Portland General Electric

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APPENDIX M – WIND PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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WIND PLANT SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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APPENDIX M2-01-1
WIND PLANT SPECIFICATIONS

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 complete development, engineering, procurement, and construction of the Project, including Wind Turbine supply and installation, all balance-of-plant infrastructure, and all tasks necessary to achieve Wind Turbine Commissioning Completion of all Wind Turbines; and (b) to summarize the minimum performance specifications, quality standards, and other criteria required for the development, engineering, procurement, and construction of the Project.

1.2 Project Description

1.2.1 The [Project Name] Wind Project is a nominal [capacity] megawatt wind energy project using a quantity of [quantity] [model] Wind Turbines located in [County Name] County, [State Name].

1.3 References

1.3.1 In addition to anything summarized herein, all Work related to the Project shall conform to the following Owner standards. In the case of any conflict between any Owner standards below and any requirement set forth herein, the more stringent requirement shall apply.

(1) PGE Appendix M1, Attachment 01, Exhibit 02: Engineering Documents, Drawings, and Other Deliverables ("**PGE Exhibit M1-01-02**"), including the Documents and Deliverables Table (M1-01-02-01) ("**PGE Exhibit M1-01-02-01**") attached thereto.

(2) PGE Appendix M1, Attachment 01, Exhibit 07: Security and Compliance ("**PGE Exhibit M1-01-07**")

(3) PGE Appendix M1, Attachment 01, Exhibit 09: PGE CAD and Numbering Standards ("**PGE Exhibit M1-01-09**")

(4) PGE Appendix M1, Attachment 04, Exhibit 02: General Transformer Specification ("**PGE Exhibit M1-04-02**")

(5) PGE Appendix M1, Attachment 05, Exhibit 04: Communication, SCADA, and Metering Facilities ("**PGE Exhibit M1-05-04**")

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. [NTD: a definition for items noted as "TBD" will be provided within the Agreement.]

(1) "**Abnormally Severe Weather Conditions**" means any of the following: (a) cumulative precipitation in excess of [2.0"] inches in a 24-hour period or (b) cumulative precipitation in excess of [4.0"] inches in a one-week period, in each case as measured at the Project Site. [NTD: to be aligned with final contract documents.]

(2) "**Applicable Law**" means [TBD].

(3) "**Applicable Permits**" means [TBD].

(4) "**Applicable Standards**" means the minimum standards and industry codes and any other criteria required for the performance of the Work by Contractor, including those set forth in Attachment 2 (*Applicable Standards*) to this exhibit.

(5) "**As-Built Drawing**" means a complete set of drawings prepared by Contractor or a Subcontractor which accurately and completely represent the Work as constructed and installed.

(6) "**BOP Contractor**" means [Contractor to add BOP Contractor name].

(7) "**Collection System Circuit**" means the permanent electrical and communications infrastructure required to transmit energy and performance and operating data between each Wind Turbine and the Project Substation, or to the Turbine SCADA System control panel as appropriate.

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

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

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

(11) "**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.

(12) "**Functional Groups**" means a rotor blade set; hub; pitch system; main shaft arrangement, including main bearing; gearbox; mechanical brake; high-speed shaft coupling; generator; internal crane; power converter; [medium-voltage transformer]; internal tower wiring and cabling; controller; auxiliary system; wind vane; anemometer; yaw system; cooling system; hydraulic system; tower section; switchgear; ground controller; or uninterruptible power supply, respectively.

(13) "**Gen-Tie Line**" means the [VOLTAGE]-kV high-voltage transmission line connecting the Project Substation with the Point of Interconnection.

(14) "**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.

(15) "**Major Subcontractor**" means any subcontractor with whom Contractor will enter (or has entered) into an agreement or purchase order for performance of any part of the Work that has an aggregate value in excess of $250,000.[NTD: to be aligned with final contract documents.]

(16) "**O&M Building**" means the operations and maintenance building for the Project.

(17) "**Owner**" means Portland General Electric.

(18) "**Point of Interconnection**" means the point where the Gen-Tie Line connects to the [Contractor to add switchyard name] Switchyard, as more fully described in Exhibit [●] (*Interconnect Agreement*).

(19) "**Project**" means the generating facility described in the Proposal.

(20) "**Project Site**" or "**Site**" means the location, or proposed location, of the Project.

(21) "**Project Substation**" means the 34.5/[VOLTAGE]-kV substation to be located at the Project Site, with all necessary equipment to connect the Project to the interconnecting utility's grid.

(22) "**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.

(23) "**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.

(24) "**Requirements**" means the Specifications in Exhibit [●] (*Specifications Exhibit Name*), Prudent Wind Industry Practices, Applicable Law, Applicable Permits, Applicable Standards, the Project Schedule, the Interconnection Agreement in Exhibit [●] (*Interconnect Agreement Exhibit Name*), the designs in Exhibit [●] (*Preliminary Design Exhibit Name*), the landowner requirements in Exhibit [●] (*Landowner Requirements Exhibit Name*), the Utility Specifications, the Turbine Supplier Project Site Requirements, and the other requirements of the Agreement.

(25) "**Roads**" and "**roadways**" means all access roads, Wind Turbine string and spur roads, substation roads, transmission line service roads, meteorological tower roads, operations and maintenance building roads, and temporary construction roads to be constructed for the Project by Contractor.

(26) "**SCADA**" means supervisory control and data acquisition.

(27) "**Special Tools**" has the meaning set forth in Section 10.3.5.

(28) "**Submittal Schedule**" means the schedule for Contractor's delivery of submittals, as set forth in PGE Exhibit M1-01-02-01 (*Documents and Deliverables Table*).

(29) "**Substantial Completion**" means [TBD].

(30) "**Turbine 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 Wind Turbine or that otherwise form or are intended to form part of the Work or the Project, including all equipment, materials, apparatus, structures, tools, supplies, Delivery Devices, Special Tools, and other goods provided and used by Turbine Supplier for performance of the Work, but that are not incorporated into the Project.

(31) "**Turbine Foundation**" means each Wind Turbine foundation.

(32) "**Turbine SCADA System**" means the supervisory control and data acquisition system for the Wind Turbines.

(33) "**Turbine Supplier**" means [Contractor to add OEM name].

(34) "**Wind Day**" means an occurrence wherein erection of Wind Turbines is specifically scheduled to occur and the main erection crane is fully functional and unable to operate due to any of the following conditions: (a) actual 10-minute average wind speeds of [22] miles or more per hour for at least four (4) consecutive hours during a regularly scheduled shift of ten (10) hours or more as measured at the tip of the respective crane. [NTD: to be aligned with final contract documents.]

(35) "**Wind Turbine**" means each of the complete, fully-functional wind turbine generators to be part of the Project.

(36) "**Wind Turbine Equipment**" means Wind Turbines, the Turbine SCADA System, and all other materials and equipment identified in the Agreement (including this exhibit) and incorporated into the Project by Contractor and Turbine Supplier in performing the Work.

(37) "**Wind Turbine Mechanical Completion**" means [TBD].

(38) "**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.

(39) "**Work**" means all actions, capital, contracts, labor, equipment, and materials necessary to construct the proposed Project and furnish wind energy and environmental attributes (including operating the Project) 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.

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, 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 (including any attachment hereto) 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, testing, 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 wind generation facilities. Equipment shall be installed, assembled, and tested in strict compliance with the manufacturer's drawings, manuals, 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 Not used.

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, terrain, ground cover / vegetation, corrosivity, precipitation (rain, snow, ice), 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 Attachment 2 (*Applicable Standards*) to this exhibit. The method for handling conflicts between Applicable Standards shall be as set forth therein.

2.1.8 This Section 2.1.8 contains a list of approved materials, equipment suppliers, and subcontractors. Contractor shall request approval from Owner prior to executing any contract for the procurement of such material or with such equipment supplier or subcontractor (a) if Contractor is considering the selection of a material, equipment supplier, or subcontractor that is not listed below; (b) for any Major Subcontractor not listed below; or (c) for the Project's engineer(s) of record and geotechnical engineer(s). Equipment catalog cut sheets shall be submitted for Owner review and approval prior to procurement. In some categories, a supplier has been identified as "Preferred" with an (*) in order to maintain the same suppliers of equipment as Owner has utilized the supplier for its generating fleet.

(1) Climb Assist Power Systems

(a) PowerClimber, IBEX

(2) Collection System Cable

(a) Southwire

(b) Prysmian Power Cables and Systems

(c) Okonite

(3) Generator Circuit Breaker

(a) *ABB

(b) GE Grid Solutions

(c) Mitsubishi

(d) Siemens

(e) HVB

(4) Generator Step-up Transformer (substation main power transformer)

(a) ABB, Varennes, Canada shop

(b) ABB, St. Louis, Missouri shop

(c) ABB, Bad Honnef, Germany shop

(d) ABB, South Boston, Virginia shop

(e) HICO, ChangWon, South Korea shop

(f) Hyundai, Montgomery, Alabama shop

(g) Hyundai, Ulsan, South Korea shop

(h) Smit, Nijimegen, The Netherlands shop

(i) SPX Waukesha, Waukesha, Wisconsin shop

(j) EFACEC, Arroteia, Portugal shop

(k) Siemens, Guanajuato, Mexico shop

(l) GE Prolec, Monterrey, Mexico shop

(m) Shihlin, Taipei, Taiwan shop

(5) Ground Reference Transformers

(a) ABB

(b) Cooper Power Systems

(c) GE

(d) Virginia Transformer

(6) GSU Pad-mount Transformers

(a) ABB

(b) General Electric

(c) Cooper Power Systems

(d) Siemens

(e) WEG

(7) Instrument Transformers

(a) ABB

(b) Trench Ltd

(c) GE/Alstom

(8) Load Center Unit Substations

(a) ABB

(b) Eaton

(c) General Electric

(d) Powell Manufacturing

(e) Schneider Electric / Square D

(f) Siemens Power T&D

(9) LV Motor Control Centers

(a) *Eaton

(b) ABB

(c) Allen Bradley

(d) General Electric

(e) Powell Manufacturing

(f) Schneider Electric / Square D

(g) Siemens Power T&D

(10) Medium Voltage Switchgear, Starters and Controllers

(a) Powercon

(b) Siemens Power T&D

(c) ABB

(d) Eaton

(e) General Electric

(f) Powell Manufacturing

(g) Schneider Electric / Square D

(11) Protective Relays and Revenue Meters*

(a) Schweitzer Engineering Laboratories (SEL)

* Final devices must be compatible with PGE standards and approved by PGE in advance of final design and start of construction

(12) Relay Panels

(a) Electrical Power Products (EP2)

(13) SF6 Circuit Breakers (High Voltage and Medium Voltage)

(a) Siemens

(b) ABB

(c) Mitsubishi

(d) GE/Alstom

(e) Hitachi/HVB (Georgia)

(14) Single Mode Fiber Cable & Attachment Hardware

(a) AFL

(b) OFS

(c) Preformed Line Products

(d) Anixter

(15) Substation Capacitors

(a) Cooper Power Systems

(b) General Electric

(16) Substation Control Enclosure

(a) Trachte

(b) AZZ

(c) Systems control

2.1.9 Substation Disconnect Switches (115-230KV)

(a) Pascor

(b) Cleaveland Price

(2) Substation Distribution Metering

(a) Novatech Bitronics M871 (SCADA distribution feeder metering)

(b) Novatech Bitronics M650 (SCADA distribution transformer metering)

(3) Substation Human/Machine Interface

(a) Schneider Electric

(4) Substation Remote Terminal Unit

(a) Eaton Cooper Power System

(5) Substation SCADA Ethernet Switches and Port Servers

(a) Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports

(b) Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports

(c) Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports

(d) Siemens RuggedCom RS416 – Serial port server, Rack mount, 16 ports

(6) Substation SCADA Gateway

(a) Eaton Cooper SMP SG4250

(7) Substation SCADA Input/Output Devices

(a) Eaton Cooper Power Systems

(8) Transformer Bushings

(a) PCORE

(b) ABB

(9) Transmission Line Type Grips

(a) *Chicago

(b) Alcoa Pocket

(c) Kellum (for stringing operation)

(10) Transmission Tubular Steel Towers

(a) Valmont

(b) Sabre

(c) Trinity Meyer

(d) Dis-Tran

(11) Uninterruptible Power Supply System (UPS)

(a) *Vertiv Chloride (formerly Emerson Network Power)

(b) Ametek Solidstate Controls

(c) CEG

(d) Gutor/Schneider

(12) Wind Turbine Generators

(a) General Electric

(b) Siemens Gamesa

(c) Vestas

(13) 48 VDC Battery & Charger

(a) East Penn Manufacturing

(b) C&D Technologies

(c) Eltek/Valere

(14) 125 VDC Chargers

(a) *SENS

(b) *Vertiv Chloride (formerly Emerson Network Power)

(c) Ametek Solid State Controls

(d) Cyberex

(e) Hindle Power

(15) 125 VDC Batteries

(a) *GNB

(b) BAE

(c) Hoppecke

(d) C&D Technologies

(16) Approved Subcontractors, Met Towers

(a) World Tower

(b) Magnum Tower

(c) CER

(d) Aerial Erectors

(e) Anetech

(f) Sabre

(g) Tower Systems

(h) Nello

(i) Vikor

(j) Vertical Technologies

2.1.10 Unless explicitly stated otherwise, including for Turbine Foundations as set forth in Section 4.1.3 herein, the minimum design working life of the Work shall be 30 years. For the avoidance of doubt, Wind Turbine shall have a minimum design life of 20 years and the Project's permanent drainage facilities shall be designed in accordance with Section 4.1.2.

2.1.11 Requirements for rigging and tooling:

(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) Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner.

(3) Contractor shall utilize tooling in accordance with manufacturer recommendations, including any Turbine Supplier guidelines for use of Special Tools.

2.1.12 Contractor shall cause the Project Contracts, including without limitation the Turbine Supply Agreement and Balance of Plant Agreement, to be entered into, either by Contractor or a direct Affiliate. The Project Contracts shall provide for the planned Wind Turbines to be purchased by (or on behalf of) Contractor and delivered to the site for installation by Contractor's subcontractors.

2.2 Site Conditions

2.2.1 Contractor shall inspect the Project Site prior to initiating the Work 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 have been contemplated and included in the Contract Price, and Contractor shall not be entitled to request or be granted any scope change claims based on the results of these investigations.

2.2.2 Contractor shall furnish weather equipment at the Project Site capable of measuring rainfall, wind speed, and other conditions as necessary to determine the occurrence of Wind Days and Abnormally Severe Weather Conditions, respectively.

2.2.3 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.

2.3 Construction Management

2.3.1 Contractor shall provide traffic control at and within the Project Site, or as otherwise required to complete the Work, including, but not limited to, traffic control along any public roads.

2.3.2 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 and be capable of reaching any and all locations at the project site where work would occur.

2.3.3 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 pressure washing of Wind Turbine components.

2.3.4 Contractor shall provide all necessary temporary/construction power, including, but not limited to, that required for the office trailers, temporary lighting, Project Substation, O&M Building, and meteorological towers. For the avoidance of doubt, Contractor shall be responsible for furnishing both the power supply and fuel source for such items.

2.3.5 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.

2.3.6 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.

2.3.7 Contractor shall support Owner with providing timely responses to reasonable requests for information from Owner or Owner's contractors, including Turbine Supplier.

2.3.8 Contractor shall ensure compliance with all landowner agreements as further prescribed in Exhibit [●] (*Landowner Requirements*), including repair of all crop damage. Recognizing the importance of strong positive landowner or occupant and community relations, Contractor shall support and participate in landowner or occupant informational/planning meetings (e.g., Wind Turbine/road/collection line location confirmation) and governmental meetings (e.g., planning commission, board, or informational meetings). Contractor shall document any landowner issues during the development and construction of the Project and share such list with Owner. [NTD: an exhibit outlining Project-related landowner requirements will be provided at a later date and attached to the Agreement]

2.3.9 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, including, but not limited to, those identified through the local "One-Call" service, the Owner-provided ALTA survey, or other similar information made available to Contractor or available to Contractor through the exercise of reasonable diligence. 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.

2.4 Project Documentation

2.4.1 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, 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; and shall comply with the minimum requirements set forth in PGE Exhibit M1-01-02 (*Engineering Documents, Drawings, and Other Deliverables*). 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 managment plan and anticipated sequence of site operations (the "**Project Schedule**"), and shall cause the reports summarized in Attachment 1 (*Schedule Requirements*) to this exhibit to be submitted with each weekly Project Schedule update; the Project Schedule shall comply with the minimum requirements set forth in Attachment 1 (*Schedule Requirements*) to this exhibit. Contractor shall also provide an individual (the "**Scheduler**") who shall (a) be dedicated to the Project; (b) develop and maintain the Project Schedule; (c) be an experienced specialist that is skilled in critical path method scheduling; (d) be capable of producing CPM reports within 24 hours of Owner's request; and (e) 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 Plan**"). These plans shall conform to the minimum requirements set forth in Exhibit [●] (*HSSE Plan Requirements*) and PGE Exhibit M1-01-07 (*Security and Compliance*), collectively. [NTD: an exhibit outlining minimum requirements for the HSSE Plan will be provided at a later date and attached to the Agreement]

(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 [●] (*Quality Plan Requirements*). [NTD: an exhibit outlining minimum requirements for the Quality Plan will be provided at a later date and attached to the Agreement]

(4) Contractor shall submit the design drawings and calculations for the Project to Owner for review and comment at points roughly equivalent to being 30 percent complete, 60 percent complete, 90 percent complete, and issued-for construction ("**IFC**") in accordance with the Agreement unless mutually agreed to between Contractor and Owner.

(5) Contractor shall provide one (1) complete copy of Job Books in hard copy format *and* one (1) complete copy of Job Books in electronic format on flash drive. Job Books shall conform to the minimum requirements set forth in Exhibit [●] (*Job Book Requirements*).

(6) Contractor shall provide one (1) complete, full-size (size D), color set *and* one (1) complete, 11-inch by 17-inch, color sets of As-Built Drawings in hard copy format, as well as one (1) complete, full-size (size D) set of As-Built Drawings in electronic format on flash drive. As-Built Drawings shall comply with PGE Exhibit M1-01-09 (*PGE CAD and Numbering Standards*).

(7) Contractor shall prepare, implement, and manage a detailed project management plan that is specific to the Project and Project Site. The project management 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 management 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.

(8) Not used.

(9) Contractor shall prepare, implement, and manage critical lift plans that are specific to the Project and Project Site. 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. Prior to performing any critical lift, Contractor shall perform a practice lift with a similar crane configuration and load configuration; practice lifts shall always be performed with the same crew and using the same lifting equipment as those used for the critical lift; to the extent that Contractor has successfully performed a practice lift, any subsequent, identical lifts shall not require another practice lift. Any lift exceeding ninety-five percent (95%) of a crane's load chart is prohibited. For purposes of this exhibit, a "critical lift" shall include, at a minimum, any lift that exceeds seventy-five percent (75%) of the rated capacity of the crane, per the respective crane's load chart; any lift that exceeds 50,000 pounds; any lift that requires the use of more than one crane; any lift requiring blind picks; any man-basket lifting operation; any load that is lifted/transported over or near energized electrical equipment, such as power lines, transformers, or switchgear; any lift in a confined space or restricted area (including an operating facility) where the load, or any part of the crane or equipment structure, could come within three (3) feet of any existing structure; or any lift where the equipment is set up near manholes, catch basins, sewers, sinkholes or other known surface or sub-surface interferences.

(10) Contractor shall prepare a spill prevention, control, and countermeasure ("**SPCC**") plan in accordance with EPA requirements. For the avoidance of doubt, Contractor shall be responsible for development both a construction-phase SPCC plan and operational-phase SPCC plan, respectively.

