Owner, and included in the Project Job Books.

(3) Contractor shall utilize tooling and testing equipment in accordance with manufacturer recommendations, including any supplier guidelines for use of special tools.

2.1.11 NERC compliance:

(1) The Project shall be compliant with all NERC requirements, including specifically the following reliability guidelines and lessons learned in its most recent versions including:

(a) "Reliability Guideline – Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources" included in Exhibit A.2.1

(b) "Reliability Guideline – BPS-Connected Inverter-Based Resource Performance" included in Exhibit A.2.2.

(c) "Lesson Learned – Battery Energy Storage System Cascading Thermal Runaway" included in Exhibit A.2.3.

(d) Comply with IEEE 2800 - Standard for Interconnection and Interoperability of Inverter-Based Resources (IBR) Interconnecting with Associated Transmission Electric Power Systems .

(2) The Project shall be designed and constructed following the latest NERC guidance for the following parameters, at a minimum:

(a) Momentary cessation

(b) Phase jump immunity

(c) Capability curve

(d) Active power frequency controls

(e) Fast frequency response

(f) Reactive power voltage control

(g) Reactive current voltage control

(h) Reactive power at no active power output

(i) Inverter current injection during fault conditions

(j) Return to service following tripping

(k) Balancing

(l) Monitoring

(m) Fault ride-through capability

(n) Protection setting

(3) Contractor shall provide, or support Owner in the provision of, any NERC requirements, studies, or deliverables associated with providing a complete, working, safe, and compliant Project. All such deliverables shall be provided in a manner that is thorough, organized, complete, and suitable for use in presentation to NERC audit personnel. Conclusions provided in any deliverable shall be supported with explanations regarding how each conclusion was made. All materials and deliverables shall be provided to Owner for review and approval.

(4) All Project drawings shall provide indication for those settings that are selectable (e.g., transformer tap settings) that are a reliance item for any part of a NERC compliance required setting position.

(5) All NERC requirements, studies, or deliverables shall be consistent with the requirements in Exhibit A.2.4 (*NERC Requirements*).

2.2 Development Services

2.2.1 Not used.

2.3 Site Conditions

2.3.1 Contractor shall inspect the Project Site prior to initiating the Work to obtain, or plan to obtain, such additional or supplementary examinations, investigations, explorations, surveys, tests, studies, and/or data concerning conditions at or contiguous to the Project Site or otherwise, which may affect cost, progress, performance, or furnishing of the Work. All such inspections shall be obtained and/or executed pursuant to the Project Schedule.

(1) Contractor shall provide the information for the Project Site in the form of Exhibit D.2 (Project Site Data).

(2) All aspects of the Project design, construction, operations and maintenance, shall take the Project Site Data into consideration. The drifting and clearing of snow from the Project facilities shall be considered in all design aspects as may be applicable.

2.3.2 Contractor shall furnish weather equipment at the Project Site capable of measuring precipitation, wind speed, and other conditions as necessary to determine the occurrence of weather days and abnormally severe weather conditions, respectively.

2.3.3 Any existing infrastructure, including communications towers, pipelines, telephone lines, and electrical lines, shall be maintained in their current condition throughout the construction of the Project. Existing access to the Project Site, including along public roads, shall remain open throughout construction.

2.4 Construction Management

2.4.1 Contractor shall provide traffic control at and within the Project Site that comply with local regulations and/or permits, or as otherwise required to complete the Work, including, but not limited to, traffic control along any public roads, as required.

2.4.2 Contractor shall provide all necessary construction water, including, but not limited to, that which is required for temporary work, concrete preparation, dust control, rock drilling operations, and washing of equipment and components. For the avoidance of doubt, Contractor shall obtain and maintain any water permits necessary or required for completion of the Work.

2.4.3 Contractor is responsible for temporary power and communication services for Facility during construction including, but not limited to, that required for office trailers, temporary lighting, Project Substation, and commissioning/testing procedures. For the avoidance of doubt, Contractor shall be responsible for furnishing both the power supply and fuel source for such items. Owner shall be allowed access to such power and communication services on Site as may be required during construction.

2.4.4 Contractor shall provide all necessary fire management devices, per the fire management plan to be prepared by Contractor as a Contractor Deliverable, including water trailers, construction vehicle fire kits, or other similar devices, as applicable.

2.4.5 Contractor shall attend and actively participate in Owner-scheduled Project meetings. These meetings may include, but are not limited to, (a) engineering update meetings to review progress against the Project Schedule, address issues related to the Work, and other similar items prior to construction of the Project; and (b) Project management meetings during construction, including plan of the day, daily safety meetings, daily logistics planning, Project Schedule progress, weekly management updates, and monthly management updates.

2.4.6 Contractor shall ensure compliance with all landowner agreements and requirements thereof.

2.4.7 Contractor shall support Owner with providing timely responses to reasonable requests for information from Owner or Owner’s contractors, including equipment suppliers.

2.4.8 Contractor shall contact local authorities, pipeline companies, and utility companies to locate conflicting underground facilities *prior* to starting any excavation or trenching Work. Contractor shall be responsible for all damages resulting from contact with identified underground facilities in the vicinity of each excavation. In the event of any conflict with an underground facility, Contractor shall immediately notify Owner and shall document the nature of the conflict, relocation of the conflicting facility or structure, any damages which occurred, and final resolution. This documentation shall be provided to Owner within 48 hours of such conflict.

(1) Contractor shall locate and maintain the location of all Contractor-installed underground facilities for purposes of Project closeout and restitution activities that may be required (e.g. drain tile repair).

2.4.9 Contractor shall regularly inspect Equipment delivery trucks and other equipment for leaks, including oil, coolant, and hydraulic fluid.

2.4.10 Contractor shall furnish and maintain throughout construction of the Project a construction radio system for use by Owner and Owner’s representative(s), including access to Contractor’s primary safety channel. At least five (5) fully functional radios shall be furnished for this purpose. This radio system shall be fully functional within 30 days of Contractor mobilization.

2.5 Project Documentation

2.5.1 Contractor shall prepare and submit all deliverables and submittals necessary for the successful completion of the Work, including, but not limited to, Job Books, As-Built Drawings, completion certificates, design documents, and all other manuals, drawings, plans, studies, calculations, safety-related documentation, reports, checklists, completion procedures, agreements, and other similar items (collectively, the "**Contractor Deliverables**"). All Contractor Deliverables shall be coordinated and discussed with all pertinent parties prior to and during the construction phase of the Project; shall be subject to review and/or approval by Owner, as applicable; shall be submitted by the applicable dates in the submittal schedule in Exhibit G.1 (*Submittal Schedule*); and shall meet the minimum requirements for submittals set forth in Exhibit A.5 (*Submittal Requirements*). OWNER REVIEW OF ANY OF THE CONTRACTOR DELIVERABLES SHALL NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR THE ACCURACY OR CORRECTNESS OF ITS WORK OR FOR THE PROPER CONSTRUCTION AND SUCCESSFUL PERFORMANCE OF THE EQUIPMENT IN ACCORDANCE WITH THE CONDITIONS SPECIFIED IN THE CONTRACT. The following list provides an indicative sample of Owner requirements for specific Contractor Deliverables for the sole purpose of ensuring clarity of expectations for the referenced submittals; *this list is not intended to be an exhaustive listing of all Contractor Deliverables or the requirements thereof.*

(1) Contractor shall prepare, implement, and manage a detailed Project schedule that reflects the Project execution plan and anticipated sequence of site operations (the "**Project Schedule**"), and shall cause the reports summarized in Exhibit A.4 (*Schedule Requirements*) to be submitted with each Project Schedule update; the Project Schedule shall comply with the minimum requirements set forth in Exhibit A.4 (*Schedule Requirements*). Contractor shall also provide an individual (the "**Scheduler**") who shall (a) be dedicated to the Project upon start of construction; (b) develop and maintain the Project Schedule; (c) be an experienced specialist that is skilled in critical path method scheduling; and (d) attend (either remotely or in person) and actively participate as needed in all Project meetings related to construction progress, alleged delays, or time impact.

(2) Contractor shall prepare, implement, manage, and observe the health and safety plan, the security plan, and the environmental plan (collectively, the "**HSSE Plans**"). These plans shall conform to the minimum requirements set forth in Exhibit C.2 (*Safety, Security, and Environmental Plan Requirements*).

(3) Contractor shall prepare, implement, and manage a detailed quality assurance plan that is specific to the Project and Project Site. This plan shall conform to the minimum requirements set forth in Exhibit C.3 (*Quality Plan Requirements*).

(4) Contractor shall provide one (1) complete copy of Job Books in hard copy format including a complete color set of full-size (size D) as-built drawings, one (1) complete copy of Job Books in electronic format on a flash drive or external hard drive, and one (1) complete copy of Job Books in electronic format uploaded to the Contractor's web-based document management site. Job Books shall conform to the minimum requirements set forth in Exhibit C.4 (*Job Book Requirements*).

(5) Contractor shall prepare a spill prevention, control, and countermeasure ("**SPCC**") plan in accordance with EPA requirements.

(6) Contractor shall prepare, implement, and manage a detailed project execution plan that is specific to the Project and Project Site. The project execution plan shall be sufficient in scope and detail to convey the means and methods that will be employed by Contractor to perform all aspects of the Work. Key elements of the project execution plan shall include, but not be limited to, project management structure and key personnel; roles and responsibilities; staffing plans; communications protocol; engineering execution plans; security plans, including, but not limited to, guards / patrols, weapons, emergency procedures, and incident notification procedures; and construction management plans, including, but not limited to, cost controls, schedule controls, mobilization, document management, materials management, details for receipt and transport of equipment, traffic management (including concrete trucks), construction sequencing, movement of cranes during construction, and other similar items.

(7) Contractor shall prepare, implement, and manage a detailed traffic management plan that is specific to the Project and Project Site. The traffic management plan shall clearly identify all haul routes from the nearest highway; proposed traffic flow within the Project Site, including public roads; plans for managing construction, delivery, public, and other traffic at the Project Site during construction; daily concrete truck delivery flow plans; speed limits; and mitigation measures to reduce risk and impact to non-construction vehicles due to construction activities. The traffic management plan shall be consistent with the requirements of Exhibit D.4 (*Road Use Agreement*) and any local AHJ requirements, including the Department of Transportation, at a minimum.

(8) Contractor shall prepare, implement, and manage critical lift plans that are specific to the Project and Project Site per the Safety Plan as part of Exhibit C.2 (*Safety, Security, and Environmental Plan Requirements*). The critical lift plan shall clearly identify precautions for all critical lifts; coordination plans, including pre-lift meetings, with all participating personnel; and sample documentation/checklists for all critical lifts.

(9) Contractor shall prepare, implement, and deliver pre- and post-construction visual surveys of the Project Site, documenting the Site conditions, with appropriate photographs/recordings. The pre-construction survey shall be delivered to Owner no later than five (5) business days prior to construction. A post-construction survey shall be delivered to Owner no later than five (5) business days of the last heavy truck leaving the Site. A final post-construction survey shall be delivered to Owner no later than ten (10) business days after all substantial construction traffic has left the Project Site

2.5.2 Contractor shall upload electronic copies of all Contractor Deliverables (including drafts and final) to Contractor's web-based document management site and shall make documentation accessible to Owner.

2.5.3 Contractor shall prepare and maintain a documentation list for the Project. This list shall include, at a minimum, a listing of all Contractor Deliverables and the status (including responsible party) and revision number of each. The naming and labeling conventions for all Contractor Deliverables shall be coordinated with and approved by Owner. The documentation list shall be updated by Contractor each time a new or revised drawing or document is issued, at a minimum.

2.5.4 Contractor shall prepare and maintain a complete log, including supporting documentation, of all requests for information (each, an "**RFI**") issued throughout performance of the Work. This log shall include, at a minimum, a listing of each RFI and the status (including responsible party) and revision number of each. The naming and labeling conventions for all RFIs shall be coordinated with and approved by Owner. The documentation list shall be updated by Contractor each time a new or revised RFI is issued, at a minimum.

2.5.5 Contractor shall provide to Owner periodic written reports as to the actual progress of the Work in comparison to the Project Schedule. These reports shall include, but are not limited to, the plan of the day report, the weekly progress report, and the monthly progress report each in accordance with Exhibit C.5 (*Progress Report Contents*).

2.5.6 Contractor shall maintain color hard copies of all issued-for-construction drawings at the Project Site during performance of the Work; such hard copies shall be updated by Contractor upon issuance of any revised issued-for-construction drawing. Contractor shall maintain separately a complete set of controlled redline drawings showing all Owner-approved changes made during construction, including an organized record log with reference to the applicable RFI number or other justification for the change; such redlines shall be included in the Job Books.

2.5.7 Contractor shall furnish and manage a web-based document management site such as Procore or Owner-approved equivalent. The document management site shall be capable of storing and sharing design and other applicable documents, managing workflows, and tracking financials and schedules, at a minimum. Contractor shall provide Owner and any Owner-requested subcontractors or representatives access to such site with permissions as necessary to perform their respective work.

2.6 Signage and Labeling

2.6.1 Contractor shall furnish, install, and maintain throughout the performance of the Work all signage required by the Applicable Permits, the Applicable Standards, and other applicable Requirements. All signage and equipment marking (including numbering and labeling) shall be weatherproof, UV resistant, and approved by Owner prior to installation.

2.6.2 Contractor shall furnish and install (a) a permanent sign at each Wind Turbine listing the name of the Wind Turbine; (b) a permanent sign at each Wind Turbine string road listing the name(s) of all Wind Turbine(s) along that road; and (c) identification numbers and permanent, weatherproof labels on the base of all Wind Turbine towers facing the immediate tower access road at an elevation which is above the tower door, indicating Owner tower number and Collection System Circuit number, respectively.

2.6.3 Contractor shall furnish and install identification numbers and permanent, weatherproof labels on all Interconnection Line structures.

2.6.4 Contractor shall furnish, install, and maintain above-ground “buried cable” marker signs (a) at all locations where an underground Collection System Circuit crosses a road, fence, or underground utility respectively; (b) at a minimum of every 2,000 continuous feet of trench length; and (c) at all sharp turns in the Collection System Circuits.

2.6.5 Contractor shall furnish and install a permanent, non-masonry sign at the O&M Building location indicating Project name, Owner name, and entry requirements. The location, contents, and format of this sign are subject to Owner approval.

2.6.6 Contractor shall furnish and install the following permanent signs at the Project Substation.

(1) Project Substation identification sign shall be placed on Project Substation fence, be a minimum of 23 inches by 14 inches and shall indicate Project name, Project Substation name (if applicable), Owner name, and contact information. The location, contents, and format of this sign are subject to Owner approval.

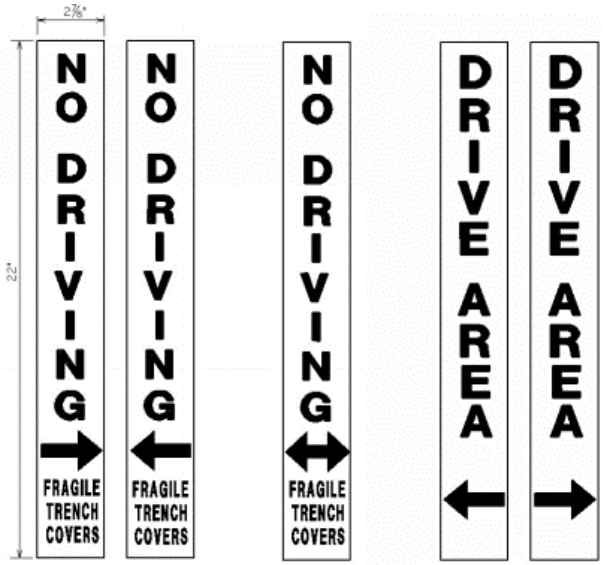
(2) Project Substation buried cable sign as shown in Figure 2-1 should be placed on Project Substation fence where buried cables are present. The signs should be mounted, back-to-back, on each side of the Project Substation fence fabric.

Figure 2-1: Substation Buried Cable Sign

10" x 7" Sign

(3) Figure 2-2Project Substation precast cable trench no-drive signs in Figure 2-3 shall be posted in the Project Substation where vehicles could mistakenly drive over the precast cable trench.

Figure 2-3: Example Substation Precast Cable Trench No Drive Sign



Sign #1 Decals Mounted Back-to-Back

Sign #2 Decals Mounted Back-to-Back

Sign #3 Decals Mounted Back-to-Back

(4) Substation Safety Signs as shown in Figure 2-4 shall be placed on Project Substation fence 30 to 45 feet apart and no more than 15 feet from the corners of the enclosure and approximately five (5) feet from grade to top of sign. Two (2) signs shall be placed on each drive gate, one on the inside and one on the outside, back-to-back, to be readable when the gate is open. One (1) sign shall be placed on the outside of each walk gate.

Figure 2-4: Example Substation Safety Sign

(5) Substation battery warning signs as required by the NEC as shown in Figure 2-5 shall be placed on the outside of all substation control house doors using sheet metal screws. The signs shall be approximately 5 feet from the bottom of door to the top of the sign and be centered on the door.

Figure 2-5: Example Battery Warning Sign

2.6.7 Contractor shall furnish and install permanent speed limit signs as required by local Department of Transportation requirements and “no trespassing” signs at Site Access Road entry points, and every Wind Turbine Door every 100 feet along the solar PV Array perimeter fencing, and on the door of each PCS every 100 feet along the BESS perimeter fencing, and on the door of any BESS PCS or containerized facility.

(1) Sign shall read "NO TRESPASSING, AUTHORIZED PERSONNEL ONLY. DANGER – HIGH VOLTAGE. Trespassers will be prosecuted." The sign shall also cite applicable ordinances or laws and penalties that may be imposed on violators.

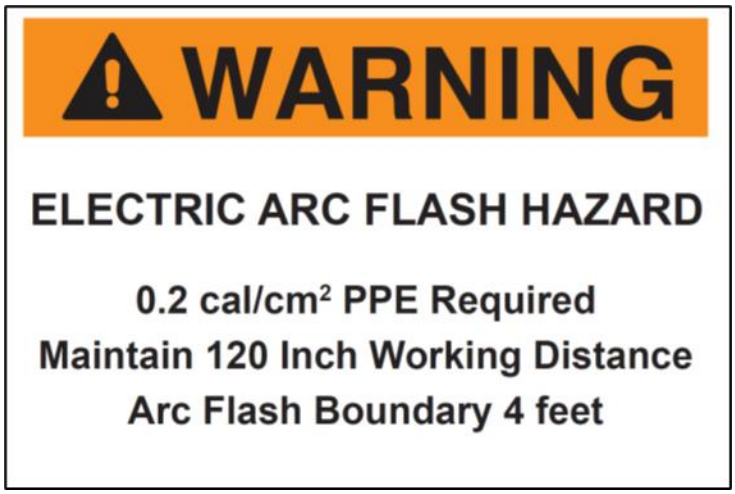
(2) Sign size, content, location, etc. shall be approved by Owner prior to installation.

2.6.8 Contractor shall supply and install ANSI-approved arc flash labels warning of the dangers of arc flash incident energy.

(1) Such labels shall be supplied and affixed to any equipment that may require service or maintenance while energized, as specified in the Contractor-provided arc flash study, including the major Equipment, Collection System Circuits, Project Substation, Interconnection Line, O&M Building, and on all applicable equipment enclosures from the Project Substation to the Wind Turbines / PV panels / BESS.

(2) The arc flash label shall include, at a minimum, the level of PPE requirement, safe working distance, and arc flash boundary distance. A typical label is shown in Figure 2-6:

Figure 2-6: Example Arc Flash Hazard Label



2.6.9 Contractor shall, prior to the start of construction activities, measure the height of all overhead power lines or obstructions at the Project Site. Contractor shall furnish, install, and maintain signage at each such crossing and incorporate any measures necessary to operate, move, and mobilize cranes and other equipment to ensure safe passage with adequate clearance.

2.6.10 Contractor shall furnish, install, and maintain signage as needed for blind corners, dips, trucks entering roadways, restricted areas, and other potential hazards. Contractor shall also furnish, install, and maintain danger signs, signals, lights, guard rails, reflectors on curves, and notices as may be necessary to adequately protect the Work and personnel of any company at the Project Site, including visitors, against injury or property damage. All such signage shall be installed prior to commencing construction activities.

2.6.11 Contractor shall furnish, install, and maintain signage as needed to provide reasonable information and direction to Project Site personnel and to facilitate orderly entrance and egress from the Project Site. Contractor shall also furnish, install, and maintain signage identifying personnel assembly locations for use during emergencies or Project Site evacuations.

2.6.12 Contractor shall furnish and install emergency response (E-911) address signs in accordance with local authorities.

2.6.13 Contractor shall uninstall, remove, and discard of all temporary signage at the completion of the Work, or as otherwise prescribed in the Applicable Permits. Temporary signage shall be legible and of sufficient durability to last the duration of construction activities.

2.6.14 Requirements for Labeling:

(1) Electrical equipment shall be labeled to meet applicable industry codes and standards.

(2) All labels shall be weatherproof and either laminated black-phenolic plastic with white engraved letters or engraved (or embossed) stainless steel nameplates.

(3) All cables shall have a label affixed to the outer jacket with a Brady or equivalent cable marker at each termination and shall not cover the barrel of the terminal lug or otherwise interfere in any way with access to the barrel of the lug.

(4) Instrumentation and control cables and wires in the same circuit or grouping shall be identified by circuit numbers as indicated in the design documents. The circuit number shall be fastened to each cable or wire grouping at each terminal, cable trench, pull box, manhole, hand hole and junction point.

(5) All Collection System Circuit power cabling labels shall be permanently attached at both ends. Labels shall be sequentially numbered.

(a) Each cable in a switch, sectionalizing cabinet, transformer, etc. shall be identified by circuit number, phase, and location of the opposite end with permanent plastic or corrosion resistant metal tags. Close to each cable termination, Contractor shall also mark the cable termination phase designation on the cabinet.

(b) Contractor shall use accepted NEC code practices for providing the required colors at the wire ends of AC power circuits.

(6) All communications cables, including fiber cables, shall be appropriately labeled with a permanently attached label at both ends. Labels shall be sequentially numbered.

(7) Labeling is required, at a minimum, on each of the following Project equipment:

(a) Nameplates for all electrical equipment in the Project Substation and MV transformers (as applicable).

(b) Indoor Substation Equipment

(c) Solar Combiner Boxes

1. For diagnostic and troubleshooting purposes, all multi-string harness inputs to each combiner box and the combiner boxes themselves shall be uniquely tagged and identified with such tagging on the record construction drawings.

2. The combiner box shall be properly labeled in the factory and/or field with permanent, sunlight-resistant labels made of laminated three-ply plastic (or better) and shall include all labels required by the NEC and NFPA 70E as well as equipment identification tags.

3. Combiner Box labels shall include an electrical shock warning label, disconnect label, number label, and warning "Do not open under load" label, at a minimum. Labels shall be reviewed and approved by Owner prior to installation.

4. All information and warnings required by the National Electrical Code sections 690 and 705 shall be provided on a permanent label attached to each combiner.

5. Arc Flash PPE requirements shall be provided on a permanent label attached to each combiner in accordance with the section herein.

(d) Inverters

(e) Solar Modules shall be provided with a permanent label indicating, at a minimum, the following information.

1. Make/model

2. Electrical characteristics, including open circuit voltage (Voc); short circuit current (Isc); maximum power point voltage (Vmpp); maximum power point current (Impp); nameplate power (W), and maximum series fuse size

3. Temperature coefficients of Isc, Voc and nameplate power

4. Nominal power conditions (STC, NOCT, etc.)

5. Environmental operating conditions

6. Compliance with Exhibit A.2 (*Applicable Standards*)

7. Warnings of electrical hazard

8. Maximum system voltage

9. Maximum Load Capacity

10. Date and location of manufacture, manufacturing code

11. Serial number

(f) BESS Battery modules shall be provided with a permanent label to indicate the following:

1. Make/model

2. Electrical characteristics: nominal voltage (V), minimum voltage (Vmin), maximum voltage (Vmax), nominal current (I), maximum current (Imax), short circuit current (Isc), nominal power (kW), nominal energy (kWh), nominal charge / discharge rates (C-rate (C), max C-rate (Cmax)).

3. Physical characteristic: height (in), length (in), width (in), weight (lbs), max operating temperature (Tmax), min operating temperature (Tmin), ideal operating temperature (Tideal)

4. Nominal power conditions (at specified testing conditions)

5. Compliances with standards

6. Warnings of electrical hazard

7. Serial number

8. Manufacturing date and location, manufacturing code

(g) Junction boxes

2.7 Permits and Agreements

2.7.1 Contractor shall obtain, pay for, and maintain all permits required for its performance of the Work, except those explicitly noted in Exhibit A.6 (*Applicable Permits*). Contractor shall provide copies to Owner of all permit applications promptly after such applications are submitted to the applicable authority.

2.7.2 Contractor shall maintain copies of all permits at the Project Site during construction of the Project and shall at all times comply with all permit requirements, including closeout of such permits, and shall transfer to Owner such permits required for the operation and maintenance of the Project.

2.7.3 Contractor shall provide reasonable assistance, including engineering support, to Owner in applying for, obtaining, and maintaining the Owner Permits.

2.7.4 Interconnection Agreement:

(1) The Contractor shall be responsible for obtaining the interconnection agreement from the Transmission Provider. Contractor will coordinate with the Transmission Provider and provide all necessary work, support, and materials for interconnection of the facility on the Owner side of the Point of Common Coupling (POCC) as defined in the Owner scope in the Interconnection Agreement, and as defined in the electrical drawings and site plan.

2.8 Training

2.8.1 Contractor shall prepare and conduct comprehensive training of Owner and its operations and maintenance personnel in the safe operation and maintenance of the Project and its equipment. Such training shall cover, at a minimum, the Project Substation, the Collection System Circuits, the Communications System, the Interconnection Line, the MET Station / Project Substation meteorological towers, PV Array, PV Inverter, BESS and the PCS.

2.8.2 Contractor shall provide regular and ongoing lockout-tagout training to on-Site personnel throughout the performance of the Work.

2.8.3 BESS Training Requirements

(1) The Contractor shall be responsible for providing training to first responders.

(2) The Contractor shall for provide on-site training class for operators, engineers, technicians, and maintenance personnel for up to ten people on the operation, maintenance, and repair of equipment furnished as part of the Works.

(3) Training shall include both classroom and hands-on training with all training materials also provided to Owner in a common electronic format (PDF, MP4, etc.) agreed upon by Owner.

(4) Contractor shall allow Owner representatives to shadow / observe Contractor's startup personnel during commissioning activities. Participation by Owner's trainees is at Owner's option and does not relieve Contractor of responsibility to properly commission the facility.

2.9 Supervision and Engineer of Record

2.9.1 All engineering shall be performed under the supervision of and stamped by the engineer(s) of record, who shall be a registered professional engineer with a current license in the Project jurisdiction. Such professional engineer(s) shall be registered in the applicable discipline for the drawings being signed and sealed.

2.9.2 All Work concerning the geotechnical services shall be supervised and directed by a qualified, competent, practicing geotechnical engineer. A geotechnical engineer or engineering geologist shall observe, log borings, obtain soil samples, and record blow counts of the samples, drill rates, rock quality, depth to ground water, and other pertinent data under the direction of a licensed geotechnical engineer.

2.9.3 Contractor shall provide a qualified third-party environmental inspector to support any state-mandated environmental inspections.

2.10 Temporary Facilities

2.10.1 Contractor shall be responsible for designing and implementing temporary traffic control measures as required by applicable County or local agencies throughout construction duration for Contractor-provided Equipment and deliveries. Owner shall be responsible for ensuring any Owner-Provided Equipment deliveries that require temporary traffic control measures are provided by Owner's delivery contractor.

2.10.2 Contractor shall be responsible for establishing and maintaining temporary parking areas for construction and office personnel. Temporary parking areas shall be returned to design grades and surfacing at the termination of construction.

2.10.3 Contractor shall furnish and install two (2) 24-foot by 60-foot double-wide office trailer for Owner's exclusive use. Each trailer shall be at the locations as specified by Owner and shall be installed and ready-to-use no later than 10 days after the Contractor mobilization date or on the same date when Contractor's trailers are installed, whichever occurs first. Owner's trailer(s) shall be removed from the Project Site at Project Substantial Completion or when Contractor's trailers are removed from the Project Site, whichever occurs last.

(1) Each trailer shall include at least four (4) offices, and Contractor shall furnish each such office with two (2) desks, two (2) two-drawer file cabinets, two (2) rolling armchairs, two (2) visitor chairs, and one (1) 4-foot by 6-foot white board.

(2) Each trailer shall include at least one (1) conference area, and Contractor shall furnish each such conference area with six (6) 8-foot-long tables, 16 chairs, and one (1) 4-foot by 6-foot white board.

(3) Not used.

(4) Each trailer shall include at least one (1) full-size drawing table, one (1) full-size drawing rack, and two (2) 4-foot by 6-foot bookshelves, respectively.

(5) Each trailer shall include one (1) full-size refrigerator with freezer and one (1) full-size microwave. All appliances shall be new and unused.

(6) Each trailer shall be furnished with central HVAC.

(7) Each trailer shall be furnished with at least one (1) first aid kit and one (1) fully-charged fire extinguisher, respectively. Contractor shall maintain and recharge such fire extinguishers throughout the duration of the construction activities, as required.

(8) Each trailer shall be furnished with a Wi-Fi-enabled printer that includes scanning capabilities, and with 8.5-inch by 11-inch and 11-inch by 17-inch print sizes.

(9) Contractor shall furnish and install phone service, broadband internet service, and electric service, for each Owner trailer, including connection of all communications (phone and internet) to the jobsite. Phone service may be VoIP and shall include at least one (1) four-line phone system up to the wall jacks in each trailer. Internet service shall include high-speed internet (minimum speeds of 100 megabits per second) infrastructure wiring up to the wall jacks in each trailer and high-speed wireless internet service (Wi-Fi) throughout the trailer compound, respectively. All utility services shall include use and service charges to Contractor's account, including for Owner's trailers.

(10) Contractor shall furnish bottled water and ice in each Owner trailer and for Owner's exclusive use throughout the duration of the construction activities.

(11) Contractor shall provide weekly cleaning services within each Owner trailer throughout the duration of the Work. This shall include cleaning restrooms and trash collection, pickup, and removal, respectively.

2.10.4 Contractor shall provide separate office trailers for their own use. Contractor shall be solely responsible for furnishing their trailer(s), including any utility services.

2.10.5 Contractor shall furnish, install, and maintain portable chemical toilets for use by site construction personnel, including Owner, Equipment suppliers, and subcontractors. This shall include cleaning (at least weekly), emptying, and disposal of such toilets through substantial completion of the Project or Contractor demobilization, whichever occurs last. Following such date, Contractor shall remove all such toilets from the Project Site.

(1) Portable chemical toilets shall be heated as may be necessary per OSHA requirements.

2.10.6 Contractor shall design, permit, furnish, construct, and maintain, as required, any temporary fuel containment facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last.

2.10.7 Contractor shall design, permit, furnish, construct, and maintain (including disposal), as required, any hazardous materials/waste facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last. Contractor shall provide Owner with a copy of all hazardous material manifests.

2.10.8 Wind Projects: As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain batch plant(s) at the Project Site, including all necessary labor and materials related to the operation of the batch plant, and removal of the batch plant at the conclusion of the Work. The batch plant shall be removed from the Project Site by Contractor within 30 days of the final Project concrete pour utilizing the batch plant, not to occur after substantial completion of the Project. Power to operate the batch plant shall be the sole responsibility of Contractor.

2.10.9 Wind Projects: As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain fixed and/or mobile rock crusher(s) at the Project Site, including all necessary labor and materials related to the operation of the rock crusher(s), and removal of the rock crusher(s) at the conclusion of the Work. The location of any fixed rock crusher(s) shall be at the temporary facility areas, and the location of any mobile rock crusher(s) shall remain within the designated disturbance areas. Power to operate the rock crusher(s) shall be the sole responsibility of Contractor.

2.10.10 Contractor shall design, furnish, construct, install, and maintain a minimum of one (1) temporary laydown yard.

(1) The laydown yard shall be constructed at a location at the Project Site to be approved by Owner.

(2) The laydown yard shall be sufficient in size to allow for simultaneous (a) storage of equipment, including any Owner-Supplied Equipment; (b) storage of office trailers and other temporary facilities; (c) portable restrooms; (d) parking for approximately ten (10) Owner vehicles; and (e) regular construction traffic; Contractor shall incorporate this into the design and construction of the laydown yard.

(3) The laydown yard shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade. The maximum aggregate size shall not exceed three (3) inches.

(4) The laydown yard shall be graded to drain and shall not exceed two percent (2%) grade, or less if required for the safe storage of equipment or to meet manufacturer’s requirements for storage of equipment.

(5) Temporary fencing shall be installed around the perimeter of the laydown yard, and vehicle gates shall be installed at all entrances to the laydown yard.

(6) Any equipment or materials delivered to the Project Site shall be stored as necessary at the temporary laydown yard. Contractor shall provide weather resistant covers and adequate blocking for equipment and materials per the manufacturer’s requirements, at a minimum.

(7) Wind Projects: The laydown yard shall comply with the Turbine Supplier Project Site Requirements.

2.11 Debris

2.11.1 Contractor shall assume ownership of all construction-related debris and unsuitable materials generated by Contractor, and each shall be removed from the Project Site and be properly disposed of by Contractor.

2.11.2 Contractor shall maintain a continuous and regular clean-up program to avoid accumulation of debris, waste, wreckage, and/or rubbish within the Project Site resulting from the Work and shall maintain the Project Site in a neat and orderly condition throughout the performance of the Work.

2.11.3 Contractor shall provide all trash collection, pickup, and removal related to the Work, including all trash associated with Owner-supplied Equipment / Owner-supplied Work within Owner's office trailers and other temporary facilities, and including disposal of cable reels and pallets. Dumpsters and trash receptacles shall be provided in sufficient quantities and with sufficient volume to support timely trash removal from the Project Site and preclude windblown trash generated during construction activities. Dumpsters and trash receptacles shall be emptied at a reasonable frequency to prevent overflowing or accumulation of trash around the dumpster or receptacle. For the avoidance of doubt, Owner and subcontractors (of both Owner and Contractor) shall be provided with access to utilize such receptacles. Contractor shall provide Owner with their debris management plan and Owner shall be provided such plan for approval.

(1) The debris management plan shall include consideration for recycling, reuse, and/or repurposing of debris as may be practicable (e.g. common recyclables, scrap metals, reuse items such as pallets).

2.11.4 Contractor shall cause its subcontractors, employees, and other representatives to refrain from littering at or within the Project Site, or within other areas (including along public roadways) used in conjunction with the Work.

2.11.5 Contractor shall use lined washout pits, washout dumpsters, or other suitable means to contain the excess concrete and runoff from the cleaning of concrete trucks. All washout waste shall be properly disposed of off-Project Site by Contractor in accordance with the Requirements.

2.12 Logistics & Deliveries

2.12.1 Contractor shall furnish and deliver all Equipment to the Project Site with the exception of only the Owner-supplied equipment as noted in Exhibit B (*Owner Scope of Work*).

(1) All equipment and materials shall be delivered/shipped in a manner consistent with the manufacturer's recommendations and shall be protected or crated to prevent damage during shipment and handling. Wooden covers shall protect equipment flange faces.

(2) Contractor shall offload and immediately inspect all equipment and materials delivered to the Project Site, including Owner-supplied equipment (unless explicitly noted otherwise), for incorporation into the Project. All equipment and materials required for the performance of the Work shall be stored as necessary at the temporary laydown yard. Contractor shall provide weather resistant covers and adequate blocking for equipment and materials per the manufacturer's requirements, at a minimum.

(3) Any equipment or materials damaged or otherwise altered during shipment, delivery, and offload shall be recorded in a Contractor managed log and shall be accompanied with time-stamped photographs detailing the damage. Contractor shall notify Owner within five (5) business days of any damage to materials and shall provide a plan to repair or replace such items with Owner's approval.

2.12.2 Contractor shall perform all off-Project Site clearing necessary for the transportation of major Equipment to the Project Site, including, but not limited to, tree trimming / removal and clearing of overhead obstructions. Contractor shall also upgrade and maintain public roads, bridges, and culverts as required for the transportation of Equipment to the Project Site and including obtaining any necessary permits.

2.12.3 Contractor shall design and prepare the site roads at the Project to facilitate a smooth traffic plan for Equipment deliveries, especially deliveries of PV modules. Such traffic plan shall take into consideration back tracking, access for emergency vehicles, and shall be consistent with the Road Use Agreement, at a minimum.

2.13 Coordination

2.13.1 Contractor shall actively coordinate the sequence and the content of Work with Owner, Owner's contractors, and the interconnecting utility to support the Project Schedule. For the avoidance of doubt, this shall include coordination with the Equipment supplier's schedule for the delivery and commissioning of the Equipment. Contractor, Owner, and Equipment supplier shall meet (a) on a weekly basis before major deliveries begin and (b) as required by Owner after Equipment component deliveries begin; the purpose of such meetings shall be to coordinate schedule for delivery and commissioning of the Equipment. On a weekly basis, a meeting shall be held to reconcile all demurrage and delays for all parties regarding deliveries and offloading of components.

2.13.2 Contractor shall (a) comply with all crossing requirements set forth in Exhibit E.4 *(Crossing Agreement Requirements*) and (b) coordinate with local utilities and pipeline companies to facilitate crossings and interconnections necessary to perform the Work. For the avoidance of doubt, this shall include contacting local authorities, pipeline companies, and utility companies to locate conflicting underground facilities *prior* to starting any excavation or trenching Work, as further described in Section 2.4.8 herein.

2.13.3 Contractor shall be responsible for site security throughout construction duration until Substantial Completion, at which time Owner will be responsible for site security.

2.13.4 Pre-construction meeting:

(1) Contractor shall attend the Owner-scheduled pre-construction meeting at the Project Site. Such meeting will occur prior to the commencement of any major work activity by Contractor. The purpose of the meeting is to confirm all parties and personnel understand their responsibilities with respect to the Work and the procedures that will be followed for the safe and efficient completion of the Work.

(2) Contractor shall include in their attendance the assigned project and site manager(s), safety professionals and leads, site superintendents, hazardous material manager(s), and any major subcontractor representatives, at a minimum.

(3) Contractor shall prepare and or be prepared to address the following information during the meeting:

1. Project Schedule and critical work sequencing
2. Routine progress reports and meetings
3. QA/QC plan compliance monitoring and reporting procedures
4. Site safety and security plan procedures and processes
5. Use of the Project Site including equipment, material storage and handling, staging areas, and temporary facilities
6. Procedures and processes for change orders
7. Processes for drawings, submittals, and RFIs
8. Close-out procedures
9. Testing schedules
10. Display requirements for permits
11. Environmental permits, notifications, water and waste management, dust control, SWPP, and SPCC plans

2.14 Quality Control and Oversight

2.14.1 Contractor shall provide Owner with access to attend factory acceptance testing for any of the major Equipment. Contractor shall provide Owner with at least 30 days' notice of such testing, including a detailed testing schedule and summary of the tests that are planned for the Equipment.

2.14.2 Contractor shall provide the results of any factory acceptance testing performed on the Project Equipment within five (5) business days of receipt of such results from the applicable equipment manufacturer.

2.14.3 Owner may, at their reasonable request, coordinate direct, on-site expediting support at any of the Project's major Equipment manufacturing or logistics facilities to track the quality and progress of the work related to the Project-specific components. Such support shall be at Owner's expense. Contractor shall provide reasonable support to Owner or Owner's representative as may be required for coordination purposes with Contractor's suppliers.

2.14.4 Damage to any coating or finish of any of the equipment or material shall be repaired in a manner consistent with the original finish or coating (e.g., damage to galvanized surface shall be re-galvanized). Owner shall be notified promptly of all damage and subsequent repair work to any equipment or material.

2.15 Project Site Closeout and Restitution

2.15.1 Contractor shall document and repair all drain tiles damaged during performance of the Work, including during road installation, Collection System Circuit installation, Turbine Foundation installation, crane walks, or otherwise. Repairs shall be consistent with or better than the original tile installation.

2.15.2 Contractor shall remove all tools, equipment, surplus materials (including unused or useless materials), waste materials, temporary work (including temporary erosion control features and temporary roads or paths), temporary buildings, temporary facilities (including batch plants, rock crushers, and office trailers), and rubbish from the Project Site prior to final completion, and shall cause any facilities used by Contractor during the performance of the Work to be restored to the same or better condition that such facilities and the Project Site were in on the date the Contractor commenced work at the Project Site, ordinary wear and tear excepted.

2.15.3 Contractor shall perform restitution, restoration, and/or reclamation of Work areas to include, but not limited to, the following. Notwithstanding anything that follows, all Work areas at the Project Site shall be restored, at a minimum, in accordance with the requirements set forth in the Applicable Permits, the SWPPP, and the other Requirements, as appropriate, and shall be fully restored to their pre-construction condition, at a minimum.

(1) Clean all drains and ditches at completion of the construction Work and leave the Project Site in a neat and presentable condition wherever construction operations have disturbed the conditions existing at the time of starting the Work.

(2) Preserve and/or restore to their pre-construction condition all land and impacted water resources adjacent to construction areas.

(3) Re-dress all road surfaces within the Project Site such that the final cross section meets the specifications in the Road Use Agreement.

(4) Wind Projects: Notwithstanding the following paragraph (a), Wind Turbine Pads, laydown areas (including the laydown yard), roadway shoulders, and roadway turning radii shall be decompacted and reclaimed, including proper grading, aggregate touchup, and seeding with an approved mixture. For the avoidance of doubt, such areas shall not be reclaimed until applicable Wind Turbine erection activities have been completed.

    (a) Crane pads shall be preserved in a suitable manner to support the use of cranes in ongoing Wind Turbine maintenance activities following construction (e.g., cranes required for gearbox removal and / or installation).

(5) Seed all cut / fill slopes and the PV Array area utilizing an approved seed mixture. Seeding shall occur during a time / season when the probability of successful seed germination is maximized; hydro-seeding is acceptable for slopes. Seeding shall conform to landowner and SWPPP requirements. Contractor is responsible for any additional seed applications as necessary to meet the requirements of the SWPP restoration plan.

    (a) The PV Array area shall be seeded with a low growth seed mix that is native to the state and area of its application.

(6) Fill all depressions and water pockets caused by construction operations and remove all obstructions within waterways.

(7) Spread surplus fill on-Project Site in areas and depths approved by Owner.

(8) Spread recovered aggregate from laydown yard, if applicable, within approved disturbance limits at Owner-approved locations including but not limited to on Site Access Roads, beauty rings, and/or the O&M Building yard.

(9) Collect large rocks (4-inches or larger in diameter) or boulders unearthed during excavation as part of the Work but not utilized in the construction of the Project and store at an Owner-approved location at the Project Site.

2.15.4 Contractor shall support Owner in performing a walkdown of each of the Project's major systems to review all As-Built conditions against the As-Built drawings.

3.0 GEOTECHNICAL SERVICES

3.1 General Provisions

3.1.1 Contractor shall conduct all geotechnical, geophysical, and other similar subsurface investigations and testing necessary for the complete engineering, procurement, and construction of the Project. For the avoidance of doubt, all such investigations shall be completed before commencing the applicable Work.

3.1.2 All Work concerning the geotechnical services shall be supervised and directed by a qualified, competent, practicing geotechnical engineer. A geotechnical engineer or engineering geologist shall observe, log borings, obtain soil samples, and record blow counts of the samples, drill rates, rock quality, depth to ground water, and other pertinent data under the direction of a licensed geotechnical engineer.

3.2 Submittals

3.2.1 Contractor shall submit to Owner, *prior* to initiating subsurface investigations, the name and qualification statement for proposed geotechnical engineer.

3.2.2 Contractor shall submit to Owner, *prior* to initiating subsurface investigations, the proposed scope of subsurface investigation, including number, location, and depths of borings; anticipated plan for laboratory testing; and detailed descriptions of additional site investigation techniques, including thermal and electrical resistivity or other necessary testing.

3.2.3 Contractor shall submit a complete geotechnical engineering report containing the required information summarized below, at a minimum. The geotechnical engineering report shall be utilized for the design and construction of all Project structures, including Foundations.

(1) Subsurface and groundwater conditions encountered.

(2) Description of the geology, including areas of landslides, potential landslides, potential geologic hazards, past (historical) earth movements, and transitions between geologic units; special consideration shall be given to identify active and potential landslide zones.

(3) Description of the drilling and sampling program.

(4) Field photographs.

(5) Boring coordinates, boring location drawings, and final boring logs.

(6) Summary of results of field and laboratory tests performed.

(7) Specific design criteria for the Project, including (a) impacts of new construction on existing facilities; (b) factors of safety used in determining allowable foundation loads; (c) recommended foundation types for all structures; (d) discussion of the dynamic soil properties at the Project Site, including dynamic shear modulus, Poisson's ratio, Young’s Modulus, and shear wave velocity; (e) recommendations for designing for seismic issues, including liquefaction potential and the identified building code site coefficient/site classification for seismic design; and (f) recommendations for site dewatering and construction practices, including design water level.

(8) For shallow foundations, (a) allowable soil bearing values and minimum bearing depths; (b) anticipated total and differential settlements; (c) uplift resistance; (d) lateral resistance; (e) subgrade modulus; and (f) dynamic spring constants for foundations supporting vibrating machines, if applicable.

(9) For deep foundations, (a) type of deep foundation (e.g., drilled shaft, rock anchor); (b) diameter (or dimensions) and depth of foundation members; (c) minimum spacing and group reduction factors; (d) allowable compressive, uplift, and lateral capacities including allowable skin friction and end bearing capacities, anticipated settlements and lateral deflections; and (e) static and dynamic spring constants.

(10) For driven piles, (a) embedment acceptance criteria; (b) drive time acceptance criteria, including target drive time (reference time); and (c) pile driving equipment.

(11) Recommendations for slopes, including (a) temporary excavation slopes and OSHA soil types; (b) permanent slopes; and (c) temporary and permanent excavation support requirements.

(12) Corrosion potential and chemical attack to construction materials.

(13) Recommended cement type in concrete and corrosion protection for buried steel, based on chemical test results. Recommended cement type shall be based on soluble sulfate content in the soil and ACI recommendations.

(14) An evaluation of the expansive, dispersive, and collapsing nature of the on-Site soil materials and discussion of design features to resist these tendencies.

(15) Recommendations for earthwork including acceptable fill materials (including structural fill if materials fail testing), moisture contents, compactive effort, lift thickness, proofrolling, equipment, and compaction testing, and recommended aggregate gradations for general fill, load bearing fill, granular road base, and granular surfacing.

3.3 Field Investigations

3.3.1 Contractor shall drill geotechnical borings and conduct material sampling at the locations and minimum frequencies set forth below:

(1) Solar PV Array: minimum of one (1) location per 20 acres of installed PV panels.

(2) Wind Turbines: one (1) per Wind Turbine location.

(3) BESS: minimum of one (1) location at each BESS module.

(4) Project Substation: minimum of five (5) locations at the Project Substation.

(5) Interconnection Line: each angled and dead-end structure, respectively, as well as any additional borings and samplings necessary to ensure that adjacent borings are no more than one (1) mile apart.

(6) O&M Building: minimum of one (1) location at the O&M Building.

(7) Collection System Circuits: minimum of one (1) location per circuit, preferably on home runs or other larger cable spans.

3.3.2 Contractor shall perform soil electrical resistivity measurements at the location of the Project Substation; along the underground Collection System Circuits; and along the Interconnection Line. Soil electrical resistivity testing shall be completed using the Wenner Four-Electrode method or Owner-approved equal.

3.3.3 Contractor shall perform soil thermal resistivity measurements at the location of the Project Substation and along the underground Collection System Circuits in accordance with IEEE 442. Sufficient soil sample locations shall be taken to account for variation in soils encountered at a site. Soil samples shall be taken at depths that are representative of the installed depth of the applicable infrastructure and above in order to model the heat transfer from the circuits to the surface of the earth. No laboratory adjustment of the soil moisture content is allowed to maximize the dry density of compacted soil in the laboratory. See Section 5.1.17 for additional information on geotechnical data required.

3.3.4 Contractor shall obtain 24-hour water level readings in boreholes or install piezometers for long-term water level readings as required to determine prevailing groundwater levels.

3.3.5 Contractor shall perform a pre-design pile test for driven piles.

3.3.6 Contractor shall perform any additional geophysical or other site investigations, including, but not limited to, standard penetration tests, Shelby tube samples, deepened borings, additional borings, test pits, seismic refractions, cone penetrometer soundings, *in situ* testing, and other similar or related methods, as necessary to supplement the required geotechnical investigations summarized herein or to otherwise provide the data and recommendations required in the geotechnical engineering report.

3.3.7 Other boring and material sampling requirements:

(1) Borings shall be backfilled with cement-bentonite grout and in a manner and with materials required under the Applicable Laws of the location of the Project Site. Excess cuttings shall be disposed of by Contractor in accordance with the applicable Requirements and subject to Owner approval, and the Project Site premises shall remain free from accumulations of waste materials or rubbish resulting from the geotechnical field investigations.

(2) Existing utilities near borings or other subsurface test locations shall be identified and protected.

(3) Each Wind Turbine boring shall be to a minimum depth of the greater of (a) 35 feet; (b) at least one (1) foundation diameter for spread footer foundations; or (c) at least 10 feet beyond the anticipated depth of the foundation at such location (including anchors, if applicable) for rock anchor foundations. All other borings shall be to a depth of at least 35 feet below the base of the applicable foundation / structure.

(4) Sufficient rock core samples shall be obtained from each boring to adequately characterize and test the material, including coring from the point at which competent rock is encountered and until the appropriate boring depth is achieved (at a minimum). All core samples shall be delineated and digitally photographed in color. Unaltered rock core samples shall be placed in a core box and taken to a laboratory for analysis.

(5) If using rock anchor foundations, Contractor shall perform a rock analysis to identify the presence of fissures, rock joints, or other discontinuities that will control the overall strength of the rock mass, including, but not limited to, rock mass rating, rock classifications, depth of overburden, rock quality designation, joint spacing and orientation, stratifications, rock material strength, and water pressure in joints.

3.4 Lab Testing

3.4.1 Contractor shall perform all laboratory testing necessary to classify the materials and to obtain physical characteristics of the subsurface materials. At a minimum, laboratory testing shall include (a) moisture content per ASTM D2216; (b) grain size analysis per ASTM D422; (c) dry unit weight tests per ASTM D7263; (d) Atterberg limits per ASTM D4318; (e) unconfined compressive strength per ASTM D2166; (f) compaction characteristics / standard proctor density of the soil per ASTM D698; (g) soil corrosiveness (chloride, sulfate, and pH) per ASTM D4972 and USEPA methods; (h) unconsolidated-undrained triaxial compression per ASTM D2850; (i) direct shear per ASTM D3080; (j) one-dimensional consolidation per ASTM D2435; (k) one-dimensional swell or collapse of soils per ASTM D4546; and (l) thermal resistivity testing per IEEE 442.

(1) It is explicitly noted that thermal resistivity testing be performed per IEEE 442 and not ASTM D5334.

3.4.2 All testing described herein shall be performed by an independent, experienced third party.

4.0 CIVIL / STRUCTURAL WORKS

4.1 General Provisions

4.1.1 All civil and structural works, including, but not limited to, Site Access Roads, foundations, piles, and the laydown yard, shall conform to Equipment supplier's requirements and the final Geotechnical report.

4.1.2 The design working life of the civil and structural works shall be a minimum of 30 years.

4.1.3 All permanent drainage facilities, including culverts, ditches, and swales, shall be designed and constructed to withstand a 100-year, 24-hour storm event.

4.1.4 In areas where drain tile or other horizontal irrigation structures and wells are present, all tile and structures shall be located prior to construction. All drain tile shall be re-routed as needed to avoid any structures or cable installed underground. All tile breaks or re-routes shall be documented via GPS and include photos showing the location of the tile. All repairs shall be of equal capacity or greater and completed to the satisfaction of the landowner and warranted for five (5) years.

4.1.5 Requirements for road crossings:

(1) All road crossings, including public roads, railroad, pipeline, utilities, and property lines, shall be as close to 90 degrees as reasonably practicable. All road crossings of buried facilities (e.g., pipeline, utility line) shall maintain at least 48 inches of cover or per the crossing agreement, whichever is more restrictive.

(2) All road crossings of buried facilities (e.g., pipeline, utility line) shall be marked on each side with an above-ground cable marker, each meeting the requirements in Section 5.1.7 below.

(3) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.13.2 herein.

4.1.6 Requirements for site roads:

(1) Roads shall be designed, constructed, and maintained adequately to support all anticipated construction loads, equipment delivery (including Owner-Supplied Equipment), crane crawling, construction traffic usage (including concrete trucks), and weather conditions to be expected. Maintenance shall include the requirements set forth in Section 4.4 herein.

(2) Roads shall comply with the Geotechnical Report (for subgrade and cross-section requirements), the Turbine Supplier Project Site Requirements, and the drainage and erosion control requirements in Section 4.1.7 herein.

(3) Roads shall be designed to minimize the risk of materials entering public waters and minimize disturbance to streams, channels, lakes, wetlands, and/or floodplains. Where viable alternatives exist, roads shall not be located on steep slopes, slide areas, or high-risk sites, or in wetlands, riparian management areas, channels, and/or floodplains.

(4) Roads shall comply with Equipment supplier project site requirements, including Turbine Supplier.

(5) Road entries, intersections, and turns shall be designed to accommodate the longest vehicle anticipated to utilize the road so that it will be able to maneuver through the entire Project Site without leaving the graveled road area. Cantilevered loads (e.g., Wind Turbine blade ends) shall be considered to ensure obstructions adjacent to the roadway are cleared and will not endanger the equipment delivery. Wind Turbine spur roads shall have a minimum turning radius of 25 feet from other roads at final construction.

(6) Approaches shall be located and designed to meet state and county setback and sight requirements.

(7) Site Access Roads shall be a minimum of 16 feet wide, except for meteorological tower roads which shall only be 12 feet wide. Where crane walks are to be utilized, roads shall have a minimum 10-foot temporary compacted earthen shoulder on each side. Roads shall be widened through turns and curves, as necessary.

(a) Solar or BESS Site Maintenance Roads shall be a minimum of 10 feet wide and may be compacted native soil. Roads shall be widened through turns and curves, as necessary.

(b) Solar Site Access Roads that extend to a PCS shall be designed to provide a turnaround loop or adequate space for a maintenance truck to perform a three-point turn.

(8) Site Access Roads shall be covered with at least six (6) inches of aggregate over a compacted subgrade, including geotextile fabric (or equivalent) as required. If geotextile fabric is not utilized, Site Access Roads shall be covered with at least 12 inches of aggregate over a compacted subgrade. All crushed rock surfacing shall conform, at a minimum, to the specifications prescribed in Section 4.1.9 (*Crushed Rock Surfacing*).

(9) Wind Roads shall be designed and constructed with a maximum grade of eight percent (8%). Approaches to Wind Turbine Pads from access / spur roads shall be designed and constructed sufficiently level to allow transport vehicles, including Wind Turbine transport vehicles, to park on a flat surface during offloading.

(10) Maximum vertical crest and dip on roads is six (6) inches vertical to 50 feet horizontal, or less if required by the supplier Project Site Requirements.

(11) Wind Projects: The longitudinal radii (convex or concave) of roads shall not be less than 750 feet.

(12) Roads shall have no more than two percent (2%) crown, unless such roads will be utilized as crane paths, in which case the maximum crown shall be one percent (1%). All roadways, including shoulders, shall be graded to self-drain and must not allow water to puddle.

(13) All roadways shall be able to accommodate light traffic consisting of general-purpose pickup trucks, SUVs, and bucket trucks, or as required during construction to perform the Work. During construction, equipment delivery trucks shall also be able to safely travel these roadways.

(14) Roads shall be designed with turnarounds to assist in truck and trailer flow throughout the Project Site, as well as lay-bys as required by Equipment supplier site requirements. Backup motions for tractor trailers shall be kept to a minimum and are subject to Owner approval; if backup motions for tractor trailers are necessary, the backup path shall be as straight and short as possible. Dead-end roads shall be designed with adequate turnaround space for a tractor/trailer to turn around.

(15) Roads shall be cleared of overhead obstructions (e.g., power lines) as necessary to complete the Work, including to support Wind Turbine deliveries.

(16) Proof rolling shall be performed in the presence of a qualified, competent, practicing geotechnical engineer or his qualified representative. Proof rolling shall be performed using a fully-loaded tandem-axle truck with a minimum gross weight of 25 tons. An acceptable proof roll shall produce rutting of no greater than 2.0 inches and no "pumping" of soil beneath and/or behind the wheels of the loaded truck.

(17) Roads shall meet all required design elements at Substantial Completion (as defined in the Agreement). For the avoidance of doubt, this shall include replenishing road aggregate, repairing road damage, repairing subgrade damage, and other loss of strength or stability that may have occurred during the course of construction.

(18) Stabilization (e.g., cement, lime) of road subgrades may be used as recommended in the Final Geotechnical report as may be beneficial to provide additional bearing capacity for permanently installed site roads.

(a) The civil engineer of record shall specify the quantity (percentage) of stabilization material to be used on the site roads as well as specify the process of installation, including testing.

4.1.7 Requirements for drainage and erosion control:

(1) The working areas of the Project Site shall be well drained during and after construction, respectively. All drainage shall be away from buildings and foundations.

(2) Erosion and sediment control, both during and after construction, shall be provided as required by the Requirements and the Contractor-provided SWPPP to retain sediment onsite and to control the erosion of embankments, temporary and final exposed slopes, and temporary stockpiles, as well to protect water quality as applicable. Silt fences, check dams, drainage ditches or swales, straw mulch, and pre-manufactured geotextiles, geotubes, geogrids, cellular geoweb, and other similar items (collectively, the "**Best Management Practices**" or "**BMPs**") shall be utilized as appropriate.

(a) Temporary BMPs shall be biodegradable where possible.

(3) Roadway cross sections shall be shaped to move water away from the road, such as crowning or cross-slopes, and roads shall be designed and constructed to prevent water ponding. Stormwater shall not channel flow across constructed roads. Sheet flows shall be collected and conveyed to culverts or channels to safely pass stormwater flows.

(4) All stormwater flows shall be returned to their original drainage patterns and the Project shall not increase flow rates from their historic levels.

(5) Culverts or low-water crossings shall be installed / constructed where required to pass existing stormwater concentrated flows. Culvert pipe ends, swales, and ditches shall be designed and constructed to control concentrated flow velocities and minimize erosion and siltation. Only culverts shall be used at entrances; low-water crossings are not allowed at entrances.

(a) Low-water crossings shall be installed in areas where a more diverse water flow during storm events would be beneficial (e.g., agricultural fields). Construction of drainage ditches or culverts is not allowed in agricultural fields unless explicitly approved by Owner.

(b) Low-water crossings shall be constructed with rock-filled geocells or 4.5" minimum thickness concrete blocks interlocked by woven stainless steel cables poured within each block. Riprap and concrete geogrid mats are not allowed for use on low-water crossings.

(c) Culverts shall be corrugated galvanized metal pipe unless specified by the AHJ.

(6) Wetlands impacts shall be avoided to the maximum extent practicable and are subject to regulatory approval or other applicable Requirements.

(7) Synthetic, toxic, or otherwise harmful erosion-control materials shall be made inaccessible to livestock on or adjacent to the Project Site during the construction period.

(8) Contractor may utilize an annual cover crop (e.g., oats) after any site grading activities to mitigate erosion. Such planting shall be consistent with the Requirements, including the SWPPP, environmental plans, and any landowner requirements.