(11) Contractor shall prepare, implement, and manage a detailed tower rescue plan that is specific to the Project and Project Site.

2.4.2 Contractor shall upload electronic copies of all Contractor Deliverables (including drafts and final) to Owner's web-based document management site. Further, Contractor shall designate a document control lead to work with Owner's document control lead towards the timely, efficient, and organized submittal of documents.

2.4.3 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, including identifying any open and/or pending submittals for review.

2.4.4 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.

2.4.5 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.

2.4.6 Contractor shall maintain color hard copies of all issued-for-construction drawings at the Project Site during performance of the Work, including at least one (1) complete set in Owner's office trailers; 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 reference to the applicable RFI number; such redlines shall be included in the Job Books.

2.5 Signage

2.5.1 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 approved by Owner prior to installation.

2.5.2 Contractor shall furnish and install (a) a permanent sign at each Wind Turbine string road listing the name(s) of all Wind Turbine(s) along that road and (b) identification numbers and permanent, weatherproof labels on the base of all Wind Turbine towers, indicating Owner tower number and Collection System Circuit number, respectively.

2.5.3 Contractor shall furnish and install identification numbers and permanent, weatherproof labels on all Gen-Tie Line structures.

2.5.4 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 feet of trench length; and (c) at all sharp turns in the Collection System Circuits.

2.5.5 Contractor shall furnish and install a permanent, free-standing, 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.

2.5.6 Contractor shall furnish and install a permanent sign on the fence at the Project Substation entrance. This sign 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.

2.5.7 Contractor shall furnish and install "no trespassing" signs at access road entry points and permanent speed limit signs at intervals of no greater than two (2) miles along all Project access roads.

2.5.8 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.

2.5.9 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.

2.5.10 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.

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

2.5.12 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 Permits

2.6.1 Contractor shall obtain, pay for, and maintain all permits required for its performance of the Work including, but not limited to, the Contractor Permits. Contractor shall provide copies to Owner of all permit applications for Contractor Permits promptly after such applications are submitted to the applicable authority.

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

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

2.6.4 Contractor shall comply in all material respects with the requirements of all Contractor Permits and all inspection and documentation requirements of all Contractor Permits and shall provide copies of inspection reports and documentation related thereto to Owner.

2.7 Training

2.7.1 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, as further described in Exhibit [●] *(Contractor-Provided Training*). Such training shall cover, at a minimum, the Project Substation, the Collection System Circuits, the Communications System, the Gen-Tie Line, the O&M Building, and the meteorological towers. [NTD: an exhibit outlining training requirements will be provided at a later date and attached to the Agreement]

2.7.2 Turbine Supplier shall prepare and conduct comprehensive training of Owner and its operations and maintenance personnel in the safe operation and maintenance of the Wind Turbines and Turbine SCADA System. Such training shall be made available to up to six (6) persons designated by Owner at a time reasonably convenient to Owner.

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

2.8 Temporary Facilities

2.8.1 Contractor shall furnish and install one (1) 24-foot by 60-foot double-wide office trailer for Owner's exclusive use. Each trailer shall be located at the laydown yard 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 arm chairs, two (2) visitor chairs, and one (1) 2-foot by 3-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) Each trailer shall include at least one (1) unisex restroom, each complete with running water, one (1) flushable toilet, one (1) flushable urinal, and one (1) sink. Toilets shall be of a type to ensure that all discharges are contained and removed from Site. Toilets shall be outfitted for weather conditions (i.e., space heater in winter).

(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 wifi-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, electric service, and running water 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 infrastructure wiring up to the wall jacks in each trailer and high-speed wireless internet service (wifi) 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 daily cleaning services within each Owner trailer throughout the duration of the Work. This shall include cleaning restrooms and trash collection, pickup, and removal, respectively.

2.8.2 Not used.

2.8.3 Contractor shall provide separate office trailers for their own use, including for the Turbine Supplier and BOP Contractor. Contractor shall be solely responsible for furnishing their trailer(s), including any utility services.

2.8.4 Contractor shall furnish, install, and maintain portable chemical toilets for use by site construction personnel, including Owner, Turbine Supplier, 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.

2.8.5 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.

2.8.6 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.

2.8.7 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.

2.8.8 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.

2.8.9 Contractor shall design, furnish, construct, install, and maintain one (1) temporary laydown yard.

2.9 Debris

2.9.1 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.

2.9.2 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.

2.9.3 Contractor shall provide all trash collection, pickup, and removal related to the Work, including within Owner's office trailers and other temporary facilities, and including disposal of cable reels. 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, Turbine Supplier shall be provided with access to utilize such receptacles.

2.9.4 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.

2.9.5 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.

2.10 Logistics

2.10.1 Contractor shall furnish and deliver all equipment to the Project Site.

2.10.2 Contractor shall perform all off-Project Site clearing necessary for the transportation of 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.

2.10.3 Contractor shall perform all clearing at the Project Site necessary for the transportation of Wind Turbines at the Project Site, including, but not limited to, tree trimming / removal, clearing of overhead obstructions, and utility line drops along county roads and access roads.

2.11 Coordination

2.11.1 Contractor shall actively coordinate the sequence of Work with Owner, Turbine Supplier, BOP Contractor, and other Subcontractors to support the Project Schedule.

2.11.2 Contractor shall coordinate with all transportation contractors to mitigate congestion within the Project Site.

2.11.3 Contractor shall (a) comply with all crossing requirements for the Project, including any crossing agreements, 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 2.3.9 herein.

2.12 Project Site Closeout and Restitution

2.12.1 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.

2.12.2 Contractor shall remove all tools, equipment, surplus materials (including unused or useless materials), waste materials, temporary work (including temporary erosion control features), 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.

2.12.3 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, including removal of silt and debris from culverts, 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 water resources adjacent to construction areas. Such work shall include restoration of all terraces to their pre-construction condition.

(3) 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).

(4) Re-dress all road surfaces within the Project Site such that the final cross section meets the Contract specifications, including those presented herein, and such that all roadway surfaces are graded for draining and low spots are removed.

(5) Seed all cut / fill slopes 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.

(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 within approved disturbance limits at Owner-approved locations including but not limited to on access roads, beauty rings, and/or the O&M Building yard.

(9) Collect large rocks 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.

(10) Contractor shall be responsible for reinstatement of all fences, walls, watercourses, roads and embankments crossed by MV cable to the satisfaction of Owner and in accordance with all Applicable Permits.

3.0 GEOTECHNICAL SERVICES

3.1 General Provisions

3.1.1 Contractor shall conduct all geotechnical, geophysical, geological, and other similar subsurface investigations and testing necessary for the complete development, 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, office location, 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 (the "**Geotechnical Report**") containing the required information summarized below, at a minimum. The Geotechnical Report shall be utilized for the design and construction of all Project structures, including Turbine Foundations.

(1) Subsurface and groundwater conditions encountered, including groundwater hydrology data and maps of the area.

(2) Description of the geology, including maps for areas of landslides, potential landslides, potential geologic hazards, karst, mine subsidence, 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; (f) recommendations for site dewatering and construction practices, including design water level; and (g) recommendations for permanent slope and rock stability measures.

(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; (e) static and dynamic spring constants; and (f) non-destructive testing requirements.

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

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

(12) 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.

(13) An evaluation of the expansive, dispersive, and collapsing nature of the on-Site soil materials and discussion of design features to resist these tendencies, including recommendations for mitigation measures for difficult soils (expansive, dispersive, and collapsible).

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

(15) Recommendations for frost heave loading, if applicable.

(16) Recommendations for shear modulus degradation factor.

(17) If needed, recommendations for design and installation of earth retaining structures and ground improvements.

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) Wind Turbines: one (1) per Wind Turbine location, or more as necessary to characterize soil and bedrock conditions within the Turbine Foundation influence zone.

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

(3) Gen-Tie 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.

(4) O&M Building: minimum of two (2) locations at the O&M Building.

(5) Meteorological towers: each free-standing meteorological tower location.

3.3.2 Contractor shall perform electrical resistivity measurements at the minimum frequencies set forth below, in each case using the Wenner Four-Electrode method (ASTM G57) in accordance with ANSI/IEEE Std 81: 1983 - IEEE Guide to Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of Ground Systems. Unless otherwise approved, the probe spacing shall be equally spaced with spacings of 2 ,5, 10, 15, 20, 30, 40, 50, 80 and 100 feet, and in each case with final locations approved by Owner prior to testing:

(1) Wind Turbines: ten percent (10%) of all Wind Turbine locations.

(2) Project Substation: one location near the center of the proposed substation footprint.

(3) Gen-Tie Line: minimum of one (1) location per mile.

(4) Collection System Circuits: minimum of one (1) location per circuit.

3.3.3 Contractor shall perform thermal resistivity testing in accordance with ASTM D5334. Laboratory testing shall include a measurement of the soil's moisture content, maximum dry density, and thermal dryout characteristics. Thermal resistivity testing shall be conducted at the same frequency as electrical resistivity measurements in Section 3.3.2 above.

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. Monitoring of groundwater levels shall be taken over a minimum one (1) year period to capture seasonal fluctuation in groundwater levels. The geotechnical engineer shall determine the design groundwater level at each of the boring locations noted above, which shall take into account seasonal fluctuation as well as long term groundwater levels and shall account for any buoyancy effects resulting from the design groundwater level.

3.3.5 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 Report.

3.3.6 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) 50 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.

3.3.7 In-situ testing, including cone penetration testing ("**CPT**"), dilatometer, pressure meter, vane shear, and other in-situ test methods shall be supplemented with a minimum of 10 percent borings with sampling to correlate soil material properties to the in-situ tests.

3.3.8 Seismic testing, including downhole seismic, seismic CPT, and surface methods, shall be conducted at minimum of 10 percent of proposed sites in order to determine shear and compression wave velocity of the subsurface materials. The shear and compression wave velocities shall then be used to determine dynamic shear modulus and be input into dynamic analyses of Turbine Foundation stiffness.

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 / settlement characteristics per ASTM D2435; (k) one-dimensional swell or collapse of soils per ASTM D4546; (l) thermal resistivity testing including dry-out curves including 0% moisture per ASTM D5334; and (m) unconfined compressive strength per ASTM D2166.

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 / structural works, including, but not limited to, access roads, Turbine Foundations, Wind Turbine Pads, and the laydown yard, shall conform to Turbine Supplier's requirements for roads, crane pads, and hardstands, as set forth in Exhibit [●] (*Turbine Supplier Project Site Requirements*) (the "**Turbine Supplier Project Site Requirements**"). [NTD: an exhibit outlining OEM-specific civil and structural requirements for civil will be provided at a later date and attached to the Agreement]

4.1.2 All low-water crossings shall be designed and constructed to withstand a 50-year, 24-hour storm event. All other permanent drainage facilities, including culverts ditches, and swales, shall be designed and constructed to withstand a 20-year, 24-hour storm event.

4.1.3 The design working life of the Turbine Foundations shall be a minimum of 30 years.

4.1.4 Requirements for access road crossings:

(1) All access road crossings, including public roads, railroad, pipeline, utilities, and property lines, shall be as close to ninety degrees (90°) as reasonably practicable. All access road crossings of buried facilities (e.g., pipeline, utility line) shall maintain at least 36 inches of cover, or deeper if required by the applicable crossing agreements.

(2) All access 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 5.1.11 below.

(3) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.11.3 herein.

4.1.5 Requirements for site roads:

(1) Roads shall be designed, constructed, and maintained adequately to support all anticipated construction loads, equipment delivery (including Wind Turbines), crane crawling, construction traffic usage (including concrete trucks), and weather conditions to be expected. Maintenance shall include the requirements set forth in Section 4.3.3 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 (12) herein.

(3) 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.

(4) 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.

(5) Roads shall be covered with at least six (6) inches of DOT-compliant aggregate over a compacted subgrade, including geotextile fabric (or equivalent) as required. The maximum aggregate size shall not exceed two (2) inches, shall include appropriate fines, and shall conform to local department of transportation requirements. The subgrade shall be cleared and compacted to at least ninety-five percent (95%) of the maximum density within the moisture content of three percent (3%) below optimum to three percent (3%) above optimum, as determined by ASTM Standard D698.

(6) 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.

(7) Maximum vertical crest and dip on roads shall comply with the Turbine Supplier Project Site Requirements.

(8) The longitudinal radii (convex or concave) of roads shall comply with the Turbine Supplier Project Site Requirements.

(9) 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 the Turbine Supplier Project 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; cleared Wind Turbine Pads are suitable for this purpose provided any non-graveled areas present a suitable driving surface.

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

(11) Proof rolling shall be performed in the presence of a qualified, competent, practicing geotechnical engineer or their qualified representative. Proof rolling shall be performed using a fully-loaded tandem-axle truck or fully-loaded water truck, in either case with a minimum gross weight of 25 tons. An acceptable proof roll shall produce rutting of no greater than 1.5 inches and no “pumping” of soil beneath and/or behind the wheels of the loaded truck.

(12) 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.

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

(3) Storm water shall not channel flow across constructed roads and a self-draining ditch shall be construed on the high (cut) side of roadways. Sheet flows shall be collected and conveyed to culverts or channels to safely pass storm water flows.

(4) 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**") shall be utilized as appropriate.

(5) All storm water flows shall be returned to their original drainage patterns and the Project shall not increase flow rates from their historic levels. The natural drainage patterns of the Project Site shall be maintained and ponding shall be prevented, other than explicitly where small scale ponding is specifically designed to minimize erosion during drainage. Any pre-existing drains which are damaged in the Work shall be restored.

(6) Culverts or low-water crossings shall be installed / constructed where required to pass existing storm water 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.

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

(8) 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.

4.1.7 Requirements for excavation, fill, and backfill:

(1) Materials suitable for use as fill at the Project Site shall include only materials that are free of debris, roots, stumps, organic matter, frozen matter, coal, ashes, cinders, large stones, 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.

(5) Excavations shall be fully drained prior to any construction work within them.

4.1.8 Requirements for fencing and gates:

(1) All permanent fencing and gate materials, including for the Project Substation, O&M Building, and meteorological towers, shall be galvanized in accordance with ASTM A392. All permanent fencing shall be appropriately grounded.

(2) Unless stated otherwise, permanent fencing shall be 8-foot-high (7-foot fence plus 1-foot barbed wire), anti-climb, chain link, perimeter fencing with 2-inch diamond mesh. Fencing fabric / slats are not required.

(3) Barbed wire shall be a minimum of 2-strand, #12-1/2 steel wire gauge with 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. At least four (4) lines of barbed wire shall be provided when used.

(4) Gate widths shall be consistent with road widths, wherein all gate posts shall be set outside of the road width area. Sufficient space and graded area shall be provided near each gate to allow truck turning.

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

(6) All corner posts and gate posts shall be steel and shall be set (embedded) in concrete. Other fence posts shall be direct-embed galvanized t-posts.

(7) Cattle guards shall (a) cover the full road width; (b) be installed level; and (c) be provided with a stable base capable of sustaining heavy loads without shifting or settling.

(8) Each temporary gate shall match the existing fence materials, and the existing fencing shall be reestablished at the end of construction activities.

4.1.9 Requirements for structures:

(1) All buildings, support structures, foundations (including Turbine Foundations), 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. Notwithstanding the foregoing, all such structures shall comply with the foundation preparation recommendations set forth in the Geotechnical Report.

(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.

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

4.1.10 Requirements for concrete:

(1) Concrete for Turbine Foundations shall have a minimum specified compressive strength of 5,000 psi and any other structural concrete (including all Project Substation concrete) shall have a minimum specified compressive strength of 4,000 psi. Wind turbine mud mats shall have a minimum specified compressive strength of 2,000 psi while all other non-structural concrete shall have a minimum specified compressive strength of 3,000 psi.

(2) Concrete mix designs and concrete placement procedures shall be approved by Owner prior to use; see Section 4.2.4 herein for mix design requirements. Concrete shall be placed only in the presence of a duly-authorized representative of Contractor. A successful break test showing the minimum specified compressive strength(s) shall be provided from the concrete source(s), including an on-site batch plant if applicable, at least five (5) days prior to placing concrete from such source(s).

(3) If allowed by the applicable engineer of record, fly ash may be used to replace up to a maximum of 20 percent (20%) of cementitious material content by weight. If used, fly ash shall be in accordance with ASTM C618 and shall be Class F; Class C fly ash shall not be used without Owner approval.

(4) 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.

(5) 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.

(6) Concrete placement shall not be permitted when weather conditions or other pertinent factors prevent proper placement and consolidation. Hot weather concreting shall be in accordance with ACI 305R. Cold weather concreting shall be in accordance with ACI 306R.

(7) The maximum aggregate size for concrete shall not exceed 1.5 inches. Smaller maximum aggregate size, such as 0.75 inches, may be necessary for pumped or tremie concrete. Rounded aggregates may be necessary to produce desired workability.

(8) All exposed foundation edges shall include a 0.75-inch chamfer.

(9) 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.

(10) Maximum water/cement ratio: 0.45.

(11) Turbine Foundations shall not have joints, unless approved by Owner and detailed by the engineer of record, and only for the base and pedestal interface in a spread footer foundation. Where allowed, the 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.

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

(13) 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 (or equivalent). Care shall be taken to see that all excess water is removed before making any finish.

(14) Concrete shall be protected from loss of moisture by membrane curing compound and the curing medium shall be maintained to prevent detrimental loss of water from the concrete for the duration of the entire curing period. An Owner-approved curing membrane shall be applied in accordance with manufacturer's recommendations as soon as the water sheen has disappeared from the concrete surface and following finishing operations, with an application rate of not less than 1 gallon per 200 square feet. If hot weather concreting is performed and an evaporation retardant is used, this retardant shall be applied prior to application of the curing agent, immediately following finishing of the concrete surface.

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

(16) All concrete which is porous, honeycombed, or otherwise defective (including conditions which adversely affect durability, strength, and/or appearance) shall be repaired. 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. 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.

(17) 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 100 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 placed 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) Electronic copies of concrete test reports shall be provided to Owner within 72 hours of testing but not less than 24 hours in advance of commencing Wind Turbine erection activities at the relevant Wind Turbine location. In the event of failure of any concrete test, Owner shall be immediately notified and a repair/remediation plan shall be provided.

(18) If the Geotechnical Report indicates the presence of high sulfate content throughout different areas of the Project Site, then all concrete design, including for Turbine Foundations, shall employ sulfate-resistant concrete, including Type V cement as appropriate.

4.1.11 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 Turbine Foundation engineer of record. All grout shall be non-ferrous, non-shrink, prepackaged/factory-packaged grout.

(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 test reports shall be provided to Owner within 72 hours of testing, and for Turbine Foundations, at least 24 hours in advance of commencing or continuing (as is the case with grouting of tower base sections) Wind Turbine erection activities at the relevant Wind Turbine location. In the event of failure of any grout test, Owner shall be immediately notified and a repair/remediation plan shall be provided. Sampling and testing of grout material shall be in accordance with ASTM C579.

(5) Any person who mixes and/or places grout below the Wind Turbine flange shall have received in-person, hands-on training from a representative of the grout manufacturer. Such training shall be received by each individual (a) with the Project-approved grout mix; (b) within the 12-month period preceding grout placement; and (c) *prior* to installation of grout.

4.1.12 Requirements for forms:

(1) Forms shall be substantial and sufficiently tight to prevent leakage and shall be properly supported and braced to maintain position and shape. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings, and forms for all exposed surfaces shall produce smooth, dense, and true finishes free of fins, imperfections, or other defects.

(2) 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.

(3) 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. 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.

(4) Forms may be of wood, plywood, concrete-form-grade hardboard, metal or other acceptable material, which will produce smooth, true surfaces. Metal forms shall have smooth surfaces free from any pattern, irregularities, dents, or sags.