(9) Riprap used for drainage control measures shall be of a type and class approved by Owner prior to use.

4.1.8 Requirements for excavation and fill/backfill:

(1) Materials suitable for use as fill or backfill at the Project Site shall include only materials that are free of debris, roots, stumps, organic matter, frozen matter, coal, ashes, cinders, stones larger than two (2) inches in diameter, slag, other deleterious materials, and as recommended by the Geotechnical Report. Surplus fill shall be spread on-Site and in areas and depths approved by Owner; surplus materials shall not be exported off-Site without the approval of Owner.

(2) Permanent slope and rock stability measures shall be part of the Project design and shall incorporate the recommendations and requirements set forth in the Geotechnical Report. Safe stabilization for all slopes, regardless of the type of rock or soil conditions, shall be guaranteed including protection of all personnel and structures against any damage from cave-ins, heaving, or other earth movements.

(3) Structural fill lifts shall not exceed a thickness of 8 inches. Other fill lifts shall not exceed a thickness of 12 inches.

(4) Turbine Foundation embedment depth shall consider final height requirements for the applicable Turbine's FAA DNH letter.

4.1.9 Requirements for crushed rock surfacing:

(1) The maximum aggregate size for surface fill (i.e., crushed rock surfacing) shall not exceed 1.5 inches with less than ten percent (10%) particles passing the No. 200 sieve, including, but not limited to, that used for roadways, O&M Building, and laydown yard. Deviations shall be explicitly approved by Owner.

(a) Aggregate shall be MnDOT Class 5Q or Owner-approved equal and shall have a minimum of three (3) fractured faces.

(2) Unless explicitly stated otherwise, all crushed rock surfacing shall be of thickness required by Project Site loading requirements, including those set forth in (i) the supplier Project Site Requirements and (ii) the geotechnical engineering report.

(3) Unless explicitly stated otherwise, all aggregate shall conform to local department of transportation requirements and shall be free of debris, roots, organic matter, frozen matter, coal, ashes or cinders, or any other deleterious material.

(4) An aggregate job mix formula shall be established prior to the start of fill operation based on recommendations from the final geotechnical engineering report. This mix shall not be changed without prior approval of Owner. Testing data, including sieve analysis, shall be submitted for all aggregate sources.

4.1.10 Requirements for fencing and gates:

(1) All permanent fencing and gate materials, including for the Project Substation, O&M Building, and solar PV Array, and BESS shall be constructed in accordance with Applicable Permits and shall be galvanized in accordance with ASTM A392. All permanent fencing shall be appropriately grounded in accordance with NESC, including any applicable rulings.

(a) Grounding shall be electrically separate for each continuous set of fencing/gates (e.g., Substation fencing shall be grounded separate from O&M Building fencing.

(b) If fencing for different parts of the Project is close in proximity, Contractor shall perform grounding studies to consider the potential contribution of electrical characteristics for each system in whole and in part.

(2) Unless stated otherwise, permanent fencing shall be 8-foot-high (7-foot fence plus height of outrigger barbed wire), anti-climb, chain link, perimeter fencing with 2-inch diamond mesh. Fencing fabric or other visual screening shall be in accordance with the Applicable Permits, if applicable.

(a) Fencing fabric shall be 1- or 2-inch diamond mesh, #9 AWG, galvanized after weaving, Class II, conforming to ASTM A392, “Zinc-Coated Steel Chain-Link Fence Fabric”.

(3) Barbed wire shall be 45-degree outrigger and a minimum of 3-strand, #12-1/2 steel wire gauge with four (4) half-round barbs of #14 steel wire gauge at 5-inch spacing. After weaving, the wire shall be galvanized per ASTM A121. Barbed wire fencing posts shall be galvanized, standard-weight steel pipe.

(4) For PV Array only, the permanent fencing shall be 8-foot-high aluminum game fence.

(5) Unless otherwise noted, all vehicle gates shall be 16 feet wide (minimum), manual, swing gate that locks at the center (i.e., two 8-foot sections).

(6) All pedestrian gates shall be 3 feet wide (minimum), locking, manual swing gate for personnel access.

(7) Sufficient space and graded area shall be provided near each gate to allow truck turning.

(8) All gates shall have tamper proof gate hinges and hardware. Gates along the perimeter fence shall include heavy duty bolt-cutter resistant padlocks, except for motorized-gates.

(9) All corner posts and gate posts shall be set (embedded) in concrete.

(10) All gates shall adequately contain livestock without being pushed open, bending, or otherwise failing. Further, all gates shall adequately prevent opening due to wind conditions expected at the Project Site.

(11) Unless prohibited by the landowner, cattle guards shall be used along fields containing livestock and shall cover the full road width and be installed level and provided with a stable base capable of sustaining heavy loads without shifting or settling.

4.1.11 Requirements for structures:

(1) All buildings, support structures, and equipment pads shall be constructed on competent material. All loose materials shall be removed from excavation bottoms. Unsatisfactory foundation subgrade material shall be removed and replaced with compacted structural fill material or with suitable concrete, as approved by Owner and the engineer of record.

(2) Foundation designs shall neglect or degrade soil strength properties at the top of the foundation as a result of frost or disturbance during drilling per recommendations of the geotechnical engineer. All foundations shall be designed with consultation of a licensed geotechnical engineer as well as in consideration of the final geotechnical report.

(3) All foundations and slabs-on-grade shall have a minimum projection of 6 inches above adjacent grade, except that concrete pier-type foundations shall have a minimum projection of 12 inches of concrete above adjacent grade.

4.1.12 Requirements for concrete:

(1) Concrete for foundations shall have a specified compressive strength of not less than 5,000 psi Concrete.

(2) Concrete materials shall be in accordance with the requirements set forth in Table 4-1 (*Summary of Requirements for Concrete Materials*) herein, at a minimum.

(3) A nominal slump at the point of delivery shall be as shown in Table 4-2 (*Slump Requirements*) herein, as tested in accordance with ASTM C143.

Table 4-1: Summary of Requirements for Concrete Materials

Material	Material Requirements
Cement	ASTM C150, Type I, II, or V (as required)
Water	Clean, potable, and free from injurious amount of oil, acid, alkali, organic matter or other deleterious substances.
Coarse aggregate	Crushed stone, washed gravel, or other acceptable inert granular material conforming to ASTM C33
Fine aggregate	Clean natural sand, ASTM C33
Fly ash	ASTM C618; determined by Contractor and approved by Owner
Air-entraining agent	ASTM C260
Chemical admixture	ASTM C494; determined by Contractor and approved by Owner
Plasticizer	ASTM C494 / ASTM C1017; determined by Contractor and approved by Owner
Form oil	Light colored paraffin oil or other acceptable non-staining material
Curing agent	ASTM C309; determined by Contractor and approved by Owner
Floor sealer	ASTM C1315; determined by Contractor and approved by Owner
Concrete repair	Determined by Contractor and approved by Owner
Compound	Determined by Contractor and approved by Owner
Joint sealant	ASTM C1193; determined by Contractor and approved by Owner
Non-shrink grout	Determined by Contractor and approved by Owner
Pre-formed joint filler	Determined by Contractor and approved by Owner
Concrete / Grout	Minimum concrete and grout compressive strength to be determined by Contractor and approved by Owner, subject to minimum requirements specified herein

Table 4-2: Slump Requirements

Description	Minimum (inches)	Maximum (inches)
Reinforced walls and footings	2.0	5.0
Slabs on-grade	2.0	4.0
Drilled piers (dry, uncased, or permanent casing drill method)	4.0	6.0
Drilled piers (temporary casing drill method, wet and dry)	6.0	8.0
Drilled piers (slurry displacement drill method)	7.0	9.0

(4) Cast-in-place concrete shall be in accordance with the latest applicable requirements of the ACI, ASTM, and CRSI, at a minimum.

(5) Ready-mixed concrete manufacturing and delivery shall conform to ASTM C94.

(6) Concrete for foundations shall have a specified compressive strength of not less than 5,000 psi. Non-structural concrete shall have a specified compressive strength of not less than 3,000 psi.

(7) Concrete mix designs and concrete placement procedures shall be approved by Owner prior to use.

(8) Aggregates shall be tested per ASTM C33 for potentially reactive materials. If such test results indicate that aggregates are reactive, an alkali-silica reaction ("**ASR**") mitigation plan shall be provided.

(9) Concrete shall be placed only in the presence of a duly-authorized representative of Contractor.

(10) Concrete placement shall not be permitted when weather conditions or other pertinent factors prevent proper placement and consolidation.

(11) Concrete shall be placed at a sufficient rate to ensure that lifts below have not taken initial set before fresh concrete is deposited. In any event, concrete shall be placed within 45 minutes after mixing. This period may be extended to 90 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.

(12) Concrete requirements shall be adjusted for hot weather:

(a) When hot weather conditions exist, including those that may impair the quality or strength of concrete, the concrete shall be placed in compliance with ACI 305R and as specified herein.

(b) Ingredients shall be cooled before mixing to maintain concrete temperature at time of placement below 90°F.

(c) Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided the water equivalent of the ice is calculated to the total amount of mixing water.

(d) Reinforcing steel and formwork shall be cooled as required in accordance with ACI 305R, including through the use of a fog nozzle. Care shall be taken to avoid excessive fog application, causing surplus water to cling to reinforcement or stand on the concrete, or causing the concrete to wash away.

(e) Retarding admixtures shall not be used unless otherwise accepted in mix designs and shall be approved by Owner prior to use.

(13) Concrete requirements shall be adjusted for cold weather:

(a) Cold weather concreting shall be in accordance with ACI 306R.

(b) After the first frost and until the mean daily temperature in the vicinity of the Work falls below 40°F for more than 24 hours, the concrete shall be protected against freezing for not less than 48 hours after it is placed.

(c) Whenever the mean daily temperature in the vicinity of the Work falls below 40°F for more than 24 hours, the concrete shall be maintained at a temperature not lower than 50°F for at least 72 hours after it is placed and shall be protected against freezing for five (5) days immediately following the 72 hours of protection at 50°F. This continuance of protection against freezing shall be such that the drop in temperature of any portion of the concrete will be gradual and will not be lower than 40°F in 24 hours.

(d) When artificial heat is employed, special care shall be taken to prevent the concrete from drying.

(e) The use of calcium chloride will not be permitted.

(f) A non-corrosive, non-chloride set accelerating admixture may be used when approved by Owner.

(g) Concrete damaged by freezing shall be removed and replaced at Contractor's expense.

(h) Concrete shall not be permitted to freeze for at least seven (7) consecutive days following placement.

(14) The maximum aggregate size for concrete shall not exceed 1.5 inches, unless otherwise specified with the exception of transmission line foundations where it shall not exceed 0.75 inches.

(a) Smaller maximum aggregate size, such as 0.75 inches, may be necessary for pumped or tremie concrete.

(b) Rounded aggregates may be necessary to produce desired workability.

(c) Interconnection Line foundation aggregate shall not exceed 0.75 inches.

(15) All exterior exposed concrete shall have an air content of 4.5 percent (4.5%) to 7.5 percent (7.5%).

(16) Concrete shall be conveyed from mixer to forms as rapidly as practicable without segregation or loss of ingredients. Concrete shall be placed in forms nearly as practicable in final position to avoid re-handling.

(17) Chutes, if used, shall slope sufficiently to ensure flow of properly proportioned concrete and must be kept free of hardened or partially set concrete.

(18) Concrete shall be carried in at such a rate that the concrete is at all times plastic and flows readily into the spaces between the bars. No concrete that has partially hardened or been contaminated by poor material shall be used nor shall re-tempered concrete be used.

(19) Immediately after depositing, concrete shall be compacted by agitating thoroughly in an approved manner to force out air pockets. The mixture shall be worked into corners around reinforcement and inserts to prevent formation of voids. Tapping or other external vibration of forms will not be permitted. Care shall be used in use of vibrators to prevent segregation of sand pockets or bleeding. Vibrators shall be moved continuously in and out of concrete, keeping stationary only a few seconds in any position. Vibrators shall not be used to transport concrete within forms.

(20) For concrete poured within forms and not involving drilled pier construction, concrete shall not drop freely over five (5) feet in unexposed work or over three (3) feet in exposed work. Where greater drops are required, tremies, concrete pump, or other approved methods shall be used.

(21) Concrete may be dropped into drilled piers installed using the dry method under the conditions that concrete shall not hit any reinforcing bars or sidewalls and that concrete with all aggregates shall be able to flow freely into the spaces between the reinforcing bars. The concrete shall be placed in the pier in one continuous operation unless agreed otherwise by Owner.

(22) For concrete involving massive structures, including Foundations, concrete mix or construction procedure shall be modified such that excessive heat produced by hydration shall be prevented.

(23) Cast-in-place concrete, at Contractor's option, may be placed by pumping in accordance with ACI 304; however, it shall use a specifically-designed mix for pumping concrete, as fine aggregate gradation and water and cement content are more critical and different from the regular concrete mix. The mortar used for lubricating the pumping equipment shall be discarded.

(24) Concrete shall not be conveyed through aluminum or aluminum alloy pipes.

(25) Maximum water/cement ratio: 0.45.

(26) Joints:

(a) A good bond and watertight joint are required at construction joints.

(b) Joints shall be obtained by adequately preparing and protecting the surface of the first pour or lower part of the construction joint.

(c) Joint surface shall be level and reasonably rough, clean, moist and some aggregate particles should be exposed. Any laitance or soft layers shall be removed from the top surface of the hardened concrete.

(d) Foundations shall not have joints, unless approved by Owner and only for the base and pedestal interface in a spread footer foundation.

(27) All fins and other surface projections shall be removed from all formed surfaces.

(28) All surfaces are to be at the specified elevation and left true and level.

(29) Surfaces that will be exposed shall be cleaned and rubbed to produce a smooth, uniform surface that is free of marks, voids, surface glaze, and discoloration. Slab foundations shall receive a light broom finish. Care shall be taken to see that all excess water is removed before making any finish.

(30) The unformed surfaces of concrete shall be screened and given an initial float finish followed by additional floating and troweling as required. Precaution shall be taken by Contractor to protect the finished surface from stains and abrasions.

(31) The removable ends of all form ties shall be removed and the recesses resulting from such removal shall be filled with dry patching mortar.

(32) "Cure & Seal 1315 UV" curing compound, manufactured by Symons Corporation, or an approved equal, shall be applied to all outside foundations to a depth of 12 inches below final ground grade.

(33) Concrete shall be protected from loss of moisture by membrane curing compound and the curing medium shall be maintained so as to prevent detrimental loss of water from the concrete for the duration of the entire curing period.

(34) Unhardened concrete shall be protected from heavy rains, flowing water, excessive heat, or mechanical damage. Finished surfaces shall be protected from stains, abrasions, or physical damage.

(35) Defects:

(a) Defects in formed concrete surfaces shall be repaired within 24 hours, and defective concrete shall be replaced within 48 hours, after the adjacent forms have been removed.

(b) All concrete which is porous, honeycombed, or otherwise defective shall be repaired.

(c) Defective concrete shall be repaired by chipping out the unsatisfactory material to a minimum depth of 0.5 inches and placing new concrete, which shall be formed with keys, dovetails, or anchors to attach it securely in place with Owner approval.

(d) Concrete surfaces, including structural concrete, that contain defects which adversely affect durability, strength, and/or appearance shall be repaired by a method approved by Owner or replaced.

(36) Concrete testing:

(a) Prepare concrete test cylinders conforming to ASTM C31 prior to the first pour of each day, and at a rate of not less than one set of cylinders for each 50 cubic yards or fraction thereof and not less than one set for each foundation or structure.

(b) Field slump tests in accordance with ASTM C143 shall be performed, at a minimum, prior to the first batch of concrete produced each day and with each set of test cylinders. Adjustment or fixing of concrete *in situ* shall not be allowed.

(c) Air content, concrete temperature, and air temperature tests shall be performed for the first batch of each day and with each set of test cylinders. All testing shall be done in accordance with the requirements of ASTM C231 (air) and ASTM C1064 (temperature).

(d) Concrete test reports shall be provided to Owner within 72 hours of testing but not less than 24 hours in advance of commencing placement of equipment at that location. In the event of failure of any concrete test, Owner shall be immediately notified and a repair/remediation plan shall be provided.

4.1.13 Requirements for grout:

(1) Grout shall be (a) cementitious grout conforming to ASTM C1107 or (b) epoxy grout with a coefficient of expansion (as determined by ASTM C531) as determined by the engineer of record. All grout shall be non-ferrous, non-shrink, prepackaged/factory-packaged grout and fit for purpose.

(a) Type of grout utilized should consider freeze/thaw cycles and the use of de-icing agents.

(b) The engineer of record shall specify the required permanent strength as well as the strength required during construction (e.g., bolt post-tensioning).

(c) Grout strength shall be greater than the strength of the concrete it is placed on.

(2) Grout specifications and grouting plans/procedures shall be approved by Owner prior to use.

(3) Grouted surfaces that contain defects which adversely affect durability, strength, and/or appearance shall be repaired by a method approved by Owner or they shall be replaced.

(4) Grout shall be tested in accordance with ASTM C109 (for cementitious grout) or ASTM C579 (for epoxy grout) and at a frequency as specified by the engineer of record.

(5) Grout test reports shall be provided to Owner within 72 hours of testing but not less than 24 hours in advance of commencing placement of equipment at that location. In the event of failure of any grout test, Owner shall be immediately notified and a repair/remediation plan shall be provided.

4.1.14 Requirements for forms:

(1) Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings.

(2) Forms shall be substantial and sufficiently tight to prevent leakage and shall be properly supported and braced to maintain position and shape. Forms for all exposed surfaces shall produce smooth, dense, and true finishes free of fins, imperfections, or other defects.

(3) Forms shall be cleaned and oiled before concrete is placed. Oil is to be applied before reinforcement is placed.

(4) Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground, and other vertical-type formwork not supporting the weight of concrete shall remain in place for at least 24 hours after concrete placement is completed.

(5) Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected.

(6) Forms may be of wood, plywood, concrete-form-grade hardboard, metal or other acceptable material, which will produce smooth, true surfaces.

(7) Metal forms shall have smooth surfaces free from any pattern, irregularities, dents, or sags.

(8) Commercial formulation form-coating compounds shall be used that will not bond with, stain, nor adversely affect concrete surfaces, nor impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound.

(9) Form ties shall be factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal. For concrete that will be exposed, provide ties so portion remaining within concrete after removal is at least 1.5 inches inside concrete. Form ties shall not leave holes larger than 1 inch in diameter in concrete surfaces.

(10) Remove forms in a manner to avoid damage to the structure, with particular care for corners and edges.

4.1.15 Requirements for drilled piers:

(1) All drilled piers shall be designed consistent with the primary load application, either as laterally loaded piers or as compression/uplift piers.

(2) Circular shafts shall be dug by means of a power driven rotary bucket or auger type drilling rig.

(3) Diameter and location of piers shall be as per the design.

(4) A steel lining shall be used for soil conditions that make it necessary to protect personnel, prevent cave-ins, or hold out ground water. Linings shall be withdrawn concurrent with placement of concrete in such a manner as to prevent formation of rock pockets or ground water mixing with concrete. Concrete shall have sufficient head above bottom of lining being withdrawn to hold out water and maintain shaft diameter.

(5) Concrete reinforcement shall be placed in dry pier excavation, unless otherwise approved by Owner, clear of all loose earth, gravel, and rock.

(6) Concrete shall be placed in continuous operation to top of pier elevation, using an elephant trunk, concrete pump, or other approved method. Time delays between shaft drilling and concrete placement shall be minimized particularly in unstable and/or granular type soils prone to sloughing or caving.

(7) When it is necessary to place concrete under water, a tremie pipe or concrete pump shall be used. The lower end of the tremie pipe shall be kept submerged in the concrete throughout concrete placement.

(8) All methods used to design and construct drilled piers shall be in accordance with ACI 336.1.

(9) Permanent casings shall not be used without prior approval by Owner.

(10) The volume of concrete required for each drilled shaft shall be plotted on a graph of concrete volume versus depth.

4.1.16 Requirements for driven piles:

(1) All driven piles shall be designed consistent with the primary load application, either as laterally loaded piles or as compression/uplift piles.

(2) Driven piles shall be galvanized (or equivalent) corrosion resistant, including as required and/or recommended by geotechnical investigations.

(3) Driven pile foundations shall be designed to consider dead loads, live loads, snow loads, wind loads, seismic loads, thermal loads, vehicle loads, soil and hydrostatic pressure loads, combinations of loading conditions, and any other loading conditions applicable to the Projects Site. Such loads shall be consistent with geotechnical investigations and recommendations.

4.1.17 Requirements for reinforcing bar:

(1) All reinforcing bars shall conform to ASTM A615 and have a minimum yield strength of 60 ksi. All reinforcing steel, including welded wire mesh, shall be accurately located and held in position using proper reinforcing steel supports, spacers, and accessories in accordance with ACI SP-66 "*Detailing Manual*" and CRSI's "*Manual of Standard Practice*".

(2) At time of placing concrete, all reinforcing shall be free of loose rust, scale, oil, paint, mud or other coatings which may destroy or reduce the concrete bond.

(3) Where not otherwise specified, the minimum coverage of concrete over steel shall be as follows:

(a) Concrete cast against and permanently exposed to earth: 3 inches.

(b) Formed concrete exposed to earth or weather: 2 inches.

(c) Concrete in beams and columns not exposed to ground or weather: 1.5 inches.

(d) Concrete slabs and walls not exposed to weather: 1.5 inches.

(4) Concrete shall be placed at a consistent coverage thickness / depth over all rebar (e.g., all areas with a required minimum of 3 inches of cover shall have a consistent thickness of 3 inches, without significant increases).

4.1.18 Requirements for anchor bolts:

(1) Cast-in-place:

(a) Anchor bolts shall be properly located, accurately positioned, and maintained securely in place before placing of concrete. The threads on the upper end of each anchor bolt shall protrude sufficiently to satisfy the Requirements and adequately complete tensioning activities.

(b) Prior to setting anchor bolts, the threads on the upper end of each anchor bolt shall be given a light coat of oil or grease to prevent adherence of concrete. When installed, anchor bolts shall be cleaned and the portions to be embedded in concrete shall be cleaned and free of oil or other deleterious substances which would adversely affect the bond between the bolt and concrete, unless otherwise specified by the Equipment suppliers.

(c) During the concrete finish and clean-up, concrete adhering to the portions of the anchor bolt extending above finished concrete grade shall be removed giving particular attention to concrete at the finish grade line which would prevent base plates from seating fully on the finished concrete elevation.

(d) Furnish sizes, types, and quantity as required by the Equipment supplier and to transfer the necessary loads to the concrete.

(e) Galvanize all anchor bolts, nuts, and washers except stainless steel.

(2) Post-installed:

(a) Furnish sizes, types, and quantity as required by the Equipment supplier and to transfer the necessary loads to the concrete.

(b) Furnish and install manually expanded and adhesive anchor types.

(c) Install to conform to manufacturer's printed instructions.

(d) Installed adhesive anchors shall not be disturbed or loaded until the anchor has been in place longer than the manufacturer's cure time for the adhesive.

(e) Anchors shall be hot-dipped galvanized or stainless steel as required by the Equipment supplier.

4.1.19 Requirements for steel:

(1) Design of hot-rolled structural and miscellaneous steel shall be in accordance with the American Institute of Steel Construction (AISC) "Manual of Steel Construction". Design of structural and miscellaneous steel shall also be in accordance with National Electrical Manufacturers Association (NEMA) "SG6" and "TT1", American Society of Civil Engineers (ACSE) "Guide for the Design of Steel Transmission Towers, Manual No. 52" and the International Code Council "International Building Code". Design of cold-formed steel shall be in accordance with the American Iron and Steel Institute (ANSI) "North American Specifications for the Design of Cold-Formed Steel Structural Members".

(2) Materials for structural steel and miscellaneous steel shall conform to the following requirements of the American Society for Testing and Materials:

(a) Wide Flange (WF) Shapes and Tees cut from WF: ASTM A992, Grade 50 or multi-certification A36/A572, Grade 50.

(b) M shapes, S shapes, HP (Bearing Piles), Channels, and Angles: ASTM A36

(c) Structural Plates and Bars: ASTM A36

(d) Square/Rectangular Hollow Structural Sections (HHS): ASTM A500 Grade B

(e) Pipe: A53, Grade B

(3) High strength bolts, nuts, and washers shall conform to ASTM A325, ASTM A563, and ASTM F436 respectively and shall be galvanized in accordance with ASTM A2329.

(4) Bolts, nuts and washers under one-half inch in diameter shall conform to ASTM A307, Grade B, ASTM 563 and ASTM F844 respectively and shall be galvanized in accordance with ASTM F2329.

(5) Anchor bolts, anchor bolt assemblies and concrete embedments shall be galvanized.

(6) Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307. Anchor bolt sleeves shall conform to ASTM A501.

(7) Design and fabrication shall be according to AISC 360 “Specification for Structural Steel Buildings”, AISC 303 “Code of Standard Practice for Steel Buildings and Bridges”, and AISC 341 “Seismic Provisions for Structural Steel Buildings”.

(8) High-strength structural steel shall be identified according to ASTM A6/A6M and maintain markings until structural steel has been erected. Materials shall be marked and match-marked for field assembly.

(9) Structural-steel assemblies shall be completed, including welding of units, before starting galvanizing operations.

(10) High-strength bolts shall be shop installed according to the RCSC’s “*Specification for Structural Joints Using ASTM A325 or A490 Bolts*” for type of bolt and type of joint specified.

(11) Built-up sections shall be assembled and welded by methods that will maintain true alignment of axes without exceeding tolerances of AISC’s “*Code of Standard Practice for Steel Buildings and Bridges*” for mill material.

(12) Weld connections shall comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding Work.

(13) Weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel shall be verified that they will limit distortions to allowable tolerances. Butt welds shall be ground flush. Exposed fillet welds shall be ground or filled to smooth profile. Exposed welds shall be dressed.

(14) Zinc coating shall be applied by the hot-dip process to structural steel according to ASTM A123/A123M.

(15) All structural welding shall conform to the requirements of AWS D1.1.

(16) Galvanizing, as specified herein, shall conform to the requirements of ASTM A123, ASTM A153 or ASTM A2329, as applicable.

(17) Stainless steel shall conform to ASTM A167.

(18) Vent holes shall be filled and ground smooth after galvanizing.

(19) Equipment support structures shall be low profile (non-lattice) framing consisting of galvanized structural steel tubing and rolled shapes as the basic structural element. Steel support structures shall be designed, fabricated, and erected in accordance with the provisions of the AISC.

4.1.20 Requirements for aluminum:

(1) Design of structural and miscellaneous aluminum shall be in accordance with the latest version of the Aluminum Association – "Aluminum Design Manual" and "Aluminum Standards and Data".

(2) Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308 and shall be aluminum alloy 6061-T6.

(3) Bolts and nuts shall conform to ASTM F468 and ASTM 467, respectively and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

4.1.21 Requirements for structural loading:

(1) Contractor shall determine all Site data for the design and construction of the plant. This shall include determination of local code requirements for seismic and wind design loads. It is the Contractor 's sole responsibility to ensure that the plant structural and architectural facilities comply with all federal, state, and local code requirements and all industry codes and standards.

(2) Structural loads shall be applied with post embedment depth accounting for maximum scour associated with 100-year storm event.

(3) Dead loads shall include all vertical loads due to weight of permanent structural and nonstructural components, including permanent hung loads.

(4) Live loads shall be in accordance with the IBC and the most recent ASCE 7 standard as modified by the applicable agency local additions and addenda.

(5) Snow loads shall be in accordance with the IBC and the most recent ASCE 7 standard as modified by the applicable agency local additions and addenda

(6) Wind loads shall be in accordance with the adopted versions of the IBC and the most recent ASCE 7 standard, as modified by the applicable agency local additions and addenda. Wind tunnel testing method is permitted upon explicit Owner consent. Irrespective of any wind tunnel testing results, the minimum design wind pressure shall be no less than 10 psf applied normal to the face of each PV module. The PV module rack shall be designed in such a way that deflections due to wind will not damage the PV modules. Contractor shall ensure that the PV modules support foundations can withstand the uplift due to wind loading.

(7) Seismic loads shall be in accordance with the adopted versions of the IBC and ASCE 7, as modified by the applicable agency local additions and addenda. The soil profile type shall be determined by the Contractor based on the results of a subsurface investigation, which shall be obtained by the Contractor.

(8) Buildings and structures shall be designed for forces and/or movements resulting from changes in temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

(9) Design loading for areas accessible to vehicles loads shall be in accordance with AASHTO HS20.

(10) Earth pressure and hydrostatic pressure loads shall be based on the geotechnical conditions and groundwater levels at the project site.

(11) In addition to the aforementioned loading criteria, overhead transmission loads shall also conform to ASCE Manuals and Reports on Engineering Practice No. 74 “Guidelines for Electrical Transmission Line Structural Loading”, NESC requirements, and Section 4.14 of this specification. Where there is a conflict between requirements, the more stringent requirement shall apply.

(12) Load combinations shall be in accordance with the IBC and ASCE 7-05. Contractor shall be responsible for determining and complying with any additions or addenda to this code as may be applicable to the County or AHJ in which the Project is located.

4.1.22 Requirements for bollards:

(1) Bollards shall be a minimum 3-inch diameter steel or PVC pipe, concrete filled for equipment protection (minimum 2000 psi), safety yellow (either painted or with a plastic sleeve) and extend four (4) feet above grade with at least six (6) inches below the bollard for concrete. Bollards shall be installed no closer than two (2) feet from equipment.

4.2 Submittals

4.2.1 Contractor shall prepare the civil works design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) plan views of Project Site, including all access / site roads, crane paths, staging / laydown areas, Project Substation location, and Interconnection Line route; (c) grading and drainage plans; (d) details for erosion control, fencing, gates, compaction, and road cross sections; (e) properties for backfill / fill and road materials; (f) public road improvements; (g) drawing index; and (h) inspection, testing, and quality control requirements.

4.2.2 Contractor shall prepare foundation and structural design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) plan and profile view of foundation and structural steel design, including cross sections; (c) details for reinforcing steel, conduit, and grouting; (d) civil works requirements; (e) structural calculations, to be provided with each set of foundation design drawings; (g) rebar shop drawings; (h) drawing index; (i) bill of materials; and (j) inspection, testing, and quality control requirements.

4.2.3 Contractor shall provide a pre- and post- construction hydrology study for the Project. Such study shall include a two-dimensional analysis of the Project area to determine specific flooding hazards (depth, velocity) at all locations within the Project Site boundary; such information shall be presented in a maximum 50-foot grid size and native (*.SHP) files shall be included. The hydrology study shall include an analysis of the following storm events: (a) 10-year, 24-hour; and (b) 100-year, 24-hour.

(1) The hydrology study shall make recommendations for flood mitigation and permitting for the applicable jurisdiction.

(2) The hydrology study shall identify any existing drainage structures within the Site and provide information on incoming stormwater flows for the storm events noted herein.

4.2.4 Contractor shall provide a stormwater pollution prevention plan (the "**SWPPP**") for the Project and shall maintain all aspects of the SWPPP, including the maintenance of the BMPs, during the entire course of construction and site restitution/reclamation process. Contractor shall maintain all SWPPP BMPs until the construction stormwater permit and/or local erosion control permit is terminated.

4.2.5 Contractor shall prepare concrete mix designs and placement procedures. All such submittals shall be approved by Owner prior to use. Each mix design submitted by Contractor shall be accompanied by documentation of achieving Project-specific compressive strength requirements per ACI procedures.

4.2.6 Contractor shall prepare an aggregate job mix formula based on recommendations from the final geotechnical engineering report. Each formula shall be approved by Owner prior to use and shall be accompanied by testing data, including sieve analysis, for each aggregate source.

4.2.7 Contractor shall submit all manufacturer's product sheets (material cut sheets), mill certificates, warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials. This shall include, but is not limited to, geotextile fabric, permanent gates, permanent culverts, block mesh / flexamat (or similar) if used for low-water crossings (if allowed), anchor bolts, rebar, curing compounds, joint compounds, crack repair compounds, sealants, corrosion inhibitors, and grout.

4.2.8 Contractor shall submit all quality control field test reports or inspections and any of the testing and quality control documentation noted in Section 4.14 within three (3) days of receipt of such report and within one (1) day of receipt of a failed test result.

4.3 Construction Surveys

4.3.1 Contractor shall provide boundary and topographical survey(s) for the design of the civil site work. Contractor may utilize surveys of applicable Right of Way (ROW) dedication prepared by Owner as may be available and required for the performance of the Work.

4.3.2 Contractor is responsible for the construction surveying and staking. All construction surveying and staking shall be performed under the supervision of a surveyor licensed in the applicable state. Environmentally sensitive areas shall be flagged in a color different from other flagged items.

4.3.3 Contractor shall be responsible for clearing the Site of any sensitive species as may be required of local, state, or federal permits or other such agency or plan for the protection of such sensitive species.

4.3.4 Contractor shall provide, as necessary, a qualified archaeological monitor to evaluate any potentially significant archaeological material identified during construction activities. Significant archaeological material is not anticipated, but unknown significant resources may be unearthed during site preparation activities. Contractor shall avoid disturbing significant archaeological material if identified in the field, shall allow the archaeological monitor to evaluate the material, and shall follow the instructions of the archaeological monitor regarding avoidance or treatment of the resource(s).

4.4 Project Site Preparation

4.4.1 Contractor shall provide all Project Site preparation as necessary to complete the Work, including, but not limited to, all clearing, grubbing, stripping, grading, compaction, demolition, blasting, excavation, soil stabilization, and drainage.

(1) Topsoil shall be stockpiled for later use at the Project Site during landscape reclamation activities. Topsoil shall not be moved or transported to other areas from which it was originally removed. Topsoil shall be stockpiled only in areas designated where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, stumps, roots, debris, and stones larger than two (2) inches in diameter. Topsoil shall not be used as structural fill. Appropriate erosion control measures shall be utilized on stockpiled topsoil.

(2) Root mats and stumps shall be completely removed from the Project Site construction areas; holes refilled with select material and compacted adequately for the ultimate expected loading for the material used; and graded to drain.

4.4.2 Contractor shall provide and maintain throughout the duration of construction activities all necessary construction surveying and marking necessary to construct the Project and complete the Work, to include, but not limited to, (a) grading limits; (b) limits of disturbance; (c) laydown and storage areas; (d) culturally-, archeologically-, and/or environmentally-sensitive areas; (e) utilities, pipelines, and other buried facilities; (f) major Equipment locations; (g) Site Access Roads and crane paths; (h) Project Substation pads; (i) Collection System Circuit routing; (j) Interconnection Line routing, including centerline and structure locations; and (k) O&M Building, including pads and parking area.

(1) Contractor shall be solely responsible for locating any survey monuments at or near the Project Site and shall replace such monuments if they are disturbed during performance of the Work.

(2) All structure foundations shall be surveyed and staked prior to excavation. The methods of staking and final alignment shall be designed such that the finished condition of the Work meets the requirements for alignment, position, elevation, and rotation.

4.4.3 Contractor shall maintain all construction areas throughout the duration of the Work. Maintenance of such areas shall include washboard removal, pothole removal, snow removal, cleaning of silt and debris from cattleguards, and other similar items, in a condition suitable for daily construction traffic. Maintenance by Contractor of graveled roads at the Project Site is included in these maintenance requirements.

4.4.4 Contractor shall furnish, install, and maintain temporary orange snow fencing around all archeologically-, culturally-, and environmentally-sensitive areas at the Project Site, including those identified in the Applicable Permits. All temporary fencing shall be removed at the completion of construction.

4.4.5 Contractor shall excavate and remove all rock as necessary to complete the Work, including any necessary blasting. Contractor shall notify Owner prior to the use of explosives at the Project Site; no blasting shall be performed without explicit written confirmation by Owner.

4.4.6 Contractor shall leave no rocks greater than 4 inches in diameter on the ground surface and shall leave the site in such a condition that it is easily walkable and can easily be transited by construction buggies. Larger rocks shall be crushed or removed from site.

4.4.7 Contractor shall minimize grading of the site to the degree practical in an effort to minimize potential drainage impacts.

4.4.8 Contractor shall control invasive weeds during construction through final completion. Special emphasis shall be given to non-native species.

4.4.9 Contractor shall be responsible for reporting the discovering of any cultural or historic resources including potential human remains and managing their discovery in accordance with AHJ requirements. Contractor shall inform all persons working on the Project Site that knowingly disturbing cultural resources or collecting artifacts is prohibited and shall ensure that any cultural resources discovered in the process of construction are protected by halting work withing 100 meters of the discovery until receiving a notice to proceed from Owner or Owner's representative.

4.5 Site Roads

4.5.1 Contractor shall design, furnish, construct, and install all roads, including Site Access Roads and Site Maintenance Roads, temporary turnarounds, intersection/radius improvements, crane paths, and transitions to/from existing roads in conformance with the minimum requirements below. Access roads shall include a road to each Wind Turbine, solar array section, BESS module, Project Substation, O&M Building, at a minimum.

(1) Roads shall be constructed within permitted boundaries and shall be subject to grading permit review and approval, if required, from the agency(ies) having jurisdiction.

(2) Roads shall be installed parallel- or orthogonal-to existing roads, fence lines, property lines etc. wherever possible and shall consider the surrounding land use impacts (e.g., farming of row crops) during the Project's operation.

(3) Road design shall consider the potential for snow drifts developing across the road and include measures to limit its impact on the road.

4.5.2 Contractor shall repair all wear, tear, and other damage to roads during and throughout construction of the Project, including, but not limited to, that which is caused by traffic, weather, and installation activities of Project infrastructure (e.g., collection trenching). Maintenance of Project roads by Contractor shall include, but not be limited to, washboard removal, pothole removal, snow removal, and dust control. Contractor shall propose a plan for remediation of damaged roads and Owner shall review and approve such plans prior to application.

4.5.3 Contractor shall furnish and install a gate and/or cattleguard at every location where a roadway penetrates an existing fence line at the Project Site, in accordance with the requirements in Section 4.1.10 and the landowner requirements.

4.5.4 Contractor shall design and prepare the site roads at the Project consistent with the traffic management plan as further described in Section 2.5.1(7) and to facilitate a smooth traffic pattern for Equipment deliveries, especially deliveries of PV modules. Such design shall take into consideration back tracking, access for emergency vehicles, and shall be consistent with the Road Use Agreement at a minimum.

4.6 Public Roads

4.6.1 Contractor shall design, furnish, construct, and install all public road improvements in accordance with any road use agreements, including upgrading and maintaining any public roads, bridges, and culverts as specified therein.

4.6.2 Contractor shall maintain graveled public roads within the Site boundary throughout construction of the Project, including dust control, washboard removal, and pothole removal.

4.6.3 Contractor shall, prior to mobilization to the Project Site, digitally video and document the condition of existing public roads and perform and pre-construction testing to provide a baseline to quantify the extent of any Contractor-caused wear and tear. Following construction and de-mobilization of all large vehicles from the Project Site, Contractor shall perform the same series of road tests post-construction.

4.7 Equipment Foundations

4.7.1 Contractor shall design, furnish, construct, and install foundations as required for Equipment, in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Equipment Foundation configuration.

(2) Equipment foundations shall, at a minimum, be designed using the final Geotechnical Report, including allowable soil bearing pressure values determined by geotechnical investigation from soil borings at each specific equipment site/locations and equipment loads provided by the suppliers.

(3) Foundation materials, including rebar, anchor bolts, forms, concrete, and grout, shall comply with the applicable structural requirements in Section 4.1 herein.

(4) Contractor shall provide all necessary dewatering of foundation excavations.

(5) Foundations shall be designed and installed to prevent frost heave.

4.8 Building Foundations

4.8.1 Building and equipment foundations shall be of reinforced concrete and shall include all formwork, rebar, waterstop, etc.

4.9 Corrosion Protection

4.9.1 In general, all exposed carbon steel surfaces shall be treated for corrosion protection, if applicable. Contractor shall design and specify corrosion protection systems, which shall include surface preparation measures, for the following conditions:

(1) Carbon steel exposed to ambient environmental conditions (i.e. PV module support structure, if applicable).

(2) Carbon steel exposed to soil conditions below grade (i.e., driven or augured piles, if applicable). This coating shall be designed such that it is not damaged during installation. The Contractor shall consult a corrosion engineer to recommend corrosion protection measures based on the soil conditions. Submit the corrosion engineer's recommendations to the Owner for information and acceptance of the recommendations.

4.9.2 Stainless steel and galvanized steel shall not be painted.

4.10 Drainage and Erosion Control

4.10.1 Contractor shall furnish, construct, install, and maintain all temporary construction and permanent drainage or erosion and sediment control, as necessary to control the erosion of embankments, temporary and final exposed slopes, and temporary stockpiles, and including the use of Best Management Practices (as defined above) all in conformance with the minimum requirements set forth herein, including Section 4.1.7 and the preliminary design documents in Exhibit D.3 (*Preliminary Design Documents*).

4.10.2 Contractor shall furnish, construct, and install any necessary controls to protect water quality.

4.10.3 Contractor shall continuously monitor construction operations to avoid creating conditions that could lead to excessive erosion of soil with surface runoff from Work areas.

4.11 Dust Control

4.11.1 Contractor shall provide construction dust control at the Project Site throughout the duration of the Work, including furnishing of all labor, equipment, and materials, including water and/or palliatives, necessary for dust control and as necessary to reduce the risk of dust becoming a nuisance. Water used for dust control shall be treated to ensure no negative impacts to human health and ecology, including downstream environments; for the avoidance of doubt, potable water is not required for dust control, and treatment of the water source utilized by Contractor for dust control is only required to the extent necessary to comply with the Requirements.

4.12 Wind Turbine Foundations

4.12.1 Contractor shall design, furnish, construct, and install one (1) Turbine Foundation per Wind Turbine location, including grounding, in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Turbine Foundation configuration.

(2) Turbine Foundations shall be conventional spread footing / gravity-type foundations. No alternate Turbine Foundation type, including P&H or rock anchor, shall be utilized without Owner approval.

(3) Turbine Foundations shall be reinforced concrete designed in accordance with Turbine Supplier Project Site Requirements, the Applicable Standards, and the Requirements.

(4) Turbine Foundations shall, at a minimum, be designed using the final Geotechnical Report, including net allowable soil bearing capacity values determined by geotechnical investigation from soil borings at each specific Wind Turbine site and equipment loads provided by Turbine Supplier. No portion of Turbine Foundations shall be constructed on fill material or within ten (10) feet of a fill slope without Owner approval.

(5) Turbine Foundations shall include a grounding grid. The design and construction of the grounding system in such foundations shall meet or include the following requirements, at a minimum: (a) Turbine Supplier Project Site Requirements; (b) incorporate the recommendations, values, and minimum requirements set forth in the Geotechnical Report; (c) installation of adequate ground for personnel safety, including touch and step potentials (to be demonstrated by Contractor via calculations in the grounding study); (d) incorporate local resistivity measurements; and (e) a ground resistance <= 10 ohms.

(6) Turbine Foundation anchor bolts shall have a minimum projection of two (2) anchor bolt diameters beyond the tightened anchor nuts. After all anchor bolts have been tensioned or torqued; a minimum of ten percent (10%) of the anchor bolts shall be tested to verify that the final design tension has been achieved. Tensioning records shall be maintained for initial tensioning and subsequent verification testing. Exterior foundation anchor bolt projections shall be coated with UV-resistant anti-seize coating applied to all exposed metal and covered with climate appropriate bolt covers that seal to the tower flange. Prior to coating, anchor rods shall be clean and free of oil and foreign materials.

(7) Turbine Foundation materials, including rebar, anchor bolts, forms, concrete, and grout, shall comply with the applicable structural requirements in Section 4.1 herein.

(8) The area surrounding the Turbine Foundation shall be constructed with a grade of two percent (2%) sloping away from the Turbine Foundation for the greater of (a) 25 feet from the edge of the pedestal or (b) the distance calculated as 1 foot from the bottom outer edge of the base plus the distance to the surface at a slope of 1H:2V from the bottom of the excavation.

(9) Contractor shall provide all necessary dewatering of the Turbine Foundation excavation.

(10) Each Turbine Foundation shall include thermocouples for concrete temperature monitoring in accordance with ACI 306R and ACI 308R and at a minimum one (1) near the center of the foundation and one (1) near the mid-point of the slope of the foundation spread footing near the concrete surface.

(11) Turbine Foundations shall be designed by a professional engineer with experience designing wind turbine foundations

(12) After placement of concrete, seal the space between the anchor bolt and the anchor bolt sleeve to prevent water from entering the sleeve annulus prior to setting of tower and grouting of baseplate.

4.12.2 Contractor shall furnish and install the subgrade improvements set forth in the Geotechnical Report, including overexcavations, geopiers, and subgrade densification as described therein.

4.13 Wind Turbine Pads

4.13.1 Contractor shall design, furnish, construct, and install one (1) Wind Turbine Pad per Wind Turbine location in conformance with the minimum requirements set forth herein and the preliminary design documents in Exhibit D.3 (*Preliminary Design Documents*). Contractor shall maintain the Wind Turbine Pads throughout the duration of the Work.

(1) Wind Turbine Pads shall be sufficient in size to allow for simultaneous offloading, storage, and assembly of all Wind Turbine components, including, but not limited to, rotor, nacelle, and tower sections.

(2) Wind Turbine Pads shall comply with the Turbine Supplier Project Site Requirements and the applicable erection crane bearing pad and critical lift requirements.

(3) Wind Turbine Pads shall be cleared of crops, brush, boulders, and other debris around each Turbine Foundation, up to the pad limits, and shall be continually maintained to ensure a safe working environment.

(4) Wind Turbine Pads shall not exceed two percent (2%) grade, or less if required for the safe execution of Work, including Wind Turbine assembly, storage, or erection.

(5) Wind Turbine Pads shall have a competent, compacted soil working surface with subgrade cleared and compacted to at least 95 percent (95%) of the maximum density within the moisture content of two percent (2%) below optimum to two percent (2%) above optimum, as determined by ASTM Standard D698, unless a higher level of compaction is required by the Geotechnical Report or the Turbine Supplier Project Site Requirements.

(6) Crane pads shall be designed and constructed to allow for use of cranes in ongoing Wind Turbine maintenance activities following construction (e.g., cranes required for gearbox removal and / or installation).

4.13.2 Contractor shall design, furnish, construct, and install a gravel ring (i.e., “beauty ring”) at each Wind Turbine location in conformance with the minimum requirements set forth herein and the preliminary design documents in Exhibit D.3 (*Preliminary Design Documents*).

(1) Each beauty ring shall be installed after the applicable Wind Turbine is installed and after the removal (including decompaction) of the Wind Turbine Pad at such location.

(2) Each beauty ring shall be installed around the perimeter of each Wind Turbine location beyond the Turbine Foundation pedestal wall, Wind Turbine tower stairs, and any ancillary equipment (e.g., pad-mounted transformer, junction box) in all directions. The beauty ring shall have a minimum width of 20 feet. The beauty ring shall be constructed such that a maintenance truck can drive completely around the turbine base and ancillary equipment.

(3) Each beauty ring (a) shall have an identical cross section as the Site Access Roads (i.e., same thickness, same surfacing material, same fabric, if applicable); (b) shall be shaped to move water away from the Turbine and pad-mount transformer (if any); and (c) shall be constructed to prevent water ponding. If geotextile fabric is utilized in the Site Access Road cross section, such fabric shall be limited to extend a width of 15 feet (i.e., 5 feet less than the extents of the beauty ring aggregate.

4.14 Interconnection Line Structures

4.14.1 Contractor shall design, furnish, construct, and install a foundation and structural supports for each Interconnection Line structure. Structure foundations shall be in conformance with the preliminary design documents in Exhibit D.3 (*Preliminary Design Documents*), and the minimum applicable requirements set forth herein.

4.14.2 Interconnection Line structure foundation holes shall be considered any hole excavated for the purpose of installing a footing, direct embedment, pre-cast, stub angle or anchor bolt foundation. Foundations shall be excavated at the locations specified and as detailed on the design drawings and as described herein.

(1) Contractor provided covers shall be placed over open holes. Open holes shall be protected from flooding. Accumulated water shall be removed from the hole prior to setting the foundation. In no case shall the depth of the hole be such that the entire corrosion treated area of any pole is below or above the ground line.

4.14.3 Interconnection line direct embedment, steel pole foundation requirements:

(1) Drilled caisson foundations shall be used on steel pole foundations with concrete backfill. The steel poles shall be square with the centerline and plumb on both the longitudinal and transverse faces.

(2) Contractor shall supply suitable templates or other means prior to the placement of the backfill material to support the steel poles.

(3) When corrosion sleeves are provided on steel pole bases, the final grade of the backfill shall be between 9 and 15 inches from the top of the corrosion sleeve.

4.14.4 Interconnection line anchor bolt, steel pole foundation requirements:

(1) Drilled caisson foundations shall be used on steel pole foundations with anchor bolts. Steel anchor bolt rebar cages shall be supported by suitable templates and other means prior to placement of concrete. A bolt pattern template shall be used. Additional supporting templates or bracing materials shall be used as necessary to maintain design locations, clearances, and the straightness of foundation components

(2) Anchor bolt projections shall be no more than 4.5 inches between the top concrete and the bottom of the base plate, and there shall be a minimum of 0.25-inch projection of the anchor bolts above the top nut.

(3) Any damage to the bolt pattern template or anchor bolts which prevents properly aligned, plumbed and level anchor bolts, shall be corrected.

(4) The concrete cap shall be square or round in shape and large enough such that the base plate of the steel pole does not overhang the concrete cap.

4.14.5 Interconnection line anchor holes, anchors, and guying:

(1) All transmission structure guys will be a minimum of 0.5-inch EHS galvanized steel strand with a minimum length of 10 feet; rods will vary in length to gain sufficient ground cover.

(2) Conductor and static guys shall be un-insulated. All overhead guys shall be installed un-insulated. All anchors are to be set in accordance with the design drawings.

(3) Anchors shall be thoroughly rocked in before backfilling. Anchors are to be thoroughly compacted with a mechanical tamper. Only mechanical tamping is acceptable with a fill lift of no greater than 6 inches.

(4) Where solid rock conditions exist, expanding rock anchors shall be installed per the design drawings.

(5) Anchor rod slot or rod hole is to be aligned and dug before the disc is placed in the hole. Hole shall be deep enough that the anchor rod remains straight when the guy is pulled. When slots or trenches are dug, they shall be properly backfilled and tamped mechanically with a maximum lift of 6 inches. The eye of the rod at no time shall be struck to drive the rod in to meet the specification.

(6) A minimum of one (1) anchor shall be test pulled at each guyed anchor grouping to no less than 20,000 pounds for 30 seconds before the conductor is strung. Anchor shall be in line with the strain. No more than eight (8) inches or less than four (4) inches of the rod shall remain out of the ground after test pulling. Contractor shall submit to Owner for review methods and devices used for test pulling anchors and the results of each test.

(7) Backfill shall not be placed in contact with the guy strand or guy grip at the rod eye.

(8) Where two grips are used on one rod, the grips shall be properly seated in the rod eyes and shall not cross. Both grips shall not occupy the same eye.

(9) Preformed guy grips shall be used on all guys at the structure attachment; guy rollers or thimble clevises shall be used in all cases.

(10) Guy grips shall be installed with the end of the guy strand extending a minimum of one (1) inch and a maximum of three (3) inches into the eye of the grip. Guy attachment at anchor rods shall also be pre-formed guy grips.

(11) One (1) guy guard shall be installed on the top guy at each anchor rod.

(12) Guy wires shall be cut to proper length and the scrap ends disposed of.

(13) Contractor is responsible for supply and installation of any temporary guys and anchors necessary for stringing the conductors.

(14) Screw anchor installation shall be performed by an experienced operator with the objective of disturbing the soil as little as possible; avoiding damage to the anchor; and maintaining the alignment during the installation of the centerline of the anchor with the guy incline.

4.14.6 Interconnection line structural loading shall comply with this specification and in addition, shall comply with the minimum applicable requirements set forth in the NESC.

(1) Foundations shall limit the total lateral deflection at grade to 3 inches maximum and total foundation rotation to 1.5 degrees maximum. Both limits shall be met under all NESC load cases including the NESC overload factors on applied loads.

(2) Interconnection Line Table 1 summarizes weather cases used for structural design. This table is for use in PLS-CADD.

Table 4-3: Weather Cases for Interconnection Line Structural Design

Weather Case Description	Wind Velocity (mph)	Wind Pressure (psf)	Wire Ice Thickness (inch)	Wire Temp. (°F)	Wire Wind Height Adjust Model	Wire Gust Response Factor	Final/ Initial
NESC Rule 250B	*Reference NESC Rule 250B, Figure 2501-1, General loading map of United States with respect to loading of overhead lines*				None	1	I
NESC Rule 250C	*Reference NESC figures 250-2(a) & Figure 250-2(b), Basic wind speed maps.* 0 inches Ice Thickness; Wire Temperature = 60°F				NESC	NESC	I
NESC Rule 250D	*Reference NESC Rule 250D, Figures 250-3(a) and Figure 250-3(b): Uniform ice thickness with concurrent wind maps.* Wire Temperature = 15°F				None	1	I
Construction	28	2	0	—20 (PSCO, NSP) 0(SPS)	None	1	I
Uplift	0	0	0	—20 (PSCO, NSP) 0(SPS)	None	1	I
Deflection	0	0	0	40 (NSP) 45 (PSCO) 55 (SPS)	None	1	F

Notes:
[1] Wind pressure, Q = 0.00256·V2, with Q in psf, and V in mph. Ice density is 57 lbs/ft3.
[2] Final = Final after Creep.

(1) Table 4-4 summarizes the load cases, with the appropriate weather case, structure load factors, and the structure types to which they apply.

Table 4-4: Interconnection Line Structural Load Cases

Load Case	Case Description	Load Factors[1]			Structure Groups		
		Vertical	Transverse	Longitudinal	Terminal Deadend	Switch Structure	All Other Structures
1	NESC Rule 250B	1.5	2.5	1.65	X	X	X
2	NESC Rule 250C	1.0	1.0	1.0	X	X	X

Load Case	Case Description	Load Factors[1]			Structure Groups		
		Vertical	Transverse	Longitudinal	Terminal Deadend	Switch Structure	All Other Structures
3	NESC Rule 250D	1.0	1.0	1.0	X	X	X
4	NESC Rule 261D5a(1)(a)	1.0	1.0	1.0			
5	Anti-Cascading	See NESC Case	See NESC Case	See NESC Case	X	X	
6	Differential Ice	1.0	1.0	1.0			X
7	Construction Snubbing	1.0	1.0	1.0	X	X	X
8	Construction - Rigging	1.0	1.0	1.0			
9	Deflection	1.0	1.0	1.0	X	X	X

Notes:
[1] For PLS-CAD, assume structure weight load factor and wind area load factor are 1.0.
[2] If stringing from a tangent location, the engineer must consider the load case.

(2) Load Case 1 – NESC Rule 250B. Owner territory is currently located in the NESC Heavy and Medium loading zones. For loading maps, refer to the NESC C2. For an interconnection line located in more than one loading district, Contractor shall use the more conservative district for the entire line unless explicitly approved by Owner.

(3) Load Case 2 – NESC Rule 250C. This load case is for an extreme wind (summer) load case. For a line located in more than one region, Contractor shall use the more conservative region for the entire line unless explicitly approved by Owner. Apply this load case to all Xcel Energy structures regardless of height.

(4) Load Case 3 – NESC Rule 250D. This load case is for an extreme ice and wind (winter) load case. For a line located in more than one region, Contractor shall use the more conservative region for the entire line unless explicitly approved by Owner. Apply this load case to all Xcel Energy structures regardless of height.

(5) Load Case 4 – NESC Rule 261D5a(1)(a). NESC Rule 261D5a(1)(a) requires that "crossarms" on grade B and C structures be designed to withstand a longitudinal load of 700 pounds applied at the outer conductor attachment point. Owner interprets this requirement to apply to structures with a crossarm, including all H-frames. This load case shall be applied using the deflection weather case with all intact wires, and a minimum of 700 pounds longitudinal load at each conductor position simultaneously. NESC Rule 261F1a has a similar requirement for "pin type insulators", however pin type insulators are not allowed.

(6) Load Case 5 – Anti-Cascading. The design engineer shall check all Terminal dead-end structures for anti-cascade loading. Anti-cascade loading consists of all wires removed in the ahead or back direction. The loading condition shall be each of weather cases NESC 250B, 250C, and 250D, with all appropriate load factors as defined in Interconnection Line Tables 1 & 2. To limit cascade damage, there shall be an upper limit to the length of line segment between terminal dead-ends of ten (10) miles.

(7) Load Case 6 – Differential Ice. Differential ice loading can occur at any structure from uneven ice melting or shaded areas. Differential ice loading applies the ice thickness from NESC Rule 250B or 250D (apply the greater ice thickness). Design engineer shall apply full ice thickness in the ahead span and one-half of the ice thickness in the back span, apply the inverse as well. Certain structures, such as H-frames, have less longitudinal stability and are susceptible to differential ice loading. Uneven spans are also susceptible to longitudinal loading due to differential ice. This load case does not apply to post or braced post insulators. This load case also does not apply to terminal deadends or switches.

(8) Load Case 7 – Construction Snubbing. All structures must be capable of withstanding construction activities. This includes simultaneous application of stringing snub loads and worker loads. While coworkers will be on structures other than during initial construction and stringing, this combined load case will govern. The construction loading shall be calculated as follows:

(a) Wire condition: Construction weather case in Interconnection Line Table 1.

(b) Additional vertical load of 750 pounds (two workers plus equipment) shall be included at each wire attachment point.

(c) A vertical load from a wire snub shall be calculated based on a 2H:1V ratio from ground to the snub attachment point using the wire tension from the intact wires. (If a more stringent slope is needed on a project, that specific slope should be used to calculate wire snub loading. If in the NESC Medium district, a 3H:1V ratio is acceptable on tangent structures provided there is adequate construction area).

(d) The final point load at the snub attachment point is the sum of the 750-pound vertical load, the vertical load from the wire snub, and the intact wire point load (transverse, vertical, and longitudinal) for the specified weather case. This is a conservative and simplified method. The location of the wire snub loading shall be applied as follows:

1. For braced line post or post insulators, the snub load shall be applied at the wire attachment point for design of the structure. During construction, wires shall not be snubbed from braced line post or post insulators unless the engineer has determined the strength of the insulator will not be exceeded. Braced line post or post insulators are not required to be analyzed with construction loading, only the supporting structure is required to be.

2. For suspension insulators, apply the snub load at the wire attachment point.

3. For all other designated structure attachment points provided for attaching the wire stringing equipment (i.e., dead-end vangs, arm pit of pole to arm connection, shield arms, etc.), the snub load shall be applied to this location for structure design.

(e) Contractor shall Design structures for the construction load case assuming it is being applied to all wire attachment points on a structure simultaneously. Note the following:

1. The intent of this load case is to provide sufficient capacity of structure arms or other working attachments. The added vertical loads from wire snubbing and workers should not be controlling the design of the pole shaft or foundation for typical structure configurations.

2. Contractor shall call out snub location on the construction drawings that are provided in the construction package.

(9) Load Case 8 – Construction: Rigging from Shield wire Arms. This load case applies to structures that have the shield wire(s) supported on a custom steel arm, and the conductors supported by post or braced post insulators. This load case does not apply to any terminal dead-end structures. This load case is used to simulate a single phase of conductor(s) being temporarily rigged off the upper shield wire arm.

(a) Calculation method: A 750-pound vertical worker load and the total calculated load for the intact single phase will be added to the intact loading of the shield wire above. The PLS-CADD criteria file is set up to calculate this load when using version 16.51 or higher. Use the construction weather case for calculating this load case.