(5) 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 one (1) inch in diameter in concrete surfaces.

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

4.1.13 Requirements for reinforcing bar:

(1) All weldable bars shall confirm to ASTM A706 while all other reinforcing bars shall conform to ASTM A615; all reinforcing steel shall 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).

(5) Concrete supports (dobies) shall have the same or higher compressive strength as specified for the concrete in which they are located.

(6) No reinforcement in the Turbine Foundation shall be welded. Exothermic (e.g., Cadweld) welding of grounding elements to reinforcing steel is also prohibited.

4.1.14 Requirements for anchor bolts:

(1) 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.

(2) 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 Turbine Supplier.

(3) 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.

(4) Following installation, anchor bolts shall be given an application of corrosion inhibitor and finished with bolt caps.

(5) Unless otherwise required by Turbine Supplier, anchor bolts, nuts, and washers shall comply with the following:

(a) Anchor bolts: ASTM A615 Grade 75 or A722 Grade 150, cold rolled threads, hot dip galvanize to ASTM A153.

(b) Nuts: ASTM A29 or ASTM A576, hot dip galvanize to ASTM A153.

(c) Washers: ASTM F436, hot dip galvanize to ASTM A153.

(6) Embedment rings shall be (a) minimum 1.5-inches thick; (b) ASTM A36, ASTM A529, or ASTM A572; (c) grade 50, minimum; (d) plain finish; and (e) new material (not reused).

(7) Template rings shall be a minimum 1-inch thick, ASTM A36 or ASTM A572 Grade 50, plain finish.

(8) Load spreading plates, if used, shall be (a) minimum 1.5-inches thick; (b) ASTM A36, ASTM A529, or ASTM A572; (c) grade 50, minimum; (d) galvanized; (e) new material (not reused); and (f) compliant with Turbine Supplier specifications. For galvanization, the plate shall be hot dip galvanized provided it does not adversely affect the flatness of the plate; otherwise, the protective finish shall be subject to Owner approval.

4.1.15 Requirements for structural steel fabrication and connections:

(1) Specific structural steel materials shall comply with the following, at a minimum:

(a) W-shapes: ASTM A992/A992M (50 ksi yield strength).

(b) Channels, angles-shapes: ASTM A36/A36M.

(c) Plate and bar: ASTM A36/A36M.

(d) Cold-formed hollow structural sections: ASTM A500, Grade B structural tubing.

(e) Steel pipe: ASTM A53/A53M, Type E or S, Grade B.

(f) Weight class: standard.

(g) Finish: galvanized.

(h) Welding electrodes: comply with AWS requirements.

(2) Structural steel shall be fabricated and assembled in shop to greatest extent possible.

(3) Design and fabrication shall be according to AISC's "*Specification for Structural Steel Buildings*".

(4) 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.

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

(6) 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.

(7) 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.

(8) 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.

(9) 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.

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

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

(12) 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.

4.2 Submittals

4.2.1 Contractor shall prepare the civil works design documents per the 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, Wind Turbine locations, staging / laydown areas, Project Substation location, Gen-Tie Line route, Collection System Circuit routes, landowner names, parcel identification number, parcel statuses (participating, non-participating), easements, and public right-of-way; (c) Wind Turbine delivery flow plan; (d) profile views for all vertical curves; (e) grading and drainage plans; (f) details for erosion control, fencing, gates, compaction, road cross sections, road curves (horizontal and vertical), and Wind Turbine Pad cross sections; (g) properties for backfill / fill and road materials; (h) public road improvements; (i) drawing index; (j) inspection, testing, and quality control requirements; and (k) geospatial file (.SHP and/or .KMZ format) showing all Wind Turbines, meteorological towers, access roads, crane paths, and intersection improvements, at a minimum.

4.2.2 Contractor shall provide a 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) 20-year, 24-hour; (b) 50-year, 24-hour; and (c) 100-year, 24-hour.

4.2.3 Contractor shall prepare the Turbine Foundation design documents per the Submittal Schedule and containing the following information, at a minimum: (a) design basis to outline all references, design procedures, and software tools to be utilized for the design and analysis of Turbine Foundations; (b) plan and profile view of Turbine Foundation design, including cross sections; (c) details for reinforcing steel, conduit, and grouting; (d) civil works requirements (e.g., backfill, compaction, grading, drainage, etc.); (e) tensioning sequencing and parameters, including post-installation re-tensioning; (f) structural calculations, to be provided with each set of Turbine Foundation design drawings; (g) rebar and embedment ring shop drawings; (h) drawing index; (i) bill of materials; and (j) inspection, testing, and quality control requirements.

(1) For the avoidance of doubt, the approval of the Turbine Foundation design documents by Owner's independent engineer shall be received *prior* to constructing any portion of the Turbine Foundation. Contractor shall allocate adequate review time to the independent engineer for this purpose and shall coordinate with the independent engineer as reasonably required to address and incorporate any comments required to receive approval.

4.2.4 Contractor shall provide a foundation inspection report for each Turbine Foundation excavation (each, a "**Foundation Inspection Report**"). A Foundation Inspection Report, including all accompanying documentation, shall be completed prior to placement of the mud mat and provided to Owner as a condition of each Turbine Foundation completion. Each report shall include information on the foundation excavation, including, but not limited to, (a) date of excavation; (b) date of inspection; (c) ambient air temperature and weather conditions at time of inspection; (d) structure name / number and location; (e) structure type and foundation type; (f) soil conditions; (g) verification of subgrade against expected condition, including test results; (h) actual depth to rock and depth to water; (i) estimated depth to rock and depth to water with corresponding borehole reference; and (j) independent verification of lift sizes.

4.2.5 Contractor shall prepare concrete mix designs; grout specifications; and concrete and grout placement procedures. All such submittals shall be approved by Owner prior to use. Each mix design submitted by Contractor shall be stamped by a professional engineer with an active license in the state where the Project is located and shall include, at a minimum, (a) documentation of achieving Project-specific compressive strength requirements per ACI procedures; (b) gradation, source, and type of aggregates; (c) mill reports for cement and fly ash; (d) product data for admixtures, including vendor certification of compliance with applicable ASTM standard; (e) ASR test results, including expansion results per ASTM C1567; (f) specified slump value; (g) specified water/cement ratio; (h) specified air entrainment per ASTM C260; (i) water quality test per Table 2 of ASTM C1602 if non-potable; and (j) an approval stamp by the applicable engineer of record.

4.2.6 Contractor shall submit three (3) laboratory tension test reports for anchor bolts for each heat number furnished, complete with threads, and to be prepared by an independent third-party tester. This task shall be in accordance with ASTM A370 and the report shall include yield stress and tensile stress.

4.2.7 Contractor shall provide copies of mill certificates for all steel reinforcement (rebar) and anchor bolts.

4.2.8 Contractor shall provide a storm water pollution prevention plan (the "**SWPPP**") for the Project.

4.2.9 If blasting is required, Contractor shall prepare blasting plans and procedures for all blasting work to be performed at the Project Site. All such submittals shall be approved by Owner prior to use.

4.2.10 Contractor shall prepare an aggregate mix formula based on recommendations from the final Geotechnical Report and complying with the requirements in Section 4.1.5 herein. Each formula shall be approved by Owner prior to use and shall be accompanied by testing data for each aggregate source, including sieve analysis, moisture data, liquid limit, and plastic limit.

4.2.11 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) 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, anchor bolts, rebar, curing compounds, joint compounds, crack repair compounds, sealants, corrosion inhibitors, and grout.

4.3 Project Site Preparation

4.3.1 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, tree trimming, and drainage.

(1) Topsoil shall be stockpiled for later use during landscape reclamation activities. 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 three (3) 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.

(3) Removal of or damage to trees outside of the designated disturbance areas is prohibited without written approval of Owner. Trees shall be adequately protected, including protecting tops, trunks, and roots of existing trees at the Project Site which are to remain.

(4) Any waste generated from such activities, including tree trimmings or grubbed vegetation material, shall be Contractor's responsibility to dispose of.

4.3.2 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) Wind Turbine locations; (g) access roads and crane paths; (h) Project Substation pads; (i) Collection System Circuit routing; (j) Gen-Tie Line routing, including centerline and structure locations; (k) O&M Building, including pads, parking area, and property limits; and (l) easements.

(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.

(3) All permanent Project facilities, including roads, Collection System Circuits (including feeder routing, junction boxes, and splices), and the Gen-Tie Line (including structures and line routing), shall be surveyed following their construction and included in the applicable As-Built Drawings. Surveyed locations shall be included in the drawings and a Contractor-provided geospatial file (.SHP and/or .KMZ format) for each. Contractor shall also furnish an as-built version of the PLS-CADD (.BAK) file for the Gen-Tie Line.

4.3.3 Contractor shall maintain all access roads and 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, cleaning of silt and debris from culverts as necessary to facilitate drainage, dust control along access roads, 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.

4.3.4 Contractor shall furnish, install, and maintain temporary orange snow fencing or other Owner-approved delineation / marking method around all archeologically-, culturally-, and environmentally-sensitive areas at the Project Site, including those identified in the Applicable Permits. All temporary fencing shall be (a) promptly replaced if it becomes deteriorated / unfit for purpose and (b) removed prior to Contractor demobilization but not before Work in the applicable area(s) is completed.

4.3.5 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. When the use of explosives is necessary for the Work, the following requirements shall apply:

(1) When the use of explosives is necessary for the Work, Contractor shall use the utmost care not to endanger life or property and shall comply with all Applicable Laws and other Requirements and conduct the necessary advance notifications. All permits and licenses required for blasting shall be obtained, paid for, and maintained by Contractor.

(2) Owner shall be notified prior to the use of explosives at the Project Site, and such blasting shall be completed, at a minimum, in accordance with the Applicable Permits and Contractor-furnished blasting plan. Blasting shall be performed only by persons who are qualified, competent, and thoroughly experienced in the use of explosives for rock excavation. Blasting near utilities, pipelines, or facilities (buried or above-ground) shall be subject to approval of owning agency and Owner.

(3) Before delivery of any explosives to the Project Site, Contractor shall have obtained a blasting endorsement on their public liability and property damage insurance policy.

(4) All explosives shall be handled in a secure manner, and all such storage places (if permitted) shall be marked clearly “DANGER - EXPLOSIVES” or as otherwise required by law. Under no circumstance shall caps or other exploders or fuses be stored, transported, or kept together with powder.

(5) Blasted material shall be crushed and screened for use as fill on access roads and in other areas of the Project Site assuming the aggregate meets the appropriate geotechnical specifications for this application. Contractor shall be responsible for verifying that the quantity and quality of such rock is suitable for use as aggregate at the Project Site.

(6) Excessive overbreak or damage to adjacent structures, exposed cut slopes, equipment, utilities, or buried pipeline and conduit shall be avoided. Charge holes shall be located properly and drilled to correct depths for charges used, and charges shall be limited in size to the minimum required for reasonable removal of material by excavating equipment. Blast mats shall be utilized as required in sensitive areas, including, but not limited to, archeologically-sensitive areas, environmentally-sensitive areas, existing Project Site facilities, and other Project infrastructure.

(7) The geotechnical engineer shall approve of material resulting from blasted excavations prior to use as general fill material. Recommendations from the geotechnical engineer regarding the use of blasted material shall be followed when using the blasted material as fill or other use on the Site.

4.4 Site Roads

4.4.1 Contractor shall design, furnish, construct, and install all roads, including access roads and spur roads, temporary turnarounds, intersection/radius improvements, crane paths, and transitions to/from existing roads in conformance with the minimum requirements set forth herein. Access roads shall include a road to each Wind Turbine, permanent meteorological tower, Project Substation, and O&M Building, at a minimum.

(1) All roads shall be constructed at the locations shown on Exhibit [●] (*Project Site Plan*). [NTD: a site plan or civil design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

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

4.4.2 Contractor shall furnish and install a gate or cattleguard at every location where a roadway penetrates an existing fence line at the Project Site.

(1) Each permanent gate shall be a double-hung, prefabricated, finished metal gate; each such gate shall be a minimum 20-feet-wide (for 16-foot roads) manual swing gate with a pipe frame and manufacturer's standard coating finish, complete with hinges and latching hardware, and lockable via lag bolt.

(2) Unless explicitly noted otherwise above, all fencing, gates, and cattleguards shall comply with the applicable requirements in Section 4.1.8 herein.

4.4.3 Contractor shall furnish and install any new, permanent wire fencing shown in the Project design documents. Unless explicitly noted otherwise, all fencing, gates, and cattleguards shall comply with the applicable requirements in Section 4.1.8 herein.

4.4.4 Contractor shall furnish and install any necessary matting, blisters, or other similar items required to facilitate crossings of pipelines or other underground facilities during construction, including for Wind Turbine deliveries at the Site.

4.5 Public Roads

4.5.1 Contractor shall design, furnish, construct, and install all public road improvements in accordance with the road use agreements in Exhibit [●] (*Road Use Agreement*), including upgrading and maintaining any public roads, bridges, and culverts as specified therein, and as necessary to permit full access for the Project and permit delivery of all plant and equipment required for the Project. [NTD: the Project(s) road use agreement(s) will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

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

4.5.3 Contractor shall, prior to mobilization to the Project Site, digitally video and document the condition of existing public roads to quantify the extent of any Contractor-caused wear and tear.

4.6 Drainage and Erosion Control

4.6.1 Contractor shall furnish, construct, install, and maintain all temporary 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 4.1.5(12) and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the Project's civil design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

4.6.2 Contractor shall continuously monitor construction operations to avoid creating conditions that could lead to excessive erosion of soil with surface runoff from Work areas. Contractor shall furnish, construct, and install any necessary controls to protect water quality.

4.7 Dust Control

4.7.1 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.

4.7.2 Not used.

4.8 Turbine Foundations

4.8.1 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 and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the Turbine Foundation design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(1) Turbine Foundations shall be constructed at the locations shown in the [preliminary] design documents in Exhibit [●] (*Design Documents*).

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

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

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

(5) 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 non-structural fill material or within ten (10) feet of a fill slope without Owner approval.

(6) 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.

(7) Turbine Foundation anchor bolts shall have a minimum projection of two (2) anchor bolt diameters beyond the tightened anchor nuts.

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

(9) 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.

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

(11) Each Turbine Foundation shall include at least two (2) thermocouples for concrete temperature monitoring, including one at the center and one near the outer surface.

(12) Turbine Foundation gapping is prohibited without Owner and Turbine Supplier approval.

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

4.9 Wind Turbine Pads

4.9.1 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 [●] (*Design Documents*). Contractor shall maintain the Wind Turbine Pads throughout the duration of the Work. [NTD: the Wind Turbine Pad design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(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.

(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 ninety-five 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).

4.9.2 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.

(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 at a minimum distance of twelve (12) feet beyond the Turbine Foundation pedestal wall and transformer pad in all directions.

(3) Each beauty ring (a) shall have an identical cross section as the Wind Turbine access roads (i.e., same thickness, same surfacing material); (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.

4.10 Testing and Quality Control

4.10.1 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; (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 standard proctor test on each material type; (c) if proof roll fails, moisture density test at 4 per lift or every 1,000 feet of road, whichever is greater; and (d) 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).

(4) Compacted subgrade: (a) proof roll over entire length prior to placement of aggregate base; (b) moisture density test every 1,000 feet or 3 per road, whichever is greater; and (c) DCP test (recorded to a minimum depth of 2 feet) 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).

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

(7) Other testing set forth in the Project design documents.

4.10.2 Contractor shall inspect and test each Turbine Foundation in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.

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

(2) Certification of integrity of Turbine Foundation sub-base, including verification that conditions within excavation align with expected / design conditions and all information required in Foundation Inspection Report (as defined herein); *the Foundation Inspection Report, including all accompanying documentation, shall be completed prior to placement of the mud mat*.

(3) Compacted subgrade (all performed prior to placement of mud mat): (a) proof roll over entire length; (b) soil probe or shallow hand auger probes to determine presence of unsuitable soils below the surface, to aid in classifying soils, and to make comparisons of exposed soils to those available in the Geotechnical Report; and (c) static cone penetrometer ("**SCP**") tests on cohesive soils and dynamic cone penetrometer ("**DCP**") tests on cohesionless soils to verify against requirements in the Geotechnical Report, including one test at the center at the Turbine Foundation and one test in each quadrant (five total). The foundation engineer of record shall specify passing criteria for the SCP/DCP test (e.g., minimum blows per 6 inches). The mud mat shall be installed within 24 hours of an approved test and inspection.

(4) Concrete / grout strength and properties, including break tests, grout cubes, slump, air, and temperature, each at the minimum frequencies specified in Section 4.1.10 and Section 4.1.11 herein.

(5) Random tension test of at least 10 percent (10%) of anchor bolts on each Turbine Foundation. If any bolts do not meet the required tension value, all bolts on such Wind Turbine shall be re-tensioned and the 10-percent check repeated until all tests pass.

(6) Other testing set forth in the Project design documents and the recommendations set forth in the Geotechnical Report.

4.10.3 Contractor shall inspect and test each Wind Turbine Pad (including Turbine Foundation backfill as applicable) in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.

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

(2) Structural fill below Turbine Foundation: (a) two (2) unit weight tests per lift and (b) two (2) moisture density compaction tests per lift.

(3) Common fill around Wind Turbines / Wind Turbine Pads (including backfill for Turbine Foundations): (a) for every 2,500 cubic yards of fill placed and at least one set per Wind Turbine location, provide (i) grain size analysis per ASTM D422; (ii) moisture content per ASTM D2216; and (iii) standard proctor maximum dry density per ASTM D698; and (b) for each fill lift at each Turbine Foundation backfill location, provide density test per ASTM D6938, including test location, dry density, and moisture content for each test.

(4) All Wind Turbine Pads shall be proof-rolled over the entire length.

(5) Turbine Foundation concrete temperature monitoring results (to be furnished to Owner within 72 hours of concrete placement).

(6) Other testing set forth in the Project design documents and the recommendations set forth in the Geotechnical Report.

4.10.4 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. Notwithstanding the preceding requirements, a copy of test results for each Turbine Foundation shall be provided to Owner *prior* to erection of the applicable Wind Turbine.

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 Project Site-specific wind distribution data, measured between the generator leads of each Wind Turbine and the Point of Interconnection shall not exceed [2.25 percent (2.25%)] (the "**Electrical Loss Limit**"). For the avoidance of doubt, this shall include all medium-voltage transformers, Wind Turbine cabling, Collection System Circuit cabling, main step-up transformer, and the Gen-Tie Line up to the Point of Interconnection. [NTD: confirm value per project]

5.1.3 Contractor shall design and construct the Collection System Circuits in accordance with the Collection System Electrical Studies, as defined herein.

5.1.4 All Collection System Circuits shall be installed underground.

5.1.5 No more than 12 Wind Turbines or 35 megawatts of combined capacity shall be installed on any single Collection System Circuit.

5.1.6 Access to the Collection System Circuits shall be from existing roads or new access roads within the permitted area. Exact Collection System Circuit routing shall be determined, however, the preferred routing shall be to parallel the access roads and crane paths as much as possible, so long as such routing does not increase the required number of crane breakdowns. When not practical or efficient to parallel the access roads, the Collection System Circuit shall be routed in a straight line, shortest distance as much as possible.

5.1.7 All Collection System Circuit backfill, including splice pits (if used), shall be compacted to a minimum of 85 percent (85%) of standard proctor density, unless otherwise noted on the design drawings. For the avoidance of doubt, collection backfill at Turbine Foundations and access road crossings shall be compacted to ninety-five percent (95%) as noted elsewhere herein.

5.1.8 Requirements for power cabling:

(1) All Collection System Circuit power cabling shall be 34.5-kV, three (3)-phase, 60 Hertz.