(10) Load Case 9 – Deflection. Deflection requirements are listed in Interconnection Line Table 3. Pole raking in the field is not allowed to meet these deflection limits. For structure deflection values to use in the calculation of required clearances or ROW (Right of Way) widths, see Owners Transmission Line Clearance Criteria.

(a) Note that the deflection limit for terminal dead-ends using the construction weather case is meant to provide more stiffness in dead-end structures that could be used for stringing operations to reduce the need for temporary guy wires and iterating sagging actions.

Table 4-5: Interconnection Line Deflection Limits

Structure Type	Allowable Deflection	Weather Case	Application
Switch Structure	2% of Height	NESC 250B No Overload Factors	Remove all wires which result in the largest moment at the structure base.
Terminal Deadends	1% of Height	Construction	All wires removed one side. For multi-circuit structures, remove all wires which result in the largest moment at the structure base.
	1.5% of Height	Deflection	All wires intact
All other Structures	1.5% of Height	Deflection	All wires intact

4.15 Testing and Quality Control

4.15.1 Contractor shall inspect and test each roadway, except for public roads, in accordance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.

(1) All roadways and compacted areas shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) Testing standards: (a) maximum dry density and optimum moisture content per ASTM D698 or ASTM D1557; (b) in-place density by nuclear methods (shallow) per ASTM D2922 every 1000 square yards; (c) aggregate sampling per ASTM D75; (d) sieve analysis of fine and coarse aggregates per ASTM C136; (e) sand equivalent value per ASTM D2419; and (f) liquid limit, plasticity limit, and plasticity index per ASTM D4318.

(3) Fill material / embankments: (a) proof roll over entire length; (b) grain size analysis, moisture content, Atterberg limits on fines contents, and two (2) standard proctor test on each material type; (c) if proof roll fails, moisture density test at four (4) per lift or every 1,000 feet of road, whichever is greater; and (d) dynamic cone penetrometer ("**DCP**") test at any location where moisture density testing fails. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(a) If on compacted fine-grained soil subgrades, contractor shall utilize the SCP to provide undrained shear strength. A correlation from UCS to CBR is preferred.

(b) If on compacted coarse-grained soil or cement-stabilized subgrades, contractor shall utilize the DCP to provide friction angle and CBR results.

(4) Compacted subgrade (including stabilized subgrade): (a) proof roll over entire length prior to placement of aggregate base; (b) moisture density test every 1,000 feet or three (3) per road, whichever is greater; and (c) DCP test (recorded to a minimum depth of 2 feet) every 500 feet if moisture density testing fails. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(5) Aggregate base: (a) proof roll over entire length; (b) DCP test (recorded to a minimum depth of 2 feet) every 1,000 feet or minimum three (3) per road, whichever is greater; (c) sieve analysis, liquid limit, and plasticity index every 2,500 cubic yards; and (d) wet ball mill or Los Angeles abrasion test, as applicable, every 5,000 cubic yards. The civil engineer of record shall specify passing criteria for the DCP test (e.g., minimum blows per 6 inches).

(6) Geogrid membrane: all testing included in (4) above and additional DCP testing every 500 feet regardless of failed proof roll.

(7) Stabilized subgrade: (a) testing in accordance with the engineer of records procedures; (b) DCP testing for every 500 feet five (5) days after final compaction; (c) a minimum 20 CBR prior to proof rolling; and (d) proof roll over entire length prior to placement of aggregate. If a CBR of 20 is not achieved, additional gravel surfacing will be required and the material stabilization content for future stabilization shall be adjusted.

(8) Crane paths (including shoulders): proof roll over entire length.

4.15.2 Contractor shall inspect and test foundations in conformance with the minimum requirements below. All testing shall be performed by an independent, experienced third party.

(1) All foundations shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) Concrete / grout strength and properties, including break tests, grout cubes, slump, air, and temperature, each at the minimum frequencies specified in Section 4.1 herein.

(3) Foundations shall be tested in accordance with the recommendations set forth in the geotechnical engineering report.

(4) Ground grid testing to confirm grounding is in compliance with the Requirements, including Turbine Supplier requirements.

4.15.3 Contractor shall perform pile load testing if driven piles are planned for the PV Array.

(1) All required construction pile tests shall be performed in the presence of an Owner representative. All load tests shall be in accordance with the design documents, the final geotechnical report, and ASTM D1143 and D3689.

(2) Excavators and other heavy equipment may be used for the load reactions but cannot be used to actively load the pile. Loads shall be applied and controlled with both calibrated jacks and in-line load cells.

(3) Piles shall be driven to the final embedment distance as indicated in the design drawings. Any pile that drives with an install time less than the reference time or less than the required embedment depth shall be flagged for testing.

(a) Failed load test: If a pile cannot be driven to the design embedment depth due to suspected subsurface obstruction (boulder, cobble, shallow bedrock), or the drive time for the pile is less than the shortest drive time identified for the test pile program, Contractor shall implement the following:

1. The tested pile shall be load tested to 100% of the design compression and uplift capacity, in increments of 25%, 50%, 75%, and 100% design capacity with two (2) minute hold times per increment up to the final increment, and then hold for five (5) minutes at maximum design capacity. The movement shall be recorded at the beginning and end of each load increment, and at every minute for the final hold at maximum design capacity.

(b) Successful load test: If a pile is driven to the design embedment, then the reference time and embedment may be adjusted as needed for a particular geotechnical zone with the approval of the engineer of record and Owner.

(4) Load testing data and results shall be provided to Owner for review and acceptance. If a pile test fails or is not accepted by Owner, Contractor shall provide a remediation plan for the failed pile for Owner's review and approval.

4.15.4 All concrete, reinforcing bar, anchor bolts, embedment plates, formwork, etc. shall be inspected per the current International Building Code, Chapter 17, "Special Inspections".

4.15.5 Contractor testing plan shall be submitted to Owner for review and approval. Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within ten (10) days of completing such test. Notwithstanding the preceding requirements, a copy of test results for foundations shall be provided to Owner *prior* to erection of the applicable major Equipment.

5.0 COLLECTION SYSTEM CIRCUITS

5.1 General Provisions

5.1.1 Contractor shall relocate, drop, or cross power lines as needed and as appropriate to complete the Work, with prior approval of the appropriate authority(ies). Contractor shall be responsible for obtaining and maintaining any necessary permits and / or easements for such work.

5.1.2 Contractor shall design and construct the Project such that the total annual energy losses under fully-loaded conditions:

(1) Measured between the PV arrays and its DC bus and the inverters and the low side of the main power transformer at the Project Substation shall not exceed 2.5 percent (2.5%) (the "**Electrical Loss Limit**"). For the avoidance of doubt, the DC losses shall not exceed an average of 1.5 percent (1.5%) and no one circuit shall have a loss exceeding 2.5 percent (2.5%). The losses on the medium-voltage cabling up to the low side of the main power transformer at the Project Substation shall not exceed 0.5 percent (0.5%). The Electrical Loss Limit specifically excludes the losses in the main power transformer.

(2) measured between the generator leads of each Wind Turbine and the Point of Interconnection shall not exceed 2.0 percent (2.0%) (the "**Electrical Loss Limit**"). For the avoidance of doubt, this shall include all medium-voltage transformers, Wind Turbine cabling, Collection System Circuit cabling, and the Interconnection Line up to the Point of Interconnection. The Electrical Loss Limit specifically excludes the losses in the main power transformer.

(3) measured between the BESS and the Point of Interconnection shall not exceed 2.0 percent (2.0%) (the "**Electrical Loss Limit**"). For the avoidance of doubt, this shall include all medium-voltage transformers, Collection System Circuit cabling, and the Interconnection Line up to the Point of Interconnection. The Electrical Loss Limit specifically excludes the losses in the main power transformer.

5.1.3 Contractor shall design, furnish, construct, and install the Collection System Circuits in conformance with the minimum requirements set forth herein and the Contractor-prepared Collection System Circuit design documents, including the Collection System Electrical Studies, as defined herein.

(1) The Collection System Circuits shall be installed within the permitted corridors shown on Exhibit D.1 (*Project Site Plan*).

(2) The Collection System Circuits shall not cross through (under / over) the O&M Building yard.

(3) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Collection System Circuit configuration, excluding only the Owner-Supplied Equipment.

5.1.4 Requirements for AC power cabling:

(1) All Collection System Circuit power cabling shall be 35-kV, 3-phase, 60 Hertz.

(a) Cabling shall be jacketed, Class B, aluminum or copper single-conductor, TRXLPE insulated, with moisture block designed to prevent longitudinal migration of water along stranded conductors (water blocking tapes installed between conductor layers are not allowed as a water blocking system) with appropriately-sized and evenly-spaced copper concentric neutrals. All underground Collection System Circuit power cabling shall be supplied with a minimum of 100 percent (100%) insulation that meets or exceeds all requirements of applicable AEIC, IEEE, ICEA, NEMA, and UL standards. All Collection System Circuit cables shall be UL listed.

(b) Cabling located in burrowing rodent prone areas shall have an armored jacket to prevent damage from chewing.

(c) Conductor and concentric neutrals shall be sized according to the Collection System Electrical Studies.

(d) Certified test reports to be provided by the manufacturer for each cable shipping reel.

(2) Collection System Circuit shall be of a discharge-free design and suitable for direct burial, installation in duct and exposure to sunlight on an alternating current, 3-phase, 34.5-kV nominal, 60-Hertz power system.

(3) All central conductors shall be Class B stranded. No more than one (1) conductor per cable shall be allowed. Conductor material shall be aluminum or copper. Allowable conductor sizes are 1/0 AWG through 1500 kcmil.

(4) Cable ampacity shall not exceed 95 percent (95%) of the rated value without explicit Owner approval, based on Project Site-specific thermal resistivity and in consideration of all external heat sources.

(5) Notwithstanding the following sentence, all underground Collection System Circuit cabling shall be direct buried at a depth of at least 48 inches below grade. Notwithstanding any additional Requirements (e.g., utility crossing agreements, road crossing agreements) all crossings, including, but not limited to, road and utility crossings, shall be installed in conduit or HDPE pipe and buried at a depth of at least 48 inches below grade.

(6) A sufficient amount of cable slack shall be provided to allow installation of elbows and termination of the cables to the appropriate junction box terminal and permit ready disconnection of the elbows and mounting on the parking stands. For the avoidance of doubt, such slack shall allow for the installation / service disconnection of connectors, dead breaks, and other similar devices.

(7) Excess slack shall be provided to allow re-termination in the event of failure. The excess slack shall be in the form of a maintenance loop. Sufficient cable length shall be provided such that the cables may be re-terminated at least two (2) times after installation.

(a) A minimum of 10 feet of cable slack shall be installed (coiled) in the basement of the transformer or junction box vault or inverter foundation or otherwise buried directly adjacent to any such component if a vault is not available.

(8) All Collection System Circuit power cabling provided with terminators and labels. Labels shall be in accordance with Section 2.6.

(9) The installation of splices shall be minimized on underground cabling and shall be completed in a dust free environment (i.e. enclosures used in dry windy areas).. Underground splices shall be identified using GPS-located marker balls, and splices shall only be performed by a skilled, qualified craft worker who shall receive training at the Project Site from the splice kit manufacturer prior to performing splices; the coordinates of each splice shall be recorded and noted within the As-Built Drawings.

(10) Excessive bending of cabling shall be avoided, and the manufacturer recommended bending radius shall not be exceeded.

(11) BIL voltage rating: 200 kV.

(12) Maximum normal conductor operating temperature: 105°C; Maximum emergency overload conductor temperature: 140°C; Maximum short-circuit conductor temperature: 350°C.

(13) No more than 28 MWac may be installed on a single AC feeder cable. No more than 56 MWac may be installed on a single AC substation feeder breaker.

5.1.5 Requirements for trenches:

(1) Collection System Circuits shall be installed via trenching. Excavation by blasting for the Collection System Circuits is strictly prohibited. Trench widths shall be kept to a minimum to allow sufficient space for equipment installation. The trench bottom shall be firm for the entire length and width. Trenches shall be kept free from water. Conduit and cable shall not be placed on frozen ground.

(2) Bedding and/or backfill material shall be installed around all buried Collection System Circuits to provide physical and/or thermal protection for buried cable. All trench bedding and/or backfill materials shall be screened and visually inspected for materials in excess of two (2) inches within six (6) inches of the buried cable. All bedding and/or backfill material shall be composed of materials that are native to the Project Site. Such materials shall be free of debris, roots, organic matter, frozen matter, coal, ashes or cinders.

(a) Backfill shall be compacted per the engineer of records requirements or to a minimum of 85 percent (85%) standard proctor per ASTM D698.

(3) Open trenches shall not be left uncovered overnight or for any extended period of time.

5.1.6 Requirements for plowing:

(1) Plowing in cables is not allowed unless explicitly approved by Owner.

5.1.7 Requirements for markers:

(1) Cable marking tape shall be furnished and installed in all trenches. Such tape shall be metallic and detectable. Marking table shall be placed 12 to 18 inches above cable.

(2) All crossings, including road and utility crossings, shall be marked on each side using a cable marker. Cable markers shall be fireproof and have the generating plant name, state, and the locating service telephone number clearly identified on it.

(3) GPS-located marker balls shall be placed within all cable trench at the following: (a) all crossings (road, pipeline); (b) every splice location; (c) all 90-degree turns in a Collection System Circuit; and (d) minimum of every 1,000 feet of trench length.

5.1.8 Requirements for fiber optic cabling:

(1) Fiber optic cable shall be installed in the same trench as the Collection System Circuit power cabling.

(2) See Section 9.1.11 for additional fiber optic cabling requirements.

5.1.9 Requirements for junction boxes:

(1) Junction boxes shall meet the requirements of ANSI C57.12.28, including water resistance.

(2) Junction boxes may be steel or fiberglass. Junction boxes shall be steel if installed within 500 feet of a Wind Turbine.

(3) Junction boxes shall be lockable with a padlock and shall be NEMA 3R rated.

(4) Junction boxes shall be installed level and plumb, and set on concrete with a rock base, with excavations filled with a minimum 2,000 psi slurry.

(5) Junction boxes shall be clearly marked with an appropriate high-voltage sign identifying the junction box number and Collection System Circuit number. The letters/numbers on the junction box shall be reflective and at least 4-inches tall.

(6) Junction boxes shall be located near other equipment, along fence lines, along field edges, along generation plant Site Access Roads, near but outside of public road ROW or as approved by Owner. Junction boxes shall not be located in wet areas or areas that are expected to be drainageways or will otherwise collection water. In all cases junction box placement must be accessible to maintenance personnel via public roadway or Site Access Road.

(7) Junction boxes shall be installed frequent enough that partial discharge testing of the cables may be performed. The maximum distance between junction boxes or a junction box and other termination shall be 8000 feet.

5.1.10 Requirements for medium-voltage step-up transformers:

(1) Medium-voltage step-up transformers shall be sized appropriately for the Project output and in accordance with the requirements set forth in Table 5-1 (*Summary of General Requirements for Medium-voltage Step-up Transformers*) herein, at a minimum.

Table 5-1: Summary of General Requirements for Medium-voltage Step-up Transformers

Description	Value
Quantity	[TBD] plus [TBD] spares
Type	Mineral oil filled or less flammable oil filled, hermetically sealed, outdoor installation. Dry-type construction must be approved by owner.
Voltage ratio MV Switch MV Bushings LV Bushings	34,500 / [TBD] Volts Under Oil – Disconnect, Load Break Dead front, Loop feed, (6) 600A bushings Spade
Phases	3
Windings Winding electrostatic shield	2 (MV, LV) Yes, drain to core ground
Steady state temperature rise	65°C above ambient at rated kVA
Maximum temperature rise	80°C above ambient at rated kVA
Frequency	60 Hz
HV / LV Impulse levels	200 kV / TBD kV
Vector group HV / LV	Grounded wye/delta
Cooling	ONAN [May consider the use of KNAN as an option in highly environmentally sensitive areas.]
Tapping range	±5%, 2.5% steps, manual control
Paint finish	Powder coated, Munsell Green or as required by the AHJ
Guaranteed losses	Not used (see Electrical Loss Limit)
Temperature gauge	Required; Provide option pricing for located in external padlockable compartment.
Nitrogen pressure level indicator	Required; Provide option pricing for located in external padlockable compartment.
Pressure relief device	Required
Oil sampling valve	Required (located on end of drain valve inside LV compartment); Provide option pricing for located in external padlockable compartment.
Nitrogen filling orifice	Required; Provide option pricing for located in external padlockable compartment.
Tank ground tag	Required
Oil level indicator	Required
Grounding	Solid (MV source, LV winding), un-grounded delta (MV winding)
Infrared viewing windows with metal cover	Optional – Provide pricing for MV and LV compartment viewing windows large enough to infrared scan all termination elbows in each cabinet.

(2) The transformer shall be connected to the inverter, and other transformers, in such a way that the transformer(s) may be subject to harmonic currents and/or abnormally high voltages associated with an inverter load rejection, switching surge, and other transient conditions. Therefore, the transformer shall be designed to withstand the harmonic currents and voltage stress associated with 1.4 times the rated voltage applied to the transformer terminals for 5 seconds.

(3) Transformers shall be handled carefully to avoid internal damage to the transformer or damage to the finish and shall be positioned in accordance with the plans and specifications. Only qualified and experienced personnel shall be allowed to make connections and cable terminations.

(4) Auxiliary equipment and accessories:

(a) Internal expulsion cartridge fuse x3

(b) Parallel oil-immersed partial range current limiting fuse x6

(c) Hook stick operable, two position, amperage rating per the engineer of record, under oil, loop feed switches. Switch positions shall be labeled “open” and “closed.” Switch position labels shall be readable from 2 feet away.

(d) Hook stick operable tap change switch located at an accessible location which does not require reaching behind cables. The tap change switch shall snap into each voltage setting. The switch shall be visible indicating from 2 feet. Provisions, such as a spring loading locking pin or set screw shall be made to assure that accidental operation of the tap changer will not occur.

(e) Low-voltage surge arrester: As specified by the engineer of record. The low voltage surge arrester shall be mounted in an easily viewable and accessible location and shall not be mounted behind cables.

(f) Low-voltage power breaker: per Exhibit A.3 (*Approved Suppliers*) or as specified by the engineer of record

(5) Enclosure:

(a) The MV transformer shall include a fully-enclosed, transformer mounted, MV and LV termination, steel cabinet, suitable for outdoor installation, as per ANSI C57.12.28. The cabinet must be so designed as to fully enclose all cable tails, cable terminations, grounding tags and transformer fittings within a tamper and rodent resistant, secure enclosure.

(b) The cabinet shall extend to floor level, fully shrouding all cable tails, having the facility for being directly bolted to the supporting pad. The cabinet depth shall be 24 inches.

(c) The MV and LV compartments shall be partitioned such that access to each compartment is via a separate door. External access shall be available through the LV compartment door only, with access to the MV compartment door lock being available within the LV compartment. The doors shall be fitted with an all steel, robust, tamper proof, three point (i.e., top, mid, and bottom) integral locking system. Each door shall have the facility of being securely locked shut via the application of a dedicated pad lock.

(d) The transformer name plate and all transformer indication fittings (e.g., oil level indicator, oil temperature indicator) shall be located within the LV compartment, while all transformer operational fittings (e.g., tap changer switch, isolation switch etc.) shall be located within the MV compartment. Option pricing shall be provided for locating the oil sampling device, oil level indicator, and temperature gauge.

(e) The cabinet doors shall be fitted with anti-close stays designed such that both doors can be held open at right angles. The anti-close stay design shall be sufficiently strong enough to withstand the prevailing wind conditions.

(f) When installation is complete, the cover of the enclosure shall not be lower than two (2) inches above the specified grade.

(6) Foundations / vaults:

(a) Pad-mount transformers may be installed with a fiberglass or concrete box pad, steel skid, or concrete slab foundation (pre-cast or cast-in-place).

(b) Box pads shall be installed level and plumb, and set on concrete with a rock base. Excavations shall be filled with a minimum 2,000 psi slurry mix.

5.1.11 Requirements for surge arresters:

(1) Surge arresters shall be provided along at the end of each collection string. Surge arresters shall be 35-kV class, 600A, 30kV/24.4kVMCOV (or greater if required by the Contractor-provided TOV study) equipment meeting the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation, unless a greater rating is required by the Contractor-provided transient overvoltage study.

(2) Surge arresters shall provide overvoltage system protection in an insulated, fully shielded, submersible, dead-front device. Surge arresters shall be provided in pre-molded rubber elbows.

5.1.12 Requirements for grounding:

(1) Grounding connections to equipment including junction boxes, central inverters, and MV transformers (if any) shall be bolted to facilitate separation of grounds from the equipment for continuity testing and ground mat testing.

(a) Contractor shall minimize the amount of exposed ground conductors and utilize approaches that hide ground conductors to minimize the potential for theft.

(2) Ground rods shall be incorporated into the grounding system. Ground rods shall be copper-clad, 3/4-inch diameter, 10-foot-long rods at a minimum.

(3) Foundations shall include a grounding grid, as further described herein.

(4) Underground ground connections on the collection system shall be exothermically welded or a listed irreversible crimp connection. Mechanical connections are not allowed for underground ground connections.

(5) Ground electrodes and groundable parts of equipment shall be interconnected. All interconnections shall be made as shown in the Design Documents. Where shown on the Design Documents, power system neutrals shall be bonded to ground. Ground rods shall be installed at all equipment locations as shown in the Design Documents. All underground ground connections on the collection system shall be exothermically welded or utilize an irreversible crimp. Grounding connections to equipment including junction boxes, central inverters, and MV transformers (if any) shall be bolted to facilitate separation of grounds from the equipment for continuity testing and ground mat testing.

(6) Grounding conductor shall not be less than 1/0 AWG.

(7) Grounding conductor may be copper, or an equivalently-sized copper-clad conductor with a suitable estimated design life (consideration for soil corrosivity shall be considered in conductor selection).

5.1.13 Requirements for bollards:

(1) See Section 4.1.22 herein.

(2) Bollards shall include a mechanism to allow for the connection of lengths of chain.

5.1.14 Requirements for conduit:

(1) All above-ground power and communications cabling shall be installed in conduit. All below grade crossings, including road and utility crossings, shall be installed in conduit. Conduit shall be installed from each MV transformer.

(2) Conduit size / fill ratio shall be in accordance with ANSI / NFPA 70, at a minimum.

(3) The location of all conduit shall be recorded within the As-Built Drawings.

(4) Non-metallic conduit shall be protected from sunlight.

(5) The interior surface of all conduits shall be smooth to prevent damage to the cables. When cable is pulled into a duct, a suitable pulling lubricant shall be used.

(6) HDPE conduit shall be SDR13.5 or heavier if needed to avoid damage when pulling into the bored hole. HDPE shall be one continuous length or connected together with fused joints.

(7) Use suitable temporary plugs or caps to protect installed conduit against entrance of dirt, moisture, and debris.

(8) All conduit materials required shall be furnished new and undamaged in accordance with the following requirements, at a minimum:

(a) Duct: polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.

(b) Couplings: plastic, for use with duct previously specified and "Duct-to-steel" adapters as required, including joint cement.

(c) Spacers: plastic high impact, interlocking, base and intermediate type

(d) Factory bends and sweeps: Schedule 40 PVC, 3-foot minimum radius (or greater if required to not violate the minimum bending radius of the cable being installed in it).

(e) End bells: plastic.

(f) Plugs: plastic, high impact, tapered to fit end bell provided.

(g) Duct binder: hemp or sisal twine coupling.

(9) Conduit duct seal shall be used to prevent rodent intrusion. Spray insulating foam is not an approved product for this application.

(10) Riser shield or conduit shall extend at least eighteen 18 inches below grade at all riser poles. If full round conduit is used as a riser shield, an end bell shall be installed on the lower end to prevent damage to the cable.

(11) Wind Turbine Foundation conduit:

(a) Conduit design shall show the routing and controlling dimensions of the conduit from the exterior of the foundation to the interior of the Wind Turbine pedestal.

(b) Design of the conduit layout shall consider magnetic induced heating effects such as hysteresis, and eddy current losses with their associated heating of the anchor bolts and rebar in the foundation.

(c) Conduit arrangement shall route the cable through the wind turbine foundation, including exit through the pedestal, the sloped portion of the foundation base, or below the entirety of the foundation base. The use of junction boxes to facilitate larger cable sizes shall be strictly minimized.

5.1.15 Requirements for equipment pads:

(1) The site for the pad shall be adjacent to but not over cable trench. The site shall be cleared of all debris and excavated to the specified depth. Cohesionless soils shall be added to the site and thoroughly compacted. The pad shall be installed level at the specified elevation.

(2) Sleeve-type sectionalizing cabinet excavation pads and other below-grade enclosures shall be made so as to disturb the surrounding earth as little as practicable. Enclosures shall be installed with side walls plumb and without any panel distortion. When installation is complete, the cover of the enclosure shall not be lower than and not more than two (2) inches higher than specified grade. Soil in the immediate vicinity shall be tamped and sloped away from the enclosure. The excess soil shall be spread evenly over the surface of the ground to the design requirements.

5.1.16 Requirements for miscellaneous material:

(1) Cable accessories, terminators, dead front, load break and/or dead break elbows shall be designed and manufactured for the cable to be utilized and rated 600-amp for outdoor 34.5-kV use.

(2) Dead front, load break, and/or dead break elbows shall be supplied with test ports.

(3) Cable fault indicators shall be capable of being reset and installed strategically in the substation and at each collector circuit branch and junction boxes including two-way junction boxes to assist in locating electrical faults during operation. At junction boxes, fault indicators shall be exterior indication. Fault indicators to be labelled with 4-inch-tall reflective letters that indicate which branch of the circuit they are connected to. At junction boxes next to a wind turbine or inverter a fiber innerduct shall be installed between the two locations.

(4) Cable caps (3M) shall be supplied when cables are waiting to be terminated in the field after installation.

(5) Each equipment enclosure or junction box shall display a "Caution" sign placed so that it is visible to anyone attempting entry to the enclosure. Also, the equipment inside the enclosure shall display a "Danger" sign so that it is visible when the enclosure is open.

5.1.17 Solar / BESS Requirements for inverters:

(1) For Owner-approved inverter suppliers, refer to Exhibit A.3 (*Approved Suppliers*). The inverter shall have a minimum of 5 years of service history unless explicitly approved by Owner.

(2) Environmental operating ratings: -20 to +50 degrees C (-4 to 122 degrees F), humidity: 15% - 95%, non-condensing, up to 6500 feet elevation without derating or as required by Exhibit D.2 (*Project Site Conditions*), whichever is more restrictive.

(3) If inverter is not contained within a fully enclosed shelter, the inverter enclosure shall be NEMA 3R and padlockable.

(4) Current harmonics: < 3 percent THD and individual harmonic level in accordance with IEEE 519 and IEEE 2800.

(5) California Energy Commission weighted efficiency: > 98 percent without medium voltage step-up transformer.

(6) Inverter shall be designed to Industry Codes and Standards, including IEEE-1547 (IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces) and FCC Part 15 Class A standards.

(a) Cyber security capabilities of inverter shall align with Industry Codes and Standards, including guidelines specified in P.IEEE-1547.3

(7) Inverters shall be programmed in accordance with the requirements of the Owner and Interconnection Agreement.

(8) Notwithstanding any Requirements, including the Interconnection Agreement, inverter shall be capable of power factor control to a minimum of 0.90 leading/lagging (at inverter output terminals) to support voltage regulation as required by Owner.

(9) Inverter shall have voltage and frequency ride-through capabilities in accordance with the Requirements, including NERC guidelines or requirements and the Interconnection Agreement.

(10) Inverter shall be compatible with the Communications System described herein and shall comply with remote control of kW/kVAr/Volt output per the Interconnection Agreement. This shall be accomplished on a Facility level by use of a Power Plant Controller.

(11) Inverters shall be provided with current transducers on each DC feeder in order to provide monitoring of each feeder; CTs shall have an accuracy of 3 percent or better.

(12) LCD screens, if installed, shall be protected from the sun.

(13) Inverter shall be designed such that the controls and auxiliary equipment (SCADA interface, LCD, communications boards, etc.) can be accessed without being exposed to the DC and/or AC bus arc flash potentials.

(14) Inverter shall include DC circuit breakers / switches and AC circuit breakers / switches that can be operated to minimize DC and/or AC bus arc flash potential exposure. DC breakers or disconnects shall include the ability to be padlockable in the open position and provide a visible means of isolation for personnel safety in lock-out tag-out.

(15) Inverters shall be listed to UL-1741 SA (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) or equivalent successor standard. Any variance to this standard is subject to Owner approval.

(16) Inverter AC output circuit breaker shall include an adjustable relay with long time, short time, instantaneous, and ground fault protection features. The relay shall include a metering display and the ability to turn un-used protection functions off.

(17) The inverter shall be capable of supplying and receiving reactive power to and from, the transmission grid, respectively.

(18) Solar + BESS: Inverter shall be designed for four-quadrant, bi-directional operation (Inverter provides DC current to charge the battery modules from the AC collection system, and also delivers AC power from the DC battery modules to supply the transmission grid).

5.1.18 Solar / BESS Requirements for Power Conversion Systems:

(1) The PCS, in conjunction with the BESS site controller when applicable, shall be capable of automatic, unattended operation. The PCS shall include all necessary self-protective and self-diagnostic features to protect itself from damage in the event of component failure or from operating beyond equipment ratings, whether due to internal or external causes.

(2) The PCS system shall include provisions for isolation on both the AC and DC terminals. Disconnecting provisions shall be capable of being locked out to facilitate Company's lockout-tagout process for maintenance work. Harmonic filter capacitors shall be provided with bleeder resistors or other means of discharging to less than 50 volts within approximately one minute of de-energization.

(3) The PCS shall include DC circuit breakers / switches and AC circuit breakers / disconnects that can be operated to minimize DC and/or AC bus arc flash potential exposure. Breakers and disconnects shall be padlockable.

(4) The PCS internal cooling system design may be the manufacturer's standard, provided that failure of a single cooling fan does not cause more than 50% derating of the affected PCS's power rating.

(5) PCS shall include Maximum Power Point Tracking ("MPPT") capability.

(6) The PCS transformer shall have the specifications as noted in Section 5.1.10.

(7) The PCS inverter shall have the specifications as noted in Section 5.1.17.

(8) PCS Shelter:

(a) Shelter shall be rated prefabricated metal or pre-cast concrete enclosures for wind, rain, or UV protection.

(b) Shelter may include HVAC equipment or other means as required to maintain inverter operating environment within inverter manufacturer's specifications. HVAC equipment with a minimum SEER rating of 16 shall be utilized.

(c) Shelter layout shall include provision for inverter(s) with adequate spacing to accommodate inverter maintenance activities and safe operating distances. Minimum equipment clearances shall be in accordance with the NESC and inverter manufacturer's installation and maintenance requirements.

(d) Shelter shall have provisions for equipment removal and replacement.

(e) Shelter shall have adequate task lighting to perform all maintenance activities.

(f) Shelter shall not be designed or classified for occupancy.

(g) Shelter shall be configured to have no roof penetrations of any kind, except for HVAC equipment needs, if any.

(h) Shelter manufacturer shall provide detailed engineering design drawings and calculations complying with the requirements of the applicable building code(s) and local and state laws that have jurisdiction where the building will be delivered and erected. Drawings shall be stamped by a Professional Engineer registered in the Project state and are subject to Owner review and approval.

(i) Shelter shall have air terminal lightning protection in accordance with NFPA 780 standards.

(j) Shelter shall have a means of prohibiting access when energized.

5.2 Submittals

5.2.1 Contractor shall prepare the Collection System Circuit design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) plan view of the overall system, including power and fiber; (c) one-line electrical diagram, including all transformer tap positions that are to be selected during the installation of that transformer; (d) fiber optic loop diagram, including communication loop and connection / termination details for all inverters, meteorological stations, and the O&M Building; (e) cable installation details, including cable specifications, trench details, splice details, and cable marker details; (f) cable crossing details, including road crossings, utility crossings, pipeline crossings, and directional boring; (g) grounding details, including trench grounds; (h) termination details, including junction boxes; (i) junction box details; (j) meteorological station power details; (k) conduit and cable schedules; (l) civil works requirements (e.g., backfill, compaction, grading, drainage, etc.); (m) drawing index; (n) bill of materials; and (o) inspection, testing, and quality control requirements.

5.2.2 Contractor shall prepare a set of studies and analyses for the Project (collectively, the "**Collection System Electrical Studies**") to demonstrate the adequacy of the proposed electrical system design, including any studies and analyses that may be necessary to ensure compliance with the Requirements, including the Applicable Standards or utility requirements. The Collection System Electrical Studies shall be submitted to Owner for review and approval *prior* to the procurement of the applicable major Equipment. The following shall be included in the Collection System Electrical Studies, at a minimum:

(1) Load Flow Study: load flow study with power flow analysis for the Collection System Circuits. Final report shall include a table showing cable ampacity and percent loading per cable section corresponding to the Project one-line diagram. Cable ampacity shall not exceed 95 percent of the rated value, based on Project Site-specific thermal resistivity testing results, as further described in Section 3.0 herein, including specifically IEEE 442. All external heat sources shall be considered, including parallel circuits. Thermal design shall account for actual field soil samples and backfill requirements (native or engineered).

(a) The Load Flow Study shall be performed utilizing CYME CYMCAP software and shall consider, at a minimum, the following factors as part of the study:

1. Historical Ambient Soil temperature data
2. Historical Soil Moisture content data
3. Air temperature data
4. Maximum rated conductor temperature
5. Critical soil interface temperature
6. Measured maximum soil temperature
7. Measured native in-situ thermal resistivity
8. Native soil dried-out thermal resistivity
9. Laboratory determined compacted soil thermal resistivity
10. Compacted soil dried out thermal resistivity

11. Load factor

12. Conductor installation arrangement (Trefoil, etc.)

13. Conductor burial / bore depth

14. Concentric Neutral conductor ampacity

15. Number and spacing of adjacent cables

16. Heating effect from adjacent cables

(b) Soil moisture content assumptions in CYMCAP shall be based upon:

1. Available historical soil water content data.

2. Soil water content measurements per the final geotechnical report.

3. Soil water content data used in CYMCAP shall account for seasonal variation in soil moisture and drought conditions.

(c) Conductor and concentric neutral is to be sized based upon the calculated current requirements and thermal damage limits that the cable can withstand under full load and short circuit conditions.

(d) No improvement in soil thermal resistivity / heat transfer characteristics of the soil is allowed when using the native soil as backfill around buried cables. Only engineered thermal backfill material is allowed for use in improving the heat transfer from buried cables.

(2) Short Circuit Study: short circuit analysis of Collection System Circuits, Project Substation, and Interconnection Line. The short circuit analysis and study shall be utilized in Contractor's electrical designs to support relay coordination study and equipment specification. The study shall be performed using Easypower or Owner-approved equivalent.

(a) Conductor shall be sized based on the assumption that 100 percent (100%) of the fault current is carried by the conductor.

(b) Concentric neutral shall be sized based on the assumption that 70 percent (70%) of the fault current is carried by the concentric neutral and 30 percent (30%) of the fault current is through earth (collection system grounding conductor) or other phase cable concentric neutral.

(c) Collection system grounding conductor routed with the collection system phase conductors shall be sized to carry 30 percent (30%) of the fault current and shall not be less than 1/0 AWG. The grounding conductor may be copper, or an equivalently sized copper-clad conductor with a suitable estimated life.

(d) Short circuit thermal damage limit calculations shall assume a minimum of a 5-cycle delay on relay trip signal, and an additional 1 cycle of margin being added to the breaker interrupt time.

(3) Annual Energy Loss Report: electrical losses evaluation, including estimate of annual energy losses for Project design. Such analysis shall be sufficient to demonstrate that the Electrical Loss Limit, as defined herein, is not being exceeded, and shall be based upon Project-specific cabling and transformer specifications, Project Site-specific soil conditions, and other similar considerations. A pre-construction annual energy loss report and an as-built energy loss report, respectively, shall be submitted.

(4) Reactive Compensation Study: reactive power flow report, including power factor study at the Point of Interconnection. The study shall identify reactive compensation required to meet the Requirements, including the requirements of interconnection for power factor and voltage regulation, and including any capacitor bank and/or reactor requirements and/or STATCOM requirements. The study shall include varying combinations of active power (from no load (0 percent real power) to full load (100 percent real power) and voltage (minimum 0.95 to 1.05 pu) at the Point of Interconnection unless the voltage letter is available in which case the study shall cover the voltage range defined in the voltage letter.

(5) Harmonic Analysis Report: power quality analysis at the Point of Interconnection to determine the harmonic resonance and flicker conditions within the Project and demonstrate that the Project design meets the harmonics distortion requirements in the Requirements (including IEEE 519, and the Interconnection Agreement), including any necessary filtering or mitigation to be provided by Contractor.

(6) Harmonic Measurement Report: the purpose of this report is to confirm the Project will meet the Interconnect Agreement harmonic requirements under all configurations of the Project and Project Substation. Upon completion of the Project, harmonic measurements shall be made at both the Point of Interconnection, and the 34.5 kV Project Substation bus to confirm the Interconnection Agreement power quality requirements and industry standard requirements, such as IEEE 519, are met. Harmonic measurements made, and the harmonic report that are prepared are to be per Exhibit E.2.11 (*Guideline for Inverter Based Renewable Generation (IBRG) Power Quality Measurements and Reports - Rev. A*).

(7) Shield Wire Induced Voltage Report: analysis to determine the maximum voltage difference between ground and the cable shield. The collection system cables shall have their shields (concentric neutral) grounded on each end of the cable and the maximum shield voltage shall not exceed 25 volts when referenced to ground. An equipment ground conductor (bare copper or copper clad steel with suitable estimated life) shall be routed with each collection system cable.

(8) Insulation Coordination Report: study to ensure the insulation coordination requirements of IEEE C62.22-2009 have been satisfied within the Project electrical design, including proper application of surge arresters to safeguard electric power equipment within the Collection System Circuits, Substation, and Interconnection Line against hazards of abnormally-high voltage surges of various origins.

(9) System Transient Temporary Overvoltage Report: the collection system transient temporary overvoltage study is developed with a digital simulation program that models transient voltages and currents on the collection system. The study shall be developed using EMTP (Electromagnetic and Electromechanical Transients Program by EMTP Alliance) or Owner-approved equal.

(a) This study shall also be used to select the MCOV (Maximum Continuous Operating Voltage) rating for the surge arresters installed on the collection system. When selecting the arrester MCOV (Maximum Continuous Operating Voltage) rating, both the highest transient overvoltage and the highest temporary over-voltages shall be considered. The system model shall determine the highest voltage that occur on the un-faulted phases for a single line to ground fault along the collection system.

(b) The highest transient overvoltage typically occurs within 3 cycles of either the fault occurring or the substation feeder breaker opening to clear the fault. Minimum MCOV rating = Peak Transient Overvoltage / (1.53 x 1.4142). See IEEE standard C62.22-2009 Figure 12: 0.02 second overvoltage duration requirement for metal oxide surge arresters on AC systems).

(c) The arrester shall also be capable of withstanding the temporary overvoltage (voltage following the transient overvoltage while the inverters continue to provide power). Minimum MCOV rating = Peak Temporary Overvoltage / (1.30 x 1.4142) (see IEEE standard C62.22-2009 Figure 12: 10 second overvoltage duration requirement for metal oxide surge arresters on AC systems).

(10) Ground Grid Report: analysis of major Equipment grounding design to verify the adequacy of the proposed design and the safety of personnel working in or around the major Equipment. The study shall confirm that the grounding system maintains touch and step voltages within tolerable limits, and shall be prepared in accordance with the procedures, data, and recommendations given in IEEE 80. The study shall determine the ground potential rise with respect to remote earth, and Foundations shall be modeled as they are actually constructed (i.e., if not solidly bonded (e.g., using wire ties), they should be modeled accordingly).

(11) Reactive Power Control Report: the purpose of the reactive power control analysis is to develop the logic for use in signaling when each reactive power source (switched capacitor, switched reactor, static var compensation, or similar device) should be turned on or off in coordination with the reactive power supplied by the inverters. Information used in determining the logic shall include, but not be limited to, (i) the voltage schedule letter; (ii) the voltage flicker limitations identified in the Reactive Power study; (iii) the Interconnect Agreement and FERC 827 power factor requirements; (iv) reactive power capability curves for applicable equipment; and (v) the dynamic model of the system to model the impact of reactive power switching.

(a) The end results of the study are the parameters / inputs required for the Wind Turbine / PCS and it's controller to coordinate with the other available reactive power sources. Parameters supplied from the study typically include (i) voltage droop profiles (percent droop, percent deadband, QMax, and Qmin); (ii) reactive power switching parameters (switch in percent and switch out percent); (iii) reactive power switching time delay (switch in delay and switch out delay); (iv) Point of Interconnection power factor limits (leading power factor limit and lagging power factor limit); and (v) Graphs of dynamic response switching events effect on voltages at the point of interconnect and at the substation.

(b) When designing the logic, the full reactive power capability of the system shall be made available to respond to grid disturbances. No artificial limiters shall be designed into the logic to limit the amount of reactive power provided to support the electric grid during grid disturbance events.

(12) Arc Flash Study: arc flash hazard analysis of the major Equipment, including all energized equipment in the solar PV Array (including inverters) / BESS / Wind Turbines Collection System Circuits, Project Substation, Interconnection Line, and O&M Building. This analysis shall be performed in accordance with the latest version of current versions of IEEE C2, National Electric Safety Code, NFPA-70E, IEEE 1584, and OSHA standard 1910.269.

(a) The arc flash study shall be performed using EasyPower software for voltages up to 15 kV and ArcPro software for voltages over 15 kV, or Owner-approved equals. For calculations above 15 kV, the ArcPro calculation results shall be adjusted to account for three phase arcs in open air or in an enclosure, as required in OSHA 1910.269 Appendix E, Table 3 Notes.

(b) The input data, one-line model, and study results shall be provided with the report (both draft and final) and shall be provided in *.pdf format. Contractor shall also provide the native software files utilized for the study for Owner's review and record.

(c) Contractor shall supply and install arc flash labels on all applicable equipment enclosures from the Project Substation to the Wind Turbines / PV panels / BESS. Labels shall be in accordance with Section 2.6.

(d) Contractor shall utilize the minimum working distances indicated in Table 13 in the arc flash study.

Table 5-2: Arc Flash Study Minimum Working Distances

Equipment Class	Working Distance
480-volt motor control center and panels	18 inches
480-volt switchgear	24 inches
5-kV switchgear	36 inches
15-kV switchgear	36 inches
15-kV equipment (outdoor)	36 inches
16- to 36-kV equipment (enclosed)	48 inches
16- to 46 kV equipment (outdoor)	48 inches
47- to 72.5-kV equipment (outdoor)	72 inches
73- to 169-kV equipment (outdoor)	84 inches
170- to 362-kV equipment (outdoor)	120 inches

5.2.3 Contractor shall prepare energization plans and procedures for each Collection System Circuit. Energization plans shall be submitted to Owner for approval *prior* to use. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.

5.2.4 Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Collection System Circuits. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

5.2.5 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials.

5.3 Collection Circuits

5.3.1 Contractor shall design, furnish, construct, and install the Collection System Circuits in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Collection System Circuit configuration, excluding only the Owner-Supplied Equipment in Exhibit B (*Owner Scope of Work*).

5.3.2 Contractor shall furnish a sufficient quantity of medium-voltage transformers, as applicable, including one (1) spare unit(s). All spare units shall be specifically marked and packed for storage.

5.3.3 Contractor shall furnish a sufficient quantity of PCS units, as applicable, including one (1) spare unit(s). All spare units shall be specifically marked and packed for storage.

5.3.4 Notwithstanding the following sentence and as more particularly described in Section 14.4.3 herein, Contractor shall complete all fiber optic terminations, including, but not limited to, those at the O&M Building, Project Substation, and permanent meteorological towers. Turbine Supplier shall complete all fiber optic terminations in the base of each Turbine.

5.3.5 Contractor shall perform directional boring at all Collection System Circuit crossings with a stream, wetland, county road, railroad, pipeline, or other buried facility. Augers or pneumatic or hydraulic jacks shall be used to install a conduit through an area that may not be trenched (such as a paved road or paved area). The diameter of the hole shall not exceed the diameter of the conduit if by more than one (1) inch. Where a gap between the conduit and hole exceeds one (1) inch a thermally conductive, flow-able material shall be added to fill the void around the conduit. Boring a hole utilizing water pressure and washing is not acceptable. HDPE type conduit shall be installed for all tunneling/boring. Proposed material for flow-able fill shall be submitted for Owner review and approval prior to use.

5.3.6 Contractor shall install four (4) bollards around every junction box and MV pad-mounted transformer (if any), respectively.

5.4 Testing and Quality Control

5.4.1 Contractor shall test, commission, start-up, and place into successful operation each Collection System Circuit, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.

(1) All Collection System Circuits shall be tested to demonstrate they meet stated design criteria and are fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA standard for Acceptance Testing Specifications.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(5) Solar and BESS: Resistance testing on grounding grid at each junction box, electrode ring and central inverter or inverter transformer.

(6) Megger test of all 34.5-kV cables.

(7) Final continuity tests after completion of all system connections. After installation of the cable and prior to the high potential test specified below, a simple continuity test shall be conducted on the system. This can be accomplished by grounding the conductor at the source and checking for continuity from the end of each tap with an ohmmeter.

(8) Cable jacket integrity testing shall be performed on all collection cables. Defects or damage to cable jackets shall be repaired using a cable OEM approved method, or the damaged cable section shall be replaced.

(9) High potential very low frequency ("VLF") test shall be performed on all 34.5-kV power cabling. After successful completion of cable continuity testing and cable jacket integrity testing.

(10) Collection system phase verification testing. Once VLF testing has been completed, and prior to energization, a test voltage shall be applied to the collection feeder riser conductors at the substation. Every inverter location in that feeder should then be checked with a meter to verify that the collection system phase sequence is correct. This test can only be conducted once all collection cables have been terminated and installed on each feeder in the systems entirety (all equipment is connected in the collection system and substation).

(11) Collection system voltage and phase rotation testing. After energization, phase and line voltage and phase rotation shall be tested at the low-voltage side of the medium voltage step-up transformer.

(12) Partial discharge testing: If more than two (2) failures of any particular collection system component occur within one (1) year of commercial operation, then partial discharge testing shall be performed on all similar components.

(13) Compaction testing shall be verified at a minimum of every 1,500 feet and at every splice pit location.

(14) Communications system testing per Section 9.4 herein.

(15) Pad-mount transformer (if any) minimum testing:

(a) Transformer turns ratio ("**TTR**") on all tap positions.

(b) Insulation resistance test (i.e., Megger), including winding-to-winding and winding-to-ground measurements.

(c) Winding resistance test.

(d) Insulation power factor test.

(e) Oil testing including color, moisture content, and dissolved gas analysis prior to energization and at least 30 days following energization, respectively.

(f) No-load and load loss test factory certified test reports.

(g) Not used.

(16) In the commissioning report, Contractor shall provide the following with respect to the collection system transformer tap position settings:

(a) Confirmation that all transformer tap settings (generator step up, etc.), relay settings, and control system parameters match the engineer of record construction documents (issued for construction drawings, PRC-019, PRC-023, PRC-024, PRC-025, PRC-027, VAR-002 studies, Substation Electrical Studies, etc.).

(b) Confirms transformer voltages are per NEMA / ANSI utilization voltage standard C84.1 (Electric Power Systems and Equipment – Voltage Ratings – 60 Hz) for transformers that provide power to utilization equipment.

(c) Confirms transformer voltages are correct per the manufacturer ratings, (issued for construction drawings, PRC-019, PRC-023, PRC-024, PRC-025, PRC-027, VAR-002 studies, reactive power flow study, reactive power Control Analysis study, arc-flash studies, etc.).

5.4.2 Contractor testing plan shall be submitted to Owner for review and approval. Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

6.0 PROJECT SUBSTATION

6.1 General Provisions

6.1.1 The Project Substation shall be constructed on owned land and not acquired through an easement, and designed and constructed per AHJ required guidelines and withstand no less than a 100-year, 24-hour storm event. Final constructed grade shall be at least 12 inches above such flood depth, as determined in the Contractor-provided hydrology study.

6.1.2 The design working life of the Project Substation shall be a minimum of 50 years.

6.1.3 The Project Substation shall be designed and constructed to a high level of reliability and shall meet the requirements set forth by the interconnection utility, Transmission Provider, FERC, and the ISO.

(1) Design shall consider the interconnecting utility's future fault values for the worst-case value over a 50-year life.

(2) The Project Substation shall be constructed with steel structures. The use of wood structures is not allowed.

6.1.4 The Project Substation shall be designed, constructed and tested at a minimum in accordance with applicable ANSI (including safety signage in accordance with ANSI Z535), IEEE and NEMA standards and in accordance with the latest version of the NESC; and shall also be designed, constructed, and tested to a high level of reliability and shall meet or exceed the requirements set forth by the interconnection utility. Contractor testing plan shall be submitted to Owner for review and approval.

6.1.5 Contractor shall design and construct the Project Substation in accordance with the Project Substation Electrical Studies and the Electrical Loss Limit, each as defined herein.

6.1.6 No splices shall be made within the Project Substation for 34.5-kV or higher system energized conductor (except for tubular bus as determined by bus support calculations). Additionally, power, instrument, and control conductors shall not be spliced. Shields may be spliced where necessary to permit connection to the Project Substation ground system.

6.1.7 Project Substation basic impulse level shall be at least 200 kV for the 34.5-kV system and in accordance with Table 6-1 below for the high-voltage system (to be determined based on the Project voltage level). Design of the high-voltage and 34.5-kV systems shall be for a short circuit rating calculated based on the results of a Contractor-furnished short circuit study.

Table 6-1: Minimum Basic Impulse Ratings and Clearances

A		B				C		D		E	F		G	H	
Nominal Voltage	Max. design application altitude	Equipment External Impulse Withstand	Insulation Coordination		Bus & Switch Insulator	Ph-Gnd Clearance		Ph-Ph Clearance		Ph-Ph Spacing without Switches & Vertical Runs	Ph-Ph Spacing		Vertical Clearance - Energized part to permanent supporting surface	Vertical Height Rigid Bus	
		Nominal (sea-level) BIL	Min. Allowable Effective BIL & Surge Arrester MCOV		Nominal (sea-level) BIL	STD. Min. IEEE C37.30.1,1427	XEL Design Min.	STD. Min. IEEE C37.30.1,1427	XEL Design Min.	XEL Design Minimum	Historical Design Min.	XEL Design Min. IEEE C37.30.1	STD. Min. NESC Table 124-1	XEL Design Minimum	
														Low	High
kV	kFT	kV	kV		kV	FT-IN		FT-IN		FT-IN	FT		FT-IN	FT-IN	
(Ph-Ph)	(ASL)	(BIL)	(BIL)	(MCOV)	(BIL)	(Metal-Metal)		(Metal-Metal)		(CL-CL)	(CL-CL)		(Surface-Metal)	(Baseplate-CL)	
2.4	14	60	36	2.55	200[4]	0-4.5	1-6	0-5	2-0	3-0	3	4	8-9	12-0	19-0
4.16	14	75	44	2.55	200[4]	0-5.6	1-6	0-6.2	2-0	3-0	3	4	8-10	12-0	19-0
7.2	14	95	56	8.4	200[4]	0-6	1-6	0-7	2-0	3-0	3	4	8-10	12-0	19-0
15	14	110[2]	65	8.4[3]	200[4]	0-7	1-6	1-0	2-0	3-0	3	4	9-0	12-0	19-0
25	14	150	89	15.3	200[4]	0-10	1-6	1-3	2-0	3-0	3	4	9-3	12-0	19-0
35	14	200	118	22[3]	200	1-1	1-6	1-6	2-0	3-0	3	5	9-6	12-0	19-0
46	14	250	148	31.5	250	1-5	1-10	1-9	2-0	4-0	4	6	9-10	12-0	19-6
69	14	350	207	48	350	2-1	2-6	2-7	3-0	5-0	5	7	10-5	13-0	20-0
115	14	550	326	76	550	3-6	3-9	4-5	5-0	7-0[1]	10	10	11-7	14-0	21-0
138	14	650	385	88	650	4-2	4-6	5-3	5-9	8-0	11	12	12-2	15-0	23-0
161	14	750	444	106	750	4-10	5-2	6-0	6-8	9-0	13	14	12-10	16-0	25-0
230	9.55	900	630	152	900	5-11	6-8	7-5	8-2	11-0	15	16	13-9	17-0	28-0
230	13.6	1050	630	152	1050	6-11	7-8	8-9	9-8	13-0	16	18	14-10	18-0	31-0
345	7.7	1300	975	230	1300	8-8	8-10	9-11	10-11	14-6	16	20	17-2	19-0	33-6
345	12.4	1550	975	230	1550	10-4	10-8	10-10	11-11	20-0	25	25	18-10	21-0	41-0
500	7.1	1800	1380	335	1800	12	12-8	12-6	13-9	22-0	27	27	20-6	31-2	53-2

6.1.8 Contractor shall receive explicit approval from Owner or Owner's representative(s) of the design of the Project Substation prior to construction. Owner shall have unlimited access to such designs throughout the design process, and construction of all such facilities shall be completed by one of Owner's approved subcontractors, as more particularly detailed in Exhibit A.3 (*Approved Suppliers*).

6.1.9 Project Substation equipment paint shall be designed for the Project environment including items such as temperature swings, ultraviolet exposure, salt exposure, chemical exposure, pesticide exposure and warranted for no less than 10 years. The coating shall consist of rust-inhibiting epoxy primer, standard intermediate coating, and two (2) finish coats of paint. The total coating shall be a minimum of five (5) mils dry. The paint color of all equipment shall match and comply with Project architectural requirements. If no architectural requirements are provided, equipment paint color shall be ANSI 70 gray, unless otherwise specified by the Requirements.

6.1.10 Station auxiliary power at the Project Substation shall be provided from two (2) sources. The Interconnection Line and local distribution system may each be utilized as a source. A standby generator shall be installed if a local distribution system connection is not available.

6.1.11 The Project Substation shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee ("**APLIC**"). Refer to Exhibit E.4 (*APLIC Guidance*) for additional information.

6.1.12 Requirements for Project Substation civil and structural works:

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the Project Substation shall be designed and constructed in accordance with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

(2) Excavation by blasting for the Project Substation is prohibited.

(3) Trench widths shall be kept to a minimum to allow sufficient space for equipment installation. The trench bottom shall be firm for the entire length and width. Trenches shall be kept free from water. Conduit and cable shall not be placed on frozen ground.

(4) Project Substation equipment shall have wind and seismic withstand capability in accordance with the Applicable Standards, including IEEE 693 and AISC's "*Manual of Steel Construction*".

(5) Areas at the Project Substation to be surfaced with finish rock, including areas outside the permanent fence, shall be treated with a weed eradicator and soil fumigant. Care shall be taken with the application of the soil sterilant to prevent contamination of adjacent areas and to comply with environmental permitting constraints.

(6) The Project Substation Site Access Road shall have a minimum inside radius of 50 feet and shall be long enough for a delivery vehicle to fully pull in and straighten prior to entering through the gate.

(7) Substation driving paths shall be designed to avoid crossing of pre-cast cable trenches if possible.

6.1.13 Requirements for substation cabling:

(1) All cable furnished shall conform, at a minimum, to the requirements included in Table 6-2 (*Summary of Cable Requirements*):

Table 6-2: Summary of Cable Requirements

Cable Type	Description
Low-voltage power	600 volts, single-conductor, Class B stranded copper; EPR or XLP insulated; CSP or CPE jacketed.
Low-voltage power	600 volts, three-conductor; concentric lay, stranded copper with a ground wire in the interstices; FRXLPE or FREPR insulation; CSP, or CPE jacketed overall.
Control	Control cable, 600 volt, multiple-conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple-conductor, XLP insulation; CSP, or CPE jacketed overall. Shielded control cable is required when 230kV or greater is present in the Project Substation.
Instrumentation	Instrumentation cable, 600 V, flame retardant single-and multiple-twisted pairs and triads, shielded instrument cable with individually shielded pairs, overall shield, and overall jacket; FRXLPE or FREPR insulation; CSP, or CPE jacketed overall. (Single pair or triad 16 AWG, multi-pair or triad 18 AWG).
Lighting and receptacles	Lighting circuit runs totally enclosed in conduit, NEC Type RHW-USE with XLPE insulation for use in outdoor or unheated areas.
Shielded control	Control cable, shielded, 600-volt, multiple conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple conductor, XLP insulation; CSP, FRPVC or CPE jacketed overall.

(2) Power conductor size and ampacity shall be coordinated with circuit protection devices. Conductor size shall be determined for 125% of connected load at the design basis maximum outdoor ambient temperature. Below-grade power cable conductor size shall be determined in accordance with the methods in IEEE 835.

(3) Control, shielded control, and instrumentation multi-conductor cable assemblies shall include a minimum of 25 percent spare conductors. Multi-conductor cable assemblies shall utilize the ICEA color coding scheme E-1.

(4) Installation of conductors shall be understood to include placement, splicing (in accordance with 6.1.6), and terminating conductors; coiling and taping of spare conductors; identification, testing, and verification of each circuit, cable, and conductor.

(5) Insulated cable, conductors, and conductor accessories shall be furnished and installed in accordance with the requirements of these specifications and the recommendations given in IEEE 525. Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation as indicated in these Specifications.

(6) Terminations of conductors shall be as follows:

(a) Connectors, sizes 12 - 2 AWG, shall be non-insulated ring-tongue type.

(b) Connectors, sizes 1 AWG – 750 kcmil, shall be uninsulated two-hole rectangular tongue.

1. Solderless-type terminal lugs and connectors shall be used for connecting #9 AWG wire and smaller stranded cable to studs.

2. Terminations for wire sizes larger than #8 AWG shall have at least two (2) indentations.

(c) Terminations shall be made with pressure-type terminal lugs using a compression tool provided with a ratchet or toggle mechanism that ensures a complete and positive crimp before the tool can be removed. Compression tools shall be approved by the lug manufacturer.

(d) Cables and wires used for all instrumentation and control connections shall be terminated with seamless, non-insulated, ring-type Burndy YAV hylug-type compression connectors.

(e) Wire strands shall not be removed from the end of a cable in order to reduce the conductor diameter. Appropriately sized terminal lugs must be used to maintain the same ampacity rating as the cable.

(f) Sufficient length shall be left at all ends of wires and cables to conveniently make connections to equipment and devices. Spare conductors at the end of a multiconductor cable shall be coiled neatly and retained in a length equal to that of the longest single conductor at each end of the multiple-conductor cable or terminated as shown in the design drawings. All cables entering a terminal cabinet, switchgear compartment, distribution board, or other such device from a conduit, cable slot, or cable trench shall be clamped securely at the opening. All exposed cable or wire runs shall be bundled together and tied so as to prevent movement.

(g) Cables and wires shall not be bundled in a cable tray or floor trench but shall be bundled and laced immediately after passing through an opening in the tray or trench cover at each instrument panel rack.

(h) A threaded stud shall be used if more than two wires are landed on the same point on a terminal block.

(7) The cable furnished shall be flame retardant construction in accordance with the applicable ICEA standards and suitable for wet or dry locations.

(8) All cable shall have surface printing showing manufacture's name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers.

(9) Control and instrument cables, and 600-volt class cables shall be terminated with ring-tongue connectors.

(10) Cable pulling shall be as follows:

(a) A careful determination of the length of all wire and cable runs shall be made by Contractor prior to any cable installation in order to minimize pulling stresses. Cable pulling tensions shall not exceed those recommended by the cable vendor or supplier. Wire and cable shall be handled with care to avoid damage. Contractor shall carefully inspect all wire or cable for visible defects. Instances of damaged wire or cable shall be promptly brought to the attention of Owner or its representative, who shall determine the action to be taken to correct such defects.

(b) A clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing the wire or cable. No wire or cable shall be installed in conduit unless it is free of all foreign material.

(c) An Owner approved water-based lubricating material non-injurious to the insulation or jacket shall be used when necessary to prevent mechanical damage.

(d) No cable shall be installed prior to the completion of the raceway system in which the cable is routed in.

(11) Shielded wire and cable shall have the shield grounded strictly in accordance with the Requirements.

6.1.14 Requirements for substation bollards:

(1) See Section 4.1.22 herein.

(2) Non-metallic bollards shall be placed as appropriate around the perimeter of above-grade equipment, including the 34.5-kV Collection System feeder conduit and cable trench as needed, in particular in areas within or adjacent to driving lanes.

6.1.15 Requirements for main power transformer:

(1) The main step-up transformer(s) has/have the technical specifications as noted in Exhibit D.6 (*Main Power Transformer Specification*).

(2) No more than 150 MW of capacity shall be directed through any single main step-up transformer. For Project's with a nameplate capacity exceeding this threshold, the Project shall incorporate parallel main step-up transformers in either 100 MW, 125 MW or 150 MW increments, where each such transformer is identical and interchangeable (mechanically and electrically). Load from each Collection System Circuit shall be split evenly across each transformer. Example: a 270-MW project shall incorporate two (2) identical 150 MW main step-up transformers with approximately 135 MW on each unit.

(3) The standard transformer MVA rating for a transformer carrying 100 MW of generation is 75/100/125 MVA with an impedance at 75 MVA of 9%. The standard transformer MVA rating for a transformer carrying 125 MW of generation shall be 94/125/156 MVA with an impedance at 125 MVA of 10 percent. The standard transformer MVA rating for a transformer carrying 150 MW of generation is 113/150/187 MVA with an impedance at 113 MVA of 10 percent.

(4) The main power transformer high side voltage rating shall coordinate with the transmission line voltage. The transformer nominal high side voltage rating shall match ANSI standard C84.1 voltage ratings. The nominal high voltage rating shall typically be either 115,000; 161,000; 230,000; or 345,000 volts.

(5) The main power transformer low side voltage rating shall be 34,500 volts.

(6) The main step-up transformer foundation and containment shall be provided with secondary oil containment equal to at least 110% of the volume of oil present in the transformer in addition to the volume of rainwater for a 100-year, 24-hour storm event over the area of the containment; a calculation shall be provided by Contractor to demonstrate compliance with this requirement. Oil containment shall be a concrete containment with a manual brass ball valve drain and shall have grating over the oil containment to facilitate access to instrumentation and control cabinets for operations.

(7) The main step-up transformer shall include a +/-10% on-load tap changer on the high side winding.

6.1.16 Requirements for circuit breakers:

(1) Circuit breaker electrical ratings shall be verified by Contractor against electrical studies including but not limited to TOV study, short circuit study, reactive switching study, and site ampacity study. Contractor is responsible for circuit breakers meeting project application.

(2) High-side bus circuit breakers shall be outdoor, air insulated, three-pole, single-throw, 60 Hertz, dead-tank design with dual trip coils, alarms, interlocks and contacts necessary to meet the Project design. Such circuit breakers shall utilize SF6 gas as the interrupting medium. Such breakers shall consist of three sections: high-voltage compartment, mounting provisions, and low-voltage compartment.

(3) 34.5-kV circuit breakers shall be installed for protection of the Collection System Circuits, capacitor banks, and reactors, respectively. Such circuit breakers shall be outdoor, distribution, 60 Hertz, vacuum circuit breakers consisting of three sections: high-voltage compartment, mounting provisions, and low-voltage compartment.

(a) The number of medium voltage 1200 Amp collection system feeder breakers shall be determined by the collection system.

(b) Up to two (2) medium-voltage collection feeders may be connected to a single vacuum breaker, provided that the equipment is capable of that arrangement based on the Substation Electrical Studies and other Requirements.

1. On projects that are geographically disperse up to 3 feeders on a single breaker may be used only with Owners explicit approval.

(c) Medium voltage main breakers shall be provided for each main power transformer. Main Power transformers with 100 MW of generation connected to it shall be rated for 2000 Amps. Main Power transformers with 150 MW of generation connected to it shall be rated for 3000 Amps unless the Engineer of record determines that a higher rating is required to meet the interconnect agreement reactive power requirements at the point of interconnect.

(d) Substations with two main power transformers shall include a medium voltage bus tie circuit breaker. Bus tie breakers shall be rated for the same ampacity as the medium voltage main breakers.

(e) Grounding breakers are not allowed as a form of grounding a feeder following disconnection of the feeder from the substation (feeder breaker opening) and shall not be used. Grounding transformers must be included (when required) to ground a feeder following the feeder breaker opening.

(f) Feeder breaker naming convention shall be as follows:

1. Bus 1: 311 to 319

2. Bus 2: 321 to 329

(4) Circuit breakers shall contain bushing current transformers for metering and/or protective relaying applications. Current transformers utilized for metering shall be provided with accuracy levels as required by the applicable metering standards of entities which will be installing metering within the station. Current transformers shall be selected for appropriate burden support during fault conditions for Project's application as well as for thermal ratings that do not limit the Project capacity output.

(a) When the highest level of metering accuracy is required, "High Accuracy, Extended Range Class 0.15" current transformers may be utilized. This means that from 1 percent of nominal current through the rating factor, accuracy is guaranteed to be ±0.15 percent. Use of the current transformer rating factor and meters that accept current inputs from 10 Amps to 20 Amps may also be used to achieve the Project requirements.

(5) Circuit breaker mounting provisions shall be formed-steel supports that mount the breaker to a foundation and provide height adjustment.

(6) The low-voltage compartment of the circuit breakers shall contain the control components and operating mechanism including anti-condensation heaters.

(7) The stored energy mechanism shall drive a common shaft which operates all three phases and the auxiliary switches for breaker position contacts.

(8) The. control enclosure shall contain the relays, meters, and switches for the breakers.

(9) The minimum continuous current rating used for transmission circuit breakers shall be 1200A for 230 KV and below and 2000A for 345 KV. The minimum continuous current rating for 34.5 KV feeder circuit breakers shall be 1200 Amps.

(10) All circuit breakers shall be sourced from one of the approved suppliers in Exhibit A.3 (Approved suppliers).

6.1.17 Requirements for voltage transformers:

(1) All voltage transformers shall be connected through an indoor, panel mounted, voltage injection test facility (test switch). Each voltage transformer neutral shall be brought through into the control building for termination and single point grounding within the associated protection relay panel.

(2) All voltage transformers shall be a 2 or 3 winding, 0.3 class unit minimum, suitable for outdoor installation. Turn ratios shall be determined by Contractor. The units shall be suitable for revenue metering and relaying accuracy as required.

(3) Capacitive Coupled Voltage Transformers ("**CCVT**") shall have the facility for grounding through an external grounding switch.

(4) Outdoor potential transformers connected to the collection system bus must be suitable for use on renewable applications including the ability to withstand frequent reactive power switching events (turning capacitor or reactor banks on and off) causing transient overvoltage conditions.

(a) Potential transformers shall meet the following standards, at a minimum:

1. IEEE C57.13-2016 – IEEE Standard Requirements for Instrument Transformers.

2. IEC 61869-3, Clause 7.2.3 – IEC standard – Instrument transformers – Part 3: Additional requirement for inductive voltage transformers.

3. CAN/CSA 411.1, Clause 6.6 – CSA standard for AC suspension insulators, clause 6.6 - requirements for basic impulse and fast impulse transient withstand.

(5) All voltage and outdoor potential transformers shall be sourced from one of the approved suppliers in Exhibit A.3 (*Approved suppliers*).

6.1.18 Requirements for current transformers:

(1) All current transformers shall be connected through an indoor, panel mounted, current injection test facility (test switch). Each current transformer neutral shall be brought through into the control building for termination and single point grounding within the associated protection relay panel.

(2) The facility for short circuiting the secondary tails of all current transformers, with removable links, must be provided. All current transformers are to be connected through an indoor, panel mounted current injection test facility (test switch).

(3) All current transformers shall be sourced from one of the approved suppliers in Exhibit A.3 (*Approved suppliers*).

6.1.19 Requirements for disconnect switches:

(1) High-side line disconnect switches: motor operated.

(2) High-side breaker disconnect switches: 3-phase gang, manually operated (hand crank).

(3) Low-side bus disconnect switches: 3-phase gang, manually operated (hand crank).

(4) Low-side breaker disconnect switches (includes all feeder breakers, reactors, capacitor banks, and/or grounding transformers as applicable): 3-phase gang, manually operated (hand crank).

(5) Low-side feeder disconnect switches: hook stick.

(6) Bus-tie disconnect switches (if used): 3-phase gang, manually operated (hand crank).

(7) All switches shall be suitable for outdoor use and shall be non-load break type.

(8) All motor-operated switches shall include contacts and interlocks wired for protection and control with provisions for padlocking for personnel safety and maintenance. All switches shall have hard-wired interlocks and shall be designed and implemented to prevent operation in an undesired state.

(9) The minimum continuous current rating used for transmission disconnect switches shall be 1200A for 230 KV and below and 2000A for 345 KV. The minimum continuous current rating for 34.5 KV feeder disconnect switches shall be 1200 Amps. The minimum continuous current rating for 34.5 KV main and tie switches shall be the 34.5 KV main bus continuous current rating.

(10) All disconnect switches shall be sourced from one of the approved suppliers in Exhibit A.3 (*Approved Suppliers*).

6.1.20 Requirements for grounding transformers:

(1) Grounding transformers (if required) shall be sized per the System Transient Temporary Overvoltage Report to effectively ground the portion of the Collection System Circuit that is disconnected from the main Project Substation 34.5-kV bus when the Project Substation feeder or collector breaker is open.

(2) The duration of time that the grounding transformer shall provide effective grounding shall be determined assuming that the Collection System Circuit was at full rated generation at the time when a fault condition occurs on the Collection System Circuit, the time required for the collector breaker to trip due to the fault condition, and the additional time that the generation on the Collection System Circuit continue to contribute energy to the fault after the collector breaker opens.

(3) Effective grounding shall be as defined in IEEE Standard 142 and meet the following two conditions, at a minimum:

(a) The positive sequence reactance is greater than the zero sequence resistance (X1 > R0)

(b) The zero sequence reactance is less than or equal to three (3) times the positive sequence reactance (X0 <= 3X1).

(4) All grounding transformers shall have the same KVA rating and shall be interchangeable.

(5) All grounding transformers shall be sourced from one of the approved suppliers in Exhibit A.3 (*Approved Suppliers*).

6.1.21 Requirements for reactive compensation devices: [if needed]

(1) Reactive compensation devices, including capacitor banks and/or reactors, shall be sized and incorporated into the Project electrical design to comply with the Requirements, including the Interconnection Agreement.

(2) Capacitor banks shall be sized so that the change in voltage at the point of interconnect does not cause a voltage increase or decrease that is objectionable (e.g., causes voltage oscillation). Capacitor bank switching shall utilize capacitor switchers with pre-insertion resistors. Interrupting breakers shall be installed between the bus and capacitor switchers.

(3) Reactors shall be sized so that the change in voltage at the POI does not cause a voltage increase or decrease with switching that is objectionable (e.g., causes voltage oscillation). Care shall be taken to minimize induced magnetic coupling currents into structures and adjacent equipment.

(4) Any reactive power compensation devices required for the Project shall be provided on the low side of the main power transformer, unless otherwise explicitly required by the Transmission Provider Requirements and approved by Owner.

6.1.22 Requirements for space heaters:

(1) Breakers and other outdoor equipment shall be furnished with space heaters (if not already provided by manufacturer of the equipment) that are thermostatically controlled and shall be rated single phase 240V for operation on 120V and shall include personnel protection screens.

6.1.23 Requirements for surge arresters:

(1) High-side voltage surge arresters shall meet the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation. Surge arresters shall be provided on the high-voltage bushings of the main step-up transformer and on the interconnection side of the motor-operated disconnect switch in the Project Substation.

(2) 34.5-kV surge arresters shall meet the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation. Surge arresters shall be provided at the 34.5 kV capacitor switchers and at each feeder disconnect switch.

(3) Equipment surge arresters shall be station class, metal-oxide type surge arresters for outdoor use and polymer housing. Surge arresters shall be shatterproof.

(4) Surge arresters shall not be used as rigid bus supports.

6.1.24 Requirements for rigid bus:

(1) Design of the bus systems shall be in accordance with IEEE 605, at a minimum.

(2) Loading and seismic performance shall be in accordance with the Project design and Project Site location. Such information is subject to verification by Contractor.

(3) Rigid bus, at a minimum, shall be seamless, Schedule 40 tube made of 6063-T6 aluminum alloy fabricated per ASTM B241. All channel bus shall be aluminum integral web channel bus (IWCB) conductor, No. 2EC-T61 Alloy.

(4) A damping conductor shall be furnished in all horizontal bus.

(5) Bus shall have 0.25-inch drain holes in all bus/fittings that could possibly trap water.

(6) Station post insulators shall be of sufficient strength to support the rigid bus and shall be ANSI 70 gray color.

(7) Filler Metal: Type ER4043 filler metal shall be used for all aluminum welding, except for those isolated cases where the base metal is a type other than 356, 6061, or 6063.

(8) Phasing shall be sequential with phase B in the center.

6.1.25 Requirements for connectors and fittings:

(1) Connectors and fittings shall be of the proper size and design to assure permanent, secure, and low-resistance connections.

(2) Rigid bus connections to transformers, breakers, CCVTs, or freestanding current transformers are prohibited.

(3) For electrical pad connections, stainless steel hex-bolts, hex-nuts, flat washers, and Belleville washers shall be provided. Belleville washers shall have a minimum compression rating of 4,000 pounds. Bolt lengths shall be sized to provide minimal projection beyond hex nut to prevent excessive noise due to corona, but entire hex nut must be engaged.

(4) For copper to aluminum connections, stainless steel bolts shall be used for copper to aluminum bar or rod connections and faced or sleeved aluminum connectors shall be used for cable connections.

(5) All connections between stranded aluminum or ACSR-type conductors and equipment stud terminals shall be made with a stud-to-pad type stud connector and a compression-type cable-to-pad type conductor termination.

(6) All dead-end fittings, terminals, splices, and other similar items for ACSR and other types of stranded aluminum conductor shall be tubular compression type fittings. In no case shall any type of stranded aluminum conductors be used with bolted or clamp-type fittings, except for through-type connections to surge arresters on transformers. At least five percent (5%) extra dead-end body filler plugs for each type used shall be provided.

(7) Stranded and tubular copper bus work, where used, shall have connectors and fittings with a minimum of four (4) bolts or two (2) "U"-bolts on each side of each joint.

(8) Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

(9) Fittings for shield wire dead ends, splices, and taps shall conform to the following:

(a) Shield wire dead-end fittings shall be compression type with bolted jumper connection. Shield wire insulators shall be located as indicated.

(b) Compression sleeves for shield wire tension splices shall be used which will develop at least ninety percent (90%) of shield wire strength.

(10) Bus support clamps for rigid bus shall be fixed or slip type as required to firmly support the bus but allow for temperature expansion and contraction.

(11) Bolted ground connectors and flexible type grounding jumpers shall be provided for operating handles of disconnect switches.

(12) All transformer and oil circuit breaker stud connectors shall be tinned bronze material.

(13) All grounding connectors in contact with galvanized structures shall be tinned bronze material.

(14) All compression tees are to be open type compression run and 4-hole NEMA pad tap.

(15) Bundled jumpers from power circuit breakers to disconnect switches shall be furnished.

(16) For disconnect switch connections, NEMA-type terminal pad connectors shall be provided with at least four (4) bolts.

(17) All materials furnished shall have mechanical and electrical ratings, types, sizes, and other similar items coordinated with adjacent hardware and fittings.

(18) All hardware furnished shall be static-free type.

(19) Ground jumpers shall be provided direct from switch-operator ground pad to ground connector on operating handle or mechanism of switch. No other ground connection is to be made to pad. Ground mat(s) shall be furnished at each switch-operator.

(20) Bus grounding stud, welded or swaged, shall be furnished as indicated and at a minimum be provided on both sides of repairable equipment.

(21) .

(22) Wire guides and bundle conductor spacers shall be provided as required and indicated to maintain adequate clearance and support on cable jumpers, connections, and overhead lines.

(23) All current carrying aluminum connections shall be thoroughly cleaned, coated and sealed with an oxide inhibiting agent. Aluminum oxide, which is a poor electrical conductor, forms rapidly on the surface of drawn or rolled aluminum. It must be removed and prevented from reforming after the connection is completed. This applies to all connections, whether bolted, clamp or compression type. Caution - Aluminum expands approximately 30 percent (1.33 times) more than copper. Every connection involving a combination of aluminum and copper must be planned to avoid gradual loosening caused by large temperature changes. Unequal expansion of aluminum, copper and steel can cause extremely high pressure during hot conditions which stretches one or more of the metals leaving a loose connection when cold conditions occur.

(a) Bolted electrical connections shall be made on flat contact surfaces, completely cleaned with an oxidation inhibitor. This must be done by thoroughly scratching-brushing the contact surfaces through the inhibitor, leaving enough of it on the surface to control reformation of oxides. After the connection is completed, additional compound shall be applied and forced into every irregularity and opening in order to completely seal the joint against moisture and corrosion.

(b) Aluminum to aluminum connections shall be fastened with aluminum bolts, 2024-T4 alloy with No. 205 alumalite finish and preferably NO-OX-ID coated. Nuts shall be of the same alloy and finish. Heavy series bolts and nuts (7/8-inch across flats) are preferred.

(c) Aluminum to copper connections shall be made only with flat contact surfaces. Dressing and sealing the connection with inhibitor is especially important where unlike metals are in contact. Care must be taken to place the aluminum above copper when in a horizontal plane so that corrosive copper salts do not flow onto the aluminum. The type of bolt used is also important because extreme temperature changes can cause a loose joint due to the expansion differential between copper and aluminum. Aluminum or bronze bolts will be used as specified below: (a) Use aluminum bolts if thickness of the aluminum conductor is the same or greater than the copper conductor. (b) Use bronze bolts if the copper conductor is thicker than the aluminum.

(24) Cable terminations can be made with clamp, compression, and welded type fittings; preferably welded or compression types.

(25) All connections shall be torqued, as applicable, and in accordance with manufacturer’s recommendations and the design drawings.

6.1.26 Requirements for grounding system:

(1) The grounding system/grid shall be installed throughout the Project Substation, including at least three (3) feet outside the perimeter fence of the Project Substation and shall be bonded to the fence as required to meet acceptable levels of both touch and step potential and ground potential rise.

(2) The Project Substation grounding grid shall be designed in accordance with the methods and recommendations of IEEE 80 and using SES-CDEGS software or Owner-approved equal. The grounding system shall have adequate capacity to dissipate heat from ground current under the most severe conditions in areas of high ground fault current concentrations, with grid spacing such that safe voltage gradients are maintained. The short-circuit design rating for the Project Substation shall be based on the calculated maximum available fault current available at that location and take into account the future growth of the substation and power system.

(3) The Project Substation grounding system shall be an interconnected network of bare copper conductor and copper-clad ground rods. Ground wells and other grounding enhancements may be utilized if required. The system shall be designed such that Project Substation personnel are protected from the hazards that can occur as the Project Substation grounding system provides the earth return electrode during power system phase to ground faults.

(a) The ground grid shall not be interconnected with other facilities' grounding (e.g. O&M Building fencing). However, to the extent that other facilities may contribute to the electrical properties of the ground grid, such facilities shall be studied appropriately to quantify and understand their impact on overall grounding.

(4) Ground resistivity testing shall be performed *prior* to final design to determine ground analysis parameters. The ground resistivity shall be measured with the methods given in IEEE 81.

(5) Contractor shall provide ground potential rise ("**GPR**") calculations to support the local telephone provider design needs, if required.

(6) Ground conductor size shall be sized accordingly to specific ground conditions and equipment requirements but shall be a minimum of 4/0. Bare conductors to be installed below grade shall be spaced in a regular pattern that is consistent with the grounding analyses. Each junction of the grid shall be bonded together by an exothermic welding process. Above ground shall be NEMA two-hole connectors.

(7) Grounding connections shall be made to all fences and equipment (including support structures).

(a) The fence and the fence counterpoise (a conductor buried 3' beyond the substation fence) are both connected to the ground grid.

(b) All equipment must have provisions for grounding in accordance with OSHA codes. The ground grid shall be attached to equipment at two different points such as opposite corners of a transformer or each leg of a switch stand. The grid shall be bolted or welded to all steel structures and fence posts.

(c) At least two (2) grounding connections shall be included to the control building.

(8) Cable trench conductor grounding shall conform to the following:

(a) One 4/0 bare copper conductor shall be laid in all precast or direct burial cable trench. The ground conductor is required to protect control cables from stray ground currents or signals usually present in high voltage installations by equalizing the potential along the length of the cables.

(b) The trench ground conductor must be connected to the station grounding system at every intersection and at the ends of each trench. In the case of direct buried trenches, the ground conductor shall be incorporated into the system grounding design.

(9) Switch handle grounding on steel structures shall have the operating pipe be bonded to the steel using a flexible grounding jumper.

(10) Substation aggregate shall conform to ASTM C33, gradation 1.5 to No. 8 particles, and shall have minimum resistivity as modeled in the Project Substation step and touch potential study but no less than 3000 Ohm-m. A minimum depth of 4 inches of aggregate shall be installed and at least 2 feet beyond the Project Substation grounding grid.

(11) All grounding materials required shall be furnished new and undamaged.

(12) All clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be made of copper. Compression fittings below grade are prohibited. Above-ground fittings shall be DMC360 swage hydraulic compression type.

6.1.27 Requirements for wildlife protection:

(1) Outdoor bushings operating at 35 kV and below shall have protection installed on them to reduce the potential for phase to ground or phase to phase faults caused by wildlife getting near the area of the bushings. The protection shall be applied on equipment such as transformer bushings, surge arresters, circuit breakers, circuit switchers, auxiliary transformers, potential transformers, etc. The bushing protection shall include covers for conductors extending from the bushings.

(2) Each bushing protector shall have a minimum of two cable ties around it to ensure it stays in place.

6.1.28 Requirements for lightning protection:

(1) Lightning protection shall be designed in accordance with IEEE 998.

(2) All Project Substation electric equipment, electric bus, and support structures shall be shielded from direct lightning strikes. Shield masts and shield wires are the preferred methods of lightning shielding within substations. When economical, it is preferred to not have shield wires directly over bus. Overhead shield wires installed on the take-off towers and lightning masts may be provided for protection from direct lightning strikes. The lightning protection system shall be adequately tied into the Project Substation ground grid.

(3) Steel masts for direct stroke protection shall be round tapered seamless extruded or spun aluminum tubes.

(a) The overall height of the masts above grade shall be determined from the direct stroke protection study, as more particularly described under the Project Substation Electrical Studies herein.

(b) Masts shall have a single uniform taper from top to bottom.

(c) Each mast shall be capped with a suitable finial.

(d) Each mast shall be equipped with an internal chain vibration dampening device.

(e) Each lightning rod mounted onto the top of masts shall be a minimum of 3 inches in diameter and a maximum of 20 feet long.

(f) The design of masts shall have a safety factor of two (2) based on the allowable yield stress for the mast material in accordance with the latest ASCE specifications governing design of structures.

(g) The horizontal deflection at the top of each free-standing mast shall be limited to L/20 of its height above foundation.

(h) Each mast shall be installed on a concrete foundation with galvanized steel anchor bolts. Foundations, bolts, and welding shall be in accordance with the Requirements, including Section 4.0 (*Civil / Structural Works*) herein.

(i) Each mast shall be provided with two grounding pads located 12 inches above the foundation.

6.1.29 Requirements for lighting:

(1) A lighting system shall be furnished for the Project Substation. The lighting system shall provide personnel with illumination for Project Substation operation and maintenance under normal conditions and means of egress under emergency conditions. Dark sky lighting is recommended.

(2) The lighting system shall be designed in accordance with IES standards to provide acceptable illumination levels, including at all switching locations. Lighting levels shall meet, at a minimum, the requirements of the NESC, including Table 111-1 therein.

(3) Outdoor lighting shall be LED type. Lighting sources and fixture selections shall be based on the applicability of the luminaries for the area under consideration.

(4) Exterior lights at doors shall be connected to photocells.

(5) All lighting shall be operable via switches or contactors in the control building, including all exterior lighting.

6.1.30 Requirements for equipment labeling:

(1) All equipment labeling shall be done in accordance with Section 2.6.

6.1.31 Requirements for electrical equipment enclosures:

(1) All control cabinets, pull boxes, and electrical junction boxes shall be in accordance with NEMA standards and type number and shall be suitable for the Project location conditions, including corrosivity. Minimum design shall be:

(a) Indoor: NEMA 1

(b) Outdoor: NEMA 4

(2) All enclosures shall be provided with pad-locking provisions.

6.1.32 Requirements for battery system:

(1) Batteries shall be provided with racks, connection devices, tools, instruction books, protection shield covers, rail protection system, and other standard items. They shall also include redundant fans for the required ventilation. Such fans shall be installed directly above the location where batteries are to be installed.

(2) Battery charger requirements:

(a) One (1) fully-rated, self-cooled battery charger shall be installed and one (1) spare charger. The charger will be served from the Project Substation AC system.

(b) Project Substation battery chargers shall be $125V_{DC}$ output, sized as required for eight (8)-hour recharge (following a complete discharge) while serving continuous load.

(c) Chargers shall include an AC circuit breaker in the charger input circuit to provide a disconnect point and overcurrent protection. Chargers also shall include DC ammeters, DC voltmeters, AC power failure alarm relays, high/low DC voltage alarm relays, ground detection alarm relays, and battery temperature compensation systems which reduce the charge rate if necessary.

(d) Chargers shall maintain output voltage within plus or minus one-half percent (0.5%) from no load to full load, with an input power supply deviation in voltage level of plus or minus ten percent (10%) and an input power supply deviation in frequency of plus or minus five percent (5%).

(e) Chargers shall automatically vary the charging rate in accordance with the requirements of the Project Substation battery.

(f) Each battery charger-eliminator furnished shall be self-regulating, natural cooled, solid-state silicon controlled full wave rectifier type designed for single and parallel operation with the batteries specified under the Specifications. Charger shall be able to provide the DC load requirements in the event that battery is disconnected.

(g) Solid-state electronic circuits shall have AC and DC transient voltage protection and shall be designed to recharge a totally discharged battery without overloading and without causing an interrupting operation of AC or DC circuit breakers.

(h) Charger shall be a full capacity charger and shall have the capacity to recharge the battery in eight (8) hours following complete discharge. Charger shall also have an equalizing charge mode. Battery charger will be self-regulating after charging levels are manually selected. Battery charger shall be manufactured in NEMA 1 enclosures suitable for placement in an indoor, environmentally controlled atmosphere. Charger shall require only front access and will allow either top or bottom conduit/cable entry.

(3) Each battery cell shall be wet cell, lead-acid pasted plate-type with lead-calcium alloy plate grids or sealed type. Cell containers shall be sealed, clear, shock absorbing, heat resistant plastic, with electrolyte high and low-level markers and spray-proof vents. Batteries shall be manufactured for full float service with a high discharge rate, low deterioration rate, and low maintenance. Batteries shall be supplied complete with all accessories (e.g., battery rack, inter-cell connectors). Racks shall be a two (2)-step configuration.

(4) The DC panel and bolted breakers shall have a main bus current rating as required to supply the connected load. The continuous current ratings and interrupting ratings of the feeder breakers shall be based on the available fault current and the characteristics of the connected loads or the battery chargers.

(a) A 15-Amp, 125 V_{DC} feeder shall be installed from the DC panel board to the Owner-supplied network equipment. Contractor to coordination the installation of this equipment with Owner.

(5) The capacity of each battery shall be determined in accordance with IEEE 485 and the specifications herein. With the battery initially fully charged at the floating voltage specified, and with the battery chargers disconnected, the battery shall be capable of supplying the duty cycle specified. The ambient temperature during the duty cycle shall be 25°C.

(6) The duty cycle for battery sizing shall include (a) one (1) minute at the level of current required to operate all Project Substation circuit breakers plus the continuous load; (b) 478 minutes of continuous load (actual but not less than 15A); and (c) one (1) minute at the level of current required to operate all Project Substation circuit breakers plus the continuous load.

6.1.33 Requirements for raceway:

(1) Raceway shall conform, at a minimum, to the recommendations included in IEEE 525.

(2) Raceway that contains multiple cable circuits shall have all cables with identical insulation ratings.

(3) Individual raceway systems shall be established for the following services: (a) 600-volt control cable; (b) special electrical noise-sensitive circuits; and (c) fiber optic cable.

(4) Hot-dipped, rigid galvanized conduit (after fabrication) shall be used for above-ground power and control cables.

(5) Flexible conduits shall be used only at locations where vibration is required; the maximum contiguous length of flexible conduit shall be three (3) feet.

(6) All raceway and conduit locations shall be coordinated with other equipment and structures. All raceway and conduit shall be installed perpendicular or parallel to the major equipment and bus structures.

(7) All raceway and conduit shall be installed in a neat, rectangular form. Special attention shall be given to securing a neat appearance.

(8) All raceway materials required shall be furnished new and undamaged in accordance with the following requirements, at a minimum:

(a) Duct: polyvinyl chloride, Schedule 40 PVC in accordance with NEMA TC-2.

(b) Couplings: plastic, for use with duct previously specified and "duct-to-steel" adapters as required, including joint cement.

(c) Spacers: plastic high impact, interlocking, base and intermediate type

(d) Factory bends and sweeps: Schedule 40 PVC, three (3)-foot minimum radius.

(e) End bells: plastic.

(f) Plugs: plastic, high impact, tapered to fit end bell provided.

(g) Riser termination: rigid hot-dip galvanized mild-steel coupling.

(h) Riser bends: rigid steel conduit elbows, factory or field made, three (3)-foot minimum radius, 90 degree, entirely concrete encased below grade; hot-dip galvanized rigid mild steel in accordance with ANSI C80.1 and UL 6; the conduit interior and exterior surfaces having a continuous zinc coating with an overcoat of transparent enamel or transparent lacquer.

(i) Cables within the substation shall be routed through a cable trench system extending from the control enclosure to equipment located within the substation. The final route from the cable trench to the device shall be in schedule 40 PVC conduit for below grade portions of the conduit, and RGS conduit for bends / sweeps and above grade locations.

6.1.34 Requirements for metering:

(1) A facility check meter (SEL-735 Power Quality and Revenue Meter) shall be provided. Inputs to the meter shall include metering grade current transformers on the high side of each main transformer and voltage input from the high side coupling capacitor voltage transformer (CCVT).

(2) Contractor shall provide provisions for the interconnecting utilities metering (if required). Contractor shall coordinate with the interconnecting utility and owner as required to complete the installation of the metering system per the interconnecting utility requirements.

6.1.35 Requirements for protective relaying:

(1) Protective relaying shall provide secure and selective isolation of equipment when necessary during faults, abnormal or hazardous operating conditions.

(2) All relays shall be microprocessor-based and wired to a central communication processor with IRIG-B time stamping. The communication processor shall integrate all relaying.

(3) Relay panels shall be located in the Project Substation control building and shall include all hard-wired and soft-wired protection and control interlocks. Relay panels shall be installed in the control building.

(4) Relays that monitor electrical lines shall be configured to have the fault distance displayed when an event occurs. Aliases in the relays should be labeled for easier troubleshooting.

(5) Protective relaying design and equipment selection shall be provided in accordance with the Requirements, including, but not limited to, the Applicable Standards and prudent electrical industry practices.

(6) All protection device settings shall be provided for Owner's review no later than 60 days prior to the system energization date.

(7) Programming of devices shall be provided in electronic format straight from the device.

(8) Owner will review and approve the final design prior to procurement of equipment.

(9) The local utility shall require review and confirm line protection, metering (if required), and signal exchange requirements. Owner shall facilitate such reviews.

(10) Protection shall be provided for all breakers, bus, transformers, 34.5-kV lines, high-side lines, capacitors, and inductors.

(11) The relaying schemes shall monitor and respond to over-currents, phase faults, ground faults, and other system abnormalities. Protection schemes to be utilized shall include, but not be limited to, line impedance/differential, bus differential, transformer differential, breaker failure, backup relaying, switch into fault, and sync check.

(12) Annunciation and alarms shall be communicated to the Operator through an RTU that will signal loss of protection integrity including, but not limited to, coil monitoring, loss of tripping power, gas pressure, relay failure, and other similar items.

(13) High-side lines shall include primary and backup relaying.

(14) Main step-up transformer protection shall include primary and backup relaying and monitor for oil and winding temperature.

(15) Observe IEEE 1050 for protective instrument grounding.

(16) All relays shall have digital read-out on the front. The following relays should be used unless the interconnecting utility requirements differ:

(a) [TBD]-kV Interconnection Line

1. Line Differential: SEL-411L

2. Line Distance: SEL-311C

(b) [TBD]/34.5 kV Transformer

1. Transformer Differential Primary: SEL-487E Transformer

2. Differential Secondary: SEL-387A

(c) 34.5kV Transformer Breaker Failure: SEL-351S

(d) 34.5kV Feeders

1. Feeder Protection: SEL-351S

(e) 34.5kV Bus

1. Bus Differential: SEL-487B

(f) 34.5kV Capacitor Bank or Reactor Bank (if required)

1. Overcurrent and voltage: SEL 487V

2. Voltage: 34,500V

6.1.36 Requirements for control building:

(1) The control building shall be a new, prefabricated, weatherproof, climate-controlled building containing protective relaying and control, communications systems equipment and cable management systems (i.e. cable trays). All electrical equipment shall be installed and pre-wired in the building prior to shipment.

(2) The control building shall be a minimum of 14 feet by 40 feet.

(3) The control building shall be located within the fenced area of the Project Substation with sufficient clearance on all sides and shall be located near the entrance gate.

(4) The control building shall be grounded in accordance with Section 6.1.26.

(5) The control building shall contain a data concentrator and communications processor to collect Project Substation data signals for facility use.

(6) The control building shall include adequate space and clearance for the following equipment, at a minimum:

(a) Any Equipment supplier-furnished Communications System equipment

(b) Owner-supplied equipment

(c) Relay and control panels (panels shall be configured to optimize panel space, with up to three relays on a single panel)

(d) Fiber patch panels & other communication equipment

(e) Field termination cabinets

(f) Station service equipment, including AC panel boards and automatic transfer switches

(g) DC panel boards, batteries, and battery chargers

(h) Eye wash station located immediately adjacent to the battery chargers

(i) Lighting contactor for control of substation lighting

(j) HVAC equipment

(k) Interior and exterior lights and receptacles, including exterior receptacles for servicing HVAC units and emergency lighting.

(l) Small desk for operators

(m) Hot-stick

(n) Fire extinguisher at each exit door

(7) Local user controls shall be included that are capable of overriding the controller if required for any reason. Local controls, including monitoring screens and keyboards, shall be placed in the control building.

(8) A ground bus shall be provided in the control building to provide grounding for all control, SCADA, and AC and DC panels.

(9) Building alarms such as fire alarms, intrusion alarms, and temperature alarms shall be submitted for Owner's review and approval.

(10) The control building shall include two (2) doors, each with panic hardware, on opposite sides of the building for ingress and egress. One door shall have a minimum width of 72 inches to facilitate the movement of equipment.

(11) The control building shall include a small desk for Owner's operator use. A standard electrical outlet shall be provided near the location of the desk for device charging as well as a 2-gang electrical box with a single gang cover with 3/4-inch conduit routed to the cable tray to allow for Owner's future internet installation.

(12) Cell phone boosters shall be included in the control building.

(13) Control building roof:

(a) The roof system shall include a 20-year warranty on material and weather tightness, and shall carry a UL Class 90 listing in accordance with UL 580.

(b) The roof covering shall include exposed metal roof panels of 12 gauge (minimum) commercially pure aluminum coated steel, "Galvalume", or coated steel (Galvanneal) with a color finish. As a minimum, base metal panels shall conform to the physical requirements of ASTM A446, Grade B. Panels shall be of such configuration to provide the load carrying capability and meet the deflection requirements specified herein. The coating shall have a 20-year warranty against rust perforation, a 20-year warranty against fading and chalking, and a 25-year warranty against flaking and peeling. Exterior color finish of roof, walls, doors shall be tan in color. Paint samples to be submitted for Owner approval.

(c) Roof panels shall be "standing-seam interlocking" design and shall be secured to the roof purlins with a concealed structural fastening system. The concealed system shall provide minimal through penetration of the roof surface and allow the roof covering to move independently of any differential thermal movement by the structural framing system. Except at the concealed fastener, there shall be no thermal contact between the roof panels and supporting purlin. The standing seams shall have a factory-applied, non-hardening sealant.

(d) Roof covering shall be properly designed with a sealing system provided at all roof and wall seams to provide a watertight building. The ridge, eaves, and openings together with necessary fascia and trim shall be caulked and sealed to provide a weather tight system.

(e) Properly sized attic space ventilation shall be provided. All attic openings shall be screened to prevent entrance of bees, large insects, or birds.

(14) Control building exterior walls:

(a) The exterior walls shall be comprised of galvanized steel panels with a PVDF resin-based finish. Exterior siding panels shall be overlapped and installed with appropriate self-tapping fasteners with integral gaskets and shall be removable without any disturbance to internal panels. The wall covering shall include a minimum 15-year warranty on paint. As a minimum, the panels shall be galvanized according to ASTM A525, coating designation G90.

(b) Manufacturer's standard exterior base flashing shall be provided with the building. Material shall be zinc-coated steel conforming to ASTM A446, Grade B and ASTM A525, coating designation G90. Flashing shall be manufacturer's standard white in color, and have a baked silicon polyester (or equivalent) enamel coating.

(c) Butted seams are not allowed.

(d) All openings in the walls are to be structurally framed, sleeved, trimmed, and provided with external drip caps.

(e) Repair or replacement of external panels must be able to be done entirely from the exterior of the control building structure.

(15) Control building interior walls:

(a) The control building interior walls shall be lined with flush-fit with a minimum of 16 gauge, roll-formed liner panels. Liners shall be zinc-coated steel conforming to ASTM A446, Grade B and ASTM A525, coating designation G90. Liners shall be provided with base and ceiling trim. Panels shall be manufacturer's standard white in color, and have a baked silicon polyester (or equivalent) enamel coating.

(b) Liner panels shall be fully reinforced with concealed fasteners.

(c) The control building interior shall feature a complete trim system, including base, jamb, header, and ceiling trim.

(16) Control building floor:

(a) The control building floor shall have a hot-rolled welded steel framework, comprised of hot-rolled steel or steel tube supports with a maximum deflection of L/240 under required loads. Cold formed joists shall be sized and spaced to meet design loads. The steel framework shall be supported on concrete piers, spacing, anchorage requirements, and layout to be indicated by the building designer. Steel floor members shall be hot-rolled steel that meets a minimum standard ASTM-A36. All galvanized steel shall meet ASTM-A653.

(b) Steel floor shall be a welded steel top surface of at least ¼" thickness to handle floor design loads with a maximum deflection of L/240. The floor shall have a painted, slip-resistant finish. The bottom of the floor shall have a rodent and moisture barrier of recessed 26-gauge sheet galvanized steel. Floor welding standards shall meet all AWS recommended practices.

(c) The floor framework and floor deck plates shall be fully cleaned, primed, and painted with a self-priming coating system designed to provide a durable finish, suitable for heavy resistance to fading. Paint is to have a minimum Dry Film Thickness per coat of 3-5 mils. Color is to be ANSI 61. A non-slip texture shall be added to the paint.

(17) Control building insulation:

(a) Floor shall be insulated with fiberglass batt insulation between the joists and rigid polystyrene insulation between joists and fully hot-dipped steel rodent and insect barrier. The insulation shall be at least R-13 for the floors and walls and R-19 for the roof, or a higher specific insulation value called out in applicable state and local codes. The entire Electrical Equipment Enclosure shall be insulated to thermal transmittance value of no more than 0.05 for walls and 0.03 for roofs when tested in accordance with ASTM C236.

(18) Control building exterior doors:

(a) There shall be two doors in the control building, at least one of which is a 72-inch wide double door to facilitate the installation of equipment. Both doors shall have the same access key. Enclosure doors shall comply with Steel Door Institute directive SDI-100 and SDI-107. Doors shall have an insulated core and be constructed of no less than 18-gage steel-faced leafs with stiffeners and 16-gauge door frames. Doors and frames are to be hot-dipped galvanized to ASTM-A294 and ASTM-A653, then factory primed and painted with epoxy enamel to match the enclosure or trim.

(b) There shall be three stainless steel ball bearing hinges per door.

(c) A drip cap shall be provided on the exterior top and bottom of each door.

(d) Each door shall have Sergeant 2828F low-profile rim device type panic interior openers, with cylinder lock keyed entry and thumb latch exterior.

(e) A door closer with hold open arm shall be installed on each door.

(f) Shock absorbing restraints shall be provided on the doors to prevent damage from high wind conditions.

(19) Control building HVAC:

(a) At least one (1) unit shall be installed on each end of the control building. HVAC equipment size shall be based on maintaining an interior temperature range of 60-80 degrees F, taking into consideration the heat load of present and future equipment and the site conditions. HVAC equipment shall consist of self-contained wall mount units, complete with supply and return grilles, lockable circuit breaker or disconnect switch, manual thermostat, barometric fresh air damper, and a disposable air filter. The following controls shall be supplied: high-pressure controls, low pressure controls, low ambient control, compressor anti-cycle relay, and alarm relay.

(20) Control building lighting:

(a) Exterior lights shall be provided above each personnel door and shall be connected to photocells for automatic dusk to dawn control. Exterior lights shall be suitable for use in wet locations.

(b) A lighting contactor located in control enclosure shall be utilized for control of the substation lighting.

(c) Control enclosure interior lighting shall be in accordance with accepted industry standards and practices. The National Electric Safety Code (ANSI C2) shall be followed in all cases. Sufficient lighting is required for safe operation and testing in front and back of all control panels.

(d) Emergency lighting shall be a self-contained battery powered unit with two directionally adjustable illuminating heads. The units shall switch on automatically upon loss of AC power and provide 1.5 hours of continuous illumination, and then turn off automatically and recharge when AC power is restored.

(e) Lighting shall be LED (Light Emitting Diode) type.

6.1.37 Requirements for fire protection:

(1) Substation fire protection designs shall be in accordance with accepted industry standards and practices. IEEE 979 Guide for Substation Fire Protection shall be consulted for new facilities.

(2) Protective firewalls or barriers should be considered whenever clearances from IEEE 979 cannot be achieved.

6.1.38 Requirements for Project Substation meteorological tower:

(1) The meteorological tower shall be a 20-foot self-supporting base hinged unit designed for an 80-mph minimum wind load and installed according to the manufacturers specification. Tower shall be Great Plains Towers model number DT/MHP20’/6 or engineer approved equal. Tower shall be installed onto a concrete pier foundation.

(2) Meteorological tower designs, including foundation design, shall be approved by Owner prior to procurement of such equipment or materials.

(3) Sufficient grounding and lightning protection per IEC 61400-12 shall be installed on all meteorological towers, including lightning finials.

(4) Each Project Substation meteorological tower shall include the following instruments as specified below, or Owner-approved equal:

(a) One (1) cup anemometer near tower height.

(b) One (1) wind direction sensor near tower height. Sensor shall be MetOne 020C or NRG #200P, respectively.

(c) One (1) temperature / relative humidity sensor with radiation shields near tower base. Sensor shall be MetOne 597 or Vaisala HMP60A.

(d) One (1) barometric pressure sensor near tower base. Sensor shall be MetOne 092 or Vaisala PTB 110.

(e) One (1) precipitation sensor. Sensor shall be Campbell Scientific 237-L above control enclosure height.

(5) Each Project Substation meteorological tower shall include the following auxiliary equipment as specified below, or Owner-approved equal:

(a) One (1) NEMA 4X fiberglass enclosure for data logger.

(b) One (1) data logger. Each shall be Campbell Scientific, model CR3000.

(c) Signal surge protection terminals. Each shall be Phoenix Contact, type Termitrab 24V.

(6) Each permanent meteorological tower shall include the following other equipment:

(a) Grounding and lightning protection, including lightning finial.

(b) Cabling.

(7) All anemometers shall be type “first class”, heated sensors. All anemometers shall be calibrated in accordance with MEASNET’s Anemometer Calibration Procedure and performed by a MEASNET-certified organization.

(8) Requirements for communications:

(a) Meteorological towers shall be connected to, and communicate with, the Communications System and allow data recording and storage through the data archival features of the Communications System.

(9) Requirements for power:

(a) Permanent power supply for the meteorological tower shall be taken from the substation control building (but not from the backup battery bank in the control building).

(b) Project Substation meteorological tower shall be capable of operation (and data storage) through a power outage for a minimum of seven (7) days through a battery backup or UPS separate from the backup battery bank in the control building.

6.2 Submittals

6.2.1 Contractor shall prepare the Project Substation design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) general arrangement plan and physical layout diagrams; (c) civil works drawings, including subgrade preparation, grading, drainage, and erosion control; (d) protection and control system designs and philosophies; (e) one-line diagrams, three-line diagrams, and wiring diagrams, including A/C and D/C schematics. One-line and three-line diagrams shall include all transformer tap position settings required to comply with the NERC studies for the site; (f) communications block diagram, including all Communications System equipment, Owner-Supplied Equipment, and utility equipment; (g) Communications System details, including logic descriptions, points lists, rack layout diagrams, HMI screen development, and fiber termination diagrams; (h) cable specifications and arrangements; (i) conduit and cable schedules; (j) panel schedules; (k) loop drawings; (l) elevation drawings; (m) connector and fitting details; (n) structural design documents, including foundation plans and details (with structural calculations to be provided with each set of foundation drawings); shop drawings showing fabrication of structural-steel components; details of cuts, connections, splices, camber, holes, and other pertinent data; indication of welds by standard AWS symbols, distinguishing between shop and field welds, and showing size, length, and type of each weld; indication of type, size, and length of bolts, distinguishing between shop and field bolts; mill test reports and structural steel properties, including chemical and physical; and fastener properties (mechanical/chemical), including bolts, nuts, and washers, and indicating coatings used to satisfy anchor bolt protection plan; (o) ground grid plans; (p) metering and relaying diagrams. Metering and relaying diagrams shall include all transformer tap position settings required to comply with the NERC studies for the site; (q) conduit and trough plans; (r) fencing and gate details; (s) control building drawings; (t) drawing index; (u) bill of materials; and (v) inspection, testing, and quality control requirements.

6.2.2 Contractor shall prepare a set of studies and analyses for the Project (collectively, the "**Project Substation Electrical Studies**") to demonstrate the adequacy of the proposed electrical system design, including any studies and analyses that may be necessary to ensure compliance with the Requirements, including the Applicable Standards or utility requirements. The Project Substation Electrical Studies shall be submitted to Owner for review *prior* to the procurement of the applicable major Equipment. The following shall be included in the Project Substation Electrical Studies, at a minimum:

(1) Substation Grounding Report: grounding system study of ground grid conductors and interconnection (if any) with the ground grid. The study shall confirm that the grounding system maintains touch and step voltages within tolerable limits, and shall be prepared in accordance with the procedures, data, and recommendations given in IEEE 80. The study shall determine the ground potential rise with respect to remote earth.

(2) Substation Short Circuit Report: Calculation of the fault currents in the substation including a study of the main power transformer neutral grounding reactor ("**NGR**") sizing to reduce the single line to ground fault current.

(3) Substation AC System Study: calculation of the capacity of the low-voltage AC systems in the Project Substation to determine the size of station service load.

(4) Substation DC System Study: calculation of the capacity of the batteries and chargers within the Project Substation with the DC service required for the equipment at the substation, as determined from a load profile developed for all DC loads. The study shall determine if the minimum voltages are maintained as specified and required by equipment vendors. The DC system shall be sized to accommodate future loads for ultimate switchyard configuration.

(5) Substation Bus Ampacity Study: calculation of bus ampacity in the Project Substation based upon continuous current rating as given on the one-line diagram and Project Site-specific conditions.

(6) Substation Bus Structural Analysis Study: analysis of bus structural design in the Project Substation including bus, insulators, bus structures, and foundations, and based upon the most stringent combination of wind, fault current, and ice load factors, as defined in the Applicable Standards and other applicable Requirements.

(7) Substation Bus Design Study: analysis of the performance of the buses, disconnect switches, and separately-mounted current transformers within the Project Substation to confirm that the ampacity, structural integrity, vibration, and required mechanical and electrical ratings are in accordance with the methods and recommendations of IEEE 605. Bus design, including gust factor, exposure height factor, importance factor, and corona considerations, shall be in accordance with the procedures and data given in IEEE 605.

(8) Substation Lighting Study: lighting illumination calculations for the Substation to determine the illumination levels within the new substation that will be achieved with added luminaires.

(9) Substation Lightning Study: direct stroke protection analysis for lightning at the Project Substation based upon Project Site-specific determinations for thunderstorm days, thunderstorm duration, isokeraunic levels, exposure, and other similar factors. The direct stroke protection system design shall include analysis using the rolling sphere method of the electrogeometric model given in IEEE 998. The direct stroke protection system design shall be in accordance with the procedures, data, and methods given in IEEE 998.

(10) Arc Flash Study: see requirements in Section 5.2.2(12).

(11) Protection Coordination Study: relay and protection equipment coordination study, including detailed calculations, one-line and three-line diagrams, fuse curves, coordination curves, protected equipment data, and relay set points. This study shall include the major Equipment (including switchgear), Collection System Circuits, Project Substation, and Interconnection Line. A narrative philosophy statement shall be submitted for comment before completing the coordination study, and the proposed settings for the Solar / BESS / Wind Turbine protection equipment shall be delivered to supplier for implementation *prior* to energization.

6.2.3 Contractor shall prepare a set of studies and forms for the Project (collectively, the "**NERC Compliance Studies**") to meet NERC Regulatory Standard Requirements. The NERC Compliance Studies shall contain all studies summarized in Table 6-3, at a minimum.

(1) For each project, Contractor is to review the required NERC compliance studies with Owner against NERC requirements and Xcel XES 7.405 and XCEL NERC compliance standard XES 2.800A01 NERC standards compliance matrix.

Table 6-3: Summary of Requirements for NERC Compliance Studies

Requirement	Timing
COM-001-3, R11	Before energization
COM-002-4, R3, R6	Before energization
CIP-002-5.1a	Before energization

Requirement	Timing
CIP-003-8, R1.2.1, R1.2.2, R1.2.4, R1.2.5, R2	Before energization
CIP-004-6, R2	Before energization
EOP-004-4 R1, R2,	Before energization
FAC-008-3 R1	At Engineer of Record 90% Design Submittal
FAC-008-3 R2	At Engineer of Record 90% Design Submittal
FAC-008-3 R6	At Engineer of Record 90% Design Submittal
FAC-008-3 R7,R8	At Engineer of Record 90% Design Submittal
PRC-027-1	At Engineer of Record 60% Design Submittal
PRC-005-6 R1, R3, R5	Two weeks prior to Commercial Operation
TOP-001-4, R3-R6	Before energization
PRC-004-5(i)R1-R6	Within 30 days after energization
PRC-004-WECC-2, R1-R3	Within 30 days after energization
PRC-019-2 R1, R2	At Engineer of Record 60% Design Submittal
PRC-024-2 R1 – R4	At Engineer of Record 60% Design Submittal
PRC-025-2 R1	At Engineer of Record 60% Design Submittal
VAR-002-4.1 R2.1-R2.3, R3-R6	Within 30 days after energization
VAR-501—WECC-3.1, R1-R5	Within 30 days after energization
EOP-005-3 R11-R16	4-12 months after energization
FAC-001-3 R2, R4	4-12 months after energization
FAC-002-2 R2	4-12 months after energization
FAC-003-4	4-12 months after energization
IRO-010-2	4-12 months after energization
MOD-025-2 R1-R2	2 months after substantial completion
MOD-026-1 R2-R5	2 months after substantial completion
MOD-027-1 R2-R4	2 months after substantial completion
MOD-032-1 R2, R3	4-12 months after energization
PRC-002-2	4-12 months after energization
PER-006-1 R1	4-12 months after energization
PRC-023-4 R1	4-12 months after energization
PRC-026-1 R1	4-12 months after energization
TOP-003-3 R5	4-12 months after energization
TPL-007-3 R6, R10	4-12 months after energization

6.2.4 Contractor shall prepare energization plans and procedures for the Project Substation. Energization plans shall be submitted to Owner for approval *prior* to use. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.

6.2.5 Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Project Substation. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

6.2.6 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials.

6.3 Project Substation

6.3.1 Contractor shall design, furnish, construct, and install one (1) 34.5/ [TBD]-kV Project Substation in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Project Substation configuration.

(2) Contractor shall install a disconnect switch between the high side of the main power transformer and the Point of Interconnection such that the Project can be isolated from the interconnecting utility's grid.

6.3.2 Contractor shall furnish all capacitor banks, reactors, and/or other reactive compensation equipment necessary for the Project.

6.3.3 Contractor shall furnish and install fencing and gates at the Project Substation.

(1) The Project Substation perimeter shall be fenced. The fence shall be tied into the Project Substation grounding grid.

(2) At least one (1) vehicle gate shall be installed at the Project Substation.

(3) At least one (1) pedestrian gate shall be installed at the Project Substation.

(4) Except as noted in the following paragraph, all fencing and gates shall comply with the minimum specifications in Section 4.1.10 herein.

(a) Project Substation fencing and gates should be a minimum of 10 feet high with 1-inch diamond mesh and no barbed wire.

(5) Contractor shall furnish and install a contact sign at the entrance to the Project Substation, as described in Section 2.6 herein.

(6) A minimum of six (6) inches of *washed* crushed aggregate shall cover the entire Project Substation footprint, including those areas reserved for future build-out, *plus* a minimum of three (3) feet outside the perimeter fence, to help reduce touch and step potentials. A greater level of washed crushed aggregate shall be installed if necessary to meet the Requirements and satisfy the recommendations set forth in the geotechnical engineering report. Any areas at the Project Substation to be utilized for traffic must be suitably compacted to support traffic loads.

6.3.4 Contractor shall furnish and install closed-circuit cameras at the Project Substation. Cameras shall be positioned to allow for monitoring of entry points and major Equipment.

6.3.5 Contractor shall be responsible for supplying all required main power transformers as specified in Exhibit D.6 (*Renewable Generation Main Power Transformer Specification),* offloading, assembling, and testing the transformer, and for completing all terminations, including, but not limited to, high-voltage terminations, medium-voltage terminations, low-voltage control and power terminations, and grounding connections.

6.3.6 Contractor shall furnish and install the revenue [check] meter(s).

6.3.7 Contractor shall furnish and install arc flash labels in accordance with Section 2.6.

6.3.8 For wind projects Contractor shall furnish, and install one (1) meteorological tower in the Project Substation.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe meteorological tower configuration.

(2) Project Substation meteorological tower shall be installed adjacent to the substation control building.

6.4 Testing and Quality Control

6.4.1 Contractor shall test, commission, start-up, and place into successful operation the Project Substation, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.

(1) All Project Substation equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA Acceptance Testing Standard (NETA ATS) tests with the exception of NETA ATS Optional tests unless they are specifically called out in this specification.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(5) Insulation testing of all installed cables.

(6) Point-to-point wiring checks of all installed wiring.

(7) After completion of wiring installation work, all circuits shall be tested for continuity, grounds, shorts. Documentation shall include highlighting or otherwise identifying each conductor verified on the AC three-line diagrams and schematics including the date verified and the authorized testing personnel’s signature that verified the installed wiring matches the drawing.

(8) Breaker function testing.

(9) PT/CT turns ratio and polarity testing.

(10) Breaker contact resistance testing.

(11) Ground resistance and continuity testing.

(12) Surge arrester testing.

(13) Instrument transformer testing.

(14) Ground grid testing.

(15) Relay functional testing.

(16) Disconnect switch testing.

(a) Commissioning of high voltage and medium voltage disconnect switches shall include the switch manufacturer's representative being at the Project Site to review the mechanical installation of the switch to confirm it is installed and adjusted properly. The switch manufacturer's representative is also required to review the electrical switch test records and confirm in writing that the switch is ready for energization prior to it being placed into service.

(b) Switch suitable for energization records to be supplied to the owner prior to switches being energized.

(17) Reactor / capacitor bank testing (if applicable).

(18) Control building testing.

(19) Minimum main step-up transformer testing:

(a) Commissioning testing of all connections (high voltage, medium voltage, low voltage power; current transformer; relay; control; instrumentation; and communication).

(b) On-load tap changer.

(c) AC power transfer switch.

(20) In the commissioning report, Contractor shall provide the following with respect to the transformer tap position settings:

(a) Confirmation that all transformer tap settings (generator or inverter step up, main power transformer, etc.), relay settings, and control system parameters match the engineer of record construction documents (issued for construction drawings, PRC-019, PRC-023, PRC-024, PRC-025, PRC-027, VAR-002 studies, Substation Electrical Studies, etc.).

(b) Confirms that transformer automatic tap changing systems are functioning properly including the On-Load Tap Changer for each main power transformer.

(c) Confirms transformer voltages are per NEMA / ANSI utilization voltage standard C84.1 (Electric Power Systems and Equipment – Voltage Ratings – 60 Hz) for transformers that provide power to utilization equipment.

(d) Confirms transformer voltages are correct per the manufacturer ratings, (issued for construction drawings, PRC-019, PRC-023, PRC-024, PRC-025, PRC-027, VAR-002 studies, reactive power flow study, reactive power Control Analysis study, arc-flash studies, etc.).

(21) Contractor to mark-up construction drawings and studies to document final, as-left transformer settings. All setting deviations from the issued for construction drawings or studies must be approved by the engineer of record and the owner prior to adjusting transformer tap positions.

(22) All Project Substation foundations shall be tested for concrete and grout properties (strength, slump, air content, temperature).

(23) Compaction.

6.4.2 Contractor testing plan shall be submitted to Owner for review and approval. Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

7.0 INTERCONNECTION LINE (IF APPLICABLE)

7.1 General Provisions

7.1.1 Contractor shall actively coordinate with Owner and any Owner representatives or contractors for the completion of the Project, including at any interfaces of the Interconnection Line including, but not limited to, sharing design drawings and studies, coordinating testing procedures, and attending meetings to discuss design implications and schedule of the work.

7.1.2 Contractor shall actively coordinate with Transmission Provider regarding any outages that may be required for the performance of the Work.

7.1.3 Contractor shall relocate, drop, or cross power lines as needed and as appropriate to complete the Work, with prior approval of the appropriate authority(ies). Contractor shall be responsible for obtaining and maintaining any necessary permits and / or easements for such work.

7.1.4 The Interconnection Line shall have a design working life of at least 50 years.

7.1.5 The Interconnection Line shall be designed and constructed to a high level of reliability and shall meet or exceed the requirements set forth by the interconnection utility.

7.1.6 Contractor shall design and construct the Interconnection Line in accordance with the Project Substation Electrical Studies and the Electrical Loss Limit, each as defined herein. In addition, contractor shall work with Owner at the design stage to evaluate options to reduce the transmission line losses by increasing the conductor size.

7.1.7 PLS-CADD software shall be utilized to spot and perform detailed analysis and design of the Interconnection Line. Copies of all PLS-CADD electronic design files shall be provided to Owner in final form at the conclusion of the Project. Copies of preliminary PLS-CADD electronic design files shall be provided to Owner with each preliminary design.