(2) Jacketed, single-conductor, appropriately-sized concentric neutral, insulated medium-voltage underground distribution power cable shall be used. 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.

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

(4) 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 1250 kcmil. Other cable sizes shall not be used without Owner approval.

(5) Cable ampacity shall not exceed 95 percent of the rated value, based on Project Site-specific thermal resistivity and in consideration of all external heat sources. Ampacity shall be calculated assuming the soil around the cable within the trench is dried out to zero percent (0%) moisture content and that soil above the cable within the trench is at two percent (2%) moisture content.

(6) Notwithstanding the requirements for cable crossings in Section 5.1.10 herein, all underground Collection System Circuit cabling shall be direct buried at a depth of at least 42 inches below grade.

(7) A sufficient amount of cable slack shall be provided to allow installation of elbows and termination of the cables to the appropriate junction box and/or Wind Turbine switchgear 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. Establishing slack via coil under the pad-mount transformer or junction box, in a plenum or vault, is required.

(8) Excess slack shall be provided to allow re-termination in the event of failure. The excess slack at each Wind Turbine location shall be in the form of a maintenance loop. At least 25 feet (or more if required to allow for at least two (2) future terminations) of excess cable shall be provided at each Wind Turbine such that the cables may be re-terminated if needed following installation.

(9) All Collection System Circuit power cabling shall be provided with terminators and labels. Labels shall be permanently attached at both ends. Labels shall be sequentially numbered.

(10) No splices shall be permitted to underground cabling unless explicitly approved in writing by Owner. 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. Splicing of different cable types, splices between Wind Turbines (except at directional boring locations), and “dutchman” cable splices are each strictly prohibited. Training certificates shall be included in the Job Books.

(11) Excessive bending of cabling shall be avoided. The manufacturer recommended bending radius or NEC standard (whichever is greater) shall not be exceeded. Contractor shall ensure vault size and depth allows for bending radius.

(12) BIL voltage rating: 200 kV.

(13) Maximum short-circuit conductor temperature: 250°C.

(14) Only Turbines from the same manufacturer shall be installed on a circuit (e.g., all Vestas Turbines shall be on the same circuit(s) and all GE Turbines shall be on the same circuit(s); no GE Turbines shall be on a Vestas circuit or vice versa).

(15) Cable trefoil configuration shall be maintained by use of zip ties or suitable tape in accordance with manufacturer recommendations and Owner approval.

5.1.9 Requirements for trenches:

(1) All Collection System Circuits shall be installed via trenching; plowing is not permitted and 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, with any backfill within 12 inches of cable being free of sharp objects, rocks, and other debris larger than 0.5 inches. 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. Backfill above the first lift shall be placed in maximum 12 inch lifts and tamped or compacted between lifts.

(3) Ditch dams, consisting of sand bags or soil cement berms placed over the conductors at a 30 degree angle, shall be placed at intervals in all cable runs which traverse slopes greater than 3 percent. Spacing shall vary, depending on the steepness of the grade, from 100 feet to 300 feet.

(4) All collector trenches shall be laid out and pre-graded to ensure correct burial during final grading. Changes of grade between trenching and final profiles shall be accounted for in confirming burial depth.

5.1.10 Requirements for cable crossings:

(1) Unless crossing agreements require a greater depth, all Collection System Circuit (a) railroad crossings shall be buried at a depth of at least 120 inches below the railroad; (b) public road crossings shall be buried at a depth of at least 60 inches below the road, including the ditch(es) on either side; (c) wetland and stream crossings shall be buried at a depth of at least 60 inches below the steam bottom; and (d) utility and pipeline crossings shall be buried at a depth of at least 48 inches below the existing utility or pipeline. All other Collection System Circuit crossings shall be buried at a depth of at least 48 inches below the applicable infrastructure. Possible surface reduction from future road maintenance shall be considered when selecting the cable burial depth at public road crossings.

(2) All Collection System Circuit crossings (including those set forth in Section 5.1.10(1) above) shall be installed in conduit as more particularly described in Section 5.1.18 below.

(3) All crossings, including public road, railroad, pipeline, utility crossings, property lines, wetlands, and streams, shall be marked on each side with buried marker balls and above-ground cable markers, each meeting the requirements in Section 5.1.11 below.

(4) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.11.3 herein.

5.1.11 Requirements for markers:

(1) Cable marking tape shall be furnished and installed in all trenches along the length of all buried cable. Such tape shall be red, metallic, and detectable. Marking tape shall be placed at least 30 inches below grade and 12 to 18 inches above cable.

(2) GPS-located marker balls shall be placed within all cable trench at the following: (a) each side of crossings / directional bore locations; (b) each above-ground cable marker location; (c) every splice location; (d) all turns in a Collection System Circuit; and (e) minimum of every 300 feet of trench length. The markers shall be programmed with the feeder number as per the substation breaker identification number.

(3) An appropriate cable locating device shall be provided to enable the location of underground cables and electronic markers.

(4) Above-ground cable markers shall be a Curv-Flex marker or equivalent and shall include a decal warning of buried cable and other Owner-approved details, including cable voltage details and telephone numbers of both the Owner and dig-safe agency. Landowners shall also be provided with these phone numbers and the as-built cable route details and drawings.

(5) In addition to crossings (noted above), all changes in Collection System Circuit direction shall be marked with buried marker balls and above-ground cable markers.

5.1.12 Requirements for fiber optic cabling:

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

(2) When fiber cables are installed in a trench, the fiber cable shall be placed in conduit, Pest Duct (required for all non-armored cable), 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. Fiber optic shall be separated from any power cables when co-located in a trench.

(3) All fiber cables shall consist of a minimum of 12-strand multi/single mode fiber, except that the fiber run between the Project Substation and O&M Building shall be a minimum of 60-strand. 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.

(4) All fiber cables shall be designed with a minimum of fifty percent (50%) spare fiber.

(5) Excess slack shall be provided to allow re-termination in the event of failure. At least 60 feet of excess cable shall be provided at each pull box such that the cables may be re-terminated if needed following installation. Terminations shall be completed with either an approved fiber optic pigtail kit or with approved mechanical connectors and an approved fanout kit.

(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) The fiber system shall be designed for a minimum of five (5) dB system margin.

(8) The fiber system design shall be a fiber ring topology or a “daisy-chained” system.

(9) Conduits for fiber entry into the Wind Turbine areas shall include a pull string for pulling the cable.

(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. Other types of splices are subject to Owner approval.

(12) Maximum attenuation: (a) 0.35 dB/km at 1310 nm and (b) 0.25 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 Turbines during the power outage.

5.1.13 Requirements for junction boxes:

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

(2) Junction boxes shall be stainless steel or fiberglass.

(3) Junction boxes shall be lockable with a padlock.

(4) Junctions 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.

(6) The coordinates of each junction box shall be recorded and noted within the As-Built Drawings. Junction box locations shall be installed reasonably close to a roadway, property line, or Wind Turbine location to facilitate access. All junction box locations are subject to Owner approval.

(7) No medium-voltage cable run shall exceed 10,000 feet without a sectionalizing junction box.

(8) A flag shall be installed at each junction box location to make them visible in the event of high snow or crops.

(9) Infrared windows shall be installed in the junction box lid such that the Owner can monitor all the bushing and elbow temperatures using an infrared camera without opening the junction box.

(10) Concentric neutral tails are to be connected to the ground bus supplied with the cabinet, with sufficient slack to allow free movement of the terminations for maintenance or replacement. The cable jacket shall be carefully sealed against moisture ingress at all jacket openings.

(11) Sufficient slack cable shall be installed such that the cables can be re-terminated after the project is commissioned per applicable section. If the cable size permits this to be achieved by coiling in the ground sleeve/basement, such cable shall be trained neatly in the ground sleeve area, with a minimum amount of crossovers and buried in sand to prevent damage to the cable from failures in the cable riser section.

(12) If a junction box is installed in area used for livestock, an appropriate Owner-approved system shall be installed to prevent the livestock from rubbing on the junction box.

5.1.14 Requirements for pad-mount transformers:

(1) If not supplied internal to the Wind Turbine, each Wind Turbine location shall include a medium-voltage, pad-mount transformer. Such transformer shall be sufficiently sized to allow the full Wind Turbine capacity to be delivered. Pad-mount transformers (including spares) shall be in accordance with the requirements set forth in Table 1 *(Summary of General Requirements for Pad-Mount Transformers)* herein, at a minimum.

Table 1: Summary of General Requirements for Pad-Mount Transformers

Description	Value
Quantity	1 per Wind Turbine plus spares noted herein (see Section 5.3.2)
Type	Oil filled, hermetically sealed, outdoor installation
Voltage ratio	34,500 / 690 Volts (or as applicable to Wind Turbine model)
Phases	3
Windings	2 (MV, LV)
Steady state temperature rise	65°C above ambient
Frequency	60 Hz
Impulse levels	150 kV (General), 200 kV (Windings)
Vector group	Grounded wye/delta
Cooling	ONAN
Tapping range	±5%, 2.5% steps, manual control
Paint finish	Munsell Green
Guaranteed losses	Not used (see Electrical Loss Limit)
Temperature gauge	Required
Pressure level indicator	Required
Pressure relief device	Required
Oil sampling valve	Required (located on end of drain valve outside LV compartment)
Filling orifice	Required
Tank ground tag	Required
Oil level indicator	Required
Grounding	Solid (MV source, LV winding), un-grounded delta (MV winding)
Nitrogen bleed valve	Required
Exterior fill valve	Required

(2) Pad-mount transformers shall be fitted with in-line, medium-voltage rated, current-limiting fuse protection per phase utilizing suitably-rated, oil-immersed, current-limiting fuses. The selection of these fuses shall be such as to ensure (a) compliance with the requirements of IEC 60787 or ANSI/IEEE equivalent; (b) short circuit protection of the MV transformer winding; (c) that degradation of the fuses does not occur as a result of the flow of repeated transformer magnetizing in-rush currents; and (d) ease of replacement following an in-service operation.

(3) Transformers shall have an appropriate K-rating to mitigate harmonic signals emitted by inverter-based wind turbines.

(4) Pad-mount transformers shall be fitted with a low-side load break disconnect from outside any arc-flash hazard with means to take a Wind Turbine offline without taking an entire Collection System Circuit offline or de-energizing other Wind Turbines.

(5) Each pad-mount transformer will have at least one three (3)-inch diameter or larger infrared viewing port installed on both primary and secondary sides, such that the viewing angle of an IR camera does not exceed 30 degrees from perpendicular.

(6) In addition to any requirements set forth herein, pad-mount transformers shall comply with the minimum requirements set forth in PGE Exhibit M1-04-02 (*General Transformer Specification*).

(7) For each Wind Turbine type and size, each transformer in the Project shall be of the same type and shall be directly interchangeable with any other.

(8) Pad-mount transformers shall be supplied with ice shields.

(9) Enclosure:

(a) The pad-mount 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 at least 24 inches.

(c) The MV and LV compartments shall be partitioned such that access to each compartment is via a separate door. HV and LV cabinet doors shall operate independently, each with own locking handle. 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) Each pad-mount transformer shall be equipped with an exterior fill valve, drain valve, external oil sample port, oil level gauge, temperature gauge, and nitrogen bleed valve, under lockable covers separate from the HV or LV cabinets. 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.

(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.

(10) Foundations / vaults:

(a) Pad-mount transformers shall be installed on vaults or concrete box pads; fiberglass box pads will not be used.

(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.

(c) Each pad-mount transformer shall have ball studs installed for capability to hang grounds on the low-voltage side. Short, vertical ball studs (facing up) are preferred.

(d) If required due to proximity to waterway, oil-filled pad-mount transformers will be supplied with a bund adequate for the purpose of containing oil. A vault, in which the transformer is mounted upon, may be configured to serve this purpose. A minimum bund capacity of 110% of the transformer's maximum oil volume is required and the bund shall be shielded to prevent the accumulation of rainwater.

(e) Transformer mounting flanges shall be flush with the vault surface to prevent rodent ingress.

(11) Contractor shall provide aluminum or copper options for LV cable for Owner's final approval. LV cable from turbine to pad-mount transformer (if any) shall be installed in conduit. Conduits shall be filled with stainless steel brillo and sealant to prevent rodent entry into tower and smoke from being drafted up tower from the pad-mount transformer. At least two spare power conduits are required between the pad-mount transformer and Wind Turbine tower.

(12) Each pad-mount transformer shall be equipped with an Oil Switch. The operating handle shall be accessible from the side of the transformer, outside the MV cabinet under a lockable cover under a lockable cover.

(13) For each Wind Turbine type and rating, each transformer in the Wind Farm shall be of the same type, configuration, and size, and shall be directly interchangeable with any other.

(14) It shall be possible to completely replace any pad-mount transformer without removing any Wind Turbine or Wind Turbine tower.

(15) Pad-mount transformer LV bushings shall be provided in a staggered arrangement, in accordance with Figure 8 in IEEE Std C57.12.34-2015

(16) X0 bonding jumper shall be external to the tank (inside the LV cabinet) and separable.

5.1.15 Requirements for surge arresters:

(1) Surge arresters shall be provided at the end of each string of Wind Turbines. Surge arresters shall be fully shielded, submersible, dead-front devices rated at 35-kV class, 600A, 30kV/24.4kV MCOV (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.

5.1.16 Requirements for grounding:

(1) Grounding connections at junction boxes and pad-mount transformers (if any) shall be bolted to facilitate separation of grounds for continuity testing and ground mat testing. Driven ground rods shall be installed for each Wind Turbine transformer, and bonded to the Turbine Foundation ground grid and rebar cage via Eufer ground, at a minimum of two places. All connections shall meet or exceed requirement identified in the grounding study report.

(2) Ground rods shall be incorporated into the grounding system (a) if determined to be necessary by the results of the Contractor-provided grounding study and/or (b) if required by Turbine Supplier. Ground rods shall be copper-clad, 5/8-inch diameter, 10-foot-long rods at a minimum.

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

(4) Meteorological towers shall be independently grounded; meteorological tower grounding shall not be interconnected to the Wind Turbine grounding system.

(5) All below-grade grounding connections shall be exothermic weld (e.g., Cadweld); mechanical / compression connections are not permitted.

(6) All Collection System Circuits shall include a bare copper ground cable. The size shall be determined by included studies but be no smaller than 1/0 bare soft-drawn cable. Copper weld trench ground cable may be proposed provided it is compliant with all requirements and modeled in applicable studies.

5.1.17 Requirements for bollards:

(1) Bollards shall (a) be a minimum three (3)-inch diameter steel pipe or a minimum four (4)-inch diameter schedule 40 PVC; (b) be concrete filled for equipment protection (minimum 2,000 psi); (c) be painted red; (d) extend four (4) feet above grade with at least six (6) inches below the bollard for concrete; and (e) tie into the Wind Turbine ground grid.

(2) Bollards shall be placed in such a fashion as to be visible and provide physical protection but not infringe upon facilities that, when opened, require extended electrical working clearances.

5.1.18 Requirements for conduit:

(1) All above-ground power and communications cabling shall be installed in conduit, specifically including substation risers. All below grade crossings, including public road and utility crossings, shall be installed in conduit. Conduit shall be installed from each Wind Turbine to each pad-mount 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 and bell housing shall be installed on all conduit ends.

(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 with smooth interior surface and suitable pulling lubricant used to prevent cable damage while pulling cable into duct.

(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.

5.1.19 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 installed. The remote head shall be mounted in the cabinet wall to allow viewing from outside the cabinet. Directional fault indicators shall be installed at every junction box and at a frequency of no more than every third Wind Turbine location (i.e., such that any single fault indicator monitors no more than three (3) cable segments). Each fault indicator shall include a fiber optic indicator-extension, with lenses mounted through the enclosure; all fiber optic indicator extensions shall be of such length as to allow normal unimpeded opening of the enclosure, and normal operation of its contents. All fault indicators shall be installed and phase orientations displayed uniformly, and be representative of the phase orientation within the enclosure.

(4) All cable and communication terminations or above-ground junctions shall be along the road-side.

5.2 Submittals

5.2.1 Contractor shall prepare the Collection System Circuit design documents per the 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; (d) fiber optic loop diagram, including communication loop and connection / termination details for all Wind Turbines, permanent meteorological towers, and the O&M Building; (e) cable installation details, including cable specifications, trench details, splice details, and cable marker details; (f) cable crossing details and schedule, including road crossings, utility crossings, pipeline crossings, and directional boring; (g) grounding details, including trench grounds and Wind Turbine grounding; (h) termination details, including junction boxes and Wind Turbine switchgear; (i) junction box details; (j) meteorological tower 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; (o) inspection, testing, and quality control requirements; and (p) geospatial file (.SHP and/or .KMZ format) showing all Wind Turbines, cable routing, and junction box locations, at a minimum.

5.2.2 Contractor shall prepare equipment specifications to define the requirements and properties for the procurement of all permanently installed Collection System Circuit equipment and materials. The specifications shall be submitted to Owner for review *prior* to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) pad-mounted transformers, including vaults; (c) junction boxes; (d) power cable; (e) fiber optic cable; (f) handholes / enclosures; and (g) surge arresters.

5.2.3 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Collection System Circuit equipment and materials, including all items identified in Section 5.2.2 above as well as splice kits, marker balls, fault detectors, surge arresters, patch panels, and elbows.

5.2.4 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 *prior* to the procurement of the applicable Equipment. The following shall be included in the Collection System Electrical Studies, at a minimum:

(1) Cable Ampacity Study: load flow study with power flow analysis for the Collection System Circuits, including all medium-voltage cable and low-voltage cable (from the Wind Turbine to the pad-mounted transformer) (if applicable). Final report shall include table showing cable ampacity and percent loading per cable section corresponding to the Project one-line diagram. Cable ampacity shall not exceed the limit set forth in Section 5.1.8(5). 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).

(2) Short Circuit Study: short circuit analysis of Collection System Circuits, Project Substation, and Gen-Tie Line, including secondary values on Wind Turbines. The short circuit analysis and study shall be utilized in Contractor's electrical designs to support relay coordination study and equipment specification.

(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, Project Site-specific wind data, and other similar considerations. A pre-construction annual energy loss report and an as-built energy loss report, respectively, shall be submitted. The energy loss calculation shall include supporting assumptions and breakdown of subsystem loss contribution The energy loss calculation shall be based on site specific wind speed distribution and turbine specific power curve.

(4) Reactive Compensation Study: reactive power flow report, including power factor study at Point of Interconnection. The study shall identify reactive compensation required to meet the Requirements, including the Generator Interconnection Agreement requirements for power factor and voltage regulation, and including any capacitor bank and/or reactor requirements. The study shall include combinations of (a) active power (no load to full load at ten percent (10%) increments); (b) power factor (0.95 leading to 0.95 lagging); and (c) voltage (0.95 to 1.05 pu) at the Point of Interconnection, or more stringent as necessary to meet the Requirements, including the Generator Interconnection Agreement and compliance with FERC Order 827. A pre-construction reactive compensation study and an as-built reactive compensation study, respectively, shall be submitted.

(5) Harmonic Analysis Report: power quality analysis at the Point of Interconnection to determine the harmonic resonance and flicker conditions within the Project, and demonstration that the Project design meets the harmonics distortion requirements in the Requirements (including IEEE 519), including any necessary filtering or mitigation to be provided by Contractor. A pre-construction harmonic analysis report (performed at 90 percent design) and an as-built harmonic analysis report, respectively, shall be submitted.

(6) Harmonics Metering Plan: process to measure the harmonic voltage distortion and harmonic current distortion at the Project to compare with the limits of IEEE 519-2014. The plan shall include recommendations for harmonic metering equipment, equipment locations, and measured quantities where the resulting harmonic meter dataset collected will be used to determine whether there are any harmonics at the site which might damage equipment or be cause for concern.