7.1.8 The Interconnection Line shall be designed to minimize or eliminate corona and not cause radio or television interference, nor excessive noise in excess of requirements set forth in the Applicable Standards, Applicable Permits, or other applicable Requirements including state noise Requirements for utility companies.

7.1.9 See Section 4.14.6 for the weather cases and loading criteria that shall be applied to the design of the Interconnection Line.

7.1.10 The Interconnection Line shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee.

7.1.11 Contractor shall receive explicit approval from Owner or Owner's representative(s) of the design of the Interconnection Line prior to construction. Owner shall have unlimited access to such designs throughout the design process.

7.1.12 Requirements for Interconnection Line civil and structural works:

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the Interconnection Line shall be designed and constructed in accordance with the applicable specifications in Section 4.0 *(Civil /* Structural Works).

7.1.13 Requirements for Interconnection Line structures:

(1) All Interconnection Line structures shall be steel. Steel structures shall be galvanized or self-weathering and comply with the Interconnection Line requirements for steel in Section 4.1.19.

(2) Interconnection Line pole shaft and arm components shall have a minimum wall thickness of 3/16 inch, except davit arm and cross arm minimum plate thickness shall be 0.25 inch.

(3) Structure shaft sections shall be regular polygonal with a minimum of 8 sides.

(4) Structure arm sections shall be regular or elliptical polygonal with a minimum of 6 sides except for the following.

(a) For temporary stringing arms and distribution arms, the use of 4-sided square tube arms with yield strengths of 50-ksi for weathering steel and 46-ksi for galvanized steel is allowed.

(b) For short static arms, the use of minimum 6-sided tubular arms is required. However, the use of 4-sided square tube arms may be approved by the Company prior to use on any project.

(5) Wind pressures shown in the loading criteria shall be multiplied by the appropriate shape factor applied to the poles. Pressures, in psf, shall be computed as follows:

$p = W \times C_d$

where:

p is the pressure on projected area of the pole normal to wind
W is the wind pressure
C_d is the shape or drag factor (per Table 7-1 below)

Table 7-1: Shape Factors (C_p)for Interconnection Line Design

Shape	Shape Factor
Square/Rectangular	1.6
6 or 8 Sided Polygonal	1.4
12 or more Sided Polygonal or Round	1.0

(1) Structure Joint Requirements:

(a) Structure shafts shall be designed with a minimal number of joints.

(b) Field welding will not be allowed as part of the design of a new structure.

(c) Shaft joints to be joined in the field shall be slip joints or bolted flange joints.

(d) H-Frame structure joints and cross-braced multi-pole structure joints shall be slip joints or bolted flange joints.

1. Slip joints shall have a minimum of two locking devices permanently installed at the joint to counteract resist 100% of the maximum axial load. The locking devices shall be equally spaced around the joint.

2. After installation, the structure cross-arm shall be level.

(e) All switch poles shall have bolted flange joints. All other pole shaft joints shall be slip joints unless approved by Owner.

(f) Manufacturer shall verify slip joint fit before shipment. Joints shall not interfere with ground pads, ladder clips or jacking nuts.

(g) Sufficient jacking nuts and permanent orientation marks shall be provided at all slip joints to ensure proper alignment and complete overlap of the joint.

(h) The maximum slip joint tolerance shall be accounted for to maintain the design dimension between the phases and the design dimension to the ground.

(i) Provide helicopter installation joint guides for slip and flanged joints when required.

(2) Structure taper requirements:

(a) Poles shall have nearly a uniform taper throughout their entire length. All sides of the shaft shall have the same taper. Where a variable taper is economical, Contractor may submit this as an alternate design for Owner review and approval. Change in taper shall be limited to 0.2 inches per foot difference.

(b) Shaft taper shall be limited to a range of 0.15 inches per foot minimum and 0.6 inches per foot maximum for custom slip jointed structures.

(3) Structure deflection at the top of the structure shall not exceed 2% of the structure height under the deflection load case unless otherwise approved by Owner.

(4) Structure Arms requirements:

(a) Arms shall be designed so the end of the arm is at the specified height under a loading of initial conductor tension, deflection load case. This everyday load case will be shown on the supplied configuration and load Drawings, denoted as the "Deflection" loading condition.

(b) Arm lengths as shown on the Contractor supplied Drawings are the horizontal distance measured from the face of the shaft to the wire attachment point on the arm.

(c) Deflection of arms shall not exceed the following criteria under the deflection loading condition:

1. Vertical deflection of davit arms:

a. Vertical deflection of davit arms:
b. Deflection shall be limited to L/200 where L is the length of the arm.

2. Vertical deflection of cross arms:

a. Deflection shall be limited to L/50 where L is the un-braced length of the cross arm.

3. Horizontal deflection:

a. (a) Deflection shall be limited to L/100 where L is the length of the arm.

(d) Arms shall not deflect vertically more than 12 inches at the end of the arm under any loading condition.

(e) Davit arms:

1. Davit arms less than 3 feet in length shall be straight (no upsweep) under deflection loading with normal gravity loads while also considering pole shaft deflection.

2. All distribution arms shall be straight.

3. Davit arms longer than 3 feet in length shall be upswept.

4. All davit arms shall be tapered, tubular steel members

5. Upsweep shall be 1-inch per foot rise unless approved by Owner.

(f) Three piece and single piece arms for H-Frame structures shall be straight under deflection loading with normal gravity loads.

(g) Arm connections to the shaft may be pinned or bolted. Pinned connections are preferred. Manufacturer shall specify connection type. Pinned connections shall utilize individual through (keeper) bolts at ends to prevent pin removal. Pins shall have chamfered ends to ease installation. Cotter pins and cotter keys are not acceptable as keeper bolts.

(h) Arms shall have a complete joint penetration weld (CJP) or partial penetration weld with fillet overlay between tube and connection plate to be attached to structure.

(i) Weathering steel arms shall be hermetically sealed.

(j) Arms and arm attachments shall be designed to avoid the trapping or holding of moisture.

(k) Unloaded arms shall be marked on Contractor supplied Drawings. For these arms the manufacturer shall provide temporary, removable weight bolted to end of arm to resist Aeolian vibration. Manufacturer to determine minimum weight required and provide the basis for the weight determined.

(5) Structure vang requirements.

(a) In the design of connections for vangs, brackets, or stiffeners, care shall be taken to distribute the loads sufficiently to protect the wall of the section from local buckling.

(b) Vertical vangs shall be designed so that the tension load is applied at an angle out of plane with the vang equal to a minimum of one half the design line angle range of the structure family plus the structure shaft twist tolerance. If the structure family has the tangent position within its range, the vangs shall be oriented in line with the longitudinal axis.

(c) All vertical dead-end vangs, through the shaft, shall have identical holes on both sides of the shaft. The holes on the back side of the shaft shall be used for temporary guying of the structure during the stringing process to control longitudinal deflections.

(6) Interconnection Line structure shall be cambered if deflection of the top of the pole shaft under the camber load case is greater than one-half of the pole top diameter. The camber shall be the calculated deflection plus the following tolerances when the pole is fully assembled.

(a) Straightness or camber in 10 feet: + 1/8 inch, -1/8 inch

(b) Total straightness or camber: +3 inches, -0 inch

(7) Design to eliminate water and refuse trap requirements:

(a) All weathering steel sections shall be hermetically sealed except for pole shaft sections that use slip joints. For slip jointed structures, the top of each section shall be sealed and the bottom of each upper section may be left open. The bottom of the base section shall be sealed.

(b) All factory drilled holes in weathering steel sections shall be sleeved to prevent moisture intrusion.

(c) Structure assembly shall not include any field drilled holes.

(d) Structures, when assembled, shall be effectively sealed to prevent moisture intrusion.

(e) Connections shall be designed to reduce the effect of pack-out by preventing moisture from entering the joint or by designing the connection to allow moisture to easily drain off.

(f) Threaded plastic plugs shall be provided for jacking nuts and threaded holes of ground pads. Hole plugs shall be slotted head, square head, or 12-point socket heat type.

(g) Cap plates located on top of pole sections shall be designed and installed flush with the top of the shaft to prevent water intrusion and wind ‘whistling’.

(8) Galvanized structure requirements:

(a) Tubular members of galvanized structures shall be designed to minimize environmental degradation.

(b) Galvanized poles shall have a drain hole at the bottom.

(c) Galvanized arms shall have drain holes where appropriate.

(d) Galvanized poles shall have a sturdy metal cap plate covering the entire pole shaft opening to minimize wind noise, wind movement and rain entry.

(e) Galvanized poles shall be designed to eliminate bird and insect entry. Openings in structure components greater than one inch wide shall be screened with 0.20-inch maximum opening galvanized steel screen material or covered with galvanized steel plate to eliminate bird or pest entry

(9) Direct embed structure requirements:

(a) Structures shall have a bearing plate. Bearing plate shall have a diameter no more than 2 inches greater than the maximum pole diameter.

(b) Structures shall have a ground sleeve. Ground sleeves shall have a minimum length of 4 feet. Ground sleeves shall have a minimum thickness of 3/16 inch. A seal weld shall be provided around the ground sleeve. The ground sleeve shall not be considered in strength calculations.

(c) Galvanized poles shall have a drain hole at the bottom. Weathering steel poles shall be hermetically sealed.

(d) Embedded pole sections shall extend at least 12 feet above grade.

(10) Climbing devices requirements:

(a) Pole shafts shall have ladder attachment clips where required.

(b) Arms shall have hand holds/climbing loops where required.

(c) Clips of proper type and spacing to support “McGregor” type ladders or equivalent shall be provided.

(d) When required, climbing clips shall be placed on one face (one flat) of the pole from the top of the pole to approximately the ground line or base plate. Working clips shall be placed on three additional faces from the top of the pole to approximately 10 feet below the bottom conductor attachment. Working clips shall be evenly spaced around the diameter of the pole. Each section of a flanged joint shall have working clips, two ladders above and below the joint, on the three additional faces if located below the lowest arm.

(e) Each ladder clip shall be designed to support a minimum 1,000 lb. vertical load and a minimum 200 lb. horizontal working load.

(f) Ladder clips shall be welded to the pole surface.

(g) Ladder clips shall be located to avoid interference between ladders and other attachments.

(h) Ladder clips shall provide maximum safety, minimal projection beyond the shaft surface, minimal opportunity for corrosion, and shall not permit air to enter the shaft.

(i) Removable step bolts shall not be used.

(11) Grounding device requirements:

(a) The grounding pads shall be a 1-1/2 x 3-1/2 inch flat, stainless steel plate, 0.75 inch thick meeting ASTM A666-10 shall be welded to the structure, as shown on Company supplied Drawings. The grounding pads shall be drilled and tapped for a standard NEMA 2-hole pad as shown in ANSI/NEMA CC 1-2018.

(b) Do not paint or cover grounding devices with any coating.

(c) Personal grounding loops shall be provided as shown on drawings. Personal ground loop shall be a 0.75-inch diameter, stainless-steel rod.

(12) Lifting devices requirements:

(a) Lifting lugs shall be installed in appropriate locations on all structure shaft and arm sections.

(b) Instructions for the handling and erection of structures shall be provided.

(13) Base plate and flange plate requirements:

(a) Base plates shall be designed so that the design moment may be applied in any direction, regardless of the base plate orientation.

(b) If designs produce a base-plate or flange plate to pole shaft thickness ratio of more than 6:1, then special finishing requirements shall be applied for galvanized structures.

(c) Carbon Equivalence (CE) shall be taken into account when determining weldability of steel plate. Proper preheat and interpass temperatures shall be maintained. The formula for carbon equivalence shall be that used by the American Welding Society.

(d) Flange and base plate joint design shall meet the minimum requirement for transverse weld dimension of at least 2X the shaft plate thickness.

(e) The use of roll-forged/ Thermo-Mechanical Controlled Process (TMCP) ring material is allowed. The Vendor supplied Drawings shall indicate where TMCP material is substituted for use. A specific welding procedure specification (WPS) must be prepared by each fabrication plant proposing to use forged ring material. The WPS and all associated documentation must be approved by the Company prior to use on any project.

(f) Place one alignment mark on the base plate of structure so proper alignment can be made with the anchor bolt v-notch line.

(g) The diameter or point–to-point dimension across the base plates shall be limited to a maximum of 12 inches larger than the anchor bolt circle of the base plate to prevent the base plate from extending outside of the circular pier foundation.

(h) Interior opening of base and flange plates shall be sized and configured appropriately to allow adequate access for proper welding procedures and inspection of the backing strip(s) or backing weld between the shaft and base/flange plates.

(14) Interchangeable Structure requirements:

(a) Structures within the same manufacturer defined part number shall be interchangeable when specified.

7.1.14 Requirements for Interconnection Line conductor design clearances:

(1) The phase-to-phase and phase-to-ground line clearance requirements shall exceed the NESC requirement by at least the following additional design margins:

(a) Additional vertical (V) design clearance margin = 5 feet.

(b) Additional horizontal (H) design clearance margin = 3 feet.

(2) The phase-to-phase and phase-to-ground clearance requirements per Owner standards are minimum dimensions. Contractor shall account for the cumulative fabrication and installation tolerances from the foundation, pole shaft, joint slip, connections, and arms to maintain these design dimensions. Clearance requirements shall also consider the structure deflection under the specified loading cases.

(3) Vertical and Horizontal Wire Clearance Requirements – Elevation adders per NESC 232-C1(b) shall be added for elevations above 3,300 feet above mean sea level.

(4) Galloping Design Requirements. An elliptical analysis shall be performed to estimate the extent of conductor galloping ellipses possible using PLS-CADD. The Cigre Report 322 calculation method shall be utilized to model galloping of a conductor.

(a) The ellipse amplitude safety factors for use in PLS-CADD are listed in Table 7-2 below.

Table 7-2: Ellipse Amplitude Factors for Use in PLS-CADD

Conductor Type	Twisted Pair	Round			
Galloping Risk Region	All	Low	Medium	High	
Span Type	All			Deadend	Other
Amplitude Factor	0.5		0.7		1.0

7.1.15 Requirements for conductors, shield wire, and OPGW:

(1) Conductors supplied shall be as listed below unless explicitly approved by Owner.

(a) ACSR: Hawk, Drake, Cardinal, Bittern

(b) ACSS: Hawk, Drake, Cardinal, Bittern.

(c) ACSR/TP: Penguin, Ibis, Hawk, Grosbeak

(2) All conductor cables, shield wire, and OPGW shall be installed by controlled tension methods.

(3) Pre-stressing of any type of wire shall not be permitted without the prior written approval of Owner.

(4) If conductors are bundled, all conductors in any one bundle shall be sagged simultaneously and all shall be clipped in on the same day.

(5) Spacers shall be installed on all spans of vertical 2-bundle configurations where needed. Spacers shall be placed in intervals recommended by the spacer manufacturer. Horizontal bundles are not allowed.

(6) Each sag span and control span shall be measured with surveyor's transits to verify exact span lengths, prior to sagging.

(7) All conductor cables, shield wire and OPGW sag spans and control spans shall be measured before sagging.

(8) Conductor cables, shield wire, and OPGW, and all Interconnection Line accessories shall be installed in accordance with IEEE's "*IEEE Guide to the Installation of Overhead Transmission Line Conductors*", Standard No. 524, and sagged to within a tolerance of 6-inch sag increase and no sag decrease. Transits shall be used for sagging and shall be maintained in good operating condition and checked for accuracy and adjusted, if necessary, a minimum of once per week during sagging operation.

(9) Conductor cables, shield wire, and OPGW shall not be dead-ended and clipped sooner than two (2) hours and should be fully tensioned within 24 hours of initial stringing. In no case shall more than 72 hours elapse between the stringing of conductor/ground wires and their final tensioning.

(10) No single conductor cable within a bundle shall be more than 3 inches from its sag position relative to the other conductor cables.

(11) No more than one (1) splice or repair on any single phase conductor in any single span shall be made. Splices shall be a minimum of 100 feet from any structure. Splices are not allowed within a dead-end span.

(a) Conductor tension splices will be one-piece compression sleeves with two core grips.

(b) Sleeves shall be installed with a hydraulic compression tool per manufacturers requirements. The aluminum compression sleeve shall be installed after the aluminum stranding is thoroughly scrubbed with a wire or nylon brush. The compression sleeves shall be pre-filled or filled with inhibitor and compressed in accordance with manufacturer recommendations and die. All burrs and sharp edges of the splice shall be removed by filing and sanding. Excess inhibitor, which has been forced out of the sleeve during compression, shall be thoroughly cleaned from the conductor. Overhead ground wire splices shall use a one-piece sleeve.

(c) Sleeves shall not be straightened. Tension sleeves or compression dead-end's bowed more than ½ (one half) conductor diameter shall be replaced.

(d) Sleeves shall be measured and conductors marked before compressing to ensure that the core grips are placed properly on the core wire and the conductor is inserted into the sleeves the proper distance.

(e) Splices are not allowed in any spans crossing railroads, main highways, major phone lines or electric lines of over 13.8kV. Sleeves shall not be pulled through any traveler unless allowed by the sleeve manufacturer.

(12) Wire tension limits shall be in accordance with the more restrictive of either Interconnection Table 5 (Cable Tension Limits), or the project site condition requirements. Note that Table 7-3 lists the base conditions per the NESC as well as the Xcel Energy design standards chosen to be more conservative than those requirements. Special loading areas exist throughout the United States and the Xcel Energy service area, examples such as the higher wind speed areas in south-west Minnesota and along the Colorado foothills may require design limits more conservative than those listed in the table. For phase conductor types not listed in Table 7-4, the lowest value listed shall be assumed.

(a) Tension limits apply to phase conductors, overhead ground shield wires (OHGW) and optical ground shield wires (OPGW).

(b) Construction limitations shall be accounted for in determining the design tension such as: substation dead-end structure loading limits, which typically require a "slack" span, limits due to available stringing equipment or available stringing locations in the field, and mechanical damage to conductors due to the type of pulling grips available

Table 7-3: Cable Tension Limits

			Tension Limits (RBS)		
			NESC	**Xcel**	
Load Case	**Weather Case**	**Final / Initial**	**All**	**ACSS**	**ACSR**
Rule 261H1a	Rule 250B	Initial	60%	50%	40%
	Rule 250C	Initial	80%		
	Rule 250D	Initial			
Rule 261H1c	Rule 261H1c	Initial	35%		
		Final	25%		

(c) The catenary constant shall be calculated using the H/w limits from CIGRE 273 and auto sag in PLS-CADD using the uplift load case from Criteria for Design of Transmission Line Structures – Loads and initial RS conductor condition. If the actual H/w for the uplift load case is greater than 3600·feet, then the design engineer should use dampers. If a different load case governs, and H/w for the uplift load case is less than 3600·feet then dampers should not be installed.

Table 7-4: Maximum Catenary Constant (H/w in feet.) for Aeolian Vibration Mitigation

	Max allowed H/w (ft) for the given ruling span (ft)									
Code Word	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1,000**	**1,100**	**1,200**
Bittern	8,700	8,400	8,100	8,000	7,800	7,700	7,600	7,500	7,400	7,300
Bunting	8,600	8,300	8,100	7,900	7,800	7,700	7,600	7,500	7,400	7,300
Cardinal	8,600	8,300	8,100	7,900	7,800	7,700	7,600	7,500	7,400	7,300
Drake	8,600	8,300	8,100	7,900	7,700	7,600	7,500	7,400	7,300	7,300
Grosbeak	8,500	8,200	8,000	7,800	7,600	7,500	7,400	7,300	7,200	7,200
Hawk	8,300	8,000	7,800	7,700	7,500	7,400	7,300	7,200	7,100	7,000
Ibis	8,200	7,900	7,700	7,600	7,400	7,300	7,200	7,100	7,000	7,000
Linnet	8,100	7,900	7,700	7,500	7,400	7,200	7,100	7,000	7,000	6,900
Partridge	8,000	7,800	7,600	7,400	7,300	7,100	7,000	6,900	6,900	6,800
Penguin	7,900	7,700	7,500	7,300	7,200	7,100	7,000	6,900	6,800	6,700
Rook	8,400	8,100	7,900	7,700	7,600	7,500	7,400	7,300	7,200	7,100
Thrasher	9,000	8,600	8,400	8,200	8,100	8,000	7,800	7,700	7,700	7,600

(13) If dampers are needed for a specific wire type, they shall be installed on the entire project for that wire type. Where dampers are required, they shall be the size, quantity, and placement dictated by the damper manufacturer. The exact location where each reel of conductor was installed shall be recorded.

(14) Final sag measurements, including but not limited to each sag span's record date, span number, span length, ruling span, wire temperature, ambient temperature, initial sag for the span, time in blocks, time of day and sag measurements, shall be recorded.

(15) OPGW (including a primary and secondary (redundant) OPGW) shall be installed the entire length of the overhead route and coordinated with the Communications System/communication/protection specification.

(16) OPGW shall be 48-count fiber, single mode manufactured by either AFL Global (AFL) or Suzhou Furukawa Power Optic Cable (SFPOC). Owner-approved conductors include:

Table 7-5: Owner Standard OPGW

Manufacturer	"Low Lightning"	"Medium Lightning"	"High Lightning"
AFL	OGW074	OGW075	OGW076
SFPOC	OGW093	OGW094	OGW091

(17) OPGW design tension limits shall be specified in the Project-specific sections.

(18) Stringing tensions for the OPGW shall not exceed twenty percent (20%) of the ultimate cable strength.

(19) Splice locations shall be selected and provided with weatherproof splice boxes suitable for the selected OPGW.

(20) At each splice location, a 50-foot coil of spare wire shall be maintained.

(21) Spare wire may be coiled on the pole, placed in an underground vault, or coiled in an aerial slack storage device.

(22) The OPGW shall be solidly bonded to the structure with a braided soft drawn copper jumper and steel structures shall incorporate a welded grounding nut for that purpose.

(23) Shield wire shall be minimum 3/8-inch, 7-strand EHS steel wire.

(24) Shield wires and OPGW shall be bonded to the pole grounding system using a suitable ground wire.

7.1.16 Requirements for wind-induced oscillation dampers.

(1) A vibration analysis shall be performed to determine the need for oscillation dampers and the preferred placement of the dampers along the interconnection line. The analysis shall consider the environmental conditions along the interconnection line and assume the following:

(a) Terrain Category: Category 1 – Open Terrain

(b) Direction of line shall be the direction between dead-ends for each section of line.

(c) The average annual minimum temperature shall be assumed to be -20 Deg. F for the Xcel – NSP and Xcel – PSCO regions and 0 Deg. F for the Xcel-SPS region.

(2) Spiral vibration dampers shall be installed on phase conductors and OPGW shield wires that are smaller than 0.75” in diameter.

(3) Stockbridge type dampers shall be installed on phase conductors and OPGW shield wires that are 0.75” diameter and larger.

(4) Placement of dampers along the line and installation of the dampers shall be consistent with the manufacturer’s recommendations including but not limited to: bolts tightened to the proper torque; prevent contamination from entering the damper clamping area, etc. Dampers shall be installed following clipping of the line.

(5) Design drawings shall include damper locations and installation requirements. The weight of the dampers shall be included in the conductor sag-tension calculations.

7.1.17 Requirements for bird diverters.

(1) Bird diverters shall be installed to increase the visibility of conductors where required by permit or recommended due to bird traffic. Bird diverters shall be spiral type unless the permit requires a different type.

(2) Design drawings shall include bird diverter locations and installation requirements. The weight of the bird diverters shall be included in the conductor sag-tension calculations.

7.1.18 Requirements for insulators and hardware:

(1) All surfaces of metal parts shall be relatively smooth with no projecting points, damage, or irregularities, which may cause corona. Damage to insulators includes, but is not limited to, breaks, scratches, chips or cracks in the glass, bent or deformed pins, nicks, cuts or undue roughness in either caps or pins.

(2) Nuts shall be hexagonal and of corona-free design.

(a) Nuts on all suspension and dead-end clamps shall be tightened in accordance with the clamp manufacturer specified torque requirements. Ten (10) minutes or greater following the initial tightening of the U bolts on the dead-end clamps, the U-bolts shall be torqued a second time. Note that dead-end clamps are not allowed on phase conductor dead-ends. Phase conductor dead end terminations shall be compression type.

(3) All ferrous material except stainless steel shall be hot dip galvanized to conform to ASTM A153.

(4) Cotter keys shall be austenitic stainless steel and each piece shall be marked for identification with the manufacturer’s part or catalog number.

(5) Dead end structures shall utilize toughened glass bell insulators. Tangent poles shall use polymer insulators. The type and manufacturer of the insulators shall be consistent by application.

(a) Toughened glass insulators shall be ANSI standard profile shape, Type K ball and socket coupling.

(b) Suspension insulators shall be Hubbell Power Systems or Maclean Power Systems as indicated in Table 7-6:

Table 7-6: Suspension Insulator Requirements

Elevation Range	Insulator Type	Voltage (kV)	Hubbell Power Systems					Maclean Power Systems				
			XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)	XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)
0'-5300'	Suspension	69/115	SUS371	1008425	S030049S2010P1	61.3	49.6	SUS372	1008611	S54080044VXSS018	55.6	47.9
	Suspension	230	SUS295	222443	S030077S201AP1	89.4	77.0	SUS376	1008615	S54080077VASS040	88.6	77.3
	Suspension	345	SUS381	1008429	S030123S201BP1	134.8	121.6	SUS382	1008618	S54080121VBSS058	132.6	121.2
5300'-7300'	Suspension	69/115	SUS371	1008425	S030049S2010P1	61.3	49.6	SUS373	1008613	S54080046VXSS018	57.6	49.9
	Suspension	230	SUS377	1008427	S030084S201AP1	95.9	83.5	SUS378	1008616	S54080082VASS038	93.6	82.3
	Suspension	345	SUS389	1008440	S030129S201BP1	141.3	128.1	SUS390	1008619	S54080128VBSS057	139.6	128.2
7300'-14000'	Suspension	69/115	SUS374	1008426	S030053S2010P1	65.7	53.9	SUS375	1008614	S54080050VXSS017	61.6	53.9
	Suspension	230	SUS379	1008428	S030090S201AP1	102.4	89.9	SUS380	1008617	S54080090VASS036	101.6	90.3
	Suspension	345	SUS391	1008441	S030146S201BP1	158.5	145.4	SUS392	1008630	S54080144VBSS054	155.6	144.2

(c) Braced line post insulators shall be Hubbell Power Systems or Maclean Power Systems as indicated in Table 7-7:

Table 7-7: Braced Line Post Insulator Requirements

Elevation Range	Insulator Type	Voltage (kV)	Hubbell Power Systems					Maclean Power Systems				
			XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)	XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)
0'-5300'	Braced Line Post	69/115	BLP090	1008813	BLP055G12041P1	67.7	49.6	BLP091	1008724	B2901060T52066MX REV 1	60.1	47.9
	Braced Line Post	230	BLP095	1008815	BLP082F00008P1	92.0	77.0	BLP096	1008728	B2511095T52087AA	94.7	77.3
	Braced Line Post	345	BLP101	1008818	BLP531F00005P1	142.2	121.6	BLP102	1008731	B3511144T52198AB	146.5	121.2
5300'-7300'	Braced Line Post	69/115	BLP090	1008813	BLP055G12041P1	67.7	49.6	BLP092	1008725	B2901065T52066BX	65.3	49.9
	Braced Line Post	230	BLP097	1008816	BLP089F00001P1	99.2	83.5	BLP098	1008729	B2511100T52087AA	99.7	82.3
	Braced Line Post	345	BLP103	1008819	BLP538F00001P1	149.5	128.1	BLP104	1008732	B3511153T52207AB	152.5	128.2
7300'-14000'	Braced Line Post	69/115	BLP093	1008814	BLP060G12008P1	72.4	53.9	BLP094	1008727	B2901070T52069AX	70.2	53.9
	Braced Line Post	230	BLP099	1008817	BLP494F00001P1	105.7	89.9	BLP100	1008730	B3511108T52093CA	107.5	90.3
	Braced Line Post	345	BLP105	1008841	BLP749F00003P1	163.9	145.4	BLP106	1008733	B4711165T52231CB	164.9	144.2

(d) Horizontal line post insulators shall be Hubbell Power Systems or Maclean Power Systems as indicated in Table 7-8:Table 7-8:

Table 7-8: Horizontal Line Post Insulator Requirements

Elevation Range	Insulator Type	Voltage (kV)	Hubbell Power Systems					Maclean Power Systems				
			XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)	XP#	CID	Manufacturer's Part #	Section/ Overall Length (in)	Dry Arc Length (in)
0'-5300'	Horizontal Post	69	HLP252	1008178	P250043S0020P1	55.9	44.0	HLP253	1008667	H29010043MXSS022	53.3	45.1
	Horizontal Post	115	HLP254	1008179	P250055S0020P1	67.7	56.0	HLP255	1008669	H29010050MXSS026	60.1	52.9
	Horizontal Post	230	HLP257	1008560	P250084S002AP1	96.1	83.0	HLP258	1008711	H29010081AASS032	90.7	82
	Horizontal Post	345	HLP261	1008562	P300129S002AP1	139.8	129.6	HLP262	1008683	H39010128ABSS050	138.3	128.4
5300'-7300'	Horizontal Post	69	HLP252	1008178	P250043S0020P1	55.9	44.0	HLP253	1008667	H29010043MXSS022	53.3	45.1
	Horizontal Post	115	HLP254	1008179	P250055S0020P1	67.7	56.0	HLP256	1008710	H29010055BXSS014	65.3	57.7
	Horizontal Post	230	HLP257	1008560	P250084S002AP1	96.1	83.0	HLP258	1008711	H29010081AASS032	90.7	82
	Horizontal Post	345	HLP261	1008562	P300129S002AP1	139.8	129.6	HLP262	1008683	H39010128ABSS050	138.3	128.4
7300'-14000'	Horizontal Post	69	HLP252	1008178	P250043S0020P1	55.9	44.0	HLP253	1008667	H29010043MXSS022	53.3	45.1
	Horizontal Post	115	HLP267	1008564	P250060S0020P1	72.4	61.0	HLP268	1008685	H29010060AXSS012	70.2	62.7
	Horizontal Post	230	HLP259	1008561	P250092S002AP1	104.0	90.0	HLP260	1008682	H29010089CASS028	98.5	90
	Horizontal Post	345	HLP263	1008563	P300144S002AP1	154.0	144.2	HLP264	1008684	H39010144CBSS044	153.6	144.4

(6) Insulator length, strength, and required number shall be determined based on loading requirements, switching surge and lightning requirements, and by contamination levels.

(7) Contractor shall use construction methods to assure all polymer insulators are not subjected to torsion, such methods shall include working swivels when pulling conductor, clipping, adjusting turn buckles and dead ending.

(8) Contractor shall inspect all insulators prior to installation to assure there is no damage to the insulator, including but not limited to polymer coating exposing the fiberglass rod

(9) Materials shall be packaged in weather-resistant cartons or crates suitable for outdoor storage.

(10) The insulators shall be protected with suitable material to prevent damage to the sheds, bell, connections, and/or end fittings during shipping and at the structure sites prior to installation.

(11) Insulators shall be inspected prior to installation, cleaned as required, protected during installation and replaced if damaged. Installation shall follow IEEE 524 "IEEE Guide to the Installation of Overhead Transmission Line Conductors"

(12) Line guards and armor rods shall be installed in conjunction with suspension clamp assemblies.

(13) Elastomeric suspension units (AGS or CGS) are the preferred conductor support. Clamps with armor rod may only be used where elastomeric suspension units are not available. (At the time of publishing this document, they were available from several manufacturers down to size 336 kcmil.) Clamps without armor rod shall not be used. Hardware shall be appropriately rated for the operating temperature of the line. See Interconnection Line Table 7: Preferred fitting types for various wire types.

(14) The termination of the armor rods shall be within one-half (0.5) inch of each other.

(15) In the assembly of insulators and insulator hardware, every cotter key shall be inspected to ascertain that it is in place and properly seated and spread.

(16) All in line bolts/pins shall face the same direction on all structures on the project. The nuts/pins on all side-to-side bolts/pins shall face the pole (except in a V-String where the outside nut/pin shall face out/down).

(17) Corona rings shall be installed per the manufacturer's requirements. The smooth side of the ring shall face the sheds on the insulator.

7.1.19 Requirements for grounding:

(1) All overhead poles shall be grounded locally at each pole. The ground should consist of a copper ground wire connected to a 5/8-inch, copper-clad steel ground rod.

(2) Grounding systems shall be designed in accordance with all Applicable Standards and best engineering practices.

(3) Maximum resistance shall be no greater than 25 ohms. If ground resistance is greater than 25 ohms, special grounding designs shall be prepared. A ground resistance test shall be done at every structure.

7.1.20 Requirements for lightning protection:

(1) The Interconnection Line shall be protected against lightning by the use of shield wire(s). The shield wires shall be located so as to intercept lightning strikes and prevent direct strikes to the conductors. Position of shield wires, ground resistance, and electrical parameters of the line insulation shall be coordinated to produce a calculated performance equal or superior to the standard value.

(2) The isokeraunic level of the area of the line shall be determined by Contractor and shall be used in the design of the shielding/grounding system.

(3) The method of grounding and the required ground resistance to minimize the outage rate shall be calculated.

(4) The shield wire shall be positioned using the rolling sphere model described in IEEE 1243. Design engineer shall achieve the lightning protection using the structure geometry, including adjustments for terrain, and the structure grounding, including allowances for the soil electrical resistivity.

7.1.21 Requirements for marking and lighting:

(1) All Interconnection Line structures shall be marked with identification numbers and permanent, weatherproof labels. Marking and identification scheme requirements include:

(a) The base piece of each structure shall be permanently marked on the pole shaft 60 inches above ground line and on the bottom of the base plate or bearing plate with the following identifying information:

1. Company

2. Load & Design Drawing Number

3. Overall Structure height

4. Month – Year structure was manufactured

5. Vendors Job Number with Fabrication Plant Code

6. Vendors Part Number including Sequence Number

(b) Each separate part of the steel pole structure shall be permanently and distinctly marked on outside face of piece with unique Manufacturer Job Number with Fabrication Plant Code and Manufacturers Part number including Sequence Number to identify the type, structure and position of the piece on the structure and for the purpose of tracking material deliveries, inspections and material properties.

(c) Each pole shaft shall be permanently and distinctly marked on plate welded to inside of pole at small diameter end of the shaft of slip-jointed and flange connections to assist in identifying shafts from their end when in storage when face markings are not visible. Top pole shafts shall be marked similarly. Mark shafts with unique Manufacturer Job Number and Manufacturers Part number including Sequence Number to identify the type, structure and position of the piece on the structure and for the purpose of tracking material deliveries and inspections.

(d) Marking shall be made by ½-inch stamping on a metal plate welded to the base piece and ½-inch stamping on a metal plate welded to all other loose shipped pieces, less hardware.

(e) All markings shall be clearly legible after finishing and galvanizing.

(f) The method of identification shall be approved by the Company.

(g) Unnecessary marks, such as chalking or scribes, are not allowed on the outer surfaces of weathering steel sections.

(h) All structure shaft pieces, davit arms and cross arms shall have a weld bead, across the same flat as the nameplate, to identify the balance point of the piece along with the letters BP.

(i) The structure manufacturer shall provide ½-inch Stainless Steel welded nuts for permanent Contractor supplied and installed structure signs. The marking and identification scheme for the structure signs shall be approved by Owner prior to use.

(2) Spherical markers shall be installed as specified by permit on at least the top conductor of the transmission line to increase visibility of the wire at all navigable river crossings or where aircraft operate. The weight of the spherical markers shall be included in the conductor sag-tension calculations.

(3) The Interconnection Line lighting system shall comply with the requirements as defined in US DOT-FAA Advisory Circular No. AC 70/7460-1K: *Obstruction Marking and Lighting*.

7.2 Submittals

7.2.1 Contractor shall prepare the Interconnection Line design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) plan and profile drawings, including electrical phasing matching the phasing at the Project Substation terminations with minimal rolls and phase swapping; (c) structure details and drawings, including elevations, spacing, and hardware; (d) civil works drawings, including subgrade preparation, grading, drainage, and erosion control; (e) foundation design and embedment drawings; (f) anchoring and guying details; (g) structural calculations; (h) PLS-CADD design files; (i) grounding details; (j) drawing index; (k) bill of materials; and (l) inspection testing, and quality control requirements.

7.2.2 Contractor shall prepare energization plans and procedures for the Interconnection Line. Energization plans shall be submitted to Owner for approval *prior* to use. Energization plans shall include both electrical and communications infrastructure as well as backfeed plans, soaking plans, testing plans, and lock out tag out procedures, at a minimum.

7.2.3 Contractor shall prepare an in-field insulator installation plan for Owner's review and approval.

7.2.4 Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Interconnection Line. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

7.2.5 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials.

7.2.6 Contractor shall enter the as-built LiDAR survey data into the existing IFC PLS-CADD model and update the model as necessary based on that data. As built PLS-CADD model to be provided to owner. Contractor shall confirm with LiDAR survey that clearances and line sag values conform to the applicable requirements.

7.3 Interconnection Line

7.3.1 Contractor shall design, furnish, construct, and install the Interconnection Line in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Interconnection Line configuration.

(2) The Interconnection Line shall not cross through (under / over) the O&M Building yard. Placement of structures within the yard is prohibited.

(3) Contractor shall allow a sufficient amount of conductor and OPGW coiled at the last structure outside the Interconnection Switchyard for termination by the Interconnecting Transmission Provider.

(4) Contractor shall actively coordinate with Owner and any Owner representatives or contractors for the completion of the Project, including the Interconnection Line interface at the Interconnection Switchyard. Such coordination may include, but not limited to, sharing design drawings and studies, coordinating testing procedures, and attending meetings to discuss design implications and Progress of the work.

7.4 Testing and Quality Control

7.4.1 Contractor shall test, commission, start-up, and place into successful operation the Interconnection Line, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.

(1) All Interconnection Line equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed conductor and OPGW sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation. Upon receipt, Contractor shall perform reel acceptance testing on all OPGW using optical time-domain reflectometer ("**OTDR**") and compare those trace results with the data from the manufacturer.

(5) After installation and completion of all required splicing and terminations, all OPGW shall be verified using OTDR. All such testing shall be done with an OTDR in both directions of the strands. For single-mode fiber, test each fiber in both directions at 1310 nm and 1550 nm. A successful test result shall have (a) attenuation less than (i) 0.50 dB per connector and (ii) 0.30 dB per fusion splice and (b) optical return loss of each connector less than (i) -35 dB if UPC and (ii) -65 dB if APC. Contractor shall compare results with reel tests performed by the manufacturer.

(6) Following OTDR testing, an optical attenuation test shall be performed on all fibers. This test shall be performed at 1310 and 1550 nanometers, using a calibrated light source and optical power meter.

(7) Resistance testing on grounding grid at each structure location.

(8) All Interconnection Line foundations shall be tested for concrete and grout properties (strength, slump, air content, temperature), with the first concrete truck of the design mixture, and every three (3) concrete trucks thereafter.

(9) Compaction.

(10) Other testing set forth in the design documents.

7.4.2 Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

8.0 INTERCONNECTION SWITCHYARD

Not used.

8.1 General Provisions

Not used

8.2 Submittals

Not used

8.3 Interconnection Switchyard

Not used

8.4 Testing and Quality Control

Not used

9.0 COMMUNICATIONS SYSTEM

9.1 General Provisions

9.1.1 Contractor shall coordinate with Owner regarding the equipment size, location, conduit entry, power, grounding and other requirements for the SCADA and meteorological equipment.

9.1.2 Contractor shall provide a Communications System that permits at least two (2) remote concurrent users. The Communications System shall operate on server operating system and shall be compatible with Owner's existing control system. Contractor shall assume 2 users and shall provide incremental pricing for the addition of more users.

9.1.3 Contractor shall provide list of networking and server equipment for Owner approval, including the equipment provided in Exhibit A.3 (*Approved Suppliers*), as applicable. Owner shall have the option to program the Contractor-provided networking equipment (e.g. switches and firewalls).

9.1.4 The Communications System, field SCADA enclosures, MET Stations, etc. shall be provided with backup power for a minimum of 8 hours. Such battery backup shall be independent of the Control House battery bank.

(1) Chargers shall include AC power failure alarm relays, high/low DC voltage alarm relays, and ground detection alarm relays.

9.1.5 The Communications System shall be designed with data continuity, reliability, and security as priority.

9.1.6 Breakers and other outdoor equipment shall be furnished with space heaters (if not already provided by manufacturer of the equipment) that are thermostatically controlled.

9.1.7 All monitoring and control devices and systems shall be suitably zone protected against lightning electromagnetic impulses in accordance with IEEE C37.90.1.

9.1.8 The Communications System shall be compliant with all Applicable Standards, including NERC Functional Model Registered Entity function, NERC Reliability Standards, Regional Entity Standards, approved regional variances, and/or FERC Orders. Further, the Communications System shall comply and be designed to work in accordance with applicable Owner's system operator approved protocols, operating guides, standards, business practice manuals, and/or approved rules. In so far as either a state utility commission or provincial authority has instituted additional regulations, the communications system should be designed to accommodate where no conflict exists with NERC or FERC. Design should include parameters for operating under conditions specified by rules stated hereto as well as capability to function on an evidentiary basis.

9.1.9 All Communications System design and construction shall conform to the supplier's requirements.

9.1.10 Requirements for system functionality:

(1) The Communications System shall be capable of centrally and remotely monitoring, controlling, and recording the performance of the Project Substation equipment, permanent MET Stations, solar PV modules, inverters / BESS / permanent meteorological towers, Wind Turbines, and other critical sensors.

(2) The Communications System design shall include configuration files and a comprehensive data points list and protocol specification for communications between all Project components requiring communications, data transfer, and control monitoring using the fiber network integrated into the Communications System. Such configuration files shall have the ability to be configured by Owner, and Contractor shall furnish development application software for each configurable device.

(3) The Communications System shall include the necessary equipment (hardware and software) for the exchange of signals with Project Substation equipment to support grid monitoring.

(4) The Communications System shall include the necessary equipment (hardware and software) for the exchange of signals with the permanent MET Stations / Met Towers to support data monitoring.

(5) The Communications System shall include the necessary equipment (hardware and software) for the exchange of signals and integration of any required reactive compensation devices (e.g., capacitor banks, reactors).

(6) Upon loss of utility power interconnection or failure of utility power, restart of the instrumentation and control system to a fully-functioning condition should require no local manual operations. Synchronization shall be performed automatically.

9.1.11 Requirements for fiber network:

(1) Fiber optic cable shall be installed in the same trench as the Collection System Circuit power cabling. Fiber optic cable shall be installed with detectable tape or other means of detection (excluding detectable tape or wire within the Project Collector Substation or other facility in which the detectable tape or wire would interfere with the safe operations of such facility.)

(a) When fiber cables are installed in a trench, the fiber cable shall be placed in non-conducting conduit or continuous innerduct; the fiber cable shall be rated for underground use; and there shall be a suitable locating cable installed in the innerduct/conduit. Innerduct shall have a minimum diameter of 1.25 inches. Conduit or innerduct located in burrowing rodent prone areas shall have an armored jacket to prevent damage from chewing. Fiber optic shall be separated from any power cables when co-located in a trench.

(2) All fiber cables shall consist of a minimum of 12-strand multi/single mode fiber. All fiber runs greater than one (1) mile in length shall be single-mode fiber, or as otherwise required to maintain a minimum of at least one (1) gigabyte bandwidth throughout the backbone of the system.

(3) The fiber optic cables shall be terminated at the Project Substation control enclosure in a patch panel provided and installed by Contractor. All spare fibers shall be terminated at each location and connected at each splice location. Launch and landing boxes shall be installed as necessary to facilitate testing.

(4) All fiber optic connectors and ports shall be LC type (patch panels, ethernet switches, etc.).

(5) All fiber cables shall be designed with a minimum of fifty percent (50%) spare fiber.

(6) Excess slack shall be provided to allow re-termination in the event of failure. Sufficient cable length shall be provided such that the cables may be re-terminated at least two (2) times after installation. Terminations shall be completed with either an approved fiber optic pigtail kit or with approved mechanical connectors and an approved fanout kit.

(7) All communications cables, including fiber cables, shall be appropriately labeled in accordance with Section 2.6.

(8) The fiber system shall be designed for a minimum of five (5) dB system margin.

(9) The fiber system design shall be a fiber ring topology or a "daisy-chained" system.

(10) Fiber cables may be routed through Project Substation control cable trenches with other control wiring provided that a high-visibility color innerduct is used for identification and protection of the fiber cables.

(11) All splices shall be fusion splices and shall be housed in splice trays. Other types of splices are subject to Owner approval. Where used, all fiber optic splice enclosures shall be NEMA 3 and locking.

(12) Maximum attenuation:

(a) 0.36 dB/km at 1310 nm.

(b) 0.22 dB/km at 1550 nm.

(13) Data collection loops shall be designed so that a loss of a power circuit does not cause a loss of data collection from the PV Array / Wind Turbines during the power outage.

9.1.12 Requirements for monitoring and control:

(1) Design and installation of the Communications System shall be provided with all hardware, telemetry, communication and other requirements as required by the interconnection utility.

(2) The Communications System shall be provided with the following supervisory screens, at a minimum.

(a) Project Substation one-line diagram, including all breakers, switches and transformers and the real-time status of each (current, power, voltage, power factor, and reactive power, as applicable).

(b) Project Substation alarms and notifications: (1) status of all relays and (2) status of all alarms and notifications.

(c) Main power transformer status, including the following for each main power transformer: (1) operation and fault status, including alarms; (2) relay statuses; (3) temperatures (winding, oil); (4) tap changer position; and (5) dissolved gas monitor data and alarms.

(d) Breaker status, including the following for each medium- and high-voltage breaker: (1) operation and fault status, including alarms; (2) relay statuses; and (3) breaker readings (current, power, voltage), including per Collection System Circuit.

(e) Control building status, including the following: (1) operation and fault status, including alarms; (2) enclosure alarms (fire/smoke alarm status, enclosure temperature, intrusion, etc.); (3) battery charger voltage and status; (4) intrusion detection; and (5) HVAC status.

(f) Solar status, including the following:

1. Meteorological parameters: GHI irradiance, plane of array ("POA") irradiance, ambient temperature, wind speed and direction, and rainfall

2. Tracker points: Status and alarms (per tracker for linked-row trackers and per row for independent row trackers), setpoint position, actual position (per tracker for linked-row trackers and per row for independent row trackers), and wind speed

3. Inverter shelter points (if applicable): Shelter environmental conditions (if applicable), shelter HVAC/climate control status (if applicable), and shelter door position switch (if applicable)

4. Inverter points: inverter status, alarm states, and faults; instantaneous input and output power; energy production (daily and total); DC and AC voltages (line-to-line and per phase for AC); DC and AC currents (per phase for AC); DC current zone-level monitoring; internal component and cooling system temperatures (IGBTs, heat sinks, air temperature, fluid temperature, as applicable)

5. Back of Module temperature points

6. Soiling station data points

7. PVCS Points (if applicable): AC disconnect switch points with position feedback (except manually operated air break switches), indicating protection relays' power information, and protection relaying auxiliary contacts for alarming

8. MV Transformer Alarms (binary): Overtemperature 1 and 2, low oil level, pressure, vacuum

(3) Other supervisory screen requirements:

(a) All major components (e.g., breakers, transformers, MET Station) shall be listed separately.

(b) Alarms and faults shall be color-coded where applicable (e.g., green, yellow, red).

(4) The Communications System shall include control functionality for the following, at a minimum: (a) active power; (b) reactive power; (c) frequency; (d) voltage; (e) power factor; and (f) noise-related operations.

(5) Fault notification shall be provided through real-time text messaging or e-mail alerts, as determined by Owner. Fault notification messages and recipients shall be specified by Owner.

9.1.13 Requirements for reporting and storage:

(1) Contractor shall provide a SCADA points list for Owner approval.

(2) All reporting shall be in Generation Availability Data System ("**GADS**"), in an appropriate format.

(3) Communications System reporting shall include, at a minimum, the following for the Project Substation, permanent MET Station, solar PV modules, and BESS: (a) performance parameters, availability, operation counters, faults, and alarms; (b) browsing and filtering of historical data; and (c) creation of pre-defined and custom reports.

(4) All data monitored by the Communications System shall be recorded and stored. Local controllers shall have sufficient buffer for at least 30 days of data storage in the event of power loss.

(5) Historical data shall be stored in an SQL database or Owner-approved equivalent for the life of the Project. Data shall be stored in the database as no higher than 1-minute averages, with accompanying statistical values including, but not limited to, minima, maxima, and standard deviation. All data shall be retrievable.

(6) All stored data and generated reports shall be exportable as ASCII and Microsoft Excel formats.

(7) The system shall not permit unwarranted tampering with or changing of raw data or functionality.

9.1.14 Requirements for data integration:

(1) Contractor shall perform data integration.

9.2 Submittals

9.2.1 Contractor shall prepare configuration files and a comprehensive data points list and protocol specification for communications, as more particularly described in Section 9.1.10 herein.

9.2.2 Contractor shall prepare a Communications System control narrative to describe the following:

(1) How data will be collected from the inverters, trackers (if applicable), substation, meters, and meteorological stations and sent to the Owner, balancing authority, and Transmission Provider in accordance with the interconnection agreement.

(2) How the substation communication systems, major Equipment SCADA, power plant controller and facility SCADA (site computer) will communicate and function together to enable Owner to monitor and control the Project locally and remotely.

(3) How the power plant controller will perform the following functions:

(a) Active power curtailment

(b) VAR control

(c) Power factor control

(d) Automatic Voltage Regulation (AVR)

(e) Active and reactive power ramp-rate control

(f) Frequency droop control (Hz vs. kW)

(g) BESS: Battery charging and discharging

9.2.3 Contractor shall provide the following documentation:

(1) IP address list.

(2) I/O list and dataset mapping.

(3) Factory acceptance test procedure and results.

(4) Recommended spare parts list with equipment make/model and pricing

(5) All credentials use and configured during setup. All system should be changed from default passwords during setup

(6) License keys and warranty\support information. All licenses, warranty and support contacts should be purchased with the owner being the end user or owning party.

9.2.4 Refer to Section 5.2.1 and Section 6.2.1 for additional Communications System submittals.

9.2.5 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials.

9.2.6 Contractor shall submit a list of all the software installed on Contractor-provided equipment

9.3 Communications System

9.3.1 Contractor shall design, furnish, construct, and install the Communications System in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Communications System configuration.

(2) Contractor shall furnish and install all network and communication devices, including programming and configuration, necessary for the Communications System.

(3) Communications System shall be support Open Platform Communications Unified Architecture (OPC UA) (IEC 62541) protocol interface.

(4) Contractor shall furnish and install / terminate all fiber optic cabling between the major Equipment, Project Substation, permanent MET Station, and O&M Building, including patch cables between fiber patch panels and devices.

(5) Contractor shall develop and furnish HMI supervisory screens for the Project Substation RTAC as described in Section 9.1 herein.

(6) Contractor shall furnish and configure the RTAC, including incorporation of the major Equipment Communications System and dissemination of points to the interconnection utility and offtaker, as requested.

9.3.2 Contractor shall install the major Equipment in the Communications System, including all power and fiber optic terminations, within the Project Substation.

9.3.3 Contractor shall coordinate with Owner's resources to integrate all Contractor-supplied equipment with Owner-supplied network equipment.

9.4 Testing and Quality Control

9.4.1 Contractor shall test, commission, start-up, and place into successful operation the Communications System, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.

(1) All Communications System Line equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation. Upon receipt, Contractor shall perform reel acceptance testing on all fiber cable using OTDR and compare those trace results with the data from the manufacturer.

(5) Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.

(6) Verify all communication channels (intra- and inter-Project Substation), including Project Substation LAN, operate as expected.

(7) After installation and completion of all required splicing and terminations, verify fiber optic system performance (power losses, splice or connector losses, etc.) using OTDR.

(a) OTDR testing shall be in accordance with TIA 568-C Tier 2.

(b) Prior to testing each fiber span, the OTDR shall be calibrated for length and pulse width.

(c) All such testing shall be done in both directions of the strands.

(d) For single-mode fiber, test each fiber in both directions at 1310 nm and 1550 nm. A successful test result shall have (a) attenuation less than (i) 0.50 dB per connector and (ii) 0.30 dB per fusion splice and (b) optical return loss of each connector less than (i) -35 dB if UPC and (ii) -65 dB if APC.

(e) Contractor shall compare test results with reel tests performed by the manufacturer to confirm consistency.

(8) Following OTDR testing, an optical attenuation test shall be performed on all fibers. This test shall be performed at 1310 and 1550 nanometers, using a calibrated light source and optical power meter.

(9) All fiber optic cable shall be visually inspected and OTDR-tested and power meter tested prior to installation / termination.

(10) Provide system functionality and compatibility at the control room / O&M Building.

(11) Test each cable and strand on every fiber run from termination to termination.

(12) Provide entire Project Site testing to ensure proper operation of all data points into the component gateways and testing of all data points provided to third parties with that party.

9.4.2 Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

10.0 O&M BUILDING

10.1 General Provisions

10.1.1 Requirements for O&M Building configuration:

(1) The O&M Building shall be constructed on at least 4.5 acres and positioned as shown in Figure 10-7. The land shall be owned and not acquired through an easement. The O&M building shall have the general dimensions as indicated in Table 10-1 below for the size of the Project, and indicative layouts shown in Figure 10-1 through Figure 10-8 herein, at a minimum. For hybrid projects selected building size and type to be approved by Owner. Minor adjustments to the size may be permitted to accommodate standard materials. Such adjustments shall be reviewed and approved by Owner.

Table 10-1: O&M Building Room Schedule

Project Rating (MWdc): Solar, BESS	Approximate Building Size and Type
< 50	40-foot converted shipping container
50-199	1,020 square feet
200-699	4,140 square feet
700+	5,780 square feet
Turbine Quantity: Wind	**Approximate Building Size**
50-150	7,520 square feet
151-250	8,320 square feet
>250	9,440 square feet

(2) The building orientation shall be fixed as shown in the site layout in Figure 10-1 through Figure 10-8 herein and the entrance road shall be from the south. The parking area may require adjustment based on final building layout.

(3) The O&M Building shall be designed and constructed such that it is ADA compliant, including parking, doorways, bathrooms, and other building features.

(4) All manufacturer installation instructions for the installation of all O&M Building equipment and components shall be obtained and followed.

(5) The O&M Building shall be constructed using metal studs.

10.1.2 Requirements for O&M Building civil works:

(1) All civil works for the O&M Building shall comply with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

(2) Excavated material shall be backfilled and compacted on the outside of the foundation walls adjacent to green areas and graded around building to provide proper drainage. The outside foundation walls adjacent to hard surfaces and future additions shall be filled with compacted granular fill.

(3) Fill shall be compacted to at least 95 percent (95%) of the maximum density within the moisture content of two percent (2%) below optimum to two percent (2%) above optimum, as determined by ASTM Standard D698, unless a higher level of compaction is required by the Geotechnical Report. Contractor shall furnish compaction-testing results to Owner.

(a) Any fill necessary for O&M site development shall be clean granular fill supplied by Contractor.

(4) The graveled fenced area for the O&M Building shall be covered throughout with at least six (6) inches of aggregate over fabric or geogrid and a compacted subgrade, with aggregate extending at least one (1) foot beyond the fence in all directions. The maximum aggregate size shall not exceed two (2) inches.

(5) Septic leach fields shall be cordoned off and protected from all construction traffic and equipment to mitigate unnecessary soil compaction in the area.

(6) All finished grades shall be 1/8-inch per foot and provide proper drainage away from buildings and structures.

10.1.3 Requirements for O&M Building structural works:

(1) All O&M Building structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.0 *(Civil / Structural Works*).

(2) The O&M Building shall have a reinforced-concrete foundation covering the building footprint. The O&M Building floor shall be at least six (6) inches thick. Where necessary, the floor shall be thickened to accommodate large equipment (e.g., generator) and heavy loads to be stored in that area. Concrete reinforcement shall be shop fabricated per design drawings. Field bending of reinforcement shall be in accordance with applicable sections of ACI 318. Shop drawings shall be submitted for review prior to construction.

(3) Contractor shall require that the concrete subcontractor has a minimum of 3 years of experience with commercial concrete construction and concrete floor finishing.

(4) Minimum concrete strength shall be 3,000 psi for footings and walls, respectively, and 3,500 psi for floors in place in 28 days.

(5) Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the CRSI's "*Manual of Standard Practice*".

(6) All foundations shall extend a minimum of six (6) inches above the adjacent finished grade.

(7) Foundation wall and under slab insulation, when required by location, shall be extruded polystyrene board insulation, ASTM C578, Type IV, 1.6 pcf density minimum, "k" factor of 0.20 at 75 deg. F (R-5), 25 psi minimum compressive strength, 0.3 percent maximum water absorption by volume, square edges, manufacturer's standard board size, such as Styrofoam SM manufactured by Dow Chemical Co., Foamular 250 manufactured by Owens Corning, or approved equal. Thickness noted on Design Documents. Install on the perimeter of the foundation and wrap around under the concrete slab floor 4'-0".

(8) Concrete for equipment pads and containment areas shall be sealed with 2 coats of petroleum resistant sealant. All exposed concrete slabs, interior or exterior, shall have a combination sealer/curing compound, ASTM C309 or equivalent applied. Sealer to be Sonneborn, Tremco, or approved equal.

(9) Footing, wall, and floor heights shall be set with a laser transit to improve accuracy of determining heights for construction.

(10) Design of structural and miscellaneous steel shall be in accordance with the AISC's "*Manual of Steel Construction*". Design of structural and miscellaneous steel shall also be in accordance with NEMA Standard SG6, NEMA Standard TT1, and the International Code Council's "*International Building Code*", respectively.

(11) High strength bolts, nuts, and washers shall be galvanized in accordance with ASTM F2329. Bolts, nuts, and washers under 0.5 inches in diameter shall conform to ASTM A307, Grade B, ASTM A563 and ASTM F844 respectively, and shall be galvanized in accordance with ASTM F2329.

(12) Anchor bolts, anchor bolt assemblies, and concrete embedments shall be galvanized. Galvanizing shall conform to the requirements of ASTM A123, ASTM A153 or ASTM A2329 as applicable.

(13) Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36 or A307. Anchor bolt sleeves shall conform to ASTM A501.

(14) Column anchor bolts, dowels, reinforcement, embed plates, etc. shall be supported by chairs, bolsters, bar supports, spacers, etc. prior to concrete placement. "Wet Setting" of reinforcement, dowels, anchor bolts, embed plates, etc. is not allowed.

(15) All structural welding shall conform to the requirements of AWS Standard D1.1.

(16) Stainless steel shall conform to ASTM A167.

(17) Design of structural and miscellaneous aluminum shall be in accordance with the latest version of the Aluminum Association's "*Aluminum Design Manual*" and "*Aluminum Standards and Data*".

(18) Materials for structural and miscellaneous aluminum including structural shapes and plates shall conform to ASTM B209 and ASTM B308 and shall be aluminum alloy 6061-T6.

(19) Bolts and nuts shall conform to ASTM F468 and ASTM F467, respectively, and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

(20) Vapor retarder: 10 mil polyethylene placed under office floor and anywhere floor finish or coating shall be used to help reduce any moisture migration through the slab. All joints shall be taped and all penetrations shall be repaired and taped.

(21) Provide cork expansion joint material, ASTM D1752-67, Type II in expansion joints for interior work as required, and seal over with Vulkem 116 or equal. Provide fiber expansion joint material, Flexcell or equal in expansion joints for exterior work as required, and seal over with Vulkem 200 or equal.

10.1.4 Requirements for metal building:

(1) The O&M Building shall be standardized metal panel and steel support and framing by Butler, Morton, or Owner-approved alternate.

(2) The main frames shall be clear span.

(3) The sidewall columns shall be tapered with inset girts.

(4) The bay spacings shall be 25 feet on center.

(5) Primer color shall be standard red.

(6) Arkema's KYNAR 500 26-gauge architectural wall panels, or Owner-approved equal, shall be applied to all exterior walls. Architectural panels shall have semi-concealed fasteners. The Premium 70 finish coating system shall have a superior high-build primer application that is then coated with premium fluorocarbon coating that contains seventy percent (70%) KYNAR 500 resin.

(7) Closure strips, sealing tape, and joint sealants shall be furnished and utilized as needed to complete the metal building erection per Prudent Wind Industry Practices.

(8) To ensure weather tightness and rodent control, a finished base angle at the bottom of each wall sheet shall be included.

(9) Provision for thermal expansion movement of the standing seam panels shall be accomplished by the use of clips with a movable tab.

(10) No roof vertical supports shall be allowed in the office area.

10.1.5 Requirements for O&M Building roof:

(1) The roof pitch shall be 1½:12.

(2) The roof shall have gable ends.

(3) The roof covering shall be American's 24-gauge Aluminum Coated Steel 360º Seamless Roof System or Owner-approved equal. The panels shall be 20-feet wide with 3-inch-high crown. The high crown shall include factory-applied, all-weather mastic. The panel overlaps shall be seamed mechanically to ensure weather tightness of the roof system.

(4) The roof shall have perimeter fascia constructed of 24-guage steel with factory applied baked enamel finish and color per Section 10.1.35.

(5) Deluxe eaves which match the rake of the building shall be included.

(6) Dektite boot flashings at 4-inch to 12-inch pipe penetrations shall be provided.

(7) The roof shall have a snow retention system to prevent snow buildup drop-off.

(8) Gutters and downspouts shall be furnished and installed. Splash blocks shall be included at all downspouts. Downspouts shall not drain onto sidewalks or aprons. Gutters shall incorporate back-up drain scuppers.

(9) The roof shall be designed, installed, and constructed to a provide a 10-year guarantee against leakage.

(10) Awnings shall be installed over access doors that are located on non-gable end walls. Awnings shall be directly attached to the building walls (i.e., no exterior columns) and shall be constructed of light gage steel.

(11) Insulated roof curbing shall be provided as required for all roof-mounted equipment.

10.1.6 Requirements for O&M Building exterior doors:

(1) Overhead doors shall be 12-foot by 12-foot doors, with vinyl seal on both sides of track, hood baffle, reversing "Feather Edge", and take-up reel. Each door shall be motor operated, and openers shall come with three-stage (open/stop/close) push button. No coil/roll-up style doors are allowed.

(a) Overhead doors shall be 24-gauge factory finished steel insulated (minimum R value of 4.0) with 2-foot panel sections. Doors to have perimeter brush seal weather-stripping, and bottom astragals.

(b) Overhead doors shall have chain releases in case of power failure.

(c) Overhead doors shall have heavy duty cycling springs, photoelectric sensors and an automatic close function.

(2) Exterior doors shall be 3-foot by 7-foot commercial-grade, insulated-steel service doors with ball-bearing hinges, hydraulic closer, latch guard, weather-stripping, self-sealing sweep, ADA-compliant aluminum threshold, and keyed lockset. One (1) lite kit shall be included per door, approximate size will be half lite (8-inch by 24-inch). All exterior doors shall be properly insulated to meet current energy requirements.

(3) All door jambs shall be completely flashed to give door opening a finished appearance.

(4) All exterior doors shall be equipped with key card readers, as further described in Section 10.1.19 herein.

(5) Panic hardware shall be provided only on doors where local fire codes require they be installed.

(6) All exterior steel doors shall be painted.

(7) Door bumpers shall be provided on every door.

(8) Door keying shall be provided on every door. Bathroom doors shall include dead bolt.

(9) All exterior doors shall push open to the north and west into the prevailing wind direction.

(10) Hollow metal work shall be as manufactured by Steelcraft Mfg. or equal SDI Member, as approved. Frames shall be welded unit type with a minimum thickness of 16 gauge. Exterior hollow metal doors shall be insulated (U value of 0.24 or less). All exterior doors shall be weather-stripped. Doors constructed of aluminum are not allowed.

10.1.7 Requirements for O&M Building interior doors:

(1) Interior doors shall be 3-foot by 7-foot by 1.75-inch-thick flush solid-core commercial-grade birch wood doors. All interior doors shall be installed in primed hollow metal frames with three (3) 4.5-inch by 4.5-inch commercial hinges. The frames shall be painted and the doors shall be stained and varnished.

(a) Provide flush 5-ply construction with solid particle core bonded to stiles and rails using Type 1 waterproof glue, conforming to AWI Type PC-5. Quality grade of wood doors shall be AWI Premium with AWI Grade A oak face veneer on all sides and edges.

(2) All interior doors except the bathrooms, SCADA, and Mechanical shall have a vertical ¼ light glass.

(a) Glass shall be tempered clear float glass, ASTM C1048, Type 1, Class 1, q3, Kind FT, horizontally tempered, ¼" thick, as required for door glass lights.

(3) All interior doors shall have medium-duty commercial lever locksets.

(4) All interior doors and woodwork shall be stained and varnished. All interior hollow metal doors and door frames shall be painted.

(5) Doors shall be fire rated as set forth in Section 10.1.20 (*Fire Protection System*).

(6) Door bumpers shall be provided on every door.

(7) Door keying shall be provided on every door. Bathroom doors shall include dead bolt.

(8) Hollow metal work shall be as manufactured by Steelcraft Mfg. or equal SDI Member, as approved. Frames shall be welded unit type with a minimum thickness of 16 gauge. Interior hollow metal doors shall be a minimum thickness of 18 gauge. Doors constructed of aluminum are not allowed.

10.1.8 Requirements for O&M Building door hardware:

(1) Provide the following hardware by the listed manufacturers or approved equals:

(a) Butts -- Stanley FBB199, US26D, 1 1/2 pair

(b) Closer -- LCN 4010/4111 Series, exposed overhead surface type, Aluminum, see table below for applicable locations.

(c) Kick Plates -- Hiawatha 10" x 34", US32D

(d) Stops and Holders -- Ives, US32D

(e) Push-Pulls -- Hiawatha, US32D, ADA approved

(f) Lock Sets -- Schlage L9000 Series, US26D, mortised (no substitutions), Function as noted on Design Documents, ADA approved lever. All exterior doors and SCADA room lock sets shall be card reader capable and comply with security system requirements. Owner shall supply additional requirements.

(g) Passage Sets -- Schlage L9010 Passage Function, US26D, mortised (no substitutions), ADA approved lever

(h) All locks shall be master keyed with a restrictive keyway master keying system as directed by Owner.

(i) All required blank plates.

10.1.9 Requirements for O&M Building door details (see Table 10-2):

Table 10-2: Door Detail Schedule

Location	Material	Light	Closure	Handle
Breakroom to Hall	Wood	1/4	N	Lever
Breakroom to Shop	Metal	1/4	Y	Lever
Exterior excl Vestibule	Metal	1/4	Y	Lever Lock / Card
Hall to Shop ceiling	Metal	1/4	Y	Lever
Mechanical	Wood	None	N	Lever
Offices & Conference	Wood	1/4	N	Lever Lock
Restroom - Guest	Wood	None	Y	Lever Lock
Restroom – Mens	Metal	None	Y	Lever lock w/3 point
Restroom – Womens	Metal	None	Y	Lever
Restroom – Womens to Hall	Wood	None	Y	Lever
SCADA	Wood	None	Y	Lever Lock / Card
Vestibule – Exterior	Metal	1/2	Y	Lever
Vestibule – Interior	Metal	1/2	Y	Lever Lock / Card

10.1.10 Requirements for O&M Building windows:

(1) 4-foot by 4-foot commercial-grade vinyl horizontal slider windows, equal to Plyco Model M3025, shall be provided in the locations shown in Figure 10-1 through Figure 10-8 herein.

(2) Window frames shall be thermally broken and color per Section 10.1.35.

(3) Operable units shall include screens.

(4) Exterior windows shall be glazed with tinted insulated glass and a ½" argon gas filled airspace, total thickness of 1". All windows shall be properly insulated to meet current energy code requirements.

(a) All exterior windows shall be of vinyl construction and face shall snap out for easy glass replacement.

(b) All exterior windows shall be IGCC Class CBA when tested per ASTM E773 and E774.

(c) Outer and inner lights of ¼" thick tinted glass shall be provided conforming to ASTM C1036 Type 1, Class 1, q3.

(d) All exterior windows shall be dual sealed units with primary polyisobutylene seal, secondary silicone seal.

(5) Windowsills shall be installed on all windows and shall be either marble or granite.

10.1.11 Requirements for O&M Building room finishes:

(1) Each room in the O&M Building shall include the minimum finishes set forth in Table 10-3 (*O&M Building Room Schedule*) and as further described below. Ceiling heights are noted to be nominal heights.

Table 10-3: O&M Building Room Schedule

Room(s)	Floor	Base	Walls	Ceiling Height	Ceiling Type
Common area Hallways Break room	Vinyl composition tile	Vinyl	Painted drywall	9’0”	Acoustical tiles
Offices Break room Meeting Conference room	Carpet tile	Vinyl	Painted drywall	9’0”	Acoustical tiles
Comm / SCADA	Anti-static vinyl composition tile	Vinyl	Painted drywall/ ½” plywood	10’0”	Painted drywalls
Bathrooms	Glazed ceramic/ porcelain tile, with floor drain	Glazed ceramic/ porcelain tile	Ceramic tile/ painted drywall	8’0”	Acoustical tiles
Shop	Sealed concrete, with floor drain	Not applicable	29 ga. white liner (steel)	Sufficient for garage door track and lighting above garage door	29 ga. white liner (steel)

(a) Paint:

1. Strictly follow manufacturer’s recommendations for surface preparation and paint application. Colors to be per Section 10.1.35. Paint to be Benjamin Moore, Sherwin-Williams or approved equal.

2. Wooden surfaces shall be sanded and prepared to receive finish. All finished hardwood to receive one coat of stain, one coat of sealer, and two coats of varnish.

3. All metal doorframes and doors and miscellaneous metals shall receive one coat of primer and two coats of enamel.

4. Masonry interior walls shall receive one coat of block filler and two coats of finish paint. Gypsum board walls shall receive one coat of primer and two coats of finish paint.

5. Exterior walls to be finished as required by the exterior wall material. If exterior walls are masonry, apply one coat of block filler and two coats of enamel.

(2) Flooring:

(a) All tile shall be waxed. All tile and grout shall be sealed.

(b) Vinyl composition floor tile shall be 12-inch by 12-inch by 1/8-inch tile adhesive applied to concrete floors similar to Armstrong "Excelon" or Tarkett "Expressions". Wall base shall be a minimum of 4 to 6 inches from the top of the finished floor, vinyl base adhesive applied to walls with covered profile.

(c) Ceramic standard mosaic floor tile shale be provided with smooth, all-purpose edge. Tile shall be 12-inch by 12-inch unglazed as manufactured by American Olean or approved equal.

1. Ceramic tile shall be installed, grouted, cleaned, protected, and cured per standard specifications of the American National Standards Institute (ANSI) and the Tile Council of America (TCA).

(d) Grout shall be Latex-Portland Cement Tile Grout as made by Custom Building Products, Mapei Corp. or approved equal. Grout and ceramic tile colors to be per Section 10.1.35.

(e) Porcelain tile shall be set by the thin-set method. Anti-fracture membrane at control joints in floors for bathroom areas shall be provided.

(f) Porcelain wall tile in bathrooms shall be 5-foot high on all sides, with painted drywall above.

(g) Vapor retarder: see Section 10.1.3 herein.

(3) Walls:

(a) The interior walls shall be constructed using 3 5/8-inch, 18-guage metal studs, 24 inches on center.

(b) Shop walls shall be finished with metal to the ceiling, including around the office area.

(c) All drywall shall be 5/8-inch, taped, sanded, and able to accept paint or vinyl finishing.

(d) All bathroom walls shall have 5/8-inch moisture-resistant drywall with at least two (2) coats of semi-gloss latex applied.

(e) A 29-gauge steel liner panel to shall be used along the exposed shop wall and shall extend to ceiling height. A 2-inch by 2-inch galvanized base angle to attach liner panel at the concrete floor shall be provided.

(f) Walls shall be fire rated as set forth in Section 10.1.20 herein.

(g) Vapor retarder: on exterior walls and walls between the shop and office space.

(h) All interior walls shall be constructed as shown in the design documents.

(i) All masonry walls are to be constructed of a minimum of 8-inch standard weight block.

(j) Retractable wall: Manual noise reducing panels with one panel including a swing door, design to be confirmed by Owner.

(k) Backing (e.g. plywood) shall be installed in areas for wall-mounted TVs, whiteboards, or other expected equipment that would require mounting on walls. Backing shall be installed underneath the finishing drywall.

(4) Ceilings:

(a) All ceiling tile shall be 2 feet by 2 feet Armstrong Cortega or Owner-approved equal.

(b) The ceiling over the electrical storage, storage, and shared workshop shall be covered with 2-inch by 8-foot beams at 16 feet on center with one (1) layer of 7/16-inch OSB over the top. This shall be designed as a dust cover and not a mezzanine.

(c) For ceilings outside the high bay area, but excluding the SCADA room, Vestibule, and Mechanical room, provide a lay-in type ceiling. Lay-in ceiling shall be a 24 inches by 24 inches with 15/16-inch exposed white grid system. Grid system shall be USG Interiors or approved equal. Acoustical panels shall be non-combustible (Flame Spread A), smooth-texture with reveal edge, factory white finish similar to USG Interiors, Millennia ClimaPlus 76705, 2 feet by 2 feet x ¾ inch, SLT edge. Acoustical ceiling panels to have a minimum Noise Reduction Coefficient (NRC) rating of 0.7, Ceiling Attenuation Class (CAC) of 35 minimum and Light Reflectance of 85 (LR-1).

(d) The ceiling over the SCADA room and Vestibule shall be covered with 5/8 gypsum board taped and sanded to accept paint of vinyl. It shall be topped with R30 insulation.

(e) Office finished ceiling height shall be 9 feet.

(f) SCADA room ceiling height shall be at least 10 feet.

(g) Mechanical room ceiling height shall match building height and walls shall extend to ceiling. It shall be metal panel or drywall at the full building height.

(h) Shop area ceiling height shall be tall enough to allow room for garage door track and lightning above garage door. Ceiling shall be finished in metal.

(5) Yarn:

(a) The following manufacturers meet Owner’s standard for carpet tiles: Constantine Commercial, Mannington, and Lees.

(b) Yarn shall be 100% advanced generation nylon such as type 6.6 produced by BASF, DuPont, or Monsanto.

(c) Minimum yarn weight is 26 ounces.

(d) Minimum construction features:

1. Pile height 0.170 to 0.28 inches

2. 1/8 gauge with 8 stitches per inch or,

3. 1/10 gauge with 10 stitches per inch

(e) The primary backing synthetic shall be polypropylene. Provide 4" high vinyl base as manufactured by VPI, Johnsonite or approved equal. Use coved base with vinyl composition tile (VCT) and carpet tiles. Colors shall be per Section 10.1.35.

10.1.12 Requirements for O&M Building accessories:

(1) Provide custom millwork in the breakroom consisting of upper and lower cabinets with stove and fridge cutouts. Cabinets shall fill the area from wall to wall, include a short upper cabinet for a microwave over the stove. Millwork shall be, of quality fire retardant particleboard core finished with wood veneer (AWI "premium" grade) or plastic laminate (NEMA LD 3, GP-50 for horizontal surfaces and GP-28 for vertical surfaces). Pattern and color per Section 10.1.35. Tops to be 1 ¾ inch thick and sides to be ¾ inch thick. Countertops and Vanities are to have a 4-inch backsplash. Provide adequate bracing hidden from view.

(2) Countertops shall be installed in the break room. Countertops shall be Corian, or Owner-approved equal.

(3) The following appliances shall be installed in the kitchen / break room. All appliances shall be new, unused, and all the same brand name (or Owner-approved equal).

(a) Not used: Xcel supplies the appliances.

(4) The following items shall be provided in the quantities shown:

(a) Men's bathroom:

1. Floor-mounted toilet: as indicated in Figure 10-1 through Figure 10-8 herein (including 1 ADA toilet stall)

2. Urinal: as indicated in Figure 10-1 through Figure 10-8 herein

3. Sink: as indicated in Figure 10-1 through Figure 10-8 herein

4. Shower: 1

(b) Women's bathroom:

1. Floor-mounted toilet: 1 (including 1 ADA toilet stall)

2. Urinal: 0

3. Sink: 1

4. Shower: 1

(c) Kitchen:

1. Sink with faucet: 1

2. Ice maker connection: 1

(d) Shop / warehouse area:

1. Floor sink: 1 located in the mechanical room adjacent the exit

2. Wash sink: 1

3. Eye wash station: 1

4. Propane or natural gas tankless hot water heater, of sufficient size to satisfy the facility's needs: 1 located in the mechanical room

(5) Equipment shall meet the following requirements:

(a) Water closets – Furnish floor mount, elongated rim, vitreous china water closet with tank and solid plastic open front seat. Unit to be the Toto brand floor mounted tank units. Units are to be suitable for the handicapped and mounted in accordance with ADA requirements.

(b) Urinal – Furnish wall hung, vitreous china washout urinal and flush valve. Unit to be equal to American Standard Lynbrook 6601 with Sloan Royal Model 180-ESS flush valve.

(c) Lavatories – Lavatory consoles are to be furnished per Design Documents. Vanity surface is to be a high-pressure plastic laminate, color and design per Section 10.1.35. Lavatory unit to be vitreous china, front overflow unit. Provide faucet and pop-up drain assembly. Console and faucet shall conform to all code requirements for the handicapped. Stand-alone sink units are not acceptable.

(d) Water Heater – Furnish a U.L. listed tankless water heater. Unit and its installation to conform to all code requirements.

(e) Slop Sink - Provide a 36" x 24" x 10" molded stone service basin with shelf and vinyl bumper guards on exposed faces. Equip with Chicago chrome plated service mixing faucet with vacuum breaker, wall brace, pail hook, and 3/4" hose thread on spout with 30" long 5/8" rubber hose with 3/4" chrome coupling. Provide 24" high water proof wall boards above sink basin on wall(s) adjacent to the sink along with a mop hanger above unit with three (3) rubber tool grips. Service basin to be Fiat or equal. Sink shall be located in the mechanical room.

(f) Wash Tub - Provide a 24" x 24" wash tub in the shop between the bathroom doors. Sink shall have both hot and cold water supplied to it, along with a drain. A separate cold water hose bib shall be located next to the sink.

(g) Eye Wash - Provide a wall mount eye wash station with drain next to the shop sink. Eyewash shall meet all applicable OSHA regulations and supply temperate water. Mixing valve shall be near the unit and accessible from ground level.

(h) Hose Bibs – Provide freeze less hose bibs, one on each side of the building.

(i) Domestic water, waste, and vent piping fittings and joints shall be in accordance with the State Plumbing Code and applicable local ordinances. Insulate hot and cold domestic water pipes with 1" minimum fiberglass insulation by Certainteed or equal insulation when required by location.

(j) Break Room Sink -- Provide Elkay LR series or equal Stainless Steel sink with duo strainer and faucet.

(k) Shower -- Provide molded fiberglass shower cabinets complete with 32" x 32" base with drain, door, Chicago or equal flow saver shower head with single lever hot and cold water operator, soap dish, and shampoo bottle holder. Cabinet to be approximately 6'-6" high and shall be seamless, rustproof, and leak proof.

(l) Washer and Dryer hookups – Provide hot and cold water and drain hookups for stackable W/D unit in the Men's Locker Room or the mechanical room.

(m) Cleanout -- Provide cleanouts in areas behind water closets and as required by code.

(n) Faucets – All faucets shall be dual handle controlled. Auto sensing devices shall not be used.

(o) All plumbing faucets, fixtures, etc. shall be of commercial grade. Brand, type, style and color shall be approved by Owner prior to installation. Color shall be per Section 10.1.35.

(6) Toilet partitions shall be installed between each toilet and urinal. Partitions shall be wall- and ceiling-mounted with baked enamel finish complete with door, latch, rubber stop, and coat hook at each stall. At least one (1) toilet partition shall conform to ADA standards.

(7) Standard mirrors (approximately 36 inches by 40 inches) shall be furnished and installed in each bathroom.

(8) Paper towel dispensers and toilet paper holders shall be furnished and installed in each bathroom.

(9) Handicap grab-bar hardware shall be furnished and installed in each bathroom stall.

(10) Liquid soap dispensers shall be furnished and installed in each bathroom

(11) Lockers shall be installed in a quantity sufficient for expected staff, Owner approved. At least eight (8) lockers shall be furnished and installed. Each locker shall measure at least 8 7 feet by 12 inches by 12 inches with color per Section 10.1.35. One (1) movable hardwood bench shall be furnished and installed in front of each set of lockers. Lockers shall be floor mounted and installed in both restrooms.

(12) A built-in reception style desk shall be constructed with studs and drywall for the vertical frame and 24" deep countertops for the sit down desk and 15" deep countertops for the walk up portion. Overall height shall be 42".

10.1.13 Requirements for O&M Building signage:

(1) Men's and women's restroom signs shall be furnished and installed.

(2) ADA-compliant and visitor parking sign(s) on steel posts in front of the handicap stalls shall be furnished and installed.

(3) Interior signage, as required by the Applicable Standards and other Requirements, shall be furnished and installed.

(4) A permanent sign at the O&M Building entrance shall be furnished and installed. This sign shall include Project name, Project address, and Owner name/logo, each subject to Owner approval.

10.1.14 Requirements for O&M Building bollards:

(1) See Section 4.1.22 herein.

(2) Bollards shall be installed (a) on each side of the overhead door(s) of the O&M Building; (b) around each propane tank, backup generator, and HVAC pad, respectively, although if such equipment is adjacent to each other then bollards may not be required around every unit; (c) around the septic tank and (d) around any holding tanks.

(3) Bollards shall be installed no closer than two (2) feet from equipment.

10.1.15 Requirements for O&M Building aprons and sidewalks:

(1) HVAC pads shall have minimum dimensions of 4 feet by 4 feet by 4 inches.

(2) A concrete slab shall be installed in front of the east garage doors. Such slab shall be designed to accommodate AASHTO HS44-20 loading.

(3) All aprons and sidewalks shall be reinforced concrete with a broom finish. Minimum thickness shall be 4 inches for the sidewalks and 6 inches for aprons.

(4) Slope exterior concrete surfaces away from the building. Sidewalk slope shall be at least ¼" per foot while driving paths and parking lots shall be sloped at least 1/8" per foot.

(5) Provide concrete steps or aprons at personnel door(s), overhead doors, and at bottom of stairs. When steps are provided, also include an ADA compliant entrance ramp.

(6) Sidewalk and curb at handicap stall shall be sloped per ADA requirements for handicap access.

10.1.16 Requirements for O&M Building landscaping:

(1) Following construction, fertile topsoil (including that has been stripped from the site prior to construction) shall be spread evenly over all seeded grass and sod areas to a minimum of 6 inches.

(2) Vegetation shall be established on all disturbed land outside the fencing perimeter of the O&M Building site.

(3) All plants and landscaping shall be suitable for the location and climate in which it is being installed and shall be free of weeds.

(4) All landscaping and re-vegetation plans and designs shall be submitted to Owner for approval prior to any landscaping or planting activities take place.

(5) All disturbed areas shall be re-vegetated within the specified time period as indicated in the Project SWPPP to mitigate runoff.

(6) Wind breaks:

(a) Two rows of evergreen trees shall be planted on the exterior of the O&M Building fencing on the north and west sides to provide protection during the winter season.

(b) Trees shall be a minimum of 8 feet tall as installed.

(c) Trees shall be planted every 18 feet.

(d) Each row of trees shall be separated 20 feet.

(e) On the west side of the building, trees shall extend past the future building expansion area. Trees on the north side shall extend 100 feet beyond the building.

(f) Shrubs shall be planted on the south and east sides.

(7) Contractor shall provide watering and periodic inspection of all plantings for the duration of construction. Such inspections shall be documented in a maintenance log.

(8) Washed rock on landscaping fabric shall be utilized in between the exterior walls of the O&M building and sidewalks.

10.1.17 Requirements for O&M Building parking and driveways:

(1) The parking area shall be sufficient to simultaneously accommodate parking for at least 8 vehicles, including ADA parking requirements, and allow deliveries to the O&M Building front entry and warehouse. ADA parking shall be an end stall, if possible.

(2) All hard surfaced areas shall be shaped and graded for drainage away from the building and curbs shall not be used, all joints between concrete, pavement, and landscape shall be at the same elevation. No parking blocks or other raised items shall be installed.

(3) Parking lot striping and handicap symbol shall be painted on the paving.

(4) All parking and driveways shall be 8 inches of compacted subgrade with plant-mixed bituminous paving. Paving shall be applied in 2 layers: 3 inches base and 1 ½ inches of surfacing

(5) All concrete and paving shall meet the design and installation requirements of the Project's state Department of Transportation standard specification.

10.1.18 Requirements for O&M Building fencing and gates:

(1) The O&M Building perimeter shall be fenced.

(2) All fencing and gates shall comply with the minimum specifications in Section 4.1.10 herein.

(3) At least one (1) vehicle gate shall be installed at the O&M Building. The vehicle gate shall be a combined 14 feet wide vertical pivot gate (AutoGate model VPL-300) and an 8-foot wide manual horizontal swing gate for a total available vehicle gate width of 22 feet. Each gate shall be 7 feet high plus 1 foot of barbed wire.

(a) The vertical pivot gate shall be remote operable with an exterior pedestal mounted access card reader and phone, an interior buried open loop and photo eye safety close device, and be designed to withstand wind loads of 60 mph in operation. The photo eye opposite the gate operator shall be mounted off the horizontal gate hinge post.

(b) The manual swing gate shall be mounted to a removable post in between the vertical swing gate and manual swing gate.

(c) The vertical swing gate shall include the following aspects:

1. Heater for cold weather operation (cold climates only)

2. Heated melt away kit for under gate (cold climates only)

3. Deep cycle marine AGM batteries

4. AutoGate footing, HydroVac'd 4 feet. x 7 feet. by 12 inches. with five 12 inches. sono tubes to 72 inches deep with #4 rebar ties and setting of latch post in a 12 inches by 72 inches deep sono tube.

5. High voltage surge suppressor, 115 vac

6. EMX, IRB-MON commercial thru-scan photo-eye with protective hoods per UL325

7. LMA-1250-LV vehicle detectors

8. Patriot Detection, direct bury loops for outside/inside obstruction and inside auto exit

9. Fire department emergency access device

(4) At least 10 remote-entry devices shall be supplied and programmed by Contractor for Owner's use.

(5) At least one (1) walk gate shall be installed at the O&M Building within 10 feet of the vehicle entrance gate and one (1) walk gate opposite the vehicle access gate. The walk gates shall be a lockable, single-hung, 4-foot-wide, swing-gate for personnel access.

10.1.19 Requirements for O&M Building electronic security system:

(1) For all access control components, the subcontractor must be "Software House" certified.

(2) Security system shall be provided and installed by VTI Security. The security system shall have a UPS, local control pad and monitor, video recording capabilities, and be linked to Owner's Security Operations Center.

(3) Vehicle access control system: not used.

(4) Personnel access control system:

(a) This system shall be installed for all man doors and vehicular gates. The system shall consist of stand-alone distributed smart panels that make the access decision and must have a stand-alone storage database capability that is downloaded routinely to the central computer database. The master computer or any other computer unit that has the proper password must be able to query it. The unit must have different levels of password control to access the data or program the unit.

(b) The system shall include card readers, associated door handles and locks, and fixed interior cameras on all exterior doors and all controlled access areas within the building as specified by Owner, two exterior mounted PTZ tower cameras and 1 fixed exterior camera with locations specified by Owner, operable entrance gate with loop detector, photo eye sensor, and call box with external dialing capabilities and pin hole camera.

(c) The card system must use a proximity or RFID card.

(d) This system must have anti-passback capabilities to prevent multiple use of the card in a short time frame. This can be accomplished through read-in and read-out card readers with a timeout feature that prevents multiple uses at the same reader with in a user-defined time frame.

(e) This system must be able to work in a local area network and/or wide area network environment and allow access from other computers on the network.

(f) The software must be capable of providing an audit trail of all who have accessed the database and all changes made by an individual.

10.1.20 Requirements for O&M Building fire protection system:

(1) The fire protection system shall receive the approval of Owner's insurance carrier.

(2) Portable CO_2 and dry chemical fire extinguishers shall be furnished and installed in the building, in a quantity and type sufficient to ensure compliance with the Applicable Standards and other Requirements. At a minimum, one (1) 10-pound ABC-type fire extinguisher (including mounting device / cabinet) shall be installed at every exit door, break room, and utility room, respectively.

(3) All local alarm, detection, and suppression panels shall report status to the main fire alarm panel located in the control room.

(4) All areas of the O&M Building shall be provided with smoke and heat detectors as the form of fire detection.

(5) Detectors shall be hardwired to a central alarm panel in the mechanical room and be supplied with all necessary equipment to send an alarm signal to the Xcel Energy Security Operations Center.

(6) The following walls and doors shall be fire rated for the minimum times shown, or as required by the authority having jurisdiction, whichever is greater:

(a) Interior wall between warehouse and office areas: 60 minutes.

(b) Interior doors between warehouse and office area: 60 minutes.

(c) Interior SCADA / communications room walls: 60 minutes

(d) Interior door to SCADA / communications room: 60 minutes

10.1.21 Requirements for O&M Building potable water system:

(1) The potable water system shall be designed to provide potable water, both hot and cold, at the proper pressure, temperature, and flow rate to all plumbing fixtures and equipment.

(2) The potable water system shall include chlorination, charcoal filters, or other treatment as required.

(3) Domestic water and refrigerant piping shall be type L copper tubing with soldered joints and fittings using lead-free No. 95-5 solders. All valves shall have brass bodies and shall be designed for a working pressure of 125 PSI. Alternatively, domestic water pipe material may be PEX type upon owner approval.

(4) All potable water piping shall be insulated with foam pipe insulation as required and sterilized in accordance with AWWA standards for disinfecting purposes prior to filling. As required by location, domestic water, refrigerant, and roof drain piping shall be insulated.

(5) At least two (2) insulated exterior hose bibs shall be installed.

(6) Water well requirements:

(a) Contractor shall furnish and install a water supply well. The work includes the excavation of a well bore, furnishing and installing a permanent well casing and screen, providing a gravel pack around the screen; installation of surface well seal; disinfection, development and test pumping of the completed well.

(b) Casing: Contractor shall furnish and install steel well casing and surface casing material conforming to ASTM A53 (Grade B).

(c) Screen: Contractor shall furnish and install a wire-wrapped well screen fabricated of Type 304 stainless steel continuous slot wire wound screen.

(d) Gravel pack: the gravel pack shall consist of hard, durable siliceous particles of washed gravel, containing no flat or elongated particles and not more than five percent (5%) particles with a fractured face. The gravel shall be placed by the tremie method without free fall. The gravel shall be disinfected with a chlorine solution containing not less than 200 milligrams per liter of available chlorine prior to placement in the annular space. The acceptable gravel pack envelope for the production wells will be based on the results of the grain size distribution analysis performed on samples collected from a test hole drilled at the production well site. A multiplier range of 3 to 6 times the d30 (cumulative percent passing) of the finest sample within the screened interval of each production well is acceptable for the filter pack. The gravel pack should have a uniformity coefficient of < 2.5.

(e) Production well seal: seal well after test pumping and after gravel pack thickness lost during development and test pumping is replaced in the well. Install a bentonite chip well seal on top of gravel pack; bentonite seal shall be a minimum thickness of five (5) feet. Install cement grout from the top of the bentonite seal to the bottom of the pitless adapter unit by pressure grouting.

(f) Well development: after construction of the well, the well shall be fully developed in order to obtain its maximum capacity. Contractor shall furnish all necessary pumps, power units, agitator plungers or other needed equipment, and shall develop the well by such approved methods as shall be necessary to give the maximum yield of water per foot of drawdown and extract from the water bearing formation the maximum practical quantity of such sands as may, during the life of the well, be drawn through the screen when the well is pumped under maximum conditions of drawdown. The well shall be bailed, washed, agitated, surged and developed until the water has a turbidity of not greater than 2 nephelometric turbidity units (NTU) and shall pump no sand.

(g) Well test: after the well has been completed and developed, as and to the extent specified in the preceding subparagraph, Contractor shall furnish, install, and operate all test pumping and auxiliary equipment necessary to measure the rate of pumping and determine the drawdown for a period of not less than eight (8) hours at the design pumping rate.

(h) Disinfection: after the well has been completely constructed, it shall be thoroughly cleaned of all foreign substances including tools, timbers, rope, debris of any kind, cement, oil, grease, joint dope and scum. The casing pipe shall be thoroughly swabbed, using alkalis if necessary, to remove oil, grease or joint dope. The well shall then be disinfected with a chlorine solution.

(i) Submersible well pump: Contractor shall supply and install a new turbine submersible pump. Pump specifications will be developed based on the field testing conditions observed during the well pumping test. The pump shall have a minimum efficiency of eighty percent (80%) at the designed operating condition and shall be capable of operation at any condition without operating above the nominal horsepower rating of the pump motor, not including service factor. A check valve shall be installed in the drop pipe, immediately above the pump assembly; the check valve will be installed to prevent backflow into the well.

(j) Pitless adaptor unit: Contractor shall supply and install a Baker Monitor pitless adaptor unit. The unit shall have (a) bury depth sufficient to prevent system from freezing; (b) water-tight cap with screened well vent extending at least two (2) feet above 100-year flood level; and (c) water sampler valve.

(k) Discharge piping: Contractor shall install discharge piping to connect the pitless unit to the new transmission water lines below grade. A flow meter, check valve, and gate valve shall be installed within a valve vault.

(l) Water line: Contractor shall provide a water line piping system complete with pipe, pipe fittings, valves, strainers, expansion loops, pipe hangers, inserts, supports, anchors, guides, sleeves, and accessories with this specification and the drawings. Pipe shall be designed to observe limits on flow velocity, pressure drop and gauge pressure associated with the pipe type and characteristics. All pipe and piping components that come in contact with the water process stream shall be NSF61 approved for potable water contact. Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures listed in the following table plus applicable allowance for surge unless otherwise specified.

(m) Chlorination system: Constructor shall supply a chlorination system that complies with all applicable Requirements.

10.1.22 Requirements for O&M Building sanitary wastewater:

(1) Sanitary wastewater shall be collected from the various points of origin in the facility and diverted to a city sewer system, if available, or diverted to a septic tank, and discharge from the septic tank shall be routed to a leach field.

(2) A pumped sanitary wastewater system shall only be used if a gravity system is impractical.

(3) Floor drains shall be installed in the shop area and in each bathroom. An oil-water separator is required in the drain in the shop area.

(a) Vehicle parking area of shop shall include a floor trench drain that flows into a minimum 260 gallon oil and water separator located to the south of the west wall garage door and then into a holding tank located outside to the north of the west wall shop door. Minimum trench width shall be 12 inches and depth shall be 8 inches below the bottom of the grating at the low point. Grating shall be galvanized.

(b) Mechanical room floor drain shall be positioned to allow all equipment to drain to it without the use of a condensate pump or in the walk path to the slop sink.

(c) Provide drain in SCADA room for wall mount AC unit.

(d) Drain line from the building to the septic tank shall be at a depth to prevent freezing from HVAC condensate flow.

10.1.23 Requirements for O&M Building heating, ventilating, and air conditioning system:

(1) Heating elements shall be propane or natural gas-fired. Cooling elements shall be electric. HVAC system shall be designed and sized to meet regional climate conditions. Recommended manufacturers are Trane, McQuay, AAON, and York.

(2) The heating, ventilating, and air conditioning systems shall satisfy the workspace environmental requirements for personnel occupancy and equipment operation.

(3) Minimum ventilation rates shall be provided in normally-occupied areas in accordance with the Applicable Standards and other Requirements. In the absence of local codes, ASHRAE Standard 62 requirements shall be met. A minimum of five (5) air changes per hour of ventilation or recirculation air shall be provided for effective mixing during heat removal ventilation or air conditioning of normally occupied spaces. Ventilation system shall have a carbon monoxide (CO) detector with manual override timer.

(4) The air conditioning for control and electrical equipment shall be designed to meet the filtration levels as defined by ASHRAE Standard 52. Minimum EER or SEER ratings for package cooling unit to meet current Code requirements. There shall be low-ambient control and a 5-year compressor warranty.

(5) Interior cooling loads for the SCADA room shall be based upon actual equipment to be installed and ASHRAE Standard requirements. This air conditioning unit shall be a ductless mini-split air conditioning unit. Condensing unit to be mounted on the ground in shop area along the bathroom wall. A high temp alarm shall be installed in the room and alarm to the adjacent hallway via sound or flashing light.

(6) Air velocities in ducts and from louvers and grills shall be sufficiently low to maintain acceptable noise levels in areas where personnel are normally located.

(7) Thermal insulation with vapor barrier shall be provided on ductwork surfaces with a temperature below the dew point of the surrounding atmosphere to prevent vapor condensation. All ductwork used for air conditioning purposes shall be insulated; ductwork used for ventilation purposes shall not require insulation.

(a) All ductwork, construction, and installation shall be in accordance with latest SMACNA standards. Ductwork shall be isolated from fans and furnace via flexible connections. Ductwork shall be equipped with fire dampers as required by codes. Branch ducts in mains shall be equipped with dampers for balancing. Flex duct shall be used for the run outs to supply air diffusers. Flex duct runs shall be no longer than 5 feet - 0 inch long. Each run out to each diffuser shall be equipped with a butterfly type balancing damper. Supply air ductwork shall be insulated with minimum 1-1/2 inch thick glass fiber exterior duct insulation with foil vapor barrier. Insulation conductivity not to exceed 0.25 BTU/inch/square feet/hour at a mean temperature to 75° F.

(b) Diffusors shall provide ability to manually adjust air flow in each room. Supply air diffusers shall be Price, Titus, Hart & Cooley or an equal square lay-in 2-feet by 2-feet adjustable pattern.

(8) Exhaust fans for bathrooms and locker room shall be furnished and installed. Exhaust systems shall be provided above the roof for toilet, shower and locker room areas and shall be controlled by occupancy sensors. Outdoor ventilation air shall be based on normal room occupancy or local codes, whichever is more stringent.

(a) Provide Greenheck vent set exhaust fans, complete with insulated roof curbs, bird screens, and back draft dampers. Restroom fans shall provide a ventilation rate meeting current Mechanical Code and ASHRAE requirements for restroom areas. Exhaust fans shall be controlled by the room automatic light switch. Provide for make-up air. Units shall be U.L. listed. Exhaust ductwork shall have 1-1/2 inch exterior insulation with foil extending from the roof curb to at least 6 feet - 0 inches from the roof curb.

(9) Functional supply duct louvers shall be provided in all office area rooms.

(10) Return air ducts shall be wall mounted near the floor.

(11) All thermostat locations shall be in room programmable units with a minimum 5-2 day program and be hard-wired to a circuit board zone controller. Wireless devices are not allowed.

(12) In-floor Heat:

(a) Hydronic in-floor radiant heat system shall be installed in regions subject to prolonged freezing conditions and shall be manufactured by Wirsbo or equivalent, and zoned to match forced air zones (zones to be approved by Owner).

(b) Propane or natural gas boiler with at least 92% efficiency

(c) Radiant or forced air propane or gas heaters shall be installed in the shop area in regions where radiant floor heat is not used. Placement and quantity to depend on climate and be approved by Owner.

(13) Forced Air Furnace:

(a) Floor mounted propane or gas furnace with at least 92% efficiency.

(b) Furnace shall include a 1-inch or 4-inch filter housing, , air conditioning coil, variable speed supply blower with premium efficiency motor, and an economizer package.

(c) An emergency cooling duct with a manual damper shall be connected to the SCADA room.

10.1.24 Requirements for O&M Building insulation systems / thermal and moisture protection:

(1) Caulking and backer board, as recommended by the manufacturer and to seal exterior and interior joints at expansion joints, frames of doors, windows, and other wall openings, shall be furnished and installed.

(2) Roof insulation shall be such that an *R* value of at least 30 is achieved. Thermal blocks shall be included within the roof system.

(3) All building walls and roof shall be insulated. Exterior wall insulation shall have an *R* value in accordance with current International Energy Code with local and state building code amendments. All interior office walls shall be insulated with 3.5-inch fiberglass batt insulation for sound control.

(4) Exterior office walls shall be spray-foamed at least 1 inch thick up to a height of 10 feet to seal air gaps.

(5) Miscellaneous insulation for filling voids at roof eave, roof peak, door frames, window frames, and other similar areas shall be furnished and installed.

(6) The SCADA room shall have a minimum R30 insulation on the ceiling.

10.1.25 Requirements for O&M Building electrical service, general:

(1) All convenience outlets shall be on 20A circuits.

(2) All equipment and materials shall bear UL label.

(3) Underground conduit shall be PVC and shall conform to the specifications for conduit set forth herein.

(4) All transformers shall be installed exterior to the building.

(5) Install receptacle outlets as specified in accordance with NFPA 70/NEC.

(6) At the service entrance, the local utility shall provide a transformer and primary service to the transformer. Contractor shall provide the secondary service into the building and is responsible for verifying the entrance location with the local utility. Contractor shall be responsible for the coordination with the local utility on the placement of the transformer. Contractor shall coordinate with local utility in metering installation.

(7) The electrical service to this building shall be single phase and sized to accommodate all electrical loads, including EV chargers, with 30% contingency and a 400-amp minimum. The service entrance equipment shall be grounded per code, and the grounding conductor installed in conduit.

(8) Level 2 electric vehicle (EV) chargers shall be provided in the shop area in a quantity sufficient to charge the amount of vehicles possible in the shop area. Additional chargers with two (2) ports shall be provided by the east shop garage door and next to the sidewalk by the paved parking area in front of the offices. Placement of all chargers subject to Owner approval.

10.1.26 Requirements for O&M Building grounding:

(1) Grounding shall be in accordance with NFPA 70/NEC. All feeder and branch circuits shall have a green-colored insulated equipment ground conductor in addition to any metallic conduit being bonded to the equipment grounding system.

(2) Ground fault protection shall be installed in receptacles in warehouse and workshop where power tools are used, and in restrooms and other locations as required by NFPA 70/NEC.

(3) The facility shall have a #4/0 AWG bare copper ground counterpoise with 0.75-inch by 10-foot copper-clad steel ground rods. The counterpoise will be connected to service entrance equipment, derived source transformer secondary neutrals, telecommunications main ground bus bar, and all building columns.

(4) The building shall have an array of air terminals, roof conductors, and down conductors. The lightning protection system shall be interconnected to the ground counterpoise system. Requirements for the building's lightning protection system shall be as determined and recommended by NFPA 780.

10.1.27 Requirements for O&M Building power distribution system:

(1) Service entrance conductors shall be installed to tie into the main distribution panel and terminated and tested by Contractor. The main distribution panel in the building shall be service-entrance rated.

(2) Feeders shall extend from the main distribution panel to serve general power panel boards.

(3) Panel boards and associated feeders shall be sized for twenty percent (20%) spare capacity. Panel boards shall contain space for twenty percent (20%) additional spare circuit breakers.

(a) Provide a Square D or equal panel board type NQOD.

(b) Provide panel board identification with an engraved plastic laminate nameplate.

(c) Panelboards shall have Square D QO breakers rated for a minimum of 10,000 A.I.C. at 240V Panel boards to be suitable for use as service entrance equipment and shall have a hinged door and lock.

(d) Panel boards shall have a minimum of 42 circuits and a 200A minimum bus rating. Contractor shall size breakers and provide power for all electrical loads.

(e) Provide a typed directory of circuits mounted behind clear plastic inside the panel board door.

(4) Building electrical service shall include an automatic transfer switch, propane tank heater, and pad-mounted generator. The backup service shall be sized equal to the utility service and provided with sufficient fuel to operate for a minimum of two (2) days without refueling. A propane or natural gas generator is required; a diesel generator is not allowed. Backup generator shall have a capacity of 40 kVA and be a Generac, or Owner approved equivalent with the extreme cold weather kit. Owner shall approve all items related to the backup generator prior to procurement.

10.1.28 Requirements for O&M Building wiring and conduit:

(1) All wiring shall be in conduit except above the finished office area as allowed by code. Type MC/AC cable shall only be used for lighting connections to/from junction boxes and lights with a maximum length of 10 feet.

(2) Low voltage wiring shall be provided for all HVAC control and run in conduit.

(3) Each length of PVC conduit furnished with coupling on one end and metal or plastic thread protector on the other end. Sizes of conduit, fittings and accessories as indicated, specified or as required by Applicable Standards or in accordance with NFPA 70/NEC requirements.

(4) Terminate all conduit runs with insulated bushings.

(5) Provide all fittings necessary for a complete installation.

(6) Lighting branch circuits, telephone circuits, fiber optic cables and intercommunications circuits shall be routed in separate conduit systems. Lighting circuits shall be routed in electrical metallic tubing for indoor concealed areas, rigid conduit for outdoor areas, and PVC tubing or Schedule 40 PVC conduit for underground.

(7) Threaded, galvanized, rigid steel conduit or intermediate metal conduit shall be PVC tape wrapped or coated for underground use and will be used in all exposed, outdoor and hazardous locations.

(8) All conductors shall be copper.

(9) All conductors #10 AWG and smaller shall be solid conductor. All conductors #8 AWG and larger shall be stranded conductor.

(10) All feeder and branch circuit wire shall be single conductor and have THWN/THHN insulation.

(11) All electrical enclosures mounted outdoors shall be NEMA 4X, stainless or aluminum.

(12) Isolate emergency lighting circuit conductors from all other wiring.

(13) Wiring Devices:

(a) Shop to have quiet toggle wall switches. Switches shall be rated at 15 or 20 A, 120 VAC. Switches shall be similar to Hubbell 1221 Series. Receptacles shall be similar to Hubbell 5262 Series.

(b) Furnish and install occupancy sensors in offices, conference room, break room, mechanical room, SCADA room, small parts room, locker rooms and restrooms.

(c) Switches and receptacles shall be white in all areas except the shop, which shall be gray. Cover plates shall match switches and receptacles in all areas except for shop and parts storage areas where the covers shall be galvanized steel.

(d) Provide a 240 VAC outlet in the shop to the south of the west garage door and to the south of the man door from the office to the parts area.

(e) Provide a 240 VAC outlet in the shop for the washer and dryer unit.

(f) Provide one 120 VAC exterior receptacle on each side and in between the two shop overhead doors and one 120 VAC exterior receptacle on each of the remaining 3 sides of the building.

(g) Provide a 120 VAC flush mount floor receptacle in the center of the conference and break rooms.

(h) Provide two 120 VAC twist lock 30A receptacles and one 120 VAC 20A duplex receptacle to Owner corporate network rack. Receptacles shall be mounted in 4 square boxes. Owner to confirm mounting locations.

(i) Provide two 120 or 240 VAC 30A circuits and one 120 VAC 20A circuit to each Turbine Supplier server cabinet. Confirm size with Turbine Supplier.

(j) Provide 5 lug ground bar mounted on the wall of the SCADA room that is grounded directly to the service ground via #6 THHN copper conductor.

10.1.29 Requirements for O&M Building exterior lighting:

(1) Exterior lighting shall be provided by building-mounted, LED light fixtures at facility personnel and overhead doors. Fixtures to be centered on each exterior wall (quantity of four) with a prismatic lens, and factory installed photo electric control on each fixture. Lighting levels shall meet the intensities indicated in the IES handbook and NFPA 70/NEC.

(2) Exterior lighting shall be controlled by lighting contactors with hands-off auto selector switches and photocells and should be equipped with vandal-resistant lenses.

(3) Alternate circuitry must be used in the power circuits so that the failure of any one lamp does not leave a large portion of critical or vulnerable areas in darkness.

10.1.30 Requirements for O&M Building emergency lighting:

(1) The facility shall use fluorescent fixtures with internal battery backup ballast for emergency egress locations such as corridors, hallways, and fire exits.

(2) Exit signs shall be illuminated LED type located at fire exits and required locations.

10.1.31 Requirements for O&M Building interior lighting:

(1) Lighting levels shall meet the intensities indicated in the IES handbook and NFPA 70/NEC.

(2) Provide lighting throughout the building as follows:

(a) All rooms except shop, parts storage, and mechanical room: Lay-in type 2, 3, or 4 lamp LED fixtures with parabolic lens, electronic ballasts, T-8 lamps, lighting level 40 foot-candles at 3 feet off floor, Lithonia or equal.

(b) Shop, parts storage, and mechanical room: Industrial type 2 lamp, 4 and/or 8 foot long LED fixture with baked enamel reflector, electronic ballast, T-8 lamps, lighting level 20 foot-candles at 3 feet off floor, Lithonia or equal.

(c) Exit Lights: LED type exit lights.

(d) Recessed can light with shower trim in each shower stall.

(3) A lighting control system shall be used to control fixtures in office areas. The lighting control system will have local low voltage switches for local control. Offices will be locally switched and have motion sensors to shut off the circuit automatically when the room is unoccupied.

10.1.32 Requirements for O&M Building communications:

(1) A complete data network system shall be provided including all distribution cable and jacks. A telephone line shall be provided to the fax area and admin area.

(a) Communication circuits shall be run in cable tray above ceiling with conduit extending down into walls.

(b) A single wall box with 2 data ports is required in each office, parts room, admin area, copier area, conference room, and SCADA room.

(c) The break room shall have 2 wall boxes with 2 data ports each on each wall, excluding the wall with kitchen cabinets.

(d) Flush mounted floor boxes with 4 data ports shall be installed in the center of the conference and break rooms.

(e) Flush mounted floor boxes with 7 data ports shall be installed in the center of the break room or spread across the center of the break room, depending on the size of the O&M Building.

(2) Coordinate installation work with local telephone Owner and Owner's Communication Technicians. Owner will order communication circuits.

(3) All ethernet wiring shall be Cat 6 type cable.

(4) A cell phone booster shall be included such that the extents of the O&M building are covered.

(5) HDMI cables, associated conduit, and ports shall be included in the conference room and break rooms between where TVs are expected to be mounted on the wall and the floor box or a wall box, locations subject to Owner approval

10.1.33 Requirements for O&M Building garbage enclosure (if required by local building codes/ordinances):

(1) The O&M Building shall include a separate, detached garbage enclosure. The enclosure shall be installed at an Owner-approved location.

(2) The enclosure shall be constructed of treated wood.

(3) The enclosure shall be 10-feet high on all sides and shall include at least 12 inches of clear space between the dumpster and enclosure in all directions.

(4) The front of the enclosure shall include a solid screening gate on a metal frame with hinges and a center latch. Such gate shall swing out to an angle greater than 90 degrees and create an opening wide enough to allow a truck to easily access the dumpster. Pins shall not be required to hold gates open while the dumpster is being accessed.

10.1.34 Requirements for O&M Building storm shelter:

(1) The storm shelter shall be (a) ventilated; (b) compliant with FEMA 320, FEMA 361, and ICC 500; and (c) sufficient in size to safely and comfortably accommodate Owners staff at the site. Contractor to coordinate with Owner for the number of personnel the storm shelter is to accommodate.

(2) The storm shelter shall be equipped with three latch points, operated by a single handle, and include a deadbolt lock.

(3) The men's locker room shall be built to provide an effective storm shelter and safe room constructed of 8-inch reinforced masonry walls or 6-inch reinforced concrete wall, 6-inch hollow core precast plank or 18-gauge roof joists and 18-gauge metal roof decking with 6-inch minimum concrete slab, footing depths to withstand overturning/uplift and designed to withstand wind gusts during an extreme event. Design shall be in accordance with International Code Council 500 (ICC) and FEMA P-361 Safe Rooms for Tornados and Hurricanes – Guidance for Community and Residential Safe Rooms. The locker room roof shall be used for storage and signage with roof deck rating shall be posted.

10.1.35 Requirements for O&M Building colors and finishes:

(1) Contractor shall provide each aspect of the O&M Building with the color and/or finish as prescribed in Table 10-4. Any additions or deletions from this table shall be explicitly approved by Owner.

Table 10-4: Color and Finish Schedule

Material	Color	Location
Acoustical grid	White	
Acoustical tile	White w/reveal edge	
Canopy	Brown	
Canopy soffit	White	
Carpet tile	Dark blue speckled w/various colors	Offices, conference
Ceramic floor tile	Matt dark grey, light black blend	Restrooms, vestibule
Ceramic grout	Pewter	Restrooms, vestibule
Ceramic wall tile	Matte grey / smoke	Restrooms
Door hardware	Satin Nickel	
Laminate cabinet	Honey oak to light cherry	Break room
Laminate countertop	Matte black marble	Break room, restrooms, admin
Locker	Tan	Restrooms
Locker bench	Honey oak	
Metal roof panel	Galvalume	Roof
Metal trim	Tan	Exterior
Metal wall panel	Tan	Exterior
Metal wall panel	White	Shop/parts walls and ceiling
Outlet cover	Light almond	All but shop/parts
Outlet cover	Steel grey	Shop, parts
Overhead door	Brown	Shop
Paint	SW 6101 Sands of Time	Vestibule, admin, hallways
Paint	SW 7059 Unusual Grey	All other areas
Plumbing fixture	Satin Nickel	
Steel door and frame	Black	
Toilet Partition	Slate	
VCT	Tan	Breakroom, SCADA, hallways
Vinyl base	Black	
Wood door	Light cherry	

10.2 Submittals

10.2.1 Contractor shall prepare the O&M Building design documents per the submittal schedule in Exhibit C (*Submittal Schedule*) and containing the following information, at a minimum: (a) electrical works, including grounding and lighting plans, one-line diagrams, electrical load list, power distribution board, communications, and construction specifications; (b) civil works, including site plan, subgrade preparation, grading/drainage, paving plan/design, and laydown area; (c) structural works, including structural steel drawings, foundation and equipment pads (locations and details), rebar, design calculations, and construction specifications; (d) mechanical works, including equipment arrangements/locations, equipment list, HVAC layout, fire protection and monitoring, piping and plumbing, vendor drawings (as applicable), and construction specifications; (e) architectural works, including building layout/plans/elevations, finishes, schedules for windows and doors, and hardware; (f) drawing index; (g) bill of materials; and (h) inspection, testing, and quality control requirements.

10.2.2 Contractor shall provide a final layout and site plan to Owner within 30 calendar days following execution of the Agreement. Such layout shall be 10% design quality or greater and subject to Owner approval.

10.2.3 Contractor shall provide all O&M Building design, construction plans, specifications, product sheets, and any similar documents in "Issued for Construction" form and approved by Owner prior to commencing construction on the O&M Building or the designated O&M building site area.

10.2.4 Contractor shall provide the landscaping plan to Owner for review. Landscaping work shall not commence prior to Owner approval of such plan.

10.2.5 Contractor shall provide a water quality test report for the O&M Building water supply. Water shall meet EPA primary and secondary drinking water standards or local state drinking water standards if more stringent.

10.2.6 Contractor shall submit material and color (interior/exterior) samples for Owner approval if material finish and color is not already specified per Section 10.1.35.

10.2.7 Contractor shall submit copies of manufacturer warranties and operation manuals (as applicable) for all permanently-installed equipment and materials.

10.2.8 Contractor shall submit manufacturer's product sheets (material cut sheets) for all permanently-installed equipment and materials. This shall include, but is not limited to, generators, transformer, electrical panels, signage, fixtures, appliances, and other similar items.

10.2.9 Contractor shall submit a training plan for the O&M building operations and conduct training with select Owner personnel after the building is completed.

10.3 O&M Building

10.3.1 Contractor shall design, furnish, construct, and install one (1) O&M Building.

(1) The O&M Building shall be constructed at a location to be approved by Owner.

(2) Contractor shall furnish all labor, equipment, materials, land rights, and permitting that are necessary for a complete, fully-functional, and safe O&M Building configuration, excluding only the Owner-Supplied Equipment in Exhibit J (*Owner-Supplied Equipment / Owner-Supplied Work*).

(3) The O&M Building shall be located on a minimum of five (5) acres of land within or directly adjacent the Project Site and shall include a fenced and graveled storage area suitable for large parts (e.g. panels, conexes).

(4) Contractor shall furnish and install a backup generator for the O&M Building.

(5) Contractor shall furnish and construct a garbage enclosure at the O&M Building, as required by local codes/ordinances or other requirements.

(6) Contractor shall integrate a storm shelter into the men's bathroom in the O&M building.

(7) Contractor shall furnish and install fencing around the perimeter of the O&M Building, including one (1) man-gate and one (1) vehicle gate, respectively.

(8) Contractor shall provide professional cleaning service for the O&M Building at the conclusion of the Work, including, but not limited to, cleaning light fixtures, mirrors, sinks, toilets, cabinets, and lockers; washing floors; washing windows; and waxing VCT.

(9) Contractor shall provide training to Owner regarding the operations of the O&M Building upon completion of all construction activities.

(10) Contractor shall furnish and install the security system at the O&M Building. Cameras shall be positioned to allow for monitoring of entry points and major equipment, with final monitoring locations to be approved by Owner.