(7) Concentric Induced Voltage Report: analysis to calculate the maximum induced voltage on the Collection System Circuit shield wires.

(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, Project Substation, and Gen-Tie Line against hazards of abnormally-high voltage surges of various origins. This study shall also confirm any system modifications required to adequately limit transient overvoltage on the collection system circuits, including determination of the transient overvoltage levels on the collection system circuits after feeders have been isolated from the project substation due to a line-to-ground fault or lightning strike, and determination of the maximum energy required to be absorbed by each surge arrester on the collection system circuit feeders Contractor shall provide calculations which verify that each equipment's basic insulation level, basic switching impulse level, and chopped wave withstand rating are acceptable. Contractor shall also provide protective ratio calculations and verify that insulation coordination has been met as defined in the most recent revision of IEEE standard C62.22 or superseding equivalent.

(9) Transient Overvoltage Report: study to confirm any system modifications required to adequately limit transient overvoltage on the Collection System Circuits, including determination of the transient overvoltage levels on the Collection System Circuits after feeders have been isolated from the Project Substation due to a line-to-ground fault, and determination of the maximum energy required to be absorbed by each surge arrester on the Collection System Circuit feeders.

(10) Wind Turbine Ground Grid Report: analysis of Wind Turbine grounding design to verify the adequacy of the proposed design and the safety of personnel working in or around the Wind Turbine. 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 Turbine 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). The study shall consider clearing time in the event of a breaker failure for the purpose of determining if the grounding design (e.g., ground potential rise) is acceptable.

(a) For both the Wind Turbine Ground Grid Report and Substation Grounding Report, Contractor shall follow (a) most conservative body weight shall be assumed (50 kg); (b) a minimum of 3,000 Ohm-meter surface rock to be installed, surface rock to be 4" in depth with an appropriately compacted base later of ¾" minus and no felt separating the layers; and (c) as-built crushed rock depth shall be recorded and updated in the calculation.

(b) The grounding calculations shall be performed in CDEGS software and provided to Owner for review. CDEGS software shall conform to the following: (i) software version: Contractor shall verify acceptable version with Owner.; (ii) multi-layer soil model in RESAP; (iii) grounding plan in SESCAD; (iv) step and touch potentials in MALZ; and (v) Wind Turbines shall be modeled as they are actually constructed (i.e., if not solidly bonded (e.g., using wire ties), they should be modeled accordingly). This study shall consider clearing time in the event of a breaker failure for the purpose of determining if the grounding design (e.g., ground potential rise) is acceptable.

(11) Arc Flash Study: see Section 6.2.4(10).

(12) Transformer Sizing Calculations: medium-voltage and main power transformers calculations shall be provided prior to procurement of any power transformer.

(13) Subsynchronous Resonance Study (if required): study shall confirm no subsynchronous resonance issues or mitigation is required. EMTP software shall be used (Owner to approve software version).

(14) The Collection System Electrical Studies shall be performed utilizing Easypower software (Contractor shall confirm acceptable software version with Owner). Systems or components considered as part of the Bulk Electric System ("**BES**") shall be modeled using Aspen OneLiner. Each report shall include executive summary, assumptions, methodology, analysis, and conclusion sections. Each report shall be submitted with the native software files and any referenced files for the Owners use in reviewing.

(a) One-Line Diagram: The Easypower/Aspen model shall include a complete system one-line electrical diagram with the following minimum requirements: (i) utility source information including calculated maximum and N-1 three-phase and single line-to-ground short-circuit current values and X/R ratios; (ii) bus nodes with ampacity and voltage ratings, and available short circuit current; (iii) transformer ratings with all MVA ratings, voltage ratings on all windings, positive and zero sequence impedance ratings of each winding connection (primary-secondary, secondary-tertiary, primary-tertiary), load tap changer ratings, de-energized tap changer ratings, and inrush currents; (iv) cable and iso-phase bus size, type, impedance, and cable lengths within 10 feet of actual (through the 480 V level); (v) circuit breaker or protective device make and model, frame ampacity, trip plug rating, and protective settings; (vi) motor circuit protectors make and model, ampacity, and protective settings; (vii) motor loads including horsepower, voltage, full load amps, and locked rotor amps; (viii) variable speed drives and protective settings; (ix) generators, including all nameplate information; (x) neutral grounding resistor/transformer size and ratings; (xi) 480 V panelboards including all branch circuit information; (xii) protective relay make, model, and protective settings; (xiii) DC/UPS chargers, inverter, batteries, disconnects, and panelboards; (xiv) 120/208 V panelboards including all branch circuit information; (xv) as agreed upon by Owner, below a certain KVA, any loads fed from a single distribution panel, including aggregated power sources, can be lumped together as an individual element within the model; and (xvi) WECC PSCAD transient model.

(b) Contractor shall provide Owner with native data files for their use. Native data files for generation facilities shall include (i) Detailed Load Flow / Dynamic (RMS) Model: PSLF or PSS/e model of the entire facility; (ii) Detailed Transient Stability Model: PSCAD model of the entire facility; and (iii) Aggregate Load Flow / Dynamic (RMS) Model: PSLF model from NERC testing would satisfy this requirement.

5.2.5 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.

5.2.6 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.

5.3 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 and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the collection system design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(1) The Collection System Circuits shall be installed at the locations shown in the [preliminary] design documents in Exhibit [●] (*Design Documents*).

(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.

5.3.2 Contractor shall furnish a quantity of [QUANTITY] medium-voltage, pad-mounted transformers, including one (1) per Wind Turbine location plus spares at a ratio of 1:40 (one spare per 40 (or fraction thereof) installed) by Contractor, including at least one (1) spare per Wind Turbine model / type. All spare units shall be specifically marked and packed for storage.

5.3.3 Contractor shall complete all electrical connections of the Wind Turbines to the Collection System Circuits, as more particularly described in Section 10.5.5 herein.

5.3.4 Notwithstanding the following sentence and as more particularly described in Section 10.5.5 herein, Contractor shall complete all fiber optic terminations, including, but not limited to, those at the Wind Turbines, O&M Building, Project Substation, and permanent meteorological towers.

5.3.5 Contractor shall perform directional boring at all Collection System Circuit crossings with a stream, wetland, public road, railroad, pipeline, or other buried facility; refer to Section 5.1.10 herein for crossing requirements.

5.3.6 Contractor shall install four (4) bollards around every junction box and pad-mount transformer, 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 be in conformance with the following minimum requirements. 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.

(3) All testing reasonably recommended or required by the applicable equipment suppliers.

(4) All exposed cable sections (including Turbine cabling) shall be visually inspected for physical damage or manufacturing defects. Such inspections shall be performed prior to and during installation.

(5) Resistance testing on grounding grid at each Wind Turbine location and junction box.

(6) Megger test of all 34.5-kV Wind Turbine cables.

(7) Very low frequency ("**VLF**") test of all 34.5-kV power cabling *prior* to energizing. Testing shall be performed at 0.1 Hertz for at least 60 minutes and in accordance with IEEE 400.2. Testing shall include all terminations and splices.

(8) Insulation resistance testing of all low-voltage cabling, including Wind Turbine down-tower cabling and 600-Volt class meteorological tower cabling.

(9) Final continuity tests (including phase continuity of each phase) after completion of all system connections.

(10) Compaction testing shall be verified at a minimum of every 1,000 feet and at every splice pit location. Compaction testing shall be performed at depths of approximately 12 inches and 24 inches, respectively, below grade.

(11) Communications system testing per Section 8.4 herein.

(12) Pad-mount transformers, minimum factory testing on all units unless expressly noted otherwise: (a) all tests identified as "Routine" in IEEE C57.12.00 Table 18 and performed in accordance with IEEE C57.12.90.00; (b) resistance measurements of all windings; (c) polarity and phase relation; (d) ratio at rated voltage on all taps; (e) no-load losses and excitation current; (f) load losses and impedance voltage; (g) lightning impulse test on first unit produced; (h) audible sound emissions on first unit produced; (i) dissolved gas analysis on all units *prior* to temperature rise test; (j) temperature rise test on first unit produced; (k) dissolved gas analysis on tested unit *after* temperature rise test; (l) dielectric tests; (m) oil testing on all units *prior* to energization; and (n) oil testing on all units within 30 days of energization.

(13) Other testing set forth in the Project design documents.

5.4.2 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.

6.0 PROJECT SUBSTATION

6.1 General Provisions

6.1.1 The Project Substation shall be designed and constructed to withstand a 100-year, 24-hour storm event. Final constructed grade shall be at least six (6) inches above such flood depth, as determined in the Contractor-provided hydrology study.

6.1.2 The Project Substation shall be designed and constructed to a high level of reliability and shall meet or exceed the requirements set forth by the interconnection utility.

6.1.3 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.

6.1.4 Project Substation basic impulse level shall be at least 200 kV for the 34.5-kV system and subject to Owner approval on 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.

6.1.5 Notwithstanding the immediately following sentence, no splices shall be made within the Project Substation, including both power and instrument and control conductors. Shields may be spliced where necessary to permit connection to the Project Substation ground system.

6.1.6 Project Substation equipment paint shall be ultraviolet resistant. 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.

6.1.7 The Project Substation shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee ("**APLIC**"), including both the medium-voltage and high-voltage sides of the Project Substation.

6.1.8 Requirements for Project Substation civil and structural works:

(1) All civil works for the Project Substation shall comply with the applicable specifications in Section 4.0 *(*Civil / Structural Works).

(2) All Project Substation structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.1.

(3) Excavation by blasting for the Project Substation is prohibited.

(4) 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. Cable runs within the Project Substation shall be installed in precast concrete trenches and/or Schedule 40 PVC conduits with a radius not less than 60 inches for conduit 5 inches or larger, or radius not less than 36 inches for conduit 2 to 4 inches in diameter. Conduit size / fill ratio shall be in accordance with ANSI / NFPA 70, at a minimum.

(5) 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*".

(6) 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.

6.1.9 Requirements for substation cabling:

(1) 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. Within the Project Substation, below-grade power cable conductor size shall be determined in accordance with the methods in IEEE 835.

(2) Installation of conductors shall be understood to include placement, splicing, and terminating conductors; coiling and taping of spare conductors; identification, testing, and verification of each circuit, cable, and conductor.

(3) 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.

(4) All Project Substation control and instrument cables shall be shielded.

(5) The cable furnished shall be flame retardant construction in accordance with the applicable ICEA standards and suitable for wet or dry locations.

(6) All cable shall have surface printing showing manufacture's name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers.

(7) Control and instrument cables, 600-volt class cables, and low-voltage cables shall be terminated with ring-tongue connectors.

6.1.10 Requirements for substation bollards:

(1) See Section 5.1.17 herein.

(2) Non-metallic bollards shall be placed as appropriate around the perimeter of above-grade equipment (including trenwa as needed), in particular in areas within or adjacent to driving lanes.

6.1.11 Requirements for main power transformer: refer to PGE Exhibit M1-04-02 (*General Transformer Specification*).

6.1.12 Requirements for circuit breakers:

(1) 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.

(2) 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 or SF6 circuit breakers consisting of three sections: medium-voltage compartment, mounting provisions, and low-voltage compartment. EMA-manufactured circuit breakers with integral grounding switches are acceptable.

(3) 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.

(4) Mounting provisions shall be formed-steel supports that mount the breaker to a foundation and provide height adjustment.

(5) The low-voltage compartment of the circuit breakers shall contain the control components and operating mechanism including anti-condensation heaters.

(6) The stored energy mechanism shall drive a common shaft which operates all three phases and the auxiliary switches for breaker position contacts.

(7) The control enclosure shall contain the relays, meters, and switches for the breakers.

(8) The circuit breakers shall have provisions for mounting the protective relays in the control cabinet and remotely.

6.1.13 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): hook stick or 3-phase gang, manually operated (hand crank).

(5) Low-side feeder disconnect switches: hook stick or 3-phase gang, manually operated (hand crank).

(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.

6.1.14 Requirements for grounding transformers:

(1) Grounding transformers shall be sized 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 isolated Wind Turbines 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).

6.1.15 Requirements for reactive compensation devices:

(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 and FERC Order 827. Sizing of each device shall comply with the Contractor-prepared Reactive Compensation Study described herein.

(2) Capacitor banks shall be no greater than 15 MVAr per stage / step. Capacitor banks shall utilize necessary current limiting reactors to mitigate back-to-back switching instead of requiring interrupting breakers to contain pre-insertion resistors.

(3) Reactors shall be no greater than 5 MVAr per stage / step. Care shall be taken to minimize induced coupling currents into structures and adjacent equipment.

6.1.16 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.

6.1.17 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.

(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 breakers.

(3) Equipment surge arresters shall be station class, metal-oxide type surge arresters for outdoor use and polymer housing. Surge arresters shall be shatterproof.

6.1.18 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.

(4) External bus dampers shall be installed on all horizontal bus.

(5) Bus shall have one-quarter inch (1/4”) 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.

6.1.19 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.

(21) 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.

6.1.20 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. Project Substation ground conductors shall be sized for fault duration of 0.5 seconds.

(3) The Project Substation grounding system shall be an interconnected network of bare copper conductor and copper-clad ground rods (ground wells may be used instead of ground rods if dictated by the soil analysis). 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.

(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) Ground conductor size shall be sized accordingly to specific ground conditions and equipment requirements. 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 exothermal welding process. Above ground shall be NEMA two-hole connectors.

(6) Grounding connections shall be made to all fences and equipment (including support structures).

(7) Substation aggregate shall conform to ASTM C33, gradation 1.5 to No. 8 particles and shall have minimum resistivity of 3,000 ohm-meters.

(8) All grounding materials required shall be furnished new and undamaged.

(9) All clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be made of copper. Within the Project Substation, below-grade connections shall be Cadweld (or approved equal); bolted fittings below grade are prohibited.

6.1.21 Requirements for lightning protection:

(1) Lightning protection shall be designed in accordance with IEEE 998.

(2) Overhead shield wires installed on the take-off towers and lightning masts shall be provided for protection from direct lightning strikes. The shield system shall be adequately tied into the Project Substation ground grid.

(3) 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 vibration dampening device.

(e) 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.

(f) The horizontal deflection at the top of each free-standing mast shall be limited to L/20 of its height above foundation.

(g) Each mast shall be installed on a concrete foundation with galvanized steel anchor bolts. Foundations, bolts, and welding shall be in accordance with the structural requirements in Section 4.1 herein.

(h) Each mast shall be provided with two grounding pads located 12 inches above the foundation.

6.1.22 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. 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.

6.1.23 Requirements for equipment labeling:

(1) All major equipment and devices shall be properly labeled with nameplates made of laminated three-ply plastic to meet Applicable Standards (including those for safety) and other Requirements.

(2) Nameplates shall be fastened to the equipment by using a minimum of one (1) blank rounded screw on each end. Nameplates shall be a minimum of 1/8-inch thick, with yellow outer layers on a black core. Nameplate edges shall be chamfered.

(3) Numbering and labeling shall comply with PGE Exhibit M1-01-09 (*PGE CAD and Numbering Standards*).

6.1.24 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 4X, stainless or aluminum

(2) All enclosures shall be provided with pad-locking provisions.

6.1.25 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) Two (2) fully-rated, self-cooled battery chargers shall be installed. The battery chargers should be connected in parallel to charge the batteries simultaneously. The chargers 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 a maximum of 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) The Project Substation shall include a DC system, including, but not limited to, batteries, two (2) battery chargers, and panelboards.

(a) Battery size shall be determined using the battery load profile.

(b) Nominal voltage shall be $125V_{DC}$ with 60 cells.

(c) Batteries shall be capable of being recharged to rated capacity from a discharge down to zero (0) volts per cell, following an equalization charge.

(d) Design shall be based on an eight (8)-hour discharge time to 1.75 volts per cell and the voltage is to be maintained for the design life of the battery.

(4) 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.

(5) 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.

(6) 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.

(7) 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.

6.1.26 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.

6.1.27 Requirements for metering:

(1) The revenue meter shall be installed at the Project Substation on the high-side of the main step-up transformer. Each revenue meter shall be high accuracy and shall comply with the requirements shown in the Interconnection Agreement and any power purchase agreement(s).

(2) Meters shall be installed on each medium-voltage (34.5-kV) Collection System Circuit feeder, although to the extent that the Communications System can register production by feeder, a separate physical meter for each feeder is not required.

(3) All metering shall comply with PGE Exhibit M1-05-04 (*Communication, SCADA, and Metering Facilities*).

6.1.28 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 a new control room.

(4) 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.

(5) All protection device settings shall be provided for Owner's review no later than 60 days prior to the system energization date.

(6) Programming of devices shall be provided in electronic format straight from the device.

(7) Owner will review and approve the final design prior to procurement of equipment.

(8) The local utility shall require review and confirm line protection and signal exchange requirements.

(9) Protection shall be provided for all breakers, bus, transformers, 34.5-kV lines, high-side lines, capacitors, and inductors.

(10) 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.

(11) 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.

(12) High-side lines shall include primary and backup relaying.

(13) Not used.

(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.

6.1.29 Requirements for control building:

(1) The control building shall be a new, prefabricated, weatherproof, climate-controlled building containing protective relaying and control and communications systems and equipment. All electrical equipment shall be installed in the building prior to shipment.

(2) The control building shall be located within the fenced area of the Project Substation with a minimum of 20 feet of clearance on all sides.

(3) The control building shall be grounded and include HVAC. Redundant HVAC systems shall be installed unless it would prevent compliance with the Turbine SCADA System specifications, including temperature control.

(4) The control building shall contain a data concentrator and communications processor to collect Project Substation data signals for facility use.

(5) The control building shall include adequate space and clearance for all Turbine Supplier-furnished Turbine SCADA System equipment.

(6) 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.

6.1.30 Requirements for electrical equipment ratings:

(1) Thermal ratings of all electrical equipment shall be adequate for continuous operation at the loading levels expected for that equipment, considering amongst other things, extremes of low voltage and low power factor, 45°C ambient air temperature (or lower as required to meet Turbine SCADA System technical specifications) and additionally temperatures experienced within the immediate installation area of the equipment. Thermal ratings of all electrical equipment shall be fully covered by Type Test Certification. Temperature rise shall be specifically addressed and only OEM Type Test certificates shall be accepted to support evidence of compliance in this matter. Designs that rely on assumptions of cyclic loading for their adequacy shall not be accepted.

(2) Fault ratings of all electrical equipment shall be such that it shall pass, without damage, the maximum expected fault currents for a period no shorter than the backup protection clearing time and considering the maximum expected future fault level at the Point of Interconnection to the TSP network within the design life.

(3) All electrical equipment shall have adequate insulation ratings for the maximum possible expected voltages - including continuous, temporary, switching, surge and lightning overvoltages. Suitable overvoltage protection shall be installed by Contractor to ensure that the insulation ratings of the Work are respected.

6.2 Submittals

6.2.1 Contractor shall prepare the Project Substation design documents per the 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; (f) communications block diagram, including all Communications System equipment, Owner-supplied equipment, Turbine SCADA System, 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 diagrams; (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 equipment specifications to define the requirements and properties for the procurement of all permanently installed Project Substation equipment and materials. The specifications shall be submitted to Owner for review prior to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) main power transformer; (c) control building, including enclosure and panels; (d) capacitor bank (if any); (e) reactor bank (if any); (f) disconnect switches; (g) capacitor switcher (if any); (h) reactor switcher (if any); (i) breakers (high voltage, medium voltage, cap/reactor); (j) neutral grounding reactor; (k) potential transformers; (l) current transformers; (m) voltage transformers; (n) CCVTs; (o) surge arresters; (p) station service transformer; and (q) grounding transformers (if any).

6.2.3 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Project Substation equipment and materials, including all items identified in Section 6.2.2 above as well as busswork, metering, relays, and gravel/aggregates.

6.2.4 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 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) Effectively Grounded Report: study to confirm the Project is considered effectively grounded, as defined in IEEE C62.92.1-2000.

(3) Substation AC System Study: calculation of the capacity of the low-voltage AC systems in the Project Substation to determine size of station service.

(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 Project Substation to determine the illumination levels within the new substation that will be achieved with added luminaries.

(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 (a) the rolling sphere method of the electrogeometric model given in IEEE 998 for high-side equipment and (b) the fixed angle method for low-side equipment. The direct stroke protection system design shall be in accordance with the procedures, data, and methods given in IEEE 998.

(10) Arc Flash Study: arc flash hazard analysis of the Equipment, including all energized equipment in the Wind Turbines, Collection System Circuits, Project Substation, Gen-Tie Line, and O&M Building. This analysis shall be performed using Easypower and in accordance with the latest version of NFPA-70E and IEEE 1584.

(11) Protection Coordination Study: relay and protection equipment coordination study using either Easypower or Aspen OneLiner (Easypower to be populated with Aspen OneLiner results), 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 Wind Turbine Equipment (including switchgear / converter), Collection System Circuits, Project Substation, and Gen-Tie Line. This study shall also consider and coordinate with the interconnection utility's reasonable requirements. A narrative philosophy statement shall be submitted for comment before completing the coordination study, and the proposed settings for the Wind Turbine switchgear / converter shall be delivered to Turbine Supplier for implementation *prior* to energization. Contractor shall be responsible for obtaining approval from the Utility for the proposed relay settings and coordination with the Utility's protection and control scheme. The Easypower or Aspen models shall include complete and accurate representations of all isolation, switching, or coordinated protective equipment.

6.2.5 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 PGE Exhibit M1-01-07 (*Security and Compliance*), at a minimum.

6.2.6 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.

6.2.7 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.

6.3 Collector Substation

6.3.1 Contractor shall design, furnish, construct, and install one (1) [34.5/###]-kV Project Substation in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the substation design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(1) The Project Substation shall be installed at the location shown in the [preliminary] design documents in Exhibit [●] (*Design Documents*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Project Substation configuration.

(3) Contractor may combine (bifurcate) up to two (2) feeders into a single medium-voltage breaker, provided that the rating for such breaker is not exceeded.

6.3.2 Contractor shall furnish all capacitor banks, reactors, and/or other reactive compensation equipment necessary for the Project. Contractor shall also furnish and implement all VAR-control logic (including switching) and program such logic into the substation RTU.

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. The vehicle gate shall be a 20-foot-wide (minimum), manual, rolling, locking gate. At least 10 remote-entry devices shall be supplied and programmed by Contractor for Owner's use.

(3) At least one (1) pedestrian gate shall be installed at the Project Substation. The pedestrian gate shall be a 4-foot-wide (minimum), locking, manual swing-gate for personnel access.

(4) All fencing and gates shall comply with the minimum specifications in Section 4.1.8 herein.

(5) Contractor shall furnish and install a contact sign at the entrance to the Project Substation, as described in Section 2.5 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 Report. Any areas at the Project Substation to be utilized for traffic must be suitably compacted to support traffic loads.

(7) The Project Substation shall comply with PGE Exhibit M1-01-07 (*Security and Compliance*).

6.3.4 Contractor shall furnish and install [QUANTITY] closed-circuit cameras at the Project Substation. Cameras shall be positioned to allow for monitoring of entry points and major equipment, with final monitoring locations to be approved by Owner.

6.3.5 Contractor shall furnish and install the main power transformer(s), including offloading, setting, completing all terminations (power, control, and grounding), dressing, filling with oil, testing, and commissioning of the unit(s).

6.3.6 Contractor shall furnish and install the revenue meter(s).

6.3.7 Contractor shall furnish and install ANSI-approved arc flash labels in the warning of the dangers of arc flash. 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 Wind Turbines, Collection System Circuits, Project Substation, Gen-Tie Line, and O&M Building.

6.3.8 Contractor shall provide the following, each as more particularly described in the Generator Interconnection Agreement:

(1) [NTD: add specific requirements from GIA (typically in Appendix) once available. Varies by Project.]

6.3.9 Contractor shall provide backup power at the Project Substation via the local distribution system or a standby generator; the battery system may not be utilized as backup power source.

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 be in conformance with the following minimum requirements. 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.

(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.

(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.

(17) Reactor / capacitor bank testing (if applicable).

(18) Control building testing.

(19) Minimum main step-up transformer testing, all on the purchased unit(s):

(a) All tests identified as “Routine” in IEEE C57.12.00 Table 18 and performed in accordance with IEEE C57.12.90.00.

(b) Temperature rise at the maximum 65°C rating.

(c) Temperature indicator accuracy test.

(d) Induced potential test with the transformer connected at high voltage, with the transformer's own bushings in place, accompanied by partial discharge monitoring (to conform to ANSI C57.12.90).

(e) Impulse tests on all winding terminals, with the transformer's own bushings in place.

(f) Switching surge tests on the high-voltage winding, with the transformer's own bushings in place.

(g) Test all control wiring for continuity, grounds, and correct connections; and test operation of all relays, indicators, switches, lights, and interlocks.

(h) Resistance measurements of all windings on the rated voltage connection and all load tap connections. Test results shall be reported in ohms at 85°C

(i) Doble insulation power factor tests conforming to Method II in Table 4 of Article 10.10 of ANSI C57.12.90. The power factor shall be equal to or less than 0.5% at 20°C.

(j) Sample tests of the transformer insulation system shall be in accordance with IEEE C57.100. The test results shall confirm the specified minimum transformer insulation life expectancy when operated at the average winding temperature rise given in IEEE C57.12.00.

(k) Load loss and no-load loss testing. Loss tests shall conform to the requirements of IEEE C57.12.90 and IEEE C57.123. Each unit shall have an auxiliary power (C57.12.00 - control (auxiliary) cooling losses) test or calculation. Auxiliary power test or calculation shall include peak simultaneous power consumption in all cooling equipment within the range of transformer rating and specified service conditions. Differences between the guaranteed values and test values for load loss, no-load loss, and auxiliary power shall result in adjustments in accordance with the commercial terms and conditions.

(l) Perform the supplier's standard tests on each surge arrester.

(m) Zero sequence.

(n) SFRA, at factory and at Project Site. The test shall be performed in accordance with IEEE Std C57.149. Digital output files from test equipment shall be supplied for comparison with future tests.

(o) Mineral oil tests: mineral oil tests for conformance with the ASTM limits shall be conducted in accordance with the ASTM standards listed in ASTM D3487. Mineral oil tests for conformance with IEEE limits shall be conducted in accordance with IEEE Std. C57.106. Corrosive sulfur shall be tested in accordance with ASTM D1275 Method B.

(p) Audible sound pressure level tests to verify specified sound pressure level shall be made for one unit of each transformer design and ratings included in this specification. Tests shall be conducted with the specified OLTC; the OLTC shall be at the principal tapping. Measurements shall be made with the transformer at rated power and shall be included in the test report. No-load and rated load audible sound level measurement shall include A-weighted and discrete frequency narrow band tests in accordance with the sound level measurement procedure given in IEEE C57.12.90.

(q) Bushings with specifications in conformance with IEEE C57.19.00 shall have type tests, special tests, and routine tests that conform to the requirements of IEEE C57.19.00

(r) Type tests and routine tests for CTs shall conform to the requirements of IEEE C57.13. Current transformers specified to be metering accuracy shall be tested at burdens B0.1, B0.5, and B1.8 for all secondary current of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, and 7.5 amperes. High accuracy CTs shall be tested in accordance with IEEE C57.13.6.

(s) DETC testing: DETC shall have type tests and routine tests that conform to the requirements of IEC 60214-1. A motor drive shall have type tests and routine tests that conform to the requirements of IEC 60214-1.

(t) OLTC testing: (1) design tests for an OLTC shall conform to the design test requirements of C57.131 and this specification; (2) dielectric tests for Category 1 and Category 2 OLTCs applied in transformers with the highest voltage of 550 kV shall have the test voltage levels from IEC 60214-1, Table 5; (3) partial discharge tests shall generally follow the test methods and instrumentation of IEEE C57.12.90, Annex A, and partial discharge tests for OLTC with nominal voltage of 500 kV shall have an extended period phase-to-ground voltage of 475 kV, and the enhancement phase-to-ground test level of 550 kV; and (4) the additional impedance voltage and load-loss tests listed in C57.12.00 shall be performed for one unit of each set of ratings included herein.

(u) Owner shall be permitted to attend all main power transformer testing, including factory acceptance testing. Contractor shall provide at least 30 days advanced notice to Owner of such testing.

(20) All Project Substation foundations shall be tested for concrete and grout properties (strength, slump, air content, temperature).

(21) Compaction.

(22) Other testing set forth in the Project design documents.

6.4.2 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.

7.0 GEN-TIE LINE

7.1 General Provisions

7.1.1 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.

7.1.2 The Gen-Tie 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. Contractor shall utilize Grade B construction.

7.1.3 Contractor shall design and construct the Gen-Tie Line in accordance with the Project Substation Electrical Studies and the Electrical Loss Limit, each as defined herein.

7.1.4 PLS-CADD software shall be utilized to spot and perform detailed analysis and design of the Gen-Tie 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.

7.1.5 The Gen-Tie Line, when in operation, shall be corona free and shall 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.

7.1.6 If it is determined by the meteorological report that an area is prone to icing, galloping should be considered. The ellipse amplitude safety factor in PLS-CADD shall not be less than 1.0.

7.1.7 Weather cases and loading criteria shall be developed by Contractor based on requirements set forth in the Applicable Standards, including extreme wind and extreme ice. All 230 kV and higher voltage transmission lines to withstand NESC heavy loading conditions, including appropriate wind and ice loading criteria defined in NESC 250C and NESC 250D.

7.1.8 The Gen-Tie Line shall be designed and constructed to meet guidelines set forth by the Avian Power Line Interaction Committee.

7.1.9 Requirements for Gen-Tie Line civil and structural works:

(1) All civil works for the Gen-Tie Line shall comply with the applicable specifications in Section 4.0 *(*Civil / Structural Works).

(2) All Gen-Tie Line structures, foundations, assemblies, and components shall be designed and constructed in accordance with the applicable structural works specifications in Section 4.1 herein, in addition to the following.

(a) All wood poles shall be directly embedded at least 10% of the structure height plus 2 feet. All light-duty steel poles shall be directly embedded at least 10% of the structure height plus 5 feet as a minimum. Each foundation embedment shall be analyzed for the given load cases and soil parameters. Adjustments may be made if rock is encountered at a shallower depth, on steep slopes, or when poor soils are encountered.

(b) A preliminary report summarizing existing soil explorations in the area will serve as a basis for 30% foundation design. This report will verify soil assumptions used for setting depths and be used to develop preliminary engineered steel pole foundation design. A final geotechnical report will be received prior to the 60% submittal.

(c) For drilled pier design, resultant horizontal deflection will be kept below 0.25" for switch supporting structures and 0.5" for other structures.

(d) Foundations shall be designed using L-Pile or MFAD software, and soil conditions shall be based on geotech study. Foundations will be designed with anchor cages and rebar (not full length anchor cages). The reinforcement steel shall be Grade 60 conforming to ASTM A-615. The concrete strength shall have a compressive strength of 3500 PSI in accordance with ASTM C150. Foundation serviceability requirements are as follows: (i) Deflection: 1.5" at top of pile head with un-factored loads (OLF = 1.0); (ii) Rotation: 1° Rotation under factored loads (From PLS-CADD/PLS-POLE); (iii) Soil Capacity: Deflection less than 10" with un-factored loads multiplied by an OLF of 2.0

(3) All Gen-Tie Line structures shall be wood, light duty steel, tubular steel, or lattice steel as necessary for the voltage class. Steel structures shall be either galvanized or self-weathering.

(4) All tangent and dead-end structures shall be analyzed using intact loading cases in addition to camber and deflection loading cases. Pole tip deflection shall be limited to 1/20 of pole height under any loading condition for dead-end. Pole shall be pre-cambered if deflection under cambered load case exceeds six (6) inches under camber load case.

7.1.10 Requirements for conductors, shield wire, and optical ground wire ("**OPGW**"):

(1) All conductor cables, shield wire, and OPGW shall be installed by controlled tension methods.

(2) Pre-stressing of any type of wire shall not be permitted without the prior written approval of Owner.

(3) If conductors are bundled, all conductors in any one bundle shall be sagged simultaneously and all shall be clipped in on the same day. As used here, the "same day" shall be understood to be the same 24-hour period to avoid cables in the same bundle having substantively different creep characteristics.

(4) Prior to sagging, each sag span and control span shall be measured with surveyor's transits to verify exact span lengths and all conductor cables, shield wire, and OPGW sag spans and control spans shall be measured. This step may be omitted if (a) staked coordinate differences between structures align with the predetermined span lengths and (b) staked locations are provided to the engineer of record and Owner for confirmation.

(5) Conductor cables, shield wire, and OPGW 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 three (3)-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.

(6) 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.

(7) No single conductor cable within a bundle shall be more than one (1) inch from its sag position relative to the other conductor cables.

(8) No more than one (1) splice or repair on any one (1) conductor in any one (1) span shall be made. Splices shall be a minimum of 25 feet from any cable hardware.

(9) Wire tension limits shall be in accordance with the Applicable Standards, including, but not limited to, NESC C2 2017.

(10) The exact location where each reel of conductor was installed shall be recorded.

(11) 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.

(12) OPGW shall be installed the entire length of the overhead route and coordinated with the SCADA System/communication/protection specification.

(13) OPGW shall include a minimum fiber count of 48, single mode.

(14) OPGW design tension limits shall be specified in the Project-specific sections.

(15) Stringing tensions for the OPGW shall not exceed twenty percent (20%) of the ultimate cable strength.

(16) Splice locations shall be selected and provided with weatherproof splice boxes suitable for the selected OPGW.

(17) At each splice location, a 50-foot coil of spare wire shall be maintained.

(18) Spare wire may be coiled on the pole, placed in an underground vault, or coiled in an aerial slack storage device.

(19) 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.

(20) Shield wire shall be minimum 3/8-inch, 7-strand EHS steel wire. OPGW / OHGW shall be sized to meet the required short circuit rating.

(21) Shield wires and OPGW shall be bonded to the pole grounding system using a suitable ground wire.

(22) Conductors shall be limited to those listed in PGE LD23000, 795 ACSS Drake, or 1272 ACSS Pheasant. Conductors shall not exceed the following maximum operating temperatures: (i) AAC: 200°F; (ii) ACSR: 212°F; (iii) ACSS: 355°F; (iv) Copper: 212°F; (v) Neutral: 120°F; (vi) Communications Wires: 120°F

7.1.11 Requirements for crossings:

(1) All Gen-Tie Line conductor cables, shield wire, and OPGW crossings, including roads, utilities, and railroads, shall comply with NESC minimum requirements plus any additional clearance that may be required for signage, fencing, guards, or other similar items.

(2) Contractor shall coordinate with local utilities and pipeline companies as set forth in Section 2.11.3 herein.

7.1.12 Requirements for insulators and hardware:

(1) All surfaces of metal parts shall be relatively smooth with no projecting points or irregularities, which may cause corona.

(2) Nuts shall be hexagonal and of corona-free design.

(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) Non-ceramic, porcelain, or toughened glass insulators shall be used for both suspension and dead-end applications and types (non-ceramic, porcelain, or toughened glass) or manufacturer of insulators shall not be mixed.

(6) Insulator length, strength, and required number shall be determined based on loading requirements, switching surge and lightning requirements, and by contamination levels.

(7) The standard porcelain / glass insulator unit to be used is a 5.75-inch by 10-inch bell with a ball and socket coupling.

(8) Insulators shall be wet-process porcelain.

(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.

(11) Line guards and armor rods shall be installed in conjunction with suspension clamp assemblies.

(12) The center of the armor rods shall be within one (1) inch of the suspension clamp.

(13) The termination of the armor rods shall be within one-half (0.5) inch of each other.

(14) 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.

(15) Transmission suspension insulators shall use built in corona rings on polymer insulators on 230 kV and higher voltages.

(16) A vertical construction load (weight of workers and equipment) of 650 pounds shall be applied at conductor wire attachment and an unbalanced longitudinal stringing load shall be applied at each attachment under the Camber / Rake weather case.

7.1.13 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 0.5-inch, coated, carbon steel ground rod.

(2) Maximum resistance shall be no greater than 10 ohms. If ground resistance is greater than 10 ohms, special grounding designs shall be prepared. A ground resistance test shall be done at every structure.

7.1.14 Requirements for lightning protection:

(1) The Gen-Tie 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.

7.1.15 Requirements for marking and lighting:

(1) All Gen-Tie Line structures shall be marked in accordance with the Requirements.

(2) The Gen-Tie 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 Gen-Tie Line design documents per the 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, including .BAK and .KMZ 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 equipment specifications to define the requirements and properties for the procurement of all permanently installed Gen-Tie Line equipment and materials. The specifications shall be submitted to Owner for review *prior* to the procurement of the applicable equipment. The following specifications shall be provided, each as applicable to the design: (a) construction specification; (b) structures; (c) conductor; and (d) OPGW.

7.2.3 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently installed Gen-Tie Line equipment and materials, including all items identified in Section 7.2.2 above.

7.2.4 Contractor shall prepare energization plans and procedures for the Gen-Tie 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.

7.2.5 Contractor shall provide a complete recommended spare parts list for the Project's electrical works, including the Gen-Tie Line. Such list shall include recommended quantities, part / model numbers, and nominal pricing.

7.2.6 Contractor shall provide a Field Effect Study for the Gen-Tie Line. Calculations shall be made for measurement heights of one (1) meter above ground surface in areas accessible to the public, within the ROW. Electric Field Strength shall be calculated for the line voltage as well as any under build. Magnetic Field Strength shall be calculated at full rated ampacity, with balanced phase currents.

7.3 Transmission Line

7.3.1 Contractor shall design, furnish, construct, and install the [/###]-kV Gen-Tie Line in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the transmission line design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(1) The Gen-Tie Line shall be installed at the location shown in the [preliminary] design documents in Exhibit [●] (*Design Documents*).

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe Gen-Tie Line configuration.

(3) The Gen-Tie Line shall not cross through (under / over) the O&M Building yard. Placement of structures within the yard is prohibited.

7.4 Testing and Quality Control

7.4.1 Contractor shall test, commission, start-up, and place into successful operation the Gen-Tie Line, including the electrical infrastructure and communications infrastructure. At a minimum, testing shall be in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.

(1) All Gen-Tie 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.

(5) After installation and completion of all required splicing and terminations, all OPGW shall be verified using optical domain reflectometer ("**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 be (a) less than 0.35 dB per connection and (b) (i) less than -50 dB if UPC and (ii) less than -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 1300 and 1550 nanometers, using a calibrated light source and optical power meter

(7) Resistance testing on grounding grid at each structure location following structure erection but prior to bonding the shield wire or optical ground to the structure.

(8) All Gen-Tie Line foundations shall be tested for concrete and grout properties (strength, slump, air content, temperature).

(9) Compaction.

(10) Other testing set forth in the Project 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 COMMUNICATIONS SYSTEM

8.1 General Provisions

8.1.1 The Communications System shall be designed with data continuity and reliability as priority.

8.1.2 All monitoring and control devices and systems shall be suitably zone protected against lightning electromagnetic impulses in accordance with IEEE C37.90.1.

8.1.3 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 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.