Figure 10-1: Solar / BESS O&M Building Interior Layout – 1,020 square feet

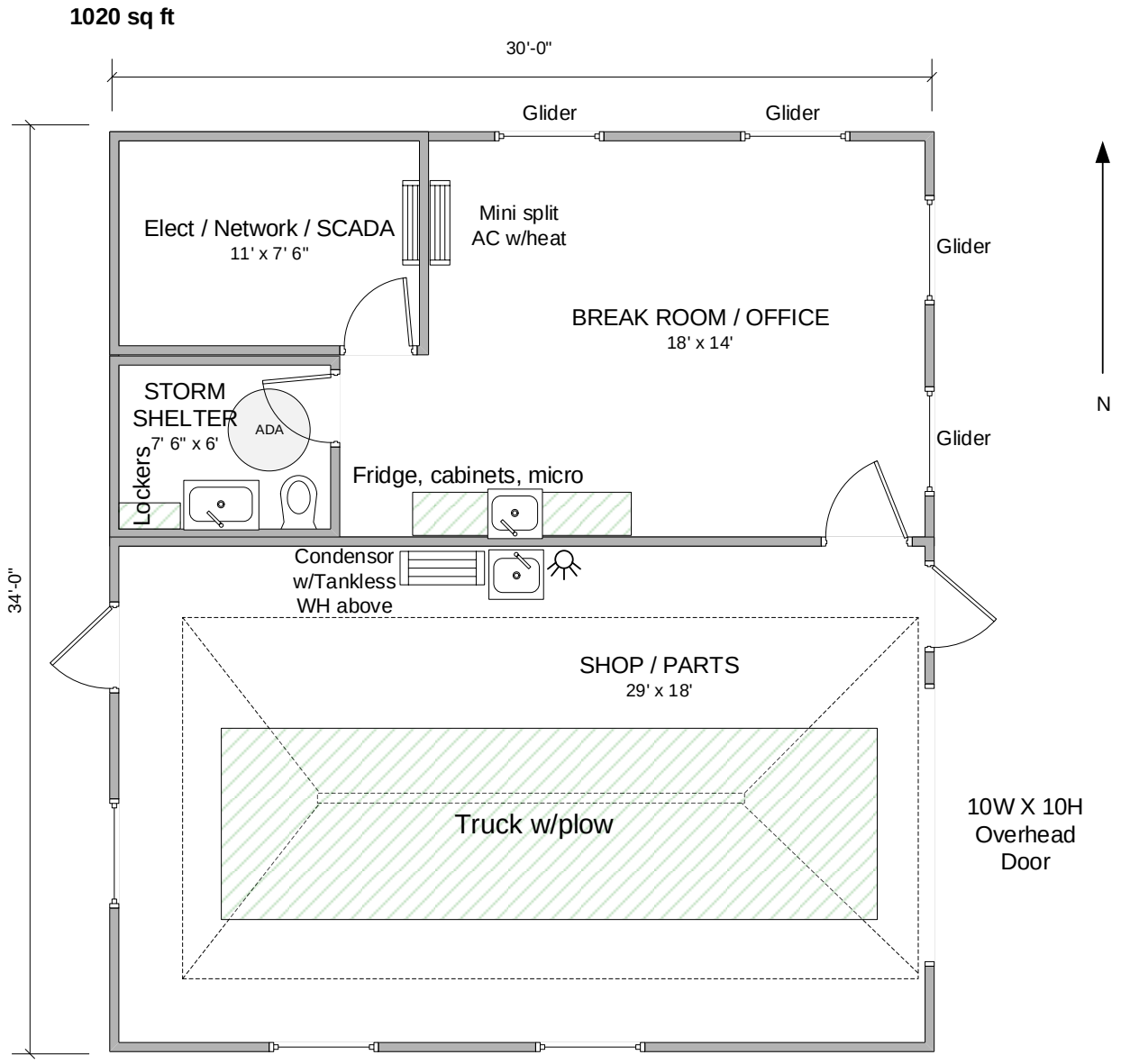


Figure 10-2: Solar / BESS O&M Building Interior Layout – 4,140 square feet

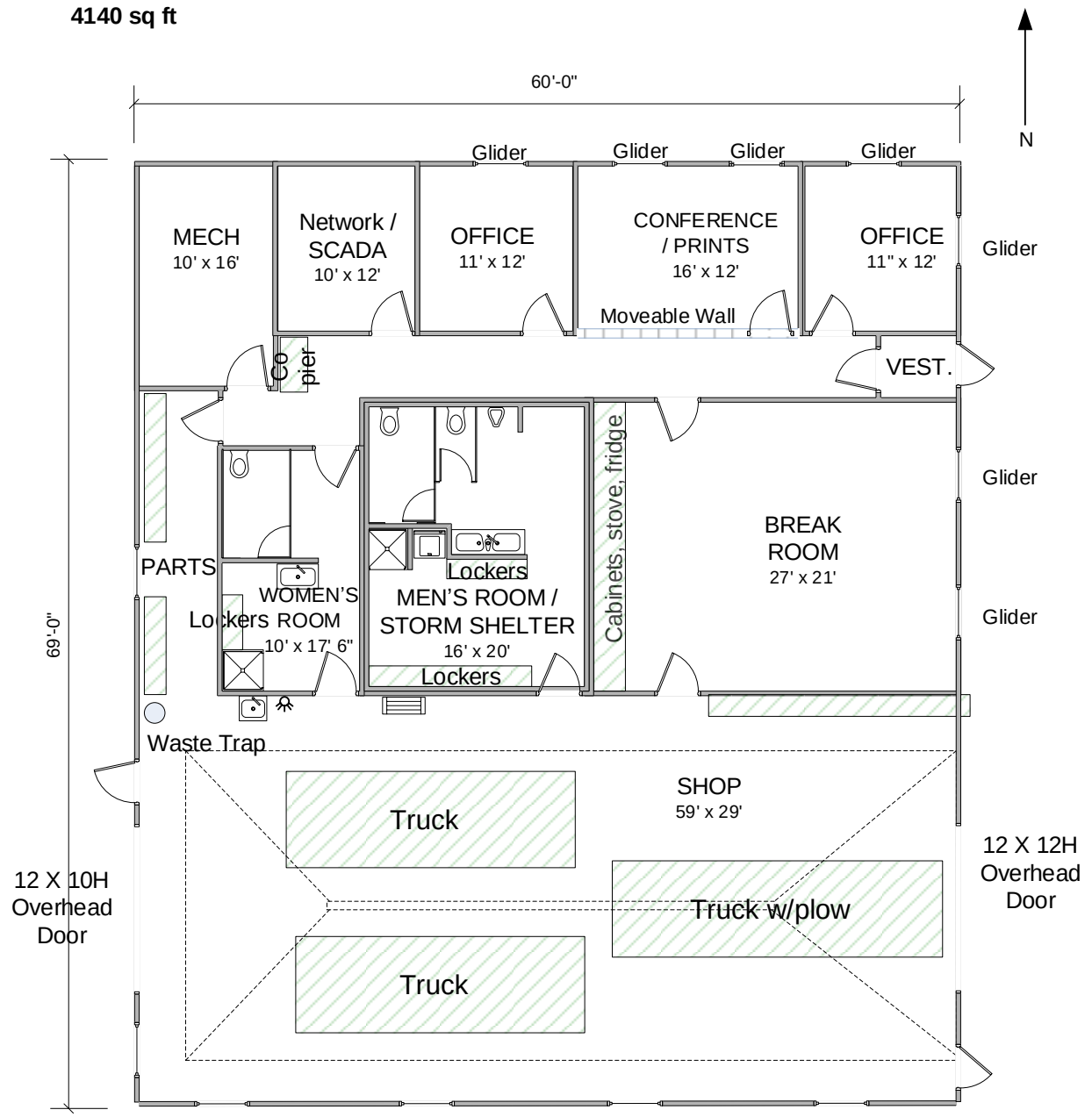


Figure 10-3: Solar / BESS O&M Building Interior Layout – 5,780 square feet

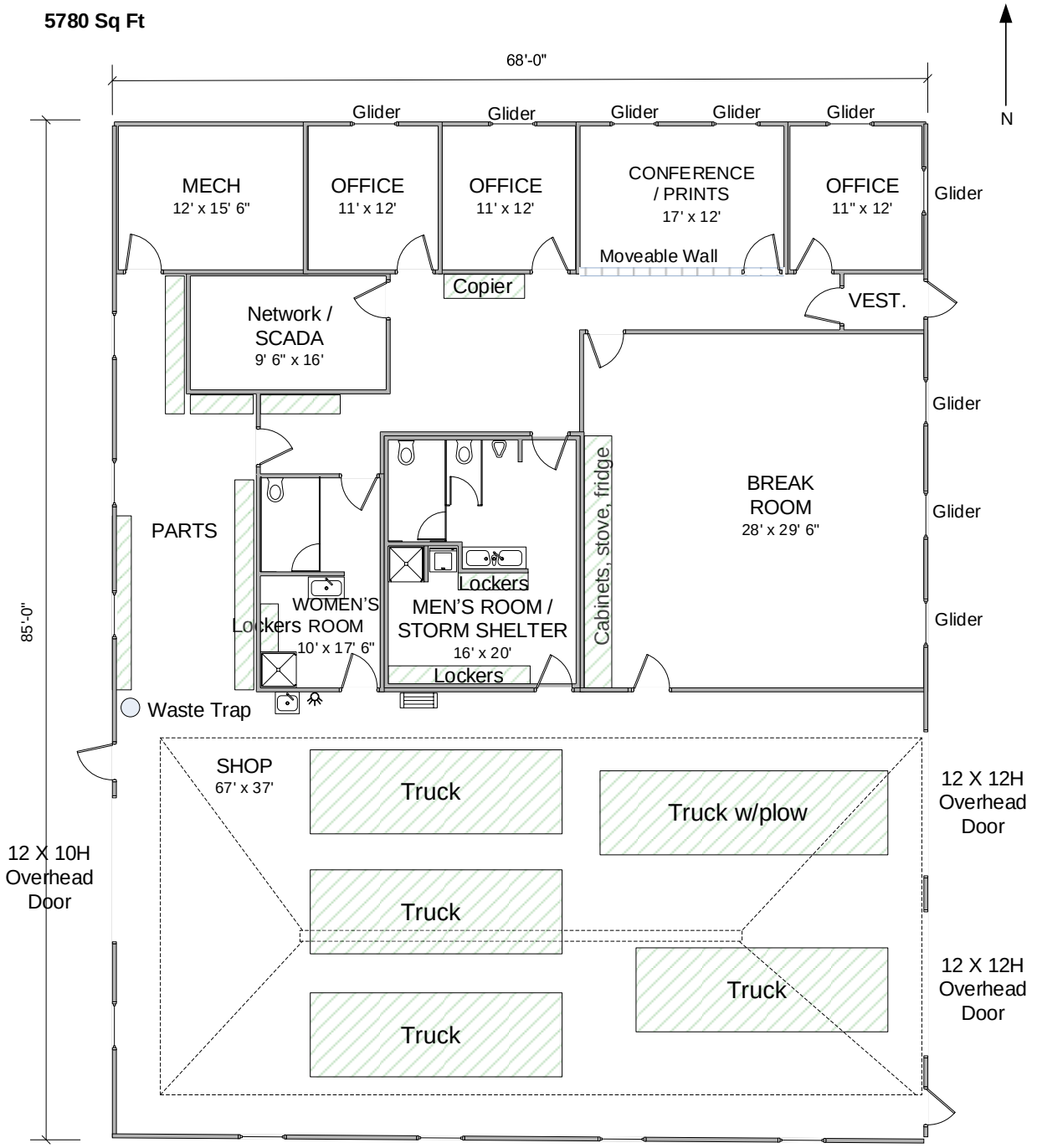


Figure 10-4: Wind O&M Building Interior Layout – 7,520 square feet

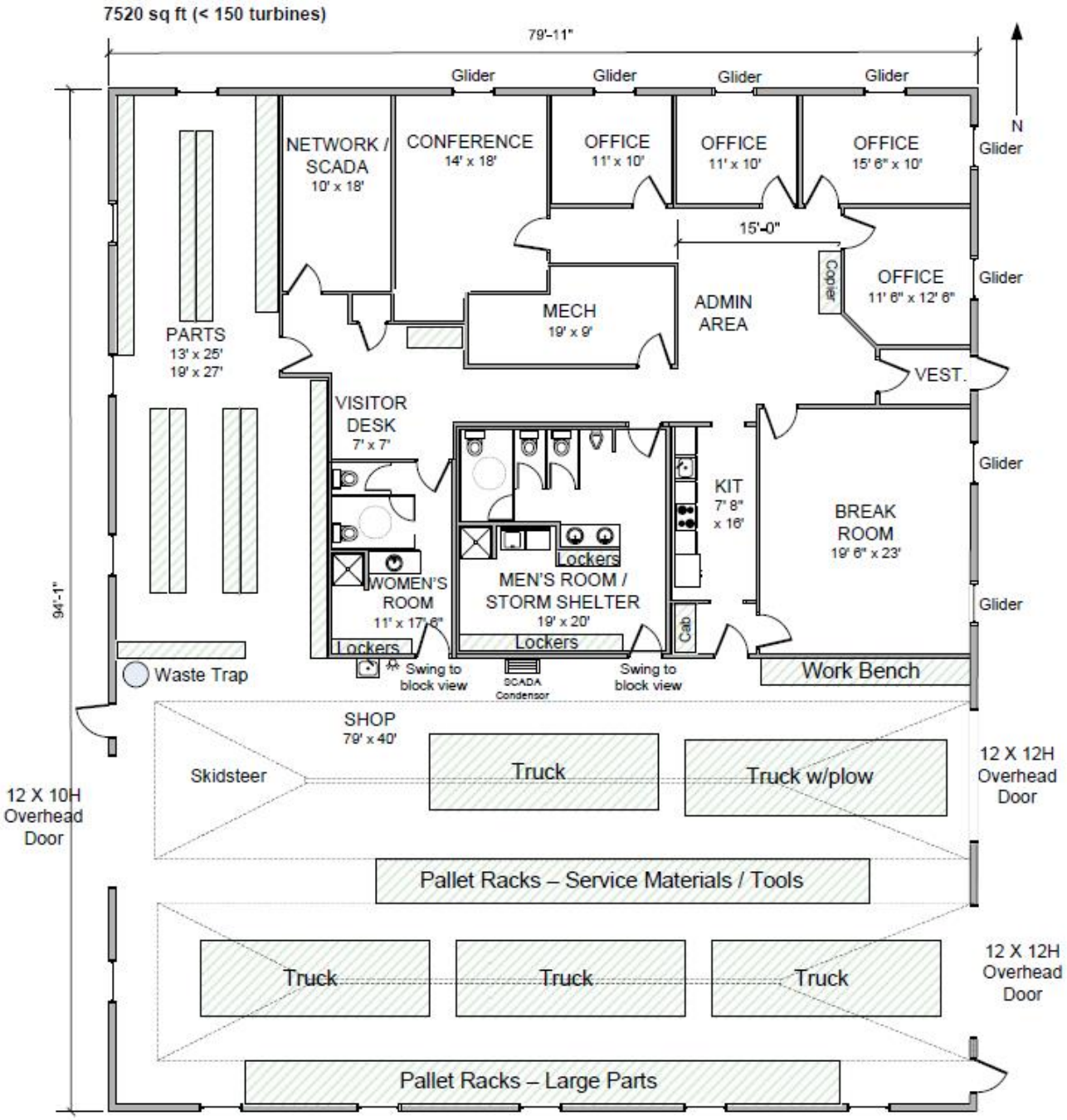


Figure 10-5: Wind O&M Building Interior Layout – 8,320 square feet

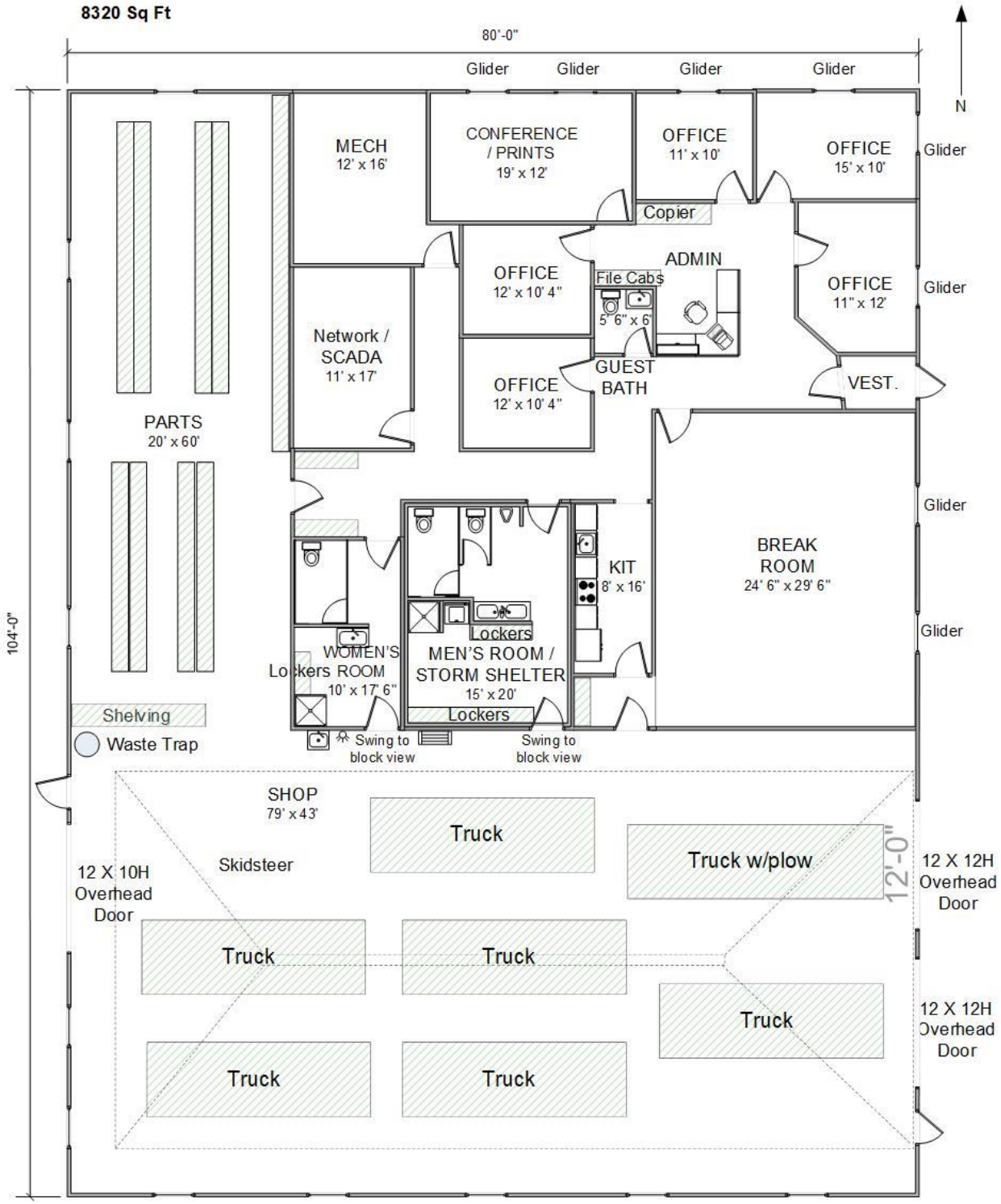


Figure 10-6: Wind O&M Building Interior Layout – 9,440 square feet

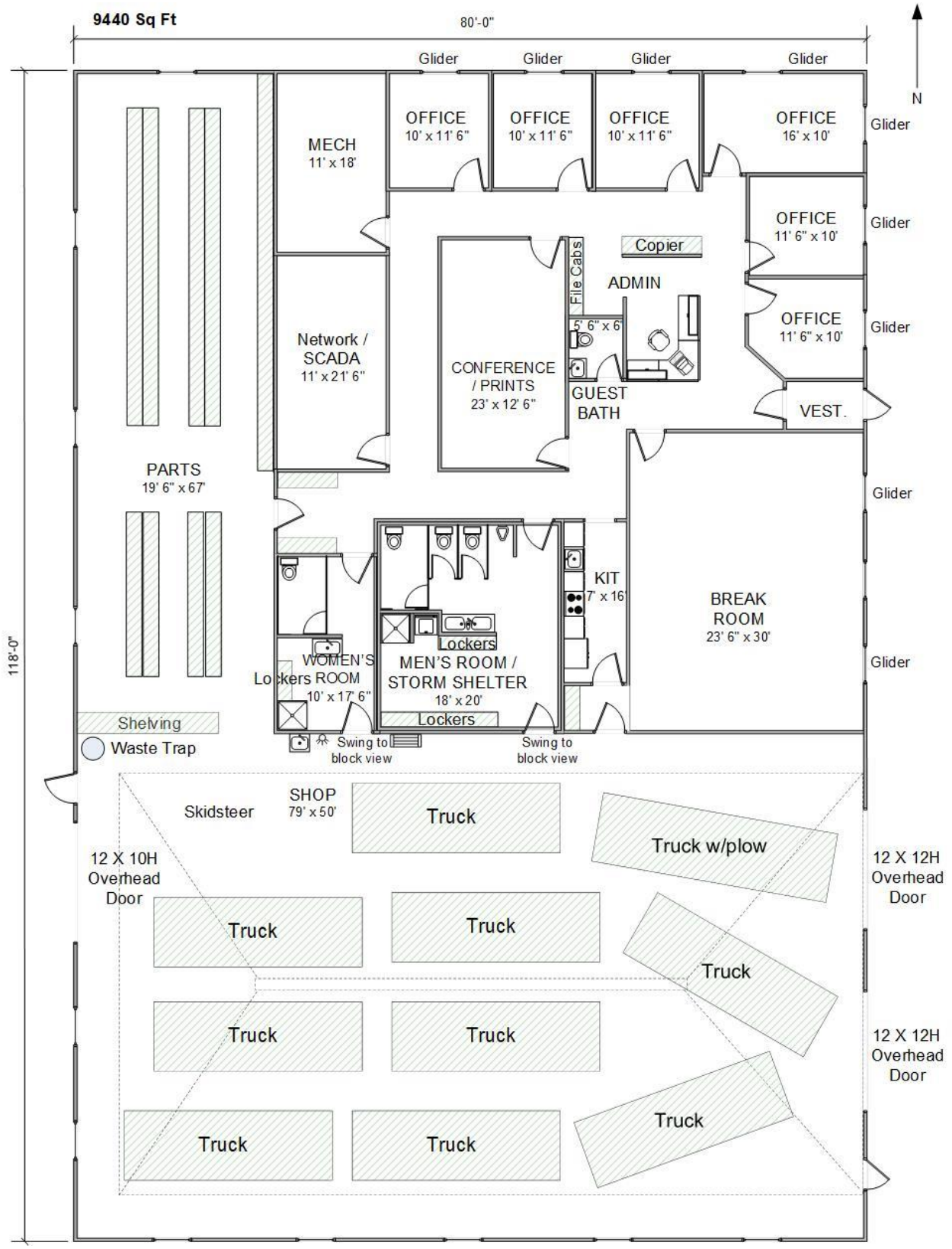


Figure 10-7: O&M Building Typical Exterior Layout

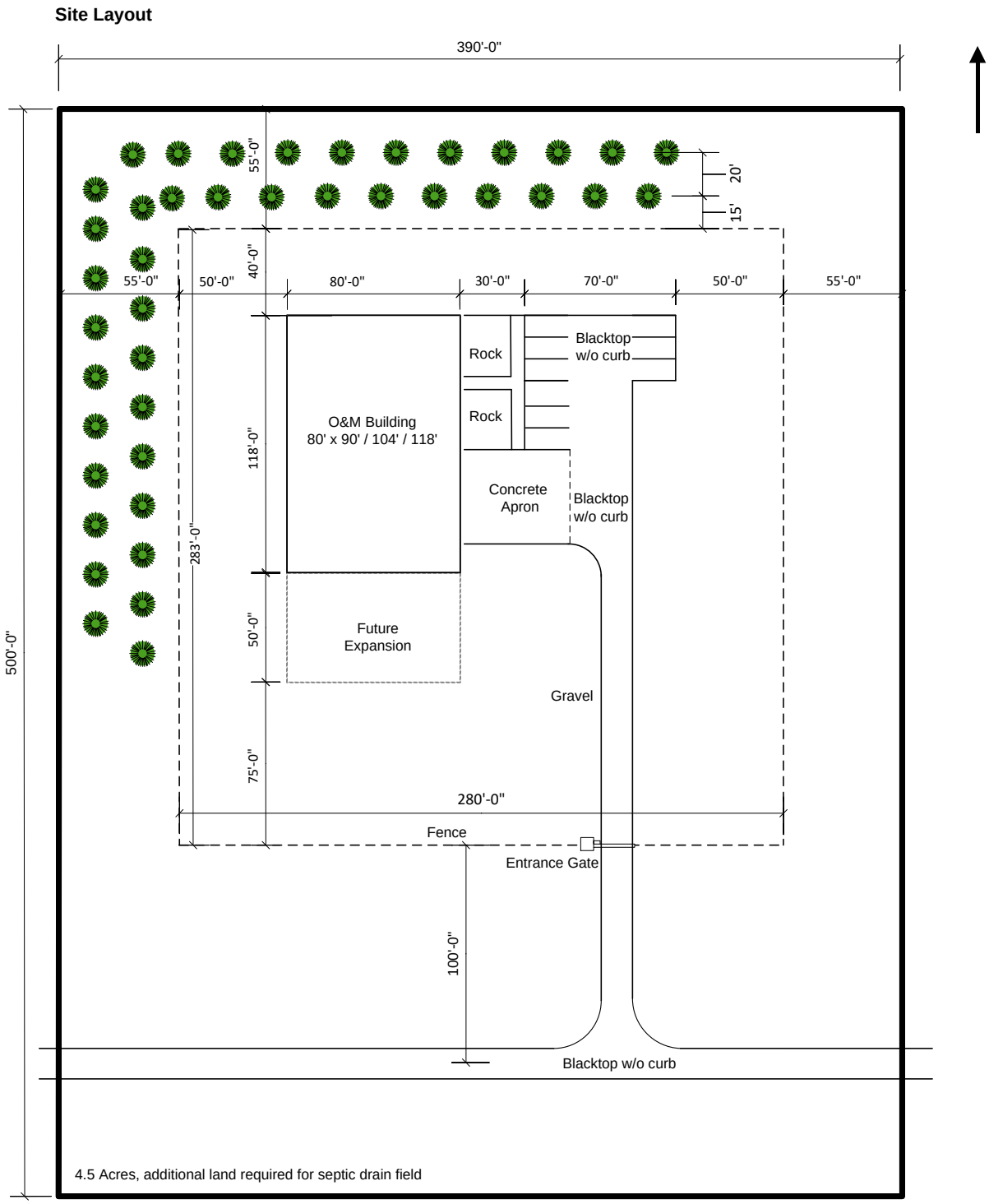
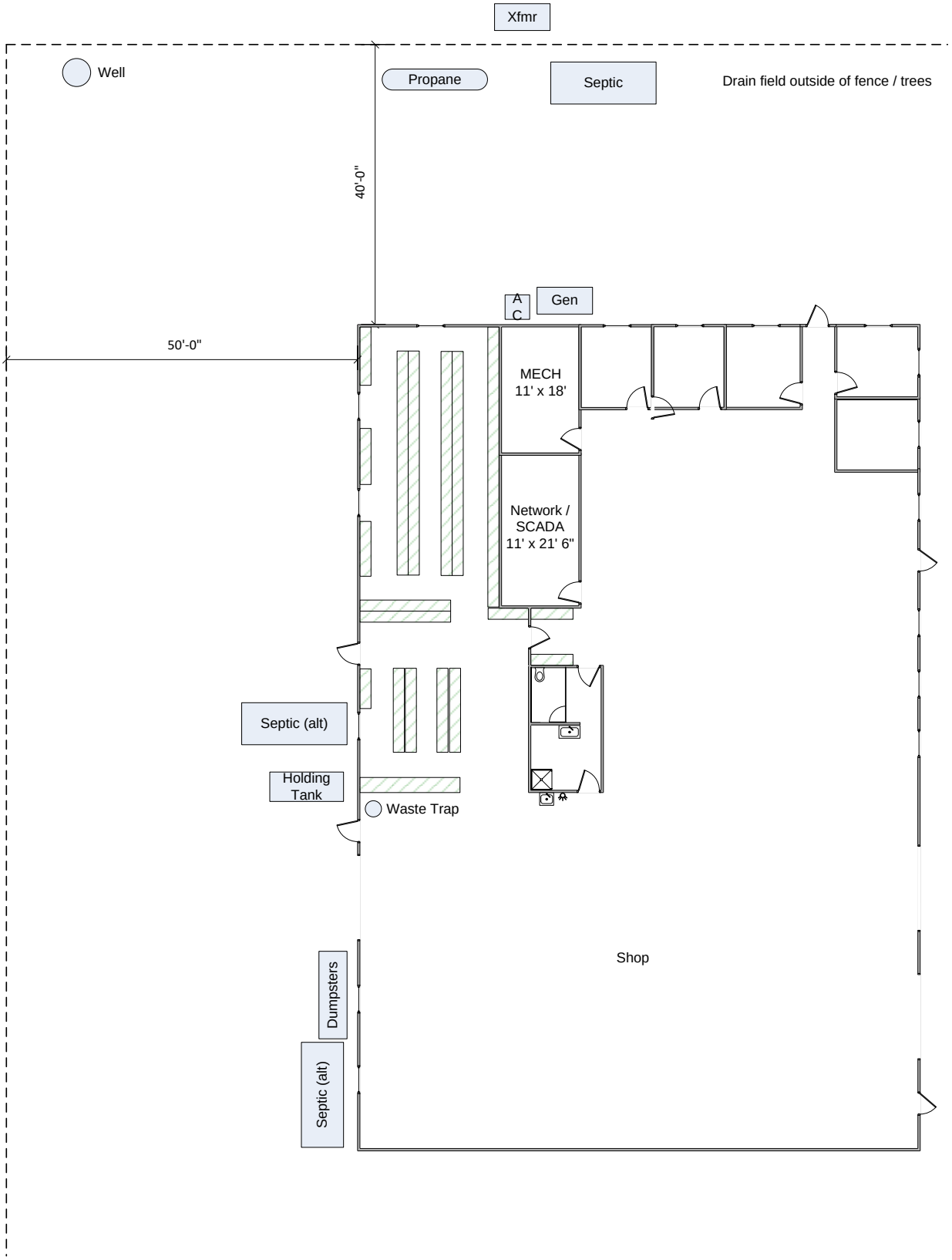


Figure 10-8: O&M Building Exterior Equipment Layout



11.0 METEOROLOGICAL STATIONS / METEOROLOGICAL TOWERS

11.1 General Provisions – Solar meteorological (MET) stations

11.1.1 Contractor shall provide, install, calibrate, commission the MET Stations, back of module sensors, and soiling stations per the requirements in this section.

11.1.2 Contractor shall conform to standard industry practices and comply with manufacturer requirements and recommendations.

11.1.3 NIST calibration certificates shall be provided for meteorological instruments.

11.1.4 Contractor shall submit a proposed equipment location map (MET Stations, back of module sensors, soiling stations, and stand-alone plane of array sensors) for Owner review and approval.

11.1.5 Requirements for pyranometers:

(1) Pyranometers shall be ISO 9060 Class A Certified.

(2) Sensors shall be heated and ventilated when dew or frost is expected in more than 2% of annual GHI hours as defined by IEC 61724:2021

11.1.6 Requirements for temperature sensors:

(1) Temperature sensors shall be enclosed in a naturally aspirated radiation shield and installed at a height similar to the average height of the array.

(2) Temperature sensor shall have a minimum accuracy of ± 0.3 degrees Celsius.

11.1.7 Requirements for back of module temperature sensors:

(1) Back of module temperature sensors shall satisfy Class A requirements established per IEC 61724-1:2021 and have a minimum accuracy of ±0.5 degrees Celsius.

(2) Back of module temperature sensors shall be attached to modules throughout the array in such a way as to reflect temperatures representative of the average of the array.

11.1.8 Requirements for soiling stations:

(1) Soiling stations shall be reference module based and consistent with the PV module technology used in the Project and mounted at the same tilt and orientation as the PV Array.

(2) The soiling station modules shall be calibrated and certified to an accuracy of ±5 percent or better by a third-party laboratory.

11.1.9 All other ancillary meteorological measurements (wind speed and direction, barometric pressure, relative humidity, and rain fall) should satisfy requirements established in the latest IEC 61424-1.

11.1.10 Requirements for data loggers:

(1) Data logger should be IEC 61400-12-1 and/or IEC 61724-1 Compliant.

(2) Data averaging interval should be 1 or 5 minutes, comprised of a 1 Hz sampling interval.

(3) Data should be transmitted via Modbus TCP protocol via either a fiber or ethernet.

(4) Data logger shall be furnished with space heater(s) (if not already provided by the manufacturer of the equipment) that are thermostatically controlled.

11.1.11 The minimum quantity of sensors to be provided is presented in Table 11-1, based on Project capacity.

Table 11-1: MET Station Equipment Quantities

Project Capacity (MWdc)	MET Station Quantity	Back of Module Sensors
0-20	2	8
20-50	3	12
50-100	4	16
100-200	4	24
200-300	8	32
300-400	12	48
400-500	16	64

11.1.12 Requirements for power supply:

(1) MET Stations shall run off of AC power supply from the PCS.

11.2 MET Stations

11.2.1 Contractor shall supply MET stations in the quantity noted in Table 11-1 to measure solar insolation, irradiance, temperature, wind direction and speed, rainfall, and albedo (if applicable). Each MET Station shall include the following instruments:

(1) Global Horizontal Irradiance ("GHI") pyranometer.

(2) POA pyranometer

(3) Rear POA pyranometer (for projects utilizing bifacial PV modules)

(4) Albedometer (for projects utilizing bifacial PV modules)

(a) Albedometers shall be in a sufficiently remote location so as not to impact albedo measurements due to object shading.

(b) Albedometers shall be installed at a representative heat of approximately 1.5 meters above ground, where possible.

(5) One (1) ambient temperature sensor

(6) One (1) heated wind speed and wind direction sensor mounted at the top height of the array. Accuracy of the wind speed sensor shall be ± 3 percent at 10 m/s or better, and accuracy of the wind direction shall be ± 5 degrees or better.

(7) One (1) rain gauge to measure rainfall amounts, with an accuracy of ± 0.01 inch.

(8) One (1) relative humidity sensor

(9) One (1) barometric pressure sensor

(10) One (1) RTU / data logger to condition the instrument's signals, record data and communicate to the SCADA server.

(11) Backup power from a dedicated battery module with dedicated PV module for recharging.

(a) MET Stations shall have the capability of uninterrupted recording and storing environmental conditions without AC power for at least seven (7) days. This may be accomplished using backup DC battery power, or a UPS system.

(b) Chargers shall include AC power failure alarm relays, high/low DC voltage alarm relays, and ground detection alarm relays.

11.2.2 All instrumentation shall be of the same make and model at each MET Station.

11.2.3 Back of module temperature sensors shall be installed in the quantity indicated in the quantity noted in Table 11-1.

11.2.4 Standalone POA pyranometers shall be installed in the quantity indicated in the quantity noted in Table 11-1.

11.2.5 Contractor shall provide soiling stations utilizing the same PV module technology used in the Project, mounted at the same tilt and orientation as the array. The soiling station modules shall be calibrated and certified to an accuracy of ±5 percent or better by a third-party laboratory.

(1) Back of module sensors installed on soiling stations are not included in the minimum quantity requirement of four (4) BOMs per MET Station.

11.2.6 The stand-alone POA requirements shall meet the same requirements of the POAs associated with the MET Stations.

11.3 Submittals – MET Stations

11.3.1 Contractor shall prepare the meteorological tower design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) foundation plans and details, including all structural calculations, pier details, and footing details; (c) instrument details, including all equipment listed herein; (d) wiring schematics; (e) grounding details; (f) power supply details; (g) fiber termination diagrams; (h) communications block diagram; (i) Communications System details including logic description, points lists, rack layout diagrams, fiber terminations; (j) one-line diagrams, three-line diagrams, and wiring diagrams, including A/C and D/C schematics; (k) drawing index; (l) bill of materials; and (m) inspection, testing, and quality control requirements.

11.3.2 Contractor shall submit manufacturer’s approval drawings or product sheets (material cut sheets) for all permanently installed equipment and materials.

11.3.3 Contractor shall issue a final report that includes the following:

(1) List of instrumentation, serial numbers, header names, heights installed, mounting arrangements and orientations, instrument calibration sheets from sensor manufacturer (to include calibration date, slope, offsets, etc.)

(2) Final MET station drawing with sensor placements

(3) Station photographs that reference direction of view and include:

(a) Entire station

(b) Each sensor

(c) Pictures of MET station exposure in all directions, standing at the base of the MET station looking in all directions (N, NE, E, SE, S, SW, W, NW)

(d) Logger enclosure, showing internal wiring,

(e) Equipment rack

(4) Check out sheet that reports weather during installation and readings from each instrument after commissioning.

(5) Final logger wiring diagram

(6) Data logger program (print out of code, if reasonable in size)

(7) Remote/uninterruptible power system wiring diagram.

11.4 Testing and Quality Control

11.4.1 Contractor shall install and commission MET Stations at least sixty (60) days prior to initial synchronization of the respective medium-voltage circuit for each MET Station. Meteorological data shall be stored in the SCADA historian once the MET Station is commissioned.

11.4.2 Copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

11.4.3 Contractor shall provide all testing and commissioning included in Exhibit A.6 (*Start-up, Testing, and Commissioning Requirements*).

11.5 General Provisions – Wind Meteorological Towers

11.5.1 References to "meteorological towers" herein shall be understood to include both permanent and temporary meteorological towers, unless explicitly stated otherwise.

11.5.2 Meteorological towers shall be sized and constructed appropriately to allow instrumentation to be placed at Wind Turbine hub height. A side-by-side (i.e., goalpost) anemometer orientation, as shown in IEC 61400-12-1, shall be utilized; such side-by-side anemometers will be mounted at Wind Turbine hub height on each permanent meteorological tower. Similarly, any height provided by a foundation for the temporary meteorological tower shall be taken into consideration relative to the final constructed hub height of the Wind Turbine.

11.5.3 Meteorological towers shall be designed and fabricated to the latest EIA/TIA-222-FS Structural Standards for Steel Antenna Towers and Antenna Supporting Structures and according to other Applicable Standards.

11.5.4 Meteorological tower designs, including foundation design, shall be approved by Owner prior to procurement of such equipment or materials.

11.5.5 All meteorological towers shall incorporate a safety climb cable.

11.5.6 Sufficient grounding and lightning protection per IEC 61400-12 shall be installed on all meteorological towers, including lightning finials. Meteorological towers shall be independently grounded; meteorological tower grounding shall not be interconnected to the Wind Turbine grounding system.

11.5.7 All anemometers shall be type "first class", heated sensors. All anemometers shall be calibrated in accordance with MEASNET's Anemometer Calibration Procedure and performed by a MEASNET-certified organization.

11.5.8 Instrumentation booms shall be oriented to minimize tower shading (e.g., perpendicular to prevailing wind direction).

11.5.9 Requirements for meteorological tower civil and structural works:

(1) All civil works for the meteorological towers shall comply with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

(2) All meteorological tower structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.0 herein.

(3) Permanent meteorological towers shall be self-supporting. No guy wires for permanent meteorological towers are allowed.

11.5.10 Requirements for meteorological tower marking and lighting:

(1) Meteorological towers shall be painted.

(2) Meteorological towers shall be marked in accordance with the Requirements.

(3) All meteorological towers shall be provided with aviation obstruction lights, including top- and mid-level as required, and including all mounting assemblies, GPS controller, and photocell as required by the Federal Aviation Administration and all other Applicable Standards. Obstruction lights shall be (a) FAA Type L-810 (red, steady burning), L-864 (red, flashing), or L-865 (white, flashing, medium intensity) as determined in Owner's *Determination of No Hazard to Air Navigation* letter from the FAA; (b) in compliance with the Requirements, including US DOT-FAA Advisory Circular No. AC 70/7460-1K: *Obstruction Marking and Lighting*; (c) provided with an uninterruptible power supply capable of supplying back-up power for at least one (1) hour; and (d) programmed to blink in unison, including with those aviation obstruction lights that are installed on the Turbines. Contractor shall remove all temporary FAA lights when no longer needed.

11.5.11 Requirements for communications:

(1) All permanent meteorological towers shall be connected to, and communicate with, the Communications System and allow data recording and storage through the data archival features of the Communications System.

(2) Communication from each permanent meteorological tower to the Communications System shall be via dedicated fiber optic circuit. Such communication path shall follow the same route as the Collection System Circuits in order to minimize disturbed area.

11.5.12 Requirements for power:

(1) Permanent power supply for each permanent meteorological tower shall be taken from the nearest Wind Turbine or Collection System Circuit. Such permanent power supply path shall follow the same route as the Collection System Circuits in order to minimize disturbed area.

11.6 Submittals – Wind Meteorological Towers

11.6.1 Contractor shall prepare the meteorological tower design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) design basis; (b) foundation plans and details, including all structural calculations, pier details, and footing details; (c) tower details, including boom elevations, boom directions, equipment mounting, guying details, and hardware details; (d) instrument details, including all equipment listed herein; (e) wiring schematics; (f) H-frame diagrams; (g) grounding details; (h) power supply details; (i) fiber termination diagrams; (j) communications block diagram; (k) Communications System details including logic description, points lists, rack layout diagrams, fiber terminations; (l) one-line diagrams, three-line diagrams, and wiring diagrams, including A/C and D/C schematics; (m) drawing index; (n) bill of materials; and (o) inspection, testing, and quality control requirements.

11.6.2 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials.

11.7 Power Curve Test Site Calibration Requirements

11.7.1 Installation of the temporary meteorological towers shall be scheduled sufficiently early in the construction of the Project to allow for adequate wind data collection before installation of the respective Wind Turbine at that location, including earthwork or Foundation construction. At least three (3) months of data collection shall be assumed to be required from the time that each temporary meteorological tower is installed until the time it is removed.

11.7.2 Meteorological towers shall be constructed in sets of two, or one permanent meteorological tower and one temporary meteorological tower, in order to maximize data collection time for Owner's site calibration (see Section 11.7.1 herein).

11.7.3 Upon completion of data collection for the power performance test site calibration (see Section 11.7.1 herein) and at the request of Owner, temporary meteorological towers shall be decommissioned and removed, including any temporary foundations and fencing. All equipment and instrumentation from the decommissioned towers shall be returned to Owner at a location requested by Owner. For the avoidance of doubt, and unless explicitly approved by Owner, Wind Turbines may only be installed (including earthwork and construction of Turbine Foundations) *after* the temporary meteorological tower at the respective Wind Turbine location has been removed.

11.8 Existing Meteorological Towers

11.8.1 Contractor shall decommission the existing, temporary meteorological towers at the Project Site. All equipment from these existing towers shall be stored at an Owner-designated location at the Project Site.

11.9 Permanent Meteorological Towers

11.9.1 Contractor shall design, furnish, construct, and install any permit required permanent meteorological towers.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe permanent meteorological tower configuration.

(2) Permanent meteorological towers shall be installed at a location at the Project Site to be specified by Owner.

(3) Permanent meteorological towers shall be turbine hub-height, self-supported (non-guyed), galvanized lattice structures, each designed and certified for maximum wind and ice loading for the Project Site conditions.

11.9.2 Contractor shall furnish and install fencing and gates at each permanent meteorological tower.

(1) Fencing shall be placed to allow a minimum of 10 feet of free space around the tower base and shall have constructed dimensions of approximately 40 feet by 40 feet. Fencing shall be grounded.

(2) At least one (1) gate shall be installed at each permanent meteorological tower. The gate shall be a lockable swing-gate, sufficiently wide for light-duty vehicle access.

(3) All fencing and gates shall comply with the minimum specifications in Section 4.1.10 herein.

(4) The fenced area for the permanent meteorological tower shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade, with aggregate extending at least one (1) foot beyond the fence in all directions and using the same aggregate material as the Site Access Roads.

11.9.3 Contractor shall furnish and install a 12-foot-wide road to each permanent meteorological tower. Such roads shall be constructed of the same materials and with the same cross section as the primary Site Access Roads.

11.9.4 Each permanent meteorological tower shall include the following instruments:

(1) Two (2) cup anemometers at Wind Turbine hub height in a goal-post configuration.

(2) One (1) cup anemometer at mid-blade height.

(3) One (1) cup anemometer at lower-blade height.

(4) One (1) vertical anemometer near Wind Turbine hub height (below goal post).

(5) Two (2) wind direction sensors near Wind Turbine hub height (below goal post). Each shall be MetOne 020C and NRG #200P, respectively.

(6) One (1) temperature / relative humidity sensor with radiation shields near Wind Turbine hub height (below goal post). Each shall be MetOne 597 or Vaisala HMP60A.

(7) One (1) barometric pressure sensor near Wind Turbine hub height (below goal post). Each shall be MetOne 092 or Vaisala PTB 110.

(8) One (1) wind direction sensor at lower-blade height. Each shall be MetOne 020C.

(9) One (1) temperature / relative humidity sensor with radiation shields at 10 meters above ground level. Each shall be MetOne 597 or Vaisala HMP60A.

(10) One (1) precipitation sensor. Each shall be Campbell Scientific 237-L.

11.9.5 Each permanent meteorological tower shall include the following auxiliary equipment:

(1) One (1) NEMA 4X fiberglass enclosure for data logger and auxiliary equipment.

(2) One (1) data logger. Each shall be Campbell Scientific, model CR3000.

(3) One (1) satellite or cellular data modem.

(4) One (1) radio. Each shall be Campbell Scientific, model 401A.

(5) Signal surge protection terminals. Each shall be Phoenix Contact, type Termitrab 24V.

11.9.6 Each permanent meteorological tower shall include the following other equipment:

(1) Two (2) obstruction lights, including top- and mid-level, and including mounting brackets. The top-level light shall be mounted below the goal post.

(2) Grounding and lightning protection, including lightning finial.

(3) Instrumentation booms.

(4) Cabling.

(5) H-frame equipment rack.

(6) Fiber patch panel.

(7) Step-up transformer.

(8) Safety climb cable.

(9) Temporary power supply for data logger and aviation lights.

11.10 Temporary Meteorological Towers

11.10.1 Contractor shall design, furnish, construct, and install any permit required temporary meteorological towers.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe temporary meteorological tower configuration.

(2) Temporary meteorological towers shall be installed at a location at the Project Site to be specified by Owner. Care shall be taken by Contractor to ensure that the constructed elevation of the temporary meteorological towers and the hub height anemometers is identical to the final hub height elevation of the respective Wind Turbine at that location.

(3) Temporary meteorological towers shall be either self-supported (non-guyed) or guy-wire-supported, galvanized lattice structures, each designed and certified for maximum wind and ice loading for the Project Site conditions. Temporary meteorological towers shall be the same height as the permanent meteorological towers.

(4) Temporary meteorological towers shall not be fenced.

(5) All guy wires for temporary meteorological towers shall include avian protection, including bird diverters.

11.10.2 Each temporary meteorological tower shall include the following minimum instruments:

(1) Two (2) cup anemometers at Wind Turbine hub height in a goal-post configuration.

(2) One (1) cup anemometer at mid-blade height.

(3) One (1) cup anemometer at lower-blade height.

(4) One (1) cup wind direction sensor near Wind Turbine hub height (below goal post).

11.10.3 Each temporary meteorological tower shall include the following auxiliary equipment:

(1) One (1) NEMA 4X fiberglass enclosure for data logger and auxiliary equipment.

(2) One (1) data logger. Each shall be Campbell Scientific, model CR1000.

(3) One (1) radio. Each shall be Campbell Scientific, model 401A.

(4) Signal surge protection terminals. Each shall be Phoenix Contact, type Termitrab 24V.

11.10.4 Each temporary meteorological tower shall include the following other equipment:

(1) One (1) obstruction light, including mounting bracket. The light shall be mounted below the goal post

(2) Grounding and lightning protection, including lightning finial.

(3) Instrumentation booms.

(4) Cabling.

(5) H-frame equipment rack.

(6) Safety climb cable.

(7) Temporary power supply for data logger and aviation lights.

11.10.5 Contractor shall decommission all temporary meteorological towers at the conclusion of Owner's site calibration test; such work shall include removal and disposal of any meteorological tower foundations. All equipment from these towers shall be stored at an Owner-designated location at the Project Site. Removal of such temporary meteorological towers must occur prior to the commencement of Turbine Foundation construction and Wind Turbine erection activities for the applicable Wind Turbine.

11.11 Testing and Quality Control

11.11.1 Contractor shall test, commission, start-up, and place into successful operation the meteorological towers. At a minimum, testing shall include the minimum requirements below. All testing shall be performed by an independent, experienced third party.

(1) All meteorological tower equipment shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) Meteorological tower foundations shall be tested for concrete strength and properties, including break tests, grout cubes, slump, air, and temperature, each at the minimum frequencies specified in Section 4.1.12 and Section 4.1.13 herein.

(5) All exposed cable sections shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(6) Resistance testing on grounding grid at each tower location.

(7) Final continuity tests after completion of all system connections. Acceptable continuity tests shall include a Megger test or VLF test at 100 percent of rated voltage.

(8) Verify all alarms, indications and analog quantities are communicated and received properly by the RTU and displayed correctly on the HMI.

(9) Verify all communication channels operate as expected.

11.11.2 Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

12.0 SOLAR PV ARRAY

12.1 General Provisions

12.1.1 The solar PV Array shall have a minimum design life of 35 years based upon the environmental conditions of the Project Site.

12.1.2 The solar PV modules have the technical specifications as noted in Exhibit D.5.2 (*PV Module Specifications*).

12.1.3 The solar PV Array shall be designed for fully automatic, unmanned operation.

12.1.4 The solar PV Array shall be oriented to optimize annual energy production with the goal of producing the lowest levelized cost of energy.

12.1.5 PV Modules shall be connected in a manner that does not exceed the DC voltage and DC current or power capabilities of the inverter.

12.1.6 Lighting systems shall provide personnel with illumination to perform general yard tasks, for safety, and security. Outdoor light fixtures shall be switched on and off with motion detectors / photoelectric controllers which will turn on at night when motion is detected but may be manually overridden by a switch. Local task lighting shall be controlled with manual switches at the task. Lights shall be LED type.

12.1.7 Fencing shall be installed around the PV Array. A man gate and vehicle gate shall be installed at each site road entrance for ingress and egress to the equipment. See Section 4.1.10 for additional fencing and gate requirements.

12.1.8 The solar PV Array shall be designed to meet the environmental characteristics noted in Exhibit D.2 *(Project Site Data*). Alternatives may be reasonably proposed, provided the alternative provides the same or better material functionality and has been approved by Owner.

(1) The Project shall be designed to withstand and operate within the ambient temperature conditions noted in Exhibit D.2 *(Project Site Data*) unless more extreme temperatures are indicated for the site.

(2) PV string sizing shall be made in accordance with the ASHRAE Extreme Annual Dry Bulb Mean Minimum design temperature for the local area.

12.1.9 Requirements for solar PV Array civil and structural works:

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the solar PV Array shall be designed and constructed in accordance with the applicable specifications in Section 4.0 (*Civil / Structural Works*).

12.1.10 Requirements for PV modules:

(1) Not used.

12.1.11 Requirements for PV module support systems:

(1) Acceptable mounting systems shall be ground mounted structures and shall be single- or dual-axis trackers.

(2) Mounting system shall be designed to withstand the Project Site environmental design conditions and provide a weather "stow" mode for the PV modules.

(3) Tracking systems and floating support systems shall be provided by a manufacturer with at least five (5) years' experience in manufacturing module support systems like the proposed design.

(4) Mounting system manufacturer shall have ISO 9001 manufacturing capability.

(5) At a minimum, steel piles shall be hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M for fabricated products and ASTM A153/153M for hardware. Any subsequent process that causes damage or otherwise removes the galvanized coating shall be repaired in accordance with ASTM A780/A780M.

(a) If additional corrosion control measures are recommended in the geotechnical report then the piles shall be designed/coated to meet such requirements.

(6) Cold formed sheet steel shall be in accordance with the requirements of one of the following standards ASTM A1008 / A1008M, ASTM A1003/A1003M, ASTM A653/A653M or ASTM A792 with a minimum coating thickness of G90.

(7) The dimensions and design of the mounting systems shall be compatible with the modules selected for the Project.

(8) The mounting system shall have provisions to be grounded to the grounding loop of the Project Site, including the solar PV modules (if they have metal frames). The module racking grounding system shall either have each component UL listed or shall be tested as an assembly to UL 2703 or UL 3703. Additionally, if a grounding bond incorporates two dissimilar metals such as tin-plated copper to steel, the joint shall be accomplished with the inclusion of a Belleville washer to prevent loosening due to thermal ratcheting or shall be otherwise installed according to manufacturer directions.

(9) All grounding connectors within 18 inches of finished grade shall be UL listed for direct burial. All grounding hardware shall utilize stainless steel, bronze, or copper hardware and be compatible for its application and environment. Tin plated aluminum with stainless steel hardware may be allowed for use if listed for the application and not located within 18" of finished grade. All grounding hardware shall be submitted to Owner for review and approval during design phase.

(10) Tracking systems

(a) Tracking systems shall be provided by a manufacturer with at least five (5) years minimum experience in manufacturing tracking systems similar to the proposed design. Contractor shall provide mean time between failures data for the proposed tracking system.

(b) Supplier shall provide details of all the support bearings for the tracker including materials of construction, specific bearing loadings, bearing safety factors, lubrication, and monitoring. supplier shall provide, at minimum, the following additional information and drawings about the trackers:

1. Grade and slope requirements for the trackers

2. Power consumption requirements for the motor controller

3. Installation manual

4. Operations & Maintenance Manual

5. Controller single- and three-line diagrams and control schematics

6. Details on “anti-shading” methods required in the layout design

(c) The tracker system may be electrically driven and shall meet all the seismic and wind loading requirements of the applicable local codes and local wind conditions as specified in ASCE 7-10. Tracker shall be suitable for the Project Site Conditions including temperature range and snow loading. If utilizing tracker stowing, function shall be independent of a grid supply of power or able to withstand any code wind conditions in any orientation.

(d) The materials shall be new and adequate to withstand the environmental design conditions of the Project location. The manufacturer shall provide a wind and snow load analysis (if applicable) and a snow shedding/clearing methodology for the Project to demonstrate the product’s structural integrity.

(e) For single-axis trackers, the system shall have a minimum tracking range of 55 degrees each way.

(11) The PV module support system shall allow for a minimum clearance between the bottom of the module and ground of 12 inches above the 100-year flood level, or as required by the Site conditions, local permits or other Requirements, whichever is greater.

12.1.12 Requirements for DC wiring harnesses:

(1) DC wiring shall consist of single conductors rated for use at the calculated maximum string voltage and shall be type PV Wire or XLPE insulated with connectors compatible with the connectors provided on the module pigtails.

(2) If factory cable assemblies are used, they shall consist of single conductors rated for use at the calculated maximum string voltage and shall be type PV Wire or XLPE insulated with connectors compatible with the connectors provided on the module pigtails. Assemblies will be pre-cut to length. If a harness contains fuses to protect each string circuit, they shall be accessible for replacement.

(3) Quick connect terminations shall mate with module terminations.

12.1.13 Requirements for DC fused combiner boxes:

(1) Enclosure shall be rated NEMA 4 with continuous hinge single door with three-point latch. Side or bottom penetrations only will be permissible. Doors shall be easily interchangeable.

(2) Factory assembled back panel shall be complete with finger safe fuse holders rated to match the maximum DC system voltage for positive conductors, power distribution blocks, labeling, and signage.

(3) The fuses and fuse holders shall be rated according to the string size and environmental conditions and shall observe applicable codes.

(4) The combiner shall be listed to UL 1741 for not less than the maximum DC voltage of the solar PV array, and rated for an operating temperature range of -40C to +50C.

(5) The power terminal blocks shall be rated for use with both copper and aluminum conductors and rated to match maximum DC system voltage and 90° Celsius (C) conductor temperature.

(6) DC surge arresters shall be rated to match maximum DC system voltage and a minimum of 85°C ambient temperature.

(7) The combiner box shall be equipped with a mechanical lug, dual rated for terminations of 90°C copper ground cables.

(8) All enclosures shall have provisions for padlocking.

(9) The door handle shall be interlocked with the disconnect switch to prevent opening the enclosure with the disconnect switch in the "on" position. A means of overriding this protection shall be provided for troubleshooting purposes.

(10) The combiner box shall include provisions for bolted terminations of the output power circuits to the inverter.

(11) The combiner box shall be properly labeled in accordance with Section 2.6.

(12) The combiner box shall be powder-coated steel with a white or off-white color.

(13) Combiner boxes shall be installed plumb and level at a minimum 48-inches above grade at the centerline.

(14) A Big Lead Assembly ("BLA") from Shoals Technologies may be utilized in lieu of combiner boxes. In-line fuses for BLA cable systems shall be field serviceable.

(15) Contractor shall provide two (2) spare combiner boxes for use during commissioning and to be turned over to Owner for its spare parts use at the end of the project. Parts used during commissioning are to be replaced by Contractor.

12.1.14 Requirements for power conversion systems:

(1) See Section 5.1.17.

(2) Each power conversion station shall consist of a minimum of 2 MVA of inverter capacity, inverter step up transformer(s), low voltage AC cabling, corresponding ancillary equipment, grounding system, and an inverter shelter (if needed).

12.1.15 Requirements for MV transformers:

(1) See Section 5.1.10.

12.1.16 Requirements for PV combining switchgear (as applicable):

(1) Equipment shall be NEMA rated for the environment, metal enclosed (ANSI C37.20.3). Contractor shall specify and install bus bracing and breaker symmetrical interrupting ratings based on the Facility short circuit study in coordination with the Substation short circuit study.

(2) Equipment shall be provided with pad locking ability.

(3) PV combining switchgear shall be rated for conditions in accordance with Exhibit D.2 (*Project Site Data*). This shall include anti-condensation heaters supervised by a thermostat as required for the conditions.

(4) Both N.O. and N.C. dry contacts shall be provided on all interrupters for monitoring by the Facility Communications System. Manual air switches shall not include contact monitoring.

(5) Surge arresters shall be provided, one per phase, mounted in the incoming line compartment.

(6) Equipment shall be mounted to a cast-in-place or pre-cast concrete foundation or piers.

(7) The switches shall be motorized. Local controls shall be provided by use of a remote switch.

(8) Switchgear shall include an auxiliary compartment containing instrument transformers associated with the protective relays and 120/240V control power transformer.

12.1.17 Requirements for DC system wiring installation:

(1) Series string connections between solar PV modules shall be via quick connect connectors factory-supplied with modules.

(2) Series string circuits shall be routed to a combiner box. If applicable, parallel connections shall be made using DC wiring harnesses consisting of pre-cut lengths of minimum 12 AWG cable with quick connects ends and shall be supported to mounting structure.

(3) Contractor shall install solar PV modules of same power class on each combiner box to minimize mismatch losses.

(4) DC cable routing and rating

(a) PV Array feeders and/or combiner box outputs shall be placed in cable tray or routed in conduit or direct buried in accordance with the NESC and any applicable environmental requirements.

(b) DC cable must be suitable for direct burial in wet or dry conditions.

(c) Cable insulation type shall have a rating to withstand long term ultraviolet sunlight exposure and have a temperature rating of 90°C or better.

(d) DC homerun cables may be direct buried. Transitions to above grade shall be via conduit. DC string wiring shall be secured to the racking structure so as to prevent mechanical damage under normal operating conditions and shall be protected against sharp edges where necessary.

(e) Cable size and insulation levels shall be rated according to the maximum system voltage and in accordance with the NEC Article 690 for "Solar Photovoltaic Systems."

(f) Cable size shall also be sized accordingly taking into account any ambient temperature or conduits de-rate factors and voltage drop considerations. A benchmark voltage drop of less than 2 percent (2%) between the PV Array and the inverters shall be used.

(g) Exposed / unsupported cables subject to damage to be in split loom or Owner approved equivalent product.

(h) Cable ties utilized for managing cables utilized in an outdoor setting shall be UV and weather resistant.

(i) Excess slack shall be provided to allow for testing and re-termination in the event of failure.

(j) Installation of cable shall not violate the minimum bending radius of the cable.

(5) All control and instrumentation conductors shall be terminated with ring-tongue connectors.

(6) Cable shall be tested in accordance with the most recent NETA ATS standards.

12.1.18 Requirements for AC system wiring (600V and below):

(1) All conductors, lugs and cable accessories shall be listed by a NRTL.

(2) No splicing shall be allowed.

(3) System wiring shall be properly rated for the installation and properly rated for the application.

(4) System wiring installed in direct burial applications shall be type USE-2 with XLP insulation. Conductors may be stranded copper or aluminum.

(5) When terminating to bus terminal pads, one-hole compression lugs for sizes 2/0 and below and two-hole for sizes 3/0 and greater shall be utilized.

(6) When terminating aluminum conductors, oxide prohibitor coating shall be used.

(7) Cable shall be tested in accordance with the current NETA ATS standards.

12.1.19 Requirements for grounding:

(1) Grounding connections at junction boxes and pad-mounted transformers shall be bolted to facilitate separation of grounds for continuity testing and ground mat testing.

(2) Ground rods shall be incorporated into the grounding system. Ground rods shall be copper-clad, 5/8-inch diameter, 10-foot-long rods at a minimum.

(3) Inverter foundations shall include a grounding grid, as further described herein.

(4) Grounding rings for the PCS shall be designed such that they can be isolated and tested independently.

(5) MET Stations shall be independently grounded.

(6) Contractor shall minimize the amount of exposed ground conductors and utilize approaches that hide ground conductors to minimize the potential for theft.