8.1.4 All Communications System design and construction shall conform to Turbine Supplier's requirements.

8.1.5 All Contractor-furnished communications facilities shall comply with PGE Exhibit M1-05-04 (*Communication, SCADA, and Metering Facilities*) and PGE Exhibit M1-01-07 (*Security and Compliance*), respectively.

8.1.6 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 meteorological towers, Wind Turbines (via Turbine SCADA System), 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 and integration of (a) Project Substation equipment to support grid monitoring; (b) any required reactive compensation devices (e.g., capacitor banks, reactors); (c) the permanent meteorological towers to support data monitoring; and (d) Wind Turbine and meteorological tower FAA lights.

(4) 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.

8.1.7 Requirements for fiber network:

(1) See Section 5.1.12 for fiber optic cabling requirements.

8.1.8 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); and (4) tap changer position.

(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) Wind Turbine status (via Turbine SCADA System), including the following: (1) Wind Turbine status (e.g., online, offline for maintenance, curtailed) for each unit; (2) Wind Turbine generation level for each unit; (3) total Project power; and (4) atmospheric conditions.

(3) Other supervisory screen requirements:

(a) All major components (e.g., breakers, transformers, meteorological towers) 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 (via Turbine SCADA System): (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.

8.1.9 Requirements for reporting and storage:

(1) All reporting shall be in Generation Availability Data System ("**GADS**"), wind format.

(2) SCADA system reporting shall include, at a minimum, the following for the Project Substation, permanent meteorological towers, and Wind Turbines: (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.

(3) 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. It shall be possible to store at least one (1) year of data from the Project without archiving it from the system. It shall be possible to remotely download raw SCADA data (in native resolution, up to 1 Hz) by means of an online database facility for further analysis. All raw data shall be available to Owner via an on-site data link.

(4) 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 by Owner.

(5) All stored data and generated reports shall be exportable as ASCII and Microsoft Excel formats.

(6) The system shall not permit unwarranted tampering with or changing of raw data or functionality.

8.1.10 Requirements for data integration:

(1) Refer to PGE Exhibit M1-05-04 (*Communication, SCADA, and Metering Facilities*).

8.2 Submittals

8.2.1 Contractor shall prepare configuration files and a comprehensive data points list and protocol specification for communications, as more particularly described in Section 8.1.6 herein. The points list shall include all required points for the Turbine Supplier, interconnection utility, and offtaker(s) as required.

8.2.2 Refer to Section 5.2.1 and Section 6.2.1 for additional Communications System submittals.

8.2.3 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials.

8.3 Communications System

8.3.1 Contractor shall design, furnish, construct, and install the Communications System in conformance with the minimum requirements set forth herein and the [preliminary] design documents in Exhibit [●] (*Design Documents*). [NTD: the comms design will be referenced here and attached to the Agreement; this information is expected to be added at a later date, prior to contract execution.]

(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) Contractor shall provide an open-process control ("**OPC**") interface for communication with Owner's AVEVA PI historian.

(4) Contractor shall furnish and install / terminate all fiber optic cabling between the Wind Turbines (subject to the responsibility for fiber terminations in the base of each Wind Turbine as described in Section 5.3.4 herein), Project Substation, permanent meteorological towers, 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 8.1 herein.

(6) Contractor shall furnish and configure the RTAC, including incorporation of the Turbine SCADA System (i.e., Vestas VOB, WindSCADA) and dissemination of points to the interconnection utility and offtaker, as requested.

8.3.2 Contractor shall furnish and install the Turbine SCADA System, including all power and fiber optic terminations.

8.4 Testing and Quality Control

8.4.1 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 be in conformance with the following minimum requirements. All testing shall be performed by an independent, experienced third party.

(1) All Communications System 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.

(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) Verify fiber optic system performance (power losses, splice or connector losses, etc.) using OTDR. All such testing shall be done with an OTDR in both directions of the strands. For single-mode fiber, test both directions at 1310 nm and 1550 nm. A successful test result shall be (a) less than 0.35 dB per connection and (b) (i) less than -50 dB if UPC and (ii) less than -65 dB if APC.

(8) All fiber optic cable shall be visually inspected and OTDR-tested prior to installation / termination.

(9) Provide system functionality and compatibility at the control room / O&M Building.

(10) Test each cable and strand on every fiber run from termination to termination.

(11) 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.

(12) Test and demonstrate integration with Owner's data collection system.

(13) Validate that security applications are configured per PGE Exhibit M1-01-07 (*Security and Compliance*).

(14) Other testing set forth in the Project design documents.

8.4.2 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.

9.0 INTERCONNECTION SWITCHYARD

Contractor shall cause the interconnection switchyard and all other network upgrades set forth in the Interconnection Agreement to be completed. All such work is expected to be performed in accordance with the applicable Utility Specifications and other requirements set forth in the Interconnection Agreement.

10.0 WIND TURBINE SUPPLY, INSTALLATION, AND COMMISSIONG SERVICES

10.1 General Provisions

10.1.1 The Wind Turbine, including all components, shall be capable of operating at rated capacity in a safe, reliable, and continuous manner and without undue maintenance under the meteorological conditions (e.g., temperature, air density, wind speed, salinity) of the Project and Project Site.

10.1.2 All exterior surfaces of the Wind Turbine shall be white or light gray in color. RAL 9010 (pure white) is an acceptable color. A non-glare finish shall be used.

10.1.3 The Wind Turbine (including the tower and nacelle) shall have no external markings unless explicitly listed herein.

10.1.4 Wind Turbines shall be supplied with the first fill of all grease, oil, and other lubricants and consumables in the Wind Turbine Equipment (or filled at the Project Site following delivery).

10.1.5 Contractor shall validate the Wind Turbine Equipment incorporated into the Work is new, unused, of good quality, consistent for use in wind generation facilities, and complies with the Requirements.

10.1.6 Requirements for Turbine Supplier:

(1) Turbine Supplier shall inspect the Project Site prior to initiating the Work 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 have been contemplated and included in the Contract Price, and Turbine Supplier shall not be entitled to request or be granted any scope change claims based on the results of these investigations.

(2) Turbine Supplier shall validate the equipment incorporated into the Work is new, unused, of good quality, consistent for use in wind generation facilities, and complies with the Requirements. The design working life of the equipment incorporated into the Work shall be a minimum of 20 years.

(3) Turbine Supplier shall represent that all Functional Groups shall be interchangeable, regardless of the suppliers or manufacturers of the Functional Group, including if such Functional Groups are furnished by different suppliers or manufacturers.

10.1.7 Requirements for Wind Turbine installation:

(1) Wind Turbine erection shall follow a “reference” approach, wherein complete erection of the first Wind Turbine shall occur prior to erecting any subsequent Wind Turbines. 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.

(2) Wind days shall be actively minimized by scheduling Wind Turbine erection activities at times of day when wind speeds are projected to be lowest.

(3) Wind Turbines shall be erected such that the tower door orientation is downwind of the of the prevailing wind direction.

(4) 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.

(5) 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.

(6) 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.

(7) 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.

(8) Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner.

10.1.8 Requirements for Wind Turbine components:

(1) The rotor shall be of three-bladed cantilevered construction, mounted upwind of the tower, and shall have a horizontal-axis orientation.

(2) Rotor blades shall be supplied with leading edge protection. Each leading edge will be treated with erosion protection prior to rotor assembly, preferably at blade factory, or prior to affixing to main bearing assembly.

(3) Blade, generator, and main bearings shall be fitted with automatic lubrication and grease catchers to prevent egress of excess grease.

(4) A climb assist system shall be included. The climb assist shall be compatible with the standard tower ladder, provide a reduced carrying weight of at least 75 pounds, and meet all OSHA standard requirements for safety and construction.

(5) Critical Wind Turbine components, including the main bearing, gearbox, generator, tower, and blades, shall be monitored by a condition monitoring system for the purpose of targeting predictive maintenance and proactively monitoring failures.

(6) Each Wind Turbine shall include all relaying and switchgear required to assure safe and proper connection and disconnection with the Collection System Circuits, including uninterruptible power supply for safe shutdown upon loss of grid power. The switchgear shall include all enclosures, fittings, disconnect switches, fuses, breakers, and other similar or related items as necessary to adequately protect and isolate the Wind Turbine Equipment. The switchgear shall consist of a main circuit breaker, along with associated equipment.

(7) Each Wind Turbine shall be furnished with lightning protection designed in compliance with, at a minimum, the requirements of IEC 61400-24 and IEC 62305.

(8) All ferrous materials shall be supplied with coating systems adequate to protect it from corrosion for the design life (minimum 20 years) of the Wind Turbines at the Project Site location.

(9) The Wind Turbine shall be compliant with all current power quality and grid interconnection standards, including, at a minimum, FERC 661a, FERC 827, and IEEE 519.

(10) Reactive power control shall be provided by the Wind Turbine to assist with regulating grid voltages. The Project (inclusive of all Wind Turbines) shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, as measured at the point of interconnection, or more stringent if required by the Interconnect Agreement.

(11) Total harmonic distortion shall be no greater than five percent (5%).

(12) Each Wind Turbine shall be equipped with an Owner-approved cold-weather package.

(13) Contractor shall design features, such as door alarm in SCADA, to prevent theft and vandalism.

10.2 Submittals

10.2.1 Contractor shall cause Turbine Supplier to prepare and submit all deliverables and submittals necessary for the successful completion of the Work, including, but not limited to, all manuals, drawings, plans, studies, calculations, checklists, completion procedures, and other similar items (collectively, the "**Turbine Supplier Deliverables**"). All such materials shall be subject to review and/or approval by Owner, as applicable; shall be coordinated and discussed with all pertinent parties prior to and during the construction phase of the Project; shall be submitted by the applicable dates in the Submittal Schedule; and shall comply with the minimum requirements set forth in PGE Exhibit M1-01-02 (*Engineering, Documents, Drawings, and Other Deliverables*). The following list provides an indicative sample of Owner requirements for specific Turbine Supplier 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 Turbine Supplier Deliverables or the requirements thereof.*

(1) Turbine Supplier shall prepare a manufacturing and testing schedule for each Wind Turbine (the "**Manufacturing Schedule**"). The Manufacturing Schedule shall be provided to Owner at least 60 days prior to the start of manufacturing of the first Wind Turbine major component and shall be updated on a weekly basis thereafter. The Manufacturing Schedule shall include the anticipated production / manufacturing dates locations for each major component.

(2) Turbine Supplier shall provide a Wind Turbine installation manual, including in hard copy format and electronic format.

(3) Turbine Supplier shall provide a Wind Turbine operations and maintenance manual, including in hard copy format and electronic format.

(4) Turbine Supplier shall provide information for the design of the Wind Turbine Foundations, including, but not limited to, loading information, Markov matrices, and tower alignment information.

(5) Turbine Supplier shall prepare an assessment of suitability of the Wind Turbines at the Project Site. This assessment shall include a representation from Turbine Supplier confirming the suitability of the Wind Turbine for the Project Site and its ability to withstand the Project Site conditions for a period of at least 20 years. Turbine Supplier's requirements for wake sector management (if any) shall be included in the suitability assessment. For cold-weather packages, the site-specific loads analysis and energy production estimate must state that it explicitly considers the planned operating temperature range. Any additional features of Wind Turbines shall be including in energy production estimates, including leading edge protection.

(6) Turbine Supplier shall provide a current certification of compliance with IEC WT 01 / IEC 61400-1 / IECRE OD-501, either in the form of a Type Certificate or an A-Design statement of compliance, for the Wind Turbine. The Certificate shall be from an approved certifying entity, including Det Norske Veritas, TÜV NORD Group, or an Owner-approved equal.

(7) Turbine Supplier shall provide the quality- and factory-testing-related documentation as set forth in Exhibit [●] (*Wind Turbine Testing Requirements*).

(8) A Wind Turbine model in PSS/E format shall be furnished and the model parameters shall be validated for both Wind Turbine and generator and automatic voltage regulator and frequency control.

(9) Turbine Supplier shall furnish a complete bill of materials for all Wind Turbine Equipment, including equipment name, serial numbers, and model numbers.

10.3 Wind Turbine Supply

10.3.1 Contractor shall furnish [QUANTITY] complete, fully-functional [MODEL] wind turbine generators.

(1) Each Wind Turbine shall conform to the specifications set forth herein, including Section 10.1 above.

(2) Each Wind Turbine shall include all of the parts, components, equipment, materials, apparatus, structures, tools, supplies, consumables, goods, and other items required or appropriate for a complete, fully-functional Wind Turbine, including, but not limited to, a rotor blade set; hub; pitch system; main shaft arrangement, including main bearing; gearbox; mechanical brake; high-speed shaft coupling; generator; internal crane; power converter; medium-voltage transformer (if applicable); internal tower wiring and cabling; controller; auxiliary system; wind vane; anemometer; yaw system; cooling system; hydraulic system; tower section, including internal access ladder, platforms, and lights; switchgear; ground controller; uninterruptible power supply; condition monitoring system; and heavy duty door with lock, key, and concealed hinges (all Wind Turbine exterior entry points shall have electronic lock sets (e-locks) by Assa-Abloy).

(3) Each Wind Turbine shall include one (1) climb assist.

(4) Each Wind Turbine shall include a minimum two-year defect warranty consistent with the terms set forth in the Turbine Supply Agreement.

(5) Each Wind Turbine shall be furnished with the power curve, sound level, defects, and serial defects warranties consistent with the terms set forth in the Turbine Supply Agreement. Contractor shall cause the power curve test and sound level test, respectively, to be performed and successfully passed.

(6) The Wind Turbine Equipment shall be factory tested in accordance with the minimum requirements set forth in Exhibit [●] (*Wind Turbine Testing Requirements*) and Owner shall have the right to witness such testing as set forth therein.

(7) Contractor shall furnish and install one (1) fire extinguisher (sized per the Applicable Standards and other Requirements); one (1) fire extinguisher bracket and fire extinguisher in the base of each Wind Turbine tower; and (1) fire extinguisher bracket and fire extinguisher in each Wind Turbine nacelle, respectively.

10.3.2 Contractor shall furnish the Turbine SCADA System and conforming to the specifications set forth herein and as provided by the Turbine Supplier, collectively, including PGE Exhibit M1-05-04 (*Communication, SCADA, and Metering Facilities*).

10.3.3 Contractor shall furnish all required obstruction light brackets and obstruction lights, including wiring.

10.3.4 Contractor shall furnish medium-voltage transformers as set forth in Section 5.3.2.

10.3.5 Contractor shall furnish all containers, stands, frames, feet, racks, and any other items required to transport the Wind Turbine Equipment (collectively, the "**Delivery Devices**") and all specialized lifting and rigging equipment necessary for Wind Turbine offloading or installation (collectively, the "**Special Tools**").

(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) Copies of testing certificates and calibration records for all tooling shall be maintained at the Project Site and available for review by Owner or Owner's representatives.

10.3.6 Contractor shall furnish all consumables, consumable parts, and installation spare parts necessary or appropriate to perform the Work.

(1) Contractor shall furnish touch-up paint as necessary to repair any damage to Wind Turbine Equipment that occurs during the transportation, offloading, erection, and/or commissioning of the Wind Turbines.

(2) Contractor shall furnish the first fill of all grease, oil, and other lubricants and consumables in the Wind Turbine Equipment. All such lubricants and consumables shall be approved by Owner prior to use.

(3) Contractor shall furnish protective tarps to eliminate unwanted materials from entering Wind Turbine Equipment after removal of shrink wrapping.

10.3.7 Contractor shall furnish all dehumidifiers, turning gears, and other similar equipment and tools that are necessary to properly store and maintain the Wind Turbine Equipment prior to Wind Turbine erection in accordance with the storage instructions.

10.3.8 Contractor shall provide an arc flash hazard analysis of the Wind Turbine Equipment and ANSI-approved warning labels warning of the dangers of arc flash to be affixed to any Wind Turbine Equipment that may require service or maintenance while energized.

10.3.9 Contractor shall furnish all spare parts necessary for Wind Turbine installation and commissioning, including the Spare Parts Inventory.

10.4 Wind Turbine Deliveries

10.4.1 Contractor shall transport all Wind Turbine Equipment to the Project Site on or before the applicable milestone dates in the Agreement.

10.4.2 Contractor shall perform all off-Project Site clearing necessary for the transportation of Wind Turbine Equipment to the Project Site, including, but not limited to, tree trimming / removal and clearing of overhead obstructions.

10.4.3 Contractor shall upgrade and maintain public roads, bridges, and culverts as required for the transportation of WTG Equipment to the Project Site, and including obtaining any necessary permits.

10.4.4 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.

10.4.5 Contractor shall furnish and operate assist vehicles as necessary for delivery and movement of Wind Turbine Equipment, including at and within the Project Site.

10.4.6 Contractor shall receive, visually inspect, and inventory all deliveries of Wind Turbine Equipment (including Wind Turbines, transformers, down-tower converters, switchgear, climb assists, Turbine SCADA System, Special Tools, and shipping containers) 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.

(1) For any previously-manufactured equipment (e.g., PTC components), Owner shall have the right (but not the obligation) to inspect such equipment prior to shipment from storage or delivery to the Site.

10.4.7 Contractor shall offload all Wind Turbine Equipment at the Project Site. Contractor shall offload and stage all Wind Turbine deliveries at the Wind Turbine Pad location nearest each Wind Turbine.

10.4.8 Contractor shall furnish and maintain protective tarps to eliminate unwanted materials from entering Wind Turbine Equipment after removal of shrink wrapping.

10.4.9 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.

10.5 Wind Turbine Installation

10.5.1 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.

10.5.2 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.

10.5.3 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.

10.5.4 Contractor shall assemble, install, construct, and erect all Wind Turbines, including all components, equipment, switchgear / down-tower assembly, stairs, climb assists, and other similar items, and including furnishing of the main crane(s) with suitable capacity for Wind Turbine erection.

(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 design, furnish, construct, and install concrete pads for the stair support columns and concrete stair landing (approximately 3-feet by 3-feet) for each Wind Turbine.

(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) Not used.

10.5.5 Contractor shall install the electrical wiring and cabling in each Wind Turbine, including all necessary pulling, dressing, lugging, taping, splicing, and terminations, to interface to 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.

(2) Contractor shall complete all fiber optic communications system terminations in each Wind Turbine and at the Turbine SCADA System server, respectively.

(3) Contractor shall install the grounding system in each Wind Turbine, including grounding of Wind Turbine stairs.

(4) 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) 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; (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; and (v) night vision goggle compliant. Contractor shall remove all temporary FAA lights when no longer needed.

10.5.6 Contractor shall provide any required Wind Turbine maintenance, including any necessary generators and fuel, prior to successfully achieving Wind Turbine Mechanical Completion.

10.5.7 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 furnished by Turbine Supplier.

10.5.8 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.

10.5.9 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.

10.5.10 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.

10.5.11 Turbine Supplier shall provide technical advisors at the Project Site for consultation during the offloading, assembly, erection, installation, and mechanical completion, and commissioning of the Wind Turbine. The technical advisors shall provide advice, consultation (including answering questions), and clarification to regarding the Turbine Supplier manuals, specifications, and other Wind Turbine-related technical documents.

10.6 Wind Turbine Commissioning

10.6.1 Following mechanical completion of each Wind Turbine, Contractor shall perform an inspection of each Wind Turbine. During inspection, if deficiencies or discrepancies in the requirements of the installation manual or any other Requirement are discovered, Contractor shall inform Owner of the discrepancy and such discrepancy shall be resolved by Contractor prior to Wind Turbine commissioning.

10.6.2 Contractor shall start-up, test, commission, and successfully achieve commissioning completion and substantial completion of all Wind Turbines and other Wind Turbine Equipment, including the Turbine SCADA System and service lifts (if any), and including achievement of SCADA completion and all reliability tests being successfully run, including all testing set forth in Section 10.8 herein.