12.2 Submittals

12.2.1 The PV Module manufacturer shall provide the estimated annual degradation of their module and justify the value provided with historical production data.

12.2.2 Contractor shall provide a copy of the preliminary PVsyst model and report for Owner review and comment. Such report is expected to be the basis of the Contractual Energy Model.

12.2.3 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials.

12.2.4 Contractor shall submit a detailed plan for the installation of the PV Module racking and mounting system. Such plan shall be consistent with the manufacturer's instructions and warranties and shall include loading calculations (e.g. wind and snow loading) to confirm the system's compliance with the Project Site Conditions.

12.2.5 Contractor shall provide a complete recommended spare parts list for the Project's PV Array. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

(1) Contractor shall provide two (2) spare PV racks for use during commissioning and to be turned over to owner for its spare parts use at the end of the project. Parts used during commissioning are to be replaced by contractor.

12.3 Solar PV Array

12.3.1 Contractor shall design, furnish, construct, and install the solar PV Array in conformance with the minimum Requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials (except specifically the Owner-Supplied Equipment as noted in Exhibit B) that are necessary for a complete, fully-functional, and safe solar PV Array, including, but not limited to, all PV modules, trackers, PCS, combiner boxes, DC cabling and cable management system, MV transformers, grounding, fencing and gates etc.

(2) All equipment shall be new and unused and come with a manufacturer's warranty.

12.3.2 Contractor shall receive, inspect, store, unload, maintain, erect, clean, align, and prepare all equipment, including Owner-Supplied Equipment in strict accordance with the equipment manufacturer's instructions.

12.3.3 Contractor shall provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.

12.4 Testing and Quality Control

12.4.1 The PV equipment shall be tested for performance prior to commercial operation. This process shall verify that the installed system is performing per the design based on the current weather variables. Performance testing shall follow ASTM E2848 (Standard Test Method for Reporting Photovoltaic Non-Concentrator System Performance).

(1) Prior to conducting the performance testing, the Contractor shall perform start up and commissioning of the solar array. This shall include:

(a) Solar PV inverter start up and commissioning as described in Section 12.4.2 herein

(b) Solar PV Array functional tests on each circuit to confirm the equipment is functioning as intended and designed as described in Section 12.4.3 herein.

12.4.2 Central inverter testing at the Project Site shall be performed in coordination with the inverter manufacturer field engineer. Testing shall include all testing recommended by the central inverter system manufacturer and testing required to maintain the central inverter system warranty. Any deviation from this requirement shall be approved by Owner. Testing shall confirm the inverter performance including power outputs, heat rejection, communications, etc. Copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

(1) The inverter manufacturer shall provide the following documentation from a certified NRTL:

(a) UL 1741 Test Report

(b) UL 1741 Certification

(c) UL 1741 SA Test Report

(d) UL 1741 SA Certification

(e) IEEE 1547/519 Harmonics Test Report (including raw test data), current THD < 3 percent

(f) NERC PRC-024-2 Voltage and Frequency Ride-Through Test Report

(g) California Energy Commission Efficiency Test Results

(2) The inverter manufacturer shall provide the following documentation from type testing (or from a certified NRTL) to show the inverter meets the specifications outlined in the data sheet. The documentation shall include, at a minimum: active power, reactive power, frequency, DC voltage/current, AC voltage/current, and critical component temperatures (for ambient temperature testing).

(a) Active Power

1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the nameplate power rating (including any “overdrive” or 110% functionality).

(b) Reactive Power

1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the maximum reactive power capabilities.

2. Minimum Requirement: 0.90 lead/lag in 0.01 intervals.

(c) Plant Controller Response

1. Inverter manufacturer shall provide test documentation showing the inverter can receive active and reactive commands from a simulated plant controller interface.

2. Inverter manufacturer shall provide test documentation showing the inverter can operate at the maximum and minimum ramp rates for both active and reactive power variation.

(d) Edge-of-Cloud Effects

1. Inverter manufacturer shall provide test documentation showing the inverter can track the PV array maximum power point (MPP) during high DC voltage and current transients.

(e) DC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated DC voltage operating range.

2. Inverter manufacturer shall provide active power vs. DC voltage de-rating curves.

(f) AC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated AC voltage operating range.

2. Inverter manufacturer shall provide active power vs. AC voltage de-rating curves from 0.9 to 1.1 p.u. terminal voltage and 0.9 lead/lag power factor.

(g) Ambient Temperature

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the entire ambient temperature range (minimum 4 hours at each test condition).

2. At a minimum, the test documentation must include the following operating conditions: 25°C, 45°C, maximum operating temperature, minimum operating temperature, and any “corner points” on ambient temperature de-rating curves.

3. Inverter manufacturer shall provide active power vs. ambient temperature de-rating curves.

(h) DC/AC Ratio

1. Inverter manufacturer shall provide design calculations and/or test data showing the inverter performance and reliability information at multiple DC/AC ratios including, but not limited to, the maximum and minimum DC/AC ratios specified for the Project.

(i) Reliability

1. Inverter manufacturer shall provide test documentation summarizing the accelerated life testing (ALT) and highly accelerated life testing (HALT) testing that has been completed.

2. Inverter manufacturer shall provide mean time between failures (MTBF) and mean time to failure (MTTF) rates for critical components such as IGBTs, DC switches/contactors, AC contactors/breakers, DC link and AC filter capacitors, communications boards, and cooling system components (fans, pumps, etc.)

(3) At a minimum, the following tests shall be performed on each inverter during production testing:

(a) Calibration of all DC and AC voltage, current, and power circuitry/sensors.

(b) UL 1741 production testing such as hi-pot and PE/ground testing.

(c) GFDI.

(d) Emergency stop (fast stop).

(e) Remote start/stop.

(f) Burn-in (minimum 4 hours per inverter). Burn-in testing should be completed under elevated ambient temperature and high DC current conditions at maximum rated power.

(g) Harmonic content verification (during burn-in tests).

(h) Efficiency verification.

(i) Verify inverter efficiency at multiple DC voltages and power levels which shall be consistent with the levels tested during CEC testing.

(j) The official CEC test procedure is not required.

(k) Reactive power control range as documented in the Interconnection Agreement or, at a minimum, across a range of 0.95pu lead/lag.

(l) Voltage and frequency ride-through verification per IEEE 1547 and/or PRC-024-2.

12.4.3 Requirements for the Solar PV Array functional testing:

(1) The equipment shall be tested for performance prior to commercial operation. This process shall verify the installed system is performing per the design based on the current weather variables.

(2) Prior to the performance test, the Contractor shall perform functional tests. As part of the commissioning process of the newly constructed solar array, the Contractor shall perform a functional test on each of the circuits to verify that they are all operating as expected and designed.

(3) The Contractor shall start up and commission each of the inverters and ensure they are running under their MPPT range for optimal performance as described in Section 12.4.2 herein.

(4) The Contractor shall inspect the entire array and measure the operating current of each individual string and the respective irradiance level in the plane of the array at the time current testing is completed. Based upon the design of the system, the Contractor shall calculate the expected current level based upon the recorded/observed conditions and compare that to the actual current level to verify that each string is performing as designed.

(5) The Contractor shall perform an infrared scan to confirm site DC system health prior to conducting the performance tests. The Contractor shall perform repairs or replacements for each string that is not performing as designed.

(6) The Contractor shall complete a PVsyst report or Owner approved alternative based upon the final design of the system and 30-year historical weather data for the area that shall provide an expected monthly production estimate for each of the 12 months of the year.

12.4.4 Requirements for the Solar PV Array capacity testing:

(1) This portion of the testing shall be conducted after the Contractor completes the functional tests. The Contractor shall meet a minimum of 98 percent (98%) of the performance guarantee prior to commercial operation.

(2) The Capacity and Performance Ratio Test shall be conducted prior to commercial operation. The basis for the test procedures is ASTM E2848 – Standard Test Method for Reporting Photovoltaic Non- Concentrator System Performance

(3) The performance test boundary for the solar array shall be Contractor supplied weather station and the production power meter or other meter as shown on the one-line diagram in Exhibit F.3 (*Interconnection Agreement*).

(4) The performance test data shall be taken in 1-minute intervals and averaged over 15 minute intervals for calculating the solar array output. The minimum number of data points over the three-day test period shall be 50 (12 hours of data collection). The minimum plane of array (POA) solar irradiance shall be 500 W/m^2 during data collection. Data shall generally be taken between 10:00 AM to 2:00 PM.

(5) The weather data and MWh (megawatt hour) output data shall be recorded during the test with the Owner approved DAS (data acquisition software). The measured total MWh output during the test shall be the actual output of the solar array. The measured total MWh output shall include the accuracy of the production power meter, line loss between inverters and meter and temperature coefficient correction factor (defined by panel manufacturer).

(6) The weather data recorded during the test shall be entered in the PVsyst or equal model included in the As-Built design. The PVsyst model or another numerical model shall be used to calculate the expected MWh output over the duration of the test. The solar irradiance input in the PVsyst model shall be corrected for the accuracy of the weather station pyranometers.

(7) This portion of the performance guarantee shall be met if the actual measured MWh output is greater than or equal to the expected MWh output calculated by PVsyst or another numerical model. If the actual measured MWh out is less than the expected MWh output, the Contractor shall repair or replace components as required and retest the solar facility to meet this portion of the performance guarantee.

(8) This portion of the performance test may be suspended and restarted due to transient weather conditions as mutually agreed to by the Owner and Contractor. The data collected during the test suspension shall be excluded from the performance calculations. The test suspension period shall not extend the overall test period.

(9) Contractor shall submit a preliminary Performance Test procedure for review 90 days prior to the Performance Test.

13.0 BATTERY ENERGY STORAGE SYSTEM

The scope and general provisions in Section 13.0 are for lithium batteries that are intended for commercial operation. Should there be a different battery chemistry or technology proposed, similar technical specifications specific to that technology would be provided by the Company and required from the resource at the time of negotiation, should the project be selected by the Minnesota Public Utilities Commission in Docket Number E002/CN-23-212. BESS units applying as a black start unit will instead be subject to black start specific criteria established in Docket No. E002/CN-23-212.

13.1 General Provisions

13.1.1 The BESS, including all components, shall have a minimum design life of 20 years based upon the Project Site Conditions and be compliant with the most recent NFPA 855 (Standard for the Installation of Stationary Battery Energy Storage Systems) and any other applicable codes and standards noted in Exhibit A2 and Exhibit D.5.3.

13.1.2 Outside of Section 13.0 and all other applicable BESS references in this Scope of Work document, Contractor shall adhere to material supply specifications highlighted in Exhibit D.5.3.

13.1.3 Battery cell / module design shall be of proven technology and shall have been installed in similar applications for a minimum of one (1) year. It is expected that replacement modules of the same design or of a directly compatible design will be readily available from the manufacturer for a minimum of 10 years such that battery rack modifications are not required. The BESS supporting infrastructure shall be designed and constructed to withstand a 100-year, 24-hour storm event. Final constructed grade shall be at least twelve (12) inches above such flood depth, as determined in the Contractor-provided hydrology study.

13.1.4 The BESS shall be designed and constructed to a high level of reliability, with ease of maintenance and shall meet or exceed the requirements set forth by the interconnection utility.

13.1.5 Contractor shall design and construct the BESS in accordance with the Interconnection Requirements, as more particularly detailed in Exhibit F, including all sub-exhibits thereto.

13.1.6 Contractor shall receive explicit approval from Owner or Owner's representative(s) of the design of the BESS supporting infrastructure prior to construction. Owner shall have unlimited access to such designs throughout the design process, and construction of all such facilities shall be completed by one of Owner's approved subcontractors, as more particularly detailed in Exhibit A.3 (*Approved Suppliers*).

13.1.7 Requirements for BESS civil and structural works:

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the BESS shall be designed and constructed in accordance with the applicable specifications in Section 4.0 *(Civil / Structural Works*).

13.1.8 Requirements for BESS operating criteria:

(1) Contractor shall design the BESS operation to assume the duty cycle and other minimum operational requirements noted in Table 13-1.

(2) Convenience power: $120V_{AC}$.

(3) Instrumentation voltage: 24 V_{DC} and/or 48 V_{DC} and/or 125 V_{DC}.

(4) Minimum battery technical specifications are listed in Table 13-1.

(5) The BESS shall meet the minimum system specifications listed in Table 13-2:

Table 13-1 – Minimum Lithium-Ion Battery Technical Specifications (Non-Black Start)

Description	Requirements
Intended Applications	Primary application is Firm Capacity but applications may include Arbitrage, Firm Capacity, Operating Reserve – Ramping / Load Following, etc.
Useable Power - AC Power at the Point of Interconnection ("POI")	Contractor to advise (XX MW)
Useable Energy – (useable at POI net of Station Power Usage) at Continuous Power ("CP")	Contractor to advise (XXS MW over X.0 hours)
Maximum average Resting and Annual State of Charge ("rSOC" / "aSOC")	As allowed/required by BESS manufacturer. Bidder to confirm allowable limit. Minimum rSOC/aSOC shall be 50%.
Minimum End of Life Energy	Contractor to provide expected annual degradation curves based on specified Duty Cycle with proposal. At a minimum, these curves shall contain annual values for the following categories: 1) AC Capacity at POI without Augmentation 2) AC Capacity at POI with Augmentation 3) Round Trip Efficiency
Capacity Retention	Maintain 100% Useable Power for 20 years at POI– no augmentation shall take place in the first three (3) operating years.
System Design Life	20 Years
Duty Cycle	Option A: Bidder to assume 365 full equivalent (100%) depth of discharge ("DOD") cycles per year. Option B: Bidder to assume 275 full equivalent (100%) DOD cycles per year. Option C: Bidder to assume 200 full equivalent (100%) DOD cycles per year.
System Frequency	60 Hz (+/- 3%)
Noise Emissions	<75 dB measured at the fence line
Total Harmonic Distortion ("THD")	<3%

Description	Requirements
Environmental Conditions	ASHRAE Climatic Design Conditions (2021) -40 °C to +45 °C Typically Below 1,500' MSL (Contractor advise) Seismic requirements: Contractor advise 13% to 98% Relative Humidity (non-condensing)
Guaranteed Monthly Availability	Minimum 98%.
Roundtrip Efficiency ("RTE")	Minimum 87% initial RTE. Contractor to provide table with annual RTE over the System Design Life.
Response Time	Maximum 1 second response time from idle to 100% discharge output or charge input, from time of receipt of signal to discharge / charge appearing at the Point of Interconnection ("POI").
Battery Power Meter	The Battery Power Meter will be located at the high side of the Main Power Transformer ("MPT").
Thermal Management System	Liquid Cooled
Charging Method	Constant current / constant voltage
Discharging Method	Constant current
Inverter Nominal Voltage Range	____ V_{DC} nominal (Contractor to Advise)
Battery Maximum Continuous Discharge to Inverter	____ A nominal (Contractor to Advise)

Table 13-2 – Minimum Battery System Requirements

Batteries	
Description	**Requirements**
General	Batteries must be field replaceable as discrete modules. All proposed systems must be pre-engineered and field certified. Designs using experimental or otherwise undocumented components are not permitted. All local and national code compliance is required. Labeling of the batteries shall include manufacturer's name, cell type, nameplate rating, date of manufacture, and unique serial number for each serviceable unit, in fully legible characters. All cells shall be traceable to the point of origin for purpose of addressing safety issues.
Nominal DC Voltage	Compatible with selected PCS
Depth of Discharge	100%

Codes and Standards	Batteries, Packs and System, where applicable, must adhere to the following codes and standards or its equivalent at a minimum: • UL 1642 (2012): Standard for Safety of Lithium Batteries • UL 1973 (2018): Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications • UL 9540 (2021): ESS and Equipment • UL9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems (Test results must be made available prior to shipping) • U.N. 38.3: Safety of Primary and Secondary Lithium Cells and Batteries During Transport • See Exhibit D.5.3 for additional information
Battery Racks	
Description	**Requirements**
General	Each rack section (or pair of sections for long duration systems) shall include a load-rated disconnecting means, to allow isolation of the rack's modules from the DC bus by the Battery Management System ("BMS").
Enclosures	
Description	**Requirements**
Enclosure Requirements	All components shall be contained within weatherproof, tamper resistant, containers or purpose-built enclosures suitable for mounting outdoors on a concrete, fiberglass or equivalent pad with a minimum NEMA 3R rating if installed in a standalone outdoor application, or within a shelter that meets all seismic, safety, environmental controls, HVAC and fire resistance requirements stated in this specification and as required for the operation of the BESS system. Enclosure shall include all internal DC and AC systems necessary for the operation of the BESS system. Containers should be shipped fully assembled to the extent practical, except for loading of the battery modules in the field. Air conditioning units and fire suppression systems may be removed for shipment if required. Doors arranged in "French Door" fashion are preferred, wherein doors open in pairs, with latch at center and left door swinging to user's left side and right door swinging to user's right, in order to provide best access to ESS equipment.
Enclosure Type	Container or prefab enclosure.
Enclosure foundation(s) and Slabs	Container foundations may be formed in place concrete, pre-cast concrete, piers, or earth augers at the option of the engineer of record, to meet OEM warranty requirements and recommendations as well as have the be stamped by a licensed structural engineer.
Environmental Controls	As required for the operation of the BESS system and to maintain temperature within warranty conditions. EMS shall be capable of starting and stopping the environmental control system.
Access	All BESS components shall be fully accessible for maintenance and inspection. Enclosure design shall in included means for safely removing battery modules and other components.
Monitoring	Container level (or lower granularity) emergency alarms should include:

	1) Fire Alarms (“FA”) 2) Fire Suppression System (“FSS”) 3) Deflagration Gas Sensor Alarms 4) Automatic Deflagration Venting Systems The BMS should provide identifying information to localize these alarms
Fire Detection and Suppression	
Description	**Requirements**
General	Refer to Exhibit D.5.3 and Section 13.1.10 (7) for further requirements
Fire protection and detection system	System to include all components, connections, programming and equipment to provide a complete, automatic fire protection and detection system including, but not limited to, fire alarm control panel(s), detection devices, annunciation devices, suppression piping and agents, and enclosures.
Suppression Agent (Manual Sprinkler)	Manual sprinkler system installed in each battery container - “drip dry pipe” connection to be made available for first responders to connect pumper truck.
Off-Gas Detection	Li-Ion Tamer or Buyer approved equivalent
Horn/Lights	Horn not required. Lights must be visible from access road.

13.1.9 Requirements for battery modules:

(1) Battery modules shall be provided with a permanent label in accordance with Section 2.6.

(2) Battery cells shall be UL1642 (Lithium-Ion Batteries), UL-9540A (Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems), and UL 2591 (Component certification for lithium-ion battery cell separators) listed.

(3) Module-to-module terminations shall utilize supplier provided quick disconnects or allow for NEMA standard connections. Any cables and connectors provided by manufacturer shall be sized in accordance with the NEC and UL listed where applicable.

(4) Positive and negative string-level post connections shall accept stranded copper conductor, NEMA standard connections, or supplier provided quick disconnects. Connections shall be sized to accept conductor rated per NEC requirements. Any cables and connectors provided by manufacturer shall be sized in accordance with the NEC and UL listed where applicable.

(5) Battery module enclosure shall be designed to be easily inserted and removed from the supplier provided battery rack. This may include non-tooled locking mechanisms, handles or lifting points, and/or track sliding.

(6) Battery modules utilizing an open rack design shall provide fans directing air flow over the battery module such that a hot/cold aisle arrangement can be designed.

(7) Battery cells shall incorporate safety features such as burst disks, replaceable fuses, and positive temperature coefficient switches.

(8) All battery modules shall be physically mounted in a battery rack system.

(a) Battery rack system shall be designed to withstand the Project Site conditions noted in Exhibit D.2 (*Project Site Data*).

(b) Battery rack system manufacturer shall have ISO 9001 manufacturing capability.

(c) Steel framing shall be hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M for fabricated products and ASTM A153/153M for hardware. Any subsequent process that causes damage or otherwise removes the galvanized coating shall be repaired in accordance with ASTM A780/A780M.

(d) Cold formed sheet steel shall be in accordance with the requirements of one of the following standards ASTM A1008 / A1008M, ASTM A1003/A1003M, ASTM A653/A653M or ASTM A792 with a coating thickness of G90.

(e) The dimensions and design of the battery rack systems shall be compatible with the battery modules selected for the Project.

(f) Metal battery racks shall be bonded or provide provisions for bonding of all components.

(g) The battery rack system shall have provisions to be grounded to the grounding loop of the Project Site. If a grounding bond incorporates two dissimilar metals such as tin-plated copper to steel, the joint shall be accomplished with the inclusion of a Belleville washer to prevent loosening or shall be otherwise installed according to manufacturer directions.

(h) All outdoor grounding connectors within 18 inches of finished grade shall be UL listed for direct burial. All grounding hardware shall utilize stainless steel, bronze, or copper hardware and be compatible for its application and environment. All grounding hardware shall be submitted to Owner for review and approval during design phase.

(i) Battery rack systems shall be factory pre-assembled into vertical sections. Rack dimensions shall be manufacturer's standard, designed for installation into a building or environmental enclosure arranged in back-to-back rows. Racks shall include all bracing required for the site seismic conditions and to ensure racks cannot tip during module installation. Racks shall be suitable for installation directly onto a finished concrete floor or electrical enclosure floor. Racks shall be anchored using drilled concrete anchors and leveling shims as required. Rack design shall include provisions to protect personnel from inadvertent contact with exposed energized parts, such as ventilated doors or insulated covers over live parts.

(j) Each rack section (or pair of sections for long duration systems) shall include a load-break disconnecting means to allow isolation of the rack's modules from the DC bus by the BMS.

(9) All battery modules shall be interchangeable in regard to size and output voltage rating as to allow any module to be inserted in place of any other module at the Project site. This shall include interchangeable replacements as needed through the design life of the BESS.

(10) Battery modules shall be provided in a containerized system, that includes, but is not limited to the battery modules, battery racks, module interconnections, DC disconnects, battery thermal management system / HVAC, etc.

13.1.10 Requirements for containerized BESS:

(1) Containers shall be shipped fully assembled to the extent practical, except for loading of the battery modules in the field.

(2) Battery thermal management / air conditioning units may be removed for shipment if required.

(3) All materials shall be non-flammable.

(4) Occupancy Class

(a) Containerized systems shall be classified as equipment enclosures rather than occupiable buildings.

(b) The layout of equipment in containerized systems shall be such that personnel cannot occupy the enclosure.

(c) Access to battery modules and other equipment shall be via doors arranged along the length of the container such that personnel have adequate working space and are not required to enter the container to perform maintenance.

(5) Windows

(a) Viewing windows that allow the main DC disconnect position to be viewed or thermal / infrared viewing windows for monitoring the temperature of connections or components are allowed.

(6) Doors

(a) Doors are not required for personnel ingress/egress.

(b) Doors for equipment access should be provided along the long sides of the container. Doors arranged in “French Door” fashion are preferred.

(c) Door opening width shall be as required to provide access to battery racks for module installation and removal.

(d) Doors shall be lockable and keyed alike. Door lock hardware shall be tamper resistant. Locks shall incorporate security features such as hardened alloys for drill or grinder resistance, shackle guards to provide protection against bolt cutters being used to remove them, cover / hood over the lock, etc.

(e) Exterior hardware shall be stainless steel.

(f) It is preferred that breakers or disconnects be able to be operated without opening doors. Breakers and disconnects shall be padlockable in the disconnect position.

(g) Doors with ventilation openings shall include additional security features on the rear of the door ventilation area such as bars to block forced entrance through the ventilation area on the door.

(7) Fire Detection and Suppression

(a) Containerized BESS systems shall comply with all applicable fire and building codes including NFPA 855 (Standard for the Installation of Stationary Energy Storage Systems).

(b) Fire detection schemes shall incorporate early off-gas detection and interlock to shut down affected BESS equipment prior to fire or smoke detection are encouraged.

(c) BESS system shall be designed and constructed to take the recommendations noted in Exhibit A.2.3 (*Lesson Learned - Battery Energy Storage System Cascading Thermal Runaway*) including, but not limited to the following:

1. Work with and/or select a BESS supplier to minimize or eliminate battery cell-to-cell and module-to-module heat transfer to stop battery thermal runaway.

2. Implement fire detection and suppression system designs that will fully manage a thermal runaway.

3. Include monitoring and reporting of flammable gas concentrations with ventilation systems to mitigate the flammable gas concentrations.

(d) Contractor shall perform a hazard mitigation analysis that includes a review of the BESS UL 9540a test data. The analysis shall be performed by a registered fire protection engineer. This report shall be provided to Owner for review. The fire protection engineer shall provide Owner with a pre-incident guide (per NFPA 1620) specific to the Project that outlines the hazards and response tactics that should be employed during an incident.

1. Prior to placing the BESS in service, a familiarization tour shall be conducted with local fire and emergency services along with any specialized units (e.g. HAZMAT) who may respond during an incident. This tour shall include supplying fire and emergency services with the pre-incident guide developed for the BESS system.

(8) Container shall include a thermal management system to maintain the battery modules and any other instruments or components with the manufacturers specifications. HVAC equipment with a minimum SEER rating of 16 shall be utilized.

(9) Thermal Management system utilized for the batteries shall be liquid cooled.

(a) Refer to Exhibit D.5.3 for other Thermal Management requirements listed.

(10) Container shall have provisions for equipment removal and replacement.

(11) Container shall have adequate task lighting to perform all maintenance activities.

(12) Container shall be configured to have no roof penetrations of any kind, except for HVAC equipment needs, if any.

(13) Container manufacturer shall provide detailed engineering design drawings and calculations complying with the requirements of the applicable building code(s) and local and state laws that have jurisdiction where the building will be delivered and erected. Drawings shall be stamped by a Professional Engineer registered in the Project state and are subject to Owner review and approval.

(14) Container shall have air terminal lightning protection in accordance with NFPA 780 standards.

(15) Container shall have a means of prohibiting access when energized.

(16) Owner shall have the option to conduct a factory visit for inspection of the manufacturing/assembly process and inspection of at least one containerized battery module system. This shall take place before the shipment of the first unit to the Project Site. Owner shall pay all its own costs associated with this visit.

13.1.11 Requirements for Battery Management System (BMS):

(1) The Buyer shall have the ability to access all data provided by the Battery Management System (BMS) through the site controller and/or Human Machine Interface (HMI) and all data shall be logged for a minimum of 6 months with the appropriate resolution required for Original Equipment Manufacturer (OEM) warranty fulfillment. Contractor shall provide training on the BMS and provide login access to the Buyer prior to the Warranty Period ending so that the Buyer can properly maintain and navigate the BMS through the life of the Project. Primary functions include but are not limited to:

(a) Monitoring at Cell, Module, and Rack Level:

1. State of Charge (SOC)

2. State of Health (SOH)

3. Voltage/Current

4. Temperature

5. Status

(b) Protection of the Cell, Module, and Rack from:

1. Overcurrent

2. Over/under-voltage

3. High/low temperatures

(c) Charge/discharge management

(d) Cell, Module, and Rack Balancing

(e) Warning and alarms

(f) Internal protective measures

(g) Any other data relevant to battery warranty

(h) HVAC or thermal management system operating status, setpoints, warnings and alarms.

(i) Logs of operations

(j) Management of any software versions

(k) Cyber Security management of the BESS

(l) Data exchange with the BESS

(m) Safety assurance and monitoring for each site

(2) The BMS shall be the battery OEM's standard product, providing the following functions, at a minimum:

(a) Measurement of battery operating parameters

(b) Measurement of battery cell voltages

(c) Measurement of battery cell temperatures

(d) Measurement of battery string current

(e) Measurement of battery string voltage

(f) Calculation of battery string State of Charge (SOC)

(g) Calculation of battery string State of Health (SOH).

(h) Cell Balancing

(i) Battery Protection from the following:

1. Cell under voltage
2. Cell over temperature
3. Cell under temperature
4. Cell over current

(j) Pre-charge protection

(3) At a minimum, the BMS shall monitor the data points listed in Table 13-3. The BMS shall monitor all data points required and store data a minimum of 24 hours of pre- and post-event (or as required by the battery OEM) for root cause / post- mortem analysis and warranty claim disposition. Data points shall also be transmitted to the site controller / Historian for long term data storage and retrieval.

(4) Rack BMS to System BMS communication protocol shall be manufacturer standard.

(5) Rack and System BM should provide the following protection and supply associated alarms and warnings as applicable:

(a) Overcurrent

(b) Over/under-voltage

(c) High/low temperatures

(d) Communication issues

(e) Other abnormalities

(6) BMS Supplier shall manage all software/firmware versions of the installed devices during system and project integration and provide associated point maps for the delivered system revision to the project integrators

(7) System BMS to site controller communication protocol shall be coordinated with the site Communication System / SCADA.

Table 13-3 – Minimum Monitored BMS Parameters

Description	**Points to be Monitored.** ***Sample interval: 1 second***
System Level	Fault Status
	Alarm Status
	System Current
	System Voltage
Each Rack or String	Rack Voltage
	Rack Current
	Rack SOC
	Rack SOH
	Rack Fault Status
	Rack Alarm Status
	Maximum Cell Voltage Value
	Maximum Cell Voltage Position
	Minimum Cell Voltage Value
	Minimum Cell Voltage Position

Description	**Points to be Monitored.** ***Sample interval: 1 second***
	Maximum Cell Temperature Value
	Maximum Cell Temperature Position
	Minimum Cell Temperature Value
	Minimum Cell Temperature Position
	Rack DC Switch Status

13.1.12 Requirements for power conversion systems:

(1) See Section 5.1.17.

(2) The PCS shall meet the requirements of Table 13-4:

Table 13-4 – Minimum PCS Functional Specifications

Description	Requirements
General	The PCS shall be capable of operating in all four power quadrants at rated power (kVA/MVA). Any combination of kW/MW and kVAR/MVAR output shall be possible that is consistent with the BESS's rated power at all levels of SOC. PCS shall be designed to operate using grid power provided through the auxiliary power system and shall not use power from the battery. The PCS, in conjunction with the Master Site Controller (MSC), shall be capable of completely automatic, unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect functions. The control of the PCS shall be integrated with the EMS. PCS shall also include all necessary self-protective features and self-diagnostic features to protect itself from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. The self-protective features shall not allow the PCS to be operated in a manner that may be unsafe or damaging. Faults due to malfunctions within the PCS, including commutation failures, shall be cleared by the PCS protection device(s). Contractor shall advise grid-forming capabilities of the PCS. Refer to Exhibit D.5.3 for additional information.
Reactive Capability	Inverters shall be capable of operation between 0.9 lagging to 0.9 leading power factor with active power de-rating
Charging Method	Constant current / constant voltage
Discharging Method	Constant current
Cooling	Forced Air or Liquid Cooled
Enclosure Protection	IP 65 or above
Inverter Overload Capability	120% of rated power (10 seconds maximum)
Insulation Coordination	Overvoltage Category III up to 3,000 m
Minimum Peak Efficiency	98.9%
Minimum Full Load Efficiency	98.5%

13.1.13 Requirements for BESS Energy Management System (EMS) / SCADA:

(1) Refer to Exhibit A.7 (BESS Energy Management System (*EMS) Scope of Work*) as well as Exhibit D.5.3 for EMS requirements. Contractor is responsible for the design, procurement and installation of the required BESS EMS control system. The EMS shall be designed to provide for automatic, unattended operation of the system. However, the control system design shall provide for local manual operation, remote operation, dispatch of the system from remote SCADA system, or a local portal. All modes of operation and setpoints shall be remotely adjustable from remote locations. Both remote and local control should:

(a) Allow changes in settings and control modes.

(b) POI data (not limited to): MW, MVar, voltages, currents.

(c) Inverter data (not limited to): MW, MVar, voltages, currents.

(d) Battery System data (not limited to): SOC, SOH, MW, voltages, currents, and any data relating to warranty.

(e) Battery Module level data (not limited to): SOC, SOH, temperature, current, voltage, etc.

(f) Have ability to be the MSC for real and reactive power commands.

(g) Provide HVAC status per unit and alarm on units de-rated or off-line based on a loss of colling or high ambient temperature.

(h) Provide HVAC on/off control.

Note: in addition to this Section, the EMS / SCADA provider shall coordinate other Project requirements with applicable sections of the Agreement, inclusive of other Exhibits.

(2) General

(a) The BESS system supplied under these specifications will be used by the Owner to operate under various operating modes. The site controller shall coordinate with the PCS and BMS to perform the functions specified in this section.

(b) The site controller shall interface with the Owner's SCADA system including the remote dispatch system. Contractor shall coordinate with owner as required.

(c) The site controller shall aggregate the operation of the individual PCS such that the BESS may be remotely operated as if a single asset. The site controller / SCADA shall include a data historian function able to store a minimum of 1 month of required BESS operating data locally. The site controller / SCADA shall include a local HMI station and shall be located in the Project Substation control building.

(d) The site controller hardware and application software shall be of proven technology and shall have been installed in similar applications for a minimum of one (1) year.

(3) Functions to be implemented in coordination with Owner include the Functions and Modes listed below. In addition, Contractor is responsible to implement all functions and modes required for NERC compliance. Contractor shall coordinate with the Owner to implement all requested Functions and Modes.

(a) Interactive Functions:

1. Monitoring
2. Disconnect/Connect
3. Cease to Energize and Return to Service

(b) Emergency Modes. – Contractor to coordinate implementation of Emergency Modes as required to comply with the applicable NERC standards.

1. Low/High Voltage Ride-Through Mode
2. Low/High Frequency Ride-Through Mode
3. Frequency-Watt Emergency Mode
4. Dynamic Reactive Current Support Mode
5. Dynamic Volt-Watt Mode

(c) Active Power Mode:

1. Active Power Limit Mode
2. Charge / Discharge Mode
3. Coordinated Charge / Discharge Management Mode
4. Peak Power Limiting Mode
5. Load Following Mode
6. Generation Following Mode
7. Automatic Generation Control (AGC) Mode
8. Active Power Smoothing Mode
9. Volt-Watt Mode
10. Frequency-Watt Mode

(d) Reactive Power Modes:

1. Constant VARs Mode
2. Fixed Power Factor Mode
3. Volt-VAR Control Mode
4. Watt-Var Mode
5. Power Factor Correction Mode

(e) Additional Capabilities

1. Pricing Signal Mode

2. Scheduling of Power Settings and Modes: a power system setting, the enabling/disabling of an operational mode, and a price signal.

3. Historical Information

4. Provide Black Start Capability

13.1.14 Requirements for Auxiliary Load:

(1) Auxiliary load includes all loads necessary to operate and protect the BESS, such as: controls, PCS, cooling systems, fans, pumps, life safety, fire mitigation, back-up power, instrumentation, controls, communications and heaters.

(2) Auxiliary loads are internal to the system and will be measured separately from the BESS nameplate capacity.

(3) Auxiliary power may also be used for temporary construction power.

(4) Backup auxiliary power source shall be integrated in the base design of the project site which is capable of automatically powering the critical components including but not limited to thermal management, fire protection, monitoring and control systems upon loss of the normal auxiliary power source.

(5) The system design needs to account for all expected auxiliary loads such that the design capacity is maintained at the POI after auxiliary loads are applied.

(a) In example, the auxiliary load requirements for both the battery enclosures and PCS shall be included in the designed AC capacity during the discharging period at the POI.

13.1.15 Requirements for grounding:

(1) Grounding shall be designed and provided as required by the NEC, NESC, IEEE 80 and local code requirements. Ground grids or ground loops shall be provided under/around major electrical equipment (step-up transformers, medium voltage switchgear, inverters, fence, etc.).

(2) All equipment ground conductors shall be copper. Grounding electrodes may be copper or copper-clad steel. Cable may be bare if exposed or protected by a conduit sleeve and green insulated if in a raceway along with the circuit conductors.

(3) Ground connections shall be exothermic or mechanical and acceptable for copper conductor termination. All exposed grounding connections within 18 inches of grade shall be listed for direct burial. All exposed grounding connections more than 18 inches above grade shall use materials compatible for the exposed application.

(4) A grounding electrode system consisting of a ring shall be installed at each power conversion system and shall consist of bare copper or copper-clad steel buried below grade, sized and located according to the Project Substation grounding study. Four (4) ¾-inch by 10-foot minimum copper-clad steel ground rods shall be placed equidistant along the ring. Below grade connections shall be exothermic. Ground grid connections to equipment shall be bolted to facilitate separation of grounds for continuity testing and ground mat testing. Ground electrode cable size shall be such to not allow ground loop resistance to exceed requirements per the NESC.

(5) Equipment grounding conductors shall be routed with the phase conductors.

(6) Module mounting structure and combiner boxes shall be grounded per NEC requirements.

(7) Transformers and inverters/PCS units shall be bonded to the ground ring.

(8) One (1) ground test well shall be furnished at each PCS. A flush cover shall expose one ground rod and cable with mechanical cable to rod connectors to allow disconnection for testing purposes.

(9) Grounding connections shall be tested in accordance with the NETA ATS standards.

13.1.16 Requirements for labeling and identification:

(1) Labels for equipment shall be provided, at a minimum, in accordance with the specifications as noted in Section 2.6.

13.2 Submittals

13.2.1 Contractor shall provide a grounding study for the BESS. Such study may be included as part of the Project Substation grounding study.

13.2.2 Contractor shall provide a BESS integration plan for the coordination, integration, and implementation of the BESS into the protection and controls of the Project Substation.

13.2.3 Contractor shall provide data sheets for the modules from the manufacturer for Owner approval, including nominal module power and energy ratings at specific environmental conditions, power and energy rating tolerance, temperature coefficients, and voltage, current, and environmental ratings. Contractor to provide performance curves for the items listed below. Data should be provided under multiple variables such as ambient temperatures, C-rates, elevation, cycles / state of health, and battery age.

(1) Energy capacity / degradation

(a) DC design capacity

(b) Useable/Guaranteed megawatts

(2) Round-trip efficiency

(3) Charge / discharge rates

(4) Cycle life / energy throughput

(5) Heat loads

(6) Operating voltage

(7) Operating current

(8) Self-discharge

(9) Available short circuit current and duration

13.2.4 Contractor shall provide a minimum 5-year warranty plan for the BESS, including the assumptions for degradation and operation over the warranty period.

13.2.5 Contractor shall provide a complete recommended spare parts list for the BESS. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

13.2.6 Contractor shall submit all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently-installed equipment and materials. This shall include, but is not limited to, HVAC, breakers, cabling, PCS, transformers, battery units, racking system, and fire protection system.

13.3 Battery Energy Storage System

13.3.1 Contractor shall design, furnish, construct, and install the BESS in conformance with the minimum requirements set forth herein.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe BESS system, including, but not limited to, battery modules, PCS, DC cabling, transformers, etc.

13.3.2 Contractor shall furnish and install fencing and gates at the BESS.

(1) The BESS perimeter shall be fenced. The fence shall be tied into the grounding grid, as applicable.

(2) At least two (2) vehicle gates located on opposite sides and one (1) pedestrian gate shall be installed at the BESS. If co-located with the Project Substation, the gates for the Project Substation may be utilized for access to the BESS.

(3) All fencing and gates shall comply with the minimum specifications in Section 4.1.10 herein.

13.3.3 Contractor shall offload, inspect, and install the BESS in accordance with the BESS specifications.

13.3.4 Contractor shall integrate the BESS systems and controls into the Project Substation protection and control schemes and shall actively coordinate with the BESS supplier and Owner with respect to such work.

13.3.5 The BESS shall be located within the Project Substation footprint.

13.3.6 The BESS shall be coupled to the AC side of the PV Array and shall allow for charging/discharging from the grid (if applicable).

13.4 Testing and Quality Control

13.4.1 Contractor shall provide reports and outputs of functional tests performed during integration of the BESS.

13.4.2 Copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

13.4.3 Requirements for capacity and functional testing must be submitted in advance and approved by the Buyer.

14.0 WIND TURBINE ERECTION SERVICES

14.1 General Provisions

14.1.1 Contractor shall meet with Owner and Turbine Supplier prior to installation of the first Wind Turbine to participate in an in-person page turn of the Wind Turbine installation manual.

14.1.2 Contractor shall clean and wash all external Wind Turbine surfaces prior to erection to remove dirt generated by delivery and on-site storage. All exterior Wind Turbine surfaces shall be cleaned via pressure washing; light brushing with mild, biodegradable detergent shall be performed as necessary. Following cleaning, all surfaces shall appear clean at a minimum distance of 50 feet. All washing, including runoff, shall be in accordance with the Applicable Permits and other Requirements.

14.1.3 Wind Turbine erection shall follow a "reference" approach, wherein complete erection of the first Wind Turbine of each Wind Turbine model type shall occur prior to erecting any subsequent Wind Turbines of that model. Such initial Wind Turbine erection shall be reviewed and approved by Owner and Turbine Supplier before continuing Wind Turbine erection activities, and such approval shall not be unreasonably withheld or delayed. The "reference" Wind Turbine, once accepted, shall serve as a model finished product for all subsequent Wind Turbine erections.

14.1.4 Wind days shall be actively minimized by scheduling Wind Turbine erection activities at times of day when wind speeds are projected to be lowest.

14.1.5 Wind Turbines shall be erected such that the tower door orientation is downwind of the of the prevailing wind direction.

14.1.6 Each crane, including the main erection crane(s) and any base/mid crane(s), shall be equipped with redundant anemometers at Wind Turbine hub height for measurement of wind speeds. Wind speeds shall be recorded from these instruments prior to the start of all lifting activities, and measurements shall be recorded on a Contractor-furnished data logger. Handheld anemometers shall also be furnished to determine safe wind speeds for all other operations. All such wind data shall be shared with Owner upon request.

14.1.7 Transportation, offloading, storage, and erection of Wind Turbines shall be performed in accordance with the applicable instructions provided by Turbine Supplier and the specifications provided herein, including critical lift plans.

14.1.8 Mechanical completion of each Wind Turbine, including documentation of progress on Turbine Supplier-furnished forms, shall be successfully achieved in accordance with the instructions set forth in the installation manual and mechanical completion checklists provided by Turbine Supplier.

14.1.9 All rigging utilized for the transportation, offloading, or erection of Wind Turbines shall be rated; inspected daily; and load tested in accordance with Applicable Standards or other more rigorous requirements set forth in the HSSE Plan. Inspection reports shall be maintained at the Project Site and available for review by Owner.

14.1.10 Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner.

14.2 Submittals

14.2.1 Not used.

14.3 Wind Turbine Deliveries

14.3.1 Contractor shall coordinate with Turbine Supplier on a test run for Wind Turbine deliveries at the Project Site by use of non-loaded trucks to demonstrate that road dimensions will be appropriate for successfully delivering components to the Wind Turbine Pads. Such trial run will be performed by Turbine Supplier prior to commencing deliveries of Wind Turbine equipment to the Project Site. Any non-compliant areas shall be immediately corrected by Contractor.

14.3.2 Contractor shall furnish and operate assist vehicles as necessary for delivery and movement of Wind Turbines at and within the Project Site

14.3.3 Contractor shall receive, visually inspect, and inventory all deliveries of Wind Turbine equipment (including Wind Turbines, transformers, down-tower converters, switchgear, service lifts, Turbine SCADA System, Special Tools, and shipping containers / Owner-Supplied Equipment to the Project Site. Contractor shall submit reports to Owner within 24 hours of delivery regarding receipt, inspection, and inventorying of all such deliveries, including any damage identified.

14.3.4 Contractor shall offload, stage, and actively coordinate deliveries with Turbine Supplier.

14.3.5 Contractor shall furnish and maintain protective tarps (or similar) to eliminate unwanted materials from entering Wind Turbine equipment after removal of any shrink wrapping from the shipping process.

14.3.6 Contractor shall furnish and install adequate measures to prevent Wind Turbine equipment from being blown over or otherwise damaged while stored at the Project Site. This shall include tie down of blades and other similar measures. Such measures shall be consistent with Turbine Supplier requirements.

14.4 Wind Turbine Installation

14.4.1 Contractor shall apply touch-up paint as necessary to repair any damage to Wind Turbine equipment, including damage that occurred prior to or during Wind Turbine erection. Paint repair shall be performed in accordance with Turbine Supplier's requirements with Owner-approved paint.

14.4.2 Contractor shall assemble, install, construct, and erect all Wind Turbines, including all components, equipment, switchgear / down-tower assembly, stairs, service lifts, and other similar items, and including furnishing of the main crane(s) with suitable capacity for Wind Turbine erection and in strict compliance with Turbine Supplier's requirements and procedures.

(1) Contractor shall furnish all labor, equipment (including rigging, tooling, hoisting equipment, and lifting devices), and materials that are necessary to assemble and install the Wind Turbines.

(2) Contractor shall fabricate and furnish all anchor bolt template rings as required to support Wind Turbine installation.

(3) Contractor shall install three precast 2-foot by 2-foot concrete paving pads at the base of the stairs matching the stair step height for each Wind Turbine. The surrounding gravel shall be graded to be flush with the top of the pads. The stair support legs shall be set on gravel, not on the paving pads .

(4) Contractor shall grout, install, shim, and level all tower base sections, including providing all necessary grease, shim packs, leveling feet, and other necessary items or consumables.

(5) Contractor shall provide all crane breakdowns, both partial and full, necessary to complete the Work.

(6) Contractor shall furnish and install one (1) fire extinguisher (sized per the Applicable Standards and other Requirements) and one (1) fire extinguisher bracket in each maintenance vehicle / in each Wind Turbine, as required by local fire codes or other Requirements.

(7) Contractor shall install the Wind Turbines at the locations specified per the component serial numbers as identified by the Turbine Supplier and/or design documents. Parts designated for a specific Wind Turbine location shall not be moved to another Wind Turbine location without explicit Owner approval.

14.4.3 Contractor shall install the electrical wiring and cabling in each Wind Turbine, including all necessary pulling, dressing, lugging, taping, splicing, and terminations, to interface with the Turbine Foundation.

(1) Contractor shall furnish all labor, equipment, and materials that are necessary for the electrical connection of the Wind Turbines to the Collection System Circuits, including all down-tower cabling.

(a) All cabling and connectors on the Wind Turbine-side of the down-tower switchgear shall be furnished and installed by Contractor.

(b) All cabling and connectors on the grid-side of the down-tower switchgear shall be furnished and installed by Contractor.

(2) Contractor shall install the grounding system in each Wind Turbine, including grounding of Wind Turbine stairs.

(3) Contractor shall furnish and install (a) all temporary Turbine obstruction lights, including wiring and mounting brackets and (b) all permanent Turbine obstruction lights, including wiring and mounting brackets. Obstruction lights shall be (i) the model as determined in Owner's *Determination of No Hazard to Air Navigation* letter from the FAA (ii) in compliance with the Requirements, including US DOT-FAA Advisory Circular No. AC 70/7460-1K: *Obstruction Marking and Lighting*; (iii) provided with an uninterruptible power supply capable of supplying back-up power for at least one (1) hour; (iv) programmed to blink in unison, including with those aviation obstruction lights that are installed on meteorological towers / (iv) compatible with the ADLS operating system; and (v) night vision goggle compliant. Contractor shall remove all temporary FAA lights when no longer needed.

14.4.4 Contractor shall provide any required Wind Turbine maintenance, including any necessary generators and fuel, prior to successfully achieving Wind Turbine Mechanical Completion.

14.4.5 Contractor shall successfully achieve Wind Turbine Mechanical Completion of each Wind Turbine, including documentation of progress on Turbine Supplier-supplied forms for each Wind Turbine, in accordance with the applicable instructions set forth in the installation manual and mechanical completion checklists.

14.4.6 Contractor shall provide a final broom cleaning of each Wind Turbine prior to handoff following Wind Turbine Mechanical Completion. Further, each Wind Turbine should be reasonably clean and free from grease, oil, and other grime prior to Wind Turbine Mechanical Completion.

14.4.7 Contractor shall collect and repackage all returnable items on loan from Turbine Supplier, including, but not limited to, shipping frames, delivery devices, brackets, lifting and rigging equipment, specialized tooling, and other returnable items. Contractor shall repackage all such items inside emptied parts containers per instructions provided by Turbine Supplier and shall provide inventory tracking and packing lists for such repackaged items. Contractor shall load all such repackaged items on transport trucks as made available by Turbine Supplier at the Project Site per the schedule set forth in the Agreement. Contractor shall be responsible for moving all such items from the Wind Turbine Pads to the designated loading area(s) for transport as necessary.

14.4.8 Contractor shall provide qualified personnel to perform lock-out / tag-out, switching, and other similar activities during the commissioning of the Wind Turbines by Turbine Supplier up until Contractor's Substantial Completion.

14.5 Coordination

14.5.1 Contractor shall actively coordinate the sequence of Work with Owner and Owner's contractors (including Turbine Supplier) to support the Project Schedule.

14.5.2 Contractor shall coordinate with Turbine Supplier on the handoff following Wind Turbine Mechanical Completion. At a minimum, such coordination shall ensure that Turbine Supplier is aware that the respective Wind Turbine has successfully completed mechanical completion so that Turbine Supplier may commence inspection and commissioning activities. Additionally, Contractor shall share reasonable information with Turbine Supplier and turn over Wind Turbine access to Turbine Supplier as part of this coordination.

14.5.3 Contractor shall attend and actively participate in all Wind Turbine Mechanical Completion walk-downs with Turbine Supplier.

14.5.4 Contractor shall provide qualified support personnel to perform all lock-out-tag-out, switching, startup and testing activities in connection with Turbine Supplier's commissioning, start-up and testing of the Wind Turbines.

14.5.5 Contractor shall coordinate with Turbine Supplier on any termination of power or fiber optic cabling in Wind Turbines following Wind Turbine Mechanical Completion.

14.6 Testing and Quality Control

14.6.1 Contractor shall test the Wind Turbine tower electrical wiring and cabling. At a minimum, testing shall include the minimum requirements set forth below. All testing shall be performed by an independent, experienced third party.

(1) All Wind Turbine electrical wiring shall be tested to demonstrate it meets stated design criteria and is fit for purpose.

(2) All testing specified in the Applicable Standards, including NETA.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) Structural works testing for grout properties, in accordance with Section 4.1.13 herein.

(5) Visual inspection, insulation resistance testing, and continuity testing of the Turbine cabling as described in Section 5.4.1 herein.

(6) Other testing set forth in the preliminary design documents in Exhibit D.3 (*Preliminary Design Documents*).

14.6.2 All wind turbines will be commissioned and tested in strict compliance with the Turbine Supplier's requirements and procedures. Once all turbines are commissioned, the site shall operate at a 97% availability for 72 continuous hours without bypassing any normal operating parameters or controls, or manually resetting faults instead of resolving the root cause (auto resets performed by the turbine controller are allowed).

14.6.3 Gearbox oil in each turbine shall be sampled and analyzed to confirm the oil meets all Wind Turbine and oil manufacture specifications.

14.6.4 Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

15.0 WIND - AIRCRAFT DETECTION LIGHTING SYSTEM

15.1 General Provisions

15.1.1 Requirements for ADLS civil and structural works:

(1) All civil and structural works including, but not limited to, grading, structures, foundations, assemblies, and components for the ADLS shall be designed and constructed in accordance with the applicable specifications in Section 4.0 *(Civil /* Structural Works).

15.1.2 Radar towers shall be self-supported (non-guyed), galvanized lattice structures, each tower shall be designed and certified for the maximum wind and ice loading for the Project Site conditions.

15.1.3 All FAA obstruction lights shall be of the same make and model and consistent with the requirements in Section 14.4.3 and shall be compatible with the Wind Turbine and ADLS communication system, respectively.

15.1.4 The ADLS shall detect when an aircraft is at a defined outer perimeter around the Project Site and place the Wind Turbine aircraft obstruction lighting system in the "ON" state. When aircraft is outside of the defined perimeter of the Project Site, the ADLS system shall maintain the lights in the "OFF" state to minimize light pollution from the obstruction lighting.

(1) A failure of the ADLS radar system shall be automatically detected and place the obstruction lights in the "ON" state.

15.1.5 Contractor shall perform all required studies and analyses of the Project Site for siting of the ADLS radar tower(s). Contractor shall propose a minimum of two potential locations for the ADLS Radar tower(s) within the Project boundary on participating landowner parcels. Potential locations shall provide adequate coverage for the entire Project site.

(1) Contractor shall optimize the system considering items such as number of radar towers, radar tower height, available tower locations, distance from Collection System Circuits, etc. Contractor shall actively attempt to minimize the number of tower locations for the Project Site.

(2) Contractor shall coordinate the selection of the radar tower location(s) that are studied / analyzed and the final selected radar tower location(s) with the Owner. Selection of the radar tower location(s) shall include a site visit by the ADLS manufacturer prior to finalizing the tower location(s) to confirm the suitability of each location.

15.1.6 Requirements for power supply:

(1) Power for each radar shall be derived from the nearest Collection System Circuit or via a nearby Project source (e.g., O&M Building, Substation).

(2) Power cable shall be installed at the same depth as the Project Collection System, unless otherwise explicitly approved by Owner.

(3) The Collection System Circuit cable power the ADLS shall include a 34.5-kV junction box extending the 34.5-kV cable from the junction box to each radar tower location. An oil-filled, distribution style pad-mounted transformer (with the requirements as in Section 5.1.10) and low-voltage Nema 4 distribution panelboard shall be utilized to step down the power to the required low voltage of the radar tower to power the radar devices.

(a) The following exceptions are made to the requirements of the pad-mounted transformer as noted in Table 5-1:

1. MV bushings: (2 or 3) 200A or (2 or 3) 600A.

2. Phases: One (1) or Three (3)

3. Vector Group HV/LV: HV = Ungrounded (Single phase or Delta) / LV = Grounded (single phase or Delta or Wye) as specified by Engineer of Record to provide the ADLS power requirements. Note that a three-phase transformer with a 34.5 kV Delta high voltage winding and a low voltage winding of 240V Delta with a center tap bonded to ground on one phase is allowed as a means of providing a solidly grounded low voltage system with both 240V three phase and 120/240V single phase power.

4. Grounding: Solid (MV source, LV winding); un-grounded delta or single phase 34.5 kV (MV winding on transformer)

5. Temperature gauge; Nitrogen pressure level indicator; Oil sampling valve; Nitrogen filling orifice: Option pricing for instrument being located in an external padlockable compartment is not required.

6. Infrared viewing windows with metal cover: Option pricing is not required.

15.1.7 Requirements for ADLS communications:

(1) The ADLS communication system shall comply with the applicable requirements in Section 9.0 (*Communication Systems*).

(2) The ADLS communication system shall be capable of controlling and communicating between the Wind Turbine obstruction lights and Owner's SCADA system with reporting/view-only function available at the Project Substation.

(3) Communications for each tower location shall include the installation of direct buried fiber optic cable extending to the ADLS radar tower.

(4) The ADLS fiber cable shall be co-located with the power cable.

15.1.8 Requirements for ADLS grounding:

(1) The grounding system for the ADLS tower shall include a ground ring at least three (3) feet outside the perimeter fence of the ADLS tower and shall be bonded to the fence, tower, and electrical system. It shall be designed as required to meet acceptable levels of both touch and step potential and ground potential rise. See Section 6.1.26 for grounding system requirements.

15.1.9 Contractor shall comply with all applicable permits, the AHJ, the Federal Communications Commission ("FCC"), the Federal Aviation Administration ("FAA"), and any applicable rules established by the State where the project is located and the State Public Utilities Commission.

15.2 Submittals

15.2.1 Contractor shall submit for Owner review the locations to be studied / analyzed for each radar tower prior to proceeding with study of the location.

15.2.2 Contractor shall submit for Owner review the study / analysis for each radar location including, but not limited to the viewshed analysis for each location, required height of the radar tower structure.

15.2.3 Contractor shall prepare the ADLS design documents per the submittal schedule in Exhibit G.1 (*Submittal Schedule*) and containing the following information, at a minimum: (a) general arrangement plan and physical layout diagrams; (b) civil works drawings; (d) one-line diagrams, wiring diagrams, schematics. (e) communications block diagram, including all Communications System equipment, Owner-Supplied Equipment, and turbine manufacturer supplied equipment; (f) Communications System details, including HMI screen development, and fiber termination diagrams; (g) cable specifications and arrangements; (h) conduit and cable schedules; (i) panel schedules; (j) elevation drawings; (k) structural design documents, including foundation plans and details (with structural calculations to be provided with each set of foundation drawings); shop drawings showing fabrication of structural-steel components; details of cuts, connections, splices, camber, holes, and other pertinent data; indication of welds by standard AWS symbols, distinguishing between shop and field welds, and showing size, length, and type of each weld; indication of type, size, and length of bolts, distinguishing between shop and field bolts; mill test reports and structural steel properties, including chemical and physical; and fastener properties (mechanical/chemical), including bolts, nuts, and washers, and indicating coatings used to satisfy anchor bolt protection plan; (l) ground grid calculations; (m) ground grid plans; (n) conduit details; (o) fencing and gate details; (p) drawing index; (q) bill of materials; and (r) inspection, testing, and quality control requirements.

15.2.4 Contractor shall submit for Owner review and approval all manufacturer's product sheets (material cut sheets), warranties, and operations and maintenance manuals (as applicable) for all permanently installed equipment and materials, including but not limited to:

(1) Radar system including its control system components and power requirements.

(2) Obstruction lighting and lighting communication modules.

(3) Radar tower.

(4) Pad-mount transformer.

(5) Distribution panelboard.

15.2.5 Contractor shall submit for Owner review a description of the data that is provided by the ADLS to the SCADA system and sample reports that can be generated by the SCADA system that provide the performance data for the ADLS.

15.2.6 Contractor shall provide a complete recommended spare parts list for the ADLS system. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

15.2.7 Contractor shall submit all required permits or approvals obtained for the ADLS system for Owner review

15.3 Aircraft Detection Lighting System

15.3.1 Contractor shall design, furnish, construct, and install an ADLS, radar-controlled aircraft obstruction lighting system for the Project. The ADLS-controlled lighting system shall include, but not be limited to, the power supply, grounding / surge protection, communications, radar tower structure, fencing and gates, access roads, ADLS radar, Wind Turbine obstruction lighting, lighting control modules, ancillary equipment, and any other materials or work as necessary to provide a complete and functioning system.

15.3.2 Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe ADLS radar-controlled lighting system.

15.3.3 Contractor shall furnish and install fencing and gates around each ADLS radar.

(1) A perimeter fence with at least one gate entrance shall surround the radar tower site including the tower, pad-mounted transformer, distribution panelboard, radar control and communications equipment.

(2) Fencing shall be placed to allow a minimum of 10 feet of free space around the radar tower base including the transformer, panelboard, and radar control equipment. Fencing shall be grounded. The gate shall be a lockable swing-gate, sufficiently wide for light-duty vehicle access. See Section 4.1.10 for fencing and gate requirements.

(3) The fenced area for the radar tower shall be covered throughout with at least six (6) inches of aggregate over a compacted subgrade, with aggregate extending at least one (1) foot beyond the fence in all directions and using the same aggregate material as the Site Access Roads.

15.3.4 Contractor shall furnish and install a 12-foot-wide road to each radar tower. Such roads shall be constructed of the same materials and with the same cross section as the Site Access Roads. See Section 4.1.6 for site road requirements.

15.4 Testing and Quality Control

15.4.1 Contractor testing plan for the ADLS system shall be submitted to Owner for review and approval. Contractor shall notify Owner of all testing schedules at least 30 days in advance of testing activities and copies of testing reports (including a summary of testing procedures and acceptance criteria) shall be submitted to Owner within 10 days of completing such test.

15.4.2 The ADLS system communication testing shall comply with Section 9.4.

15.4.3 Acceptance of the Work shall be determined by Owner only when the ADLS is fully commissioned including, but not limited to, remote access capability, ADLS report generation capability, and the ADLS is in compliance with the Requirements.