10.6.3 Following commissioning of the first Wind Turbine and until final closing, except during the performance of a Run Test, each Wind Turbine shall be maintained in normal operational mode.

10.7 Coordination

10.7.1 Contractor shall actively coordinate the sequence of Work with Turbine Supplier and other stakeholders to support the Project Schedule.

10.7.2 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.

10.7.3 Contractor shall attend and actively participate in all Wind Turbine Mechanical Completion walk-downs with Turbine Supplier.

10.7.4 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.

10.7.5 Not used.

10.8 Testing and Quality Control

10.8.1 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 4.1.11 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 Project design documents.

10.8.2 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.

10.8.3 Contractor shall cause the following (each a "**Run Test**") to be performed and successfully passed for each Wind Turbine. Each Run Test shall include (i) 168 continuous hours error free operation with operational data recorded by the SCADA; (ii) a minimum Wind Turbine availability of 92%, as measured in accordance with the availability guaranty; and (iii) at least 10 MWh of energy production from such Wind Turbine during the test. For the avoidance of doubt, the Run Test shall be conducted and successfully passed for each Wind Turbine prior to commencing the final Performance Test (defined below).

10.8.4 Contractor shall cause a 72-hour Project-side performance test (the "**Performance Test**") to be performed and successfully passed to demonstrate to Owner that the Work operates satisfactorily and safely, complies with the requirements of the Agreement, and is suitable for operational handover and for the purpose of achieving Project substantial completion. A successful Performance Test shall be defined as achieving the same criteria as the individual Wind Turbine Run Tests defined in Section 10.8.3 above.

(1) If any 72-hour Performance Test is interrupted due to a fault of Contractor-supplied equipment, the test shall be restarted. If any significant defect occurs during the course of any Performance Test, it shall be remedied immediately by Contractor and the Performance Test shall be restarted.

(2) Contractor shall be responsible for liaising with third parties, including the network service provider, to ensure the efficient and timely acceptance testing of the Work.

(3) All performance data, faults, errors, trips etc. that occur during the Performance Tests(s) shall be recorded by the SCADA until such time that the test has been successfully completed. Contractor shall provide Owner with the appropriate documentation for the test period in order to verify the tests have taken place and were successfully completed.

11.0 METEOROLOGICAL TOWERS

11.1 General Provisions

11.1.1 References to "meteorological towers" herein shall be understood to include both permanent and temporary meteorological towers, unless explicitly stated otherwise.

11.1.2 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.

11.1.3 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.

11.1.4 Meteorological tower designs, including foundation design, shall be approved by Owner prior to procurement of such equipment or materials.

11.1.5 All meteorological towers shall incorporate a safety climb cable that is capable of supporting support two persons at any one time. Each mast shall include a suitable wire or rail free fall-arrest system in accordance with ANSI A14.3 Safety Requirements for Fixed Ladders and identical to the fall-arrest system used in the Wind Turbines.

11.1.6 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.

11.1.7 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.

11.1.8 Instrumentation booms shall be oriented to minimize tower shading (e.g., perpendicular to prevailing wind direction).

11.1.9 Contractor shall include power performance testing of the Wind Turbines for compliance with the Turbine Supplier's guaranteed power curve and the following requirements:

(1) An independently performed power curve measurement test of each Wind Turbine model shall be performed in accordance with the IEC 61400-12-1 Ed. 1.0 (Wind Turbines - Part 12-1: Power performance measurements of electricity producing wind turbines) on the number of Wind Turbines required by the Turbine Supplier per terms of the power performance guarantee, with such number being at least two (2) Wind Turbines or 5% of the Project's Wind Turbines, whichever is greater. The report on such shall be provided within Contractor's Specifications.

(2) As part of the power performance test, a site evaluation shall be performed in accordance with the IEC 61400-12-1 Ed. 1.0 to determine whether a site calibration is required.

(3) Any modifications or deviations on the turbine manufacturer warranty document from IEC 61400-12-1 Ed. 1.0 must be reviewed and approved by Owner, including its independent engineer.

(4) Upon completion of the Power Curve Test, an independent engineer shall issue a report stating the result to the Owner. Contractor shall provide a digital test report compliant with IEC 61400-12-1 Ed. 1.0 and any turbine agreement requirements.

(5) The Power Curve Test shall be completed within 90 days of commissioning of the final Wind Turbine. A Power Curve Test shall be deemed to be successful if measured energy production during the test exceeds 100% of the warranted energy production, minus uncertainties.

(6) Contractor will maintain comprehensive records of the testing work and provide Owner with a copy of these records at the completion of the work.

11.1.10 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 4.1 herein.

11.1.11 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.

11.1.12 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. All such data shall be available to and accessible by Owner.

(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.

11.1.13 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. If a pad-mount transformer feeds a meteorological tower, one additional meteorological tower power and one additional communication conduit or duct getaway shall be provided. The length of this duct shall be sufficient to exit the transformer vault footprint.

(2) Meteorological towers shall have local UPS or equivalent supply, capable of lasting a minimum of eight (8) hours.

11.2 Submittals

11.2.1 Contractor shall prepare the meteorological tower design documents per the 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) drawing index; (k) bill of materials; and (l) inspection, testing, and quality control requirements.

11.2.2 Contractor shall submit manufacturer's approval drawings or product sheets (material cut sheets) for all permanently-installed equipment and materials.

11.3 Power Curve Test Site Calibration Requirements

11.3.1 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 Turbine 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.

11.3.2 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 11.3.1 herein).

11.3.3 Upon completion of data collection for the power performance test site calibration (see Section 11.3.1 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.

11.4 Existing Meteorological Towers

11.4.1 Contractor shall decommission any existing (prior to Project construction), 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.

11.5 Permanent Meteorological Towers

11.5.1 Contractor shall design, furnish, construct, and install the permanent meteorological towers.

(1) The number and location of permanent meteorological towers shall be such that at all times there shall be at least one (1) mast within free-stream, non-wake-affected wind, effectively covering wind speed and direction measurement at hub height for all wind directions (360°). The permanent meteorological towers shall be at least two (2) rotor diameters from the nearest Wind Turbine.

(2) Contractor shall furnish all labor, equipment, and materials that are necessary for a complete, fully-functional, and safe permanent meteorological tower configuration.

(3) Permanent meteorological towers shall be installed at locations to be approved by Owner.

(4) Permanent meteorological towers shall be hub height, self-supported (non-guyed), galvanized lattice structures, each designed and certified for maximum wind and ice loading for the Project Site conditions.

11.5.2 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 fifteen (15) foot swing-gate, sufficiently wide for light-duty vehicle access.

(3) All fencing and gates shall comply with the minimum specifications in Section 4.1.8 herein.

(4) The fenced area for the permanent meteorological tower shall be covered throughout with at least three (3) 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 access roads. Grounding shall be installed throughout (and 3 feet beyond) the fenced area.

11.5.3 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 access roads.

11.5.4 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) wind direction sensors near Wind Turbine hub height (below goal post).

(5) One (1) temperature / relative humidity sensor with radiation shields near Wind Turbine hub height (below goal post).

(6) One (1) barometric pressure sensor near Wind Turbine hub height (below goal post).

(7) One (1) wind direction sensor at lower-blade height.

(8) One (1) temperature / relative humidity sensor with radiation shields at 10 meters above ground level.

(9) One (1) precipitation sensor.

11.5.5 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 CR1000.

(3) One (1) satellite or cellular (as appropriate) 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.

11.5.6 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. All cables running up the mast shall be armored, or travel within flexible conduit. The protected cables shall run into a junction box of minimum IP 66 rating for all seals and plugs.

(5) H-frame equipment rack located on the South-facing side of the mast. The H-frame shall have a minimum separation of 10 feet between support posts

(6) Fiber patch panel.

(7) Step-up transformer.

(8) Safety climb cable.

(9) Temporary power supply for data logger and aviation lights.

11.5.7 Details regarding the instrumentation and mounting hardware shall be reviewed by the manufacturer and incorporated into the design with a minimum of 3kW service for all equipment, plus auxiliary 120VAC provisions and a 20A/120VAC GFCI outlet for service work.

11.6 Temporary Meteorological Towers

11.6.1 Contractor shall design, furnish, construct, and install temporary meteorological towers as required for the site calibration.

(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 approved 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. The bird diverters shall be placed such that they do not interfere with the air flow at the anemometers and wind vanes.

11.6.2 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 wind direction sensor near Wind Turbine hub height (below goal post).

11.6.3 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.

11.6.4 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.

11.6.5 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.

11.7 Testing and Quality Control

11.7.1 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 4.1.10 and Section 4.1.11 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 prior to connection to (isolated from) trench ground.

(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.

(10) Other testing set forth in the Project design documents.

11.7.2 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 O&M BUILDING

Contractor shall furnish and install one (1) O&M Building at the Project Site. The O&M Building shall comply with the Project's future service provider requirements, including those of the Turbine Supplier, and shall (i) incorporate a furnished office space reserved for Owner of at least [TBD] square feet and (ii) reserve adequate space in the SCADA room for any Owner-installed communications equipment.

ATTACHMENT 1 TO APPENDIX M2-01-01
SCHEDULE REQUIREMENTS

Without limiting the information summarized herein, the purpose of this attachment is to summarize the minimum contents and requirements for the Contractor-prepared Project Schedule.

A. Definitions:

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

   a. "**Activity**" means a discrete part of a contract that can be identified for planning, scheduling, monitoring, and controlling the construction Work. Activities included in a construction schedule consume time and resources but shall not include planned work stoppages. Activities shall not normally reflect the Work of more than one trade.

   b. "**Baseline**" schedule means the initial Project Schedule, as approved by Owner.

   c. "**Critical path**" means the longest sequence of activities in a project plan which must be completed on time for that project to complete by the stated due date.

   d. "**Critical path method**" or "**CPM**" means a method of planning and scheduling a construction contract where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Agreement.

   e. "**Float**" means the measure of leeway in starting and completing an activity. Float time (including total float) is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly-owned, expiring Project resource available to both parties as needed to meet schedule milestones and Agreement completion date.

   f. "**Predecessor activity**" means an activity that precedes another activity in the network.

   g. "**Resource loading**" means the allocation of manpower, equipment, or material necessary for the completion of an activity as scheduled.

   h. "**Successor activity**" means an activity that follows another activity in the network.

   i. "**Total float**" is the measure of leeway in starting or completing an activity without adversely affecting an intermediate deadline or the planned Agreement completion date.

B. General requirements:

1. Contractor's accepted Baseline schedule will be set forth in Exhibit [●] (*Project Schedule*).

2. Contractor shall utilize Primavera Professional Project Management Software from Oracle for preparation of the Project Schedule. At a minimum, this shall be version Primavera P6.7 or newer.

3. Activities in the Project Schedule shall be defined so that no single construction activity is longer than 20 calendar days and no single other activity is longer than 30 calendar days, respectively, unless specifically allowed by Owner.

4. The Project Schedule shall include a clear and logical work breakdown structure, wherein all items are assigned a sensible activity number based upon the type of work being performed. Such work breakdown structure shall be subject to approval by Owner. Activity numbering shall be such that predecessor activity numbers are smaller numerically than successor activity numbers in the Baseline Project Schedule. Contractor shall use even-numbered activities for base Agreement Work, and odd-numbered activities for change order work. No activity number shall change after approval of the Baseline Project Schedule.

5. Procurement process activities shall be included for all long-lead and major items (as defined by Owner) as separate activities in the Project Schedule. Procurement cycle activities shall include, but not be limited to, submittals, approvals, purchasing, fabrication, and delivery.

6. The Project Schedule shall indicate important stages of construction for each major portion of the Work, including, but not limited to, the following: (a) preparation and processing of submittals; (b) mobilization and demobilization; (c) acquisition of key permits; (d) purchase, fabrication, and delivery of major equipment; (e) installation; (f) utility interruptions; (g) tests and inspections; (h) startup and initial operations; (i) work by Owner that may affect or be affected by Contractor's activities; and (j) training.

7. The Project Schedule shall include Milestones indicated in the Agreement. All major milestones shall be presented at the top of the Project Schedule.

8. The Project Schedule shall show the Work in Gantt chart format, on a sheet size of 11-inch by 17-inch, the scale and spacing shall allow room for notation and revisions, and the font shall be sized such that it is easily legible when printed.

9. Each revised or updated Project Schedule shall show actual progress compared to the originally-accepted Baseline schedule and any proposed changes in the schedule of remaining Work.

10. The Project Schedule shall clearly identify all critical path activities. Scheduled start and completion dates shall be consistent with Agreement milestone dates.

11. Contractor shall not use artificial activity durations, preferential logic, or other devices for sequestering Float. Owner retains the right to reject any schedule submittal in which Contractor has sequestered Float. Any activity with lag greater than two (2) days shall be identified in the activity description.

12. Constraint dates shall be kept to a minimum, and all constraints shall be identified with descriptive text in the activity description.

13. All activities shall have a predecessor activity and successor activity except for the first and last activities in the Project Schedule.

14. The Project Schedule shall include allowances for delays that may be encountered for reasonably-expected weather conditions, non-working holidays, and other similar items.

C. Concurrent with each Project Schedule submittal, Contractor shall submit the following reports. Each such report shall contain, at a minimum, activity number, activity description, resource loading, original duration, remaining duration, early finish date, late start date, late finish date (or actual start date and/or actual finish date, as applicable), and total float in calendar days.

1. General: electronic copies of the complete Project Schedule file in P6 executable (*.xer) format (including the Project-specific *.plf layout filters) and Adobe (*.pdf) format, respectively.

2. Critical path report: list of all activities on critical path, sorted in ascending order by activity number.

3. Activity report: list of all activities sorted by activity number and then start date, or actual start date if known. Within each activity, Contractor shall indicate estimated completion percentage in no greater than 10 percent (10%) increments.

4. Logic report: list of preceding and succeeding activities for all activities, sorted in ascending order by activity number.

5. Total float report: list of all activities sorted in ascending order by activity number and showing total float by activity.

6. Three-week look ahead: list of all planned Work activities during the current week and the subsequent two-week interval, sorted in ascending order by activity number.

7. Tabulated reports and/or schedule layouts showing the following: (a) identification of activities that have been added, deleted, or changed; (b) changes in activity durations in workdays; (c) changes in total float; (d) detailed schedule layout showing start and finish date variances; (e) critical path and near critical path (1 to 15 days float) layout with variances; (f) major milestone report with variances; and (g) activity constraints, including type.

ATTACHMENT 2 TO APPENDIX M2-01-01
APPLICABLE STANDARDS

Without limiting the information summarized herein, the purpose of this attachment is to summarize the applicable industry codes and standards for Contractor's Work.

A. General requirements:

1. The Applicable Standards shall include (a) each of the standards and industry codes listed below and (b) each of the relevant standards and codes issued by the organizations listed below. For the avoidance of doubt, any standards or industry codes not identified herein but pertinent to the Work shall also apply.

2. Unless otherwise specified, all engineering, procurement, and construction associated with the Project shall comply with the latest revision of all applicable codes and standards including, but not limited to, those listed herein. Any departure from the referenced codes and standards must be fully explained in writing and submitted for Owner's review and approval prior to implementation.

3. All specific standards applicable to pieces of equipment, structures, and/or buildings may not be listed herein. Specifications may describe the specific standards that may apply.

4. Any general standard or organization listed below shall be understood to include all relevant codes, standards, and/or guidelines under that particular standard or organization. For example, ACI shall include ACI 301, ACI 305, ACI 306, ACI 318, etc.

5. Unless otherwise specified herein, in the case of conflict between any Applicable Standards, the more stringent requirement shall apply.

B. Applicable Standards:

1. Air Movement and Control Association ("AMCA")

2. Aluminum Association ("AA")

3. American Association of State Highway and Transportation Officials ("AASHTO")

4. American Bearing Manufacturer Association ("ABMA")

5. American Concrete Institute ("ACI")

6. American Institute of Constructors ("AIC")

7. American Institute of Steel Construction ("AISC")

8. American Iron and Steel Institute ("AISI")

9. Association of Iron and Steel Engineers ("AISE")

10. Association of Edison Illuminating Companies ("AEIC")

11. American Gear Manufacturer Association ("AGMA")

12. American Land and Title Association (“ALTA”)
13. American National Standards Institute (“ANSI”)
14. American Society of Civil Engineers (“ASCE”)
15. American Society of Heating, Refrigeration, and Air Conditioning Engineers (“ASHRAE”)
16. American Society of Mechanical Engineers (“ASME”)
17. American Society of Nondestructive Testing (“ASNT”)
18. American Society of Testing and Materials (“ASTM”)
19. American Water Works Association (“AWWA”)
20. American Welding Society (“AWS”)
21. Avian Power Line Interaction Committee (“APLIC”)
22. Bonneville Power Administration (“BPA”) Master Specifications
23. Code of Federal Regulations (“CFR”)
24. Concrete Reinforcing Steel Institute (“CRSI”)
25. Crane Manufacturer Association of America (“CMAA”)
26. Department of Transportation (“DOT”)
27. Det Norske Veritas Germanischer Lloyd (“DNV GL”)
28. Expansion Joint Manufacturer Association (“EJMA”)
29. Electric Power Research Institute (“EPRI”)
30. United States Environmental Protection Agency (“EPA”)
31. Federal Aviation Agency, Department of Transportation (“FAA”)
32. Federal Energy Regulatory Commission (“FERC”)
33. Federal Highway Administration (“FHWA”)
34. FM Global (“FM”)
35. Hydraulic Institute (“HI”)
36. IAPMO Uniform Plumbing Code
37. Illuminating Engineering Society (“IES”)
38. Institute of Electrical and Electronic Engineers (“IEEE”)

39. Instrumentation Society of America (“ISA”)
40. Insulated Cable Engineering Association (“ICEA”)
41. International Building Code (“IBC”)
42. International Electrotechnical Commission (“IEC”)
43. International Federation for Structural Concrete (“FIB”)
44. International Fire Code (“IFC”)
45. International Network for Harmonisex and Recognized Measurements in Wind Energy (“MEASNET”)
46. International Organization for Standardization (“ISO”)
47. International Society of Automation (“ISA”)
48. Applicable state requirements, including State Department of Transportation
49. Metal Building Manufacturers Association (“MBMA”)
50. Manufacturer’s Standardization Society of the Valve and Fittings Industry (“MSS”)
51. National Association of Corrosion Engineers (“NACE”)
52. National Electric Code (“NEC”)
53. National Electrical Contractors Association (“NECA”)
54. National Electric Safety Code (“NESC”)
55. National Electrical Manufacturers Association (“NEMA”)
56. National Electrical Testing Association (“NETA”)
57. National Fire Protection Association (“NFPA”)
58. National Safety Council (“NSC”)
59. National Institute of Standards and Technology (“NIST”)
60. North American Electric Reliability Corporation (“NERC”)
61. Occupational Safety and Health Administration (“OSHA”)
62. Post-Tensioning Institute (“PTI”)
63. Pipe Fabrication Institute (“PFI”)
64. Scientific Apparatus Makers Association (“SAMA”)
65. Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)

66. Society for Protective Coatings (“SPC”)

67. Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)

68. Thermal Insulation Manufacturer Association (“TIMA”)

69. Underwriter’s Laboratories (“UL”)

70. United States Department of Agriculture (“USDA”)

71. Welding Research Council (“WRC”)

C. Applicable Standards (Oregon Projects only):

1. Oregon Structural Specialty Code (based on the International Building Code)

2. Oregon Mechanical Specialty Code (based on the International Mechanical Code)

3. Oregon Electrical Specialty Code (based on the National Electrical Code)

4. Oregon Plumbing Specialty Code (based on the Uniform Plumbing Code)

5. Oregon Fire Code (based on the International Fire Code)

6. Oregon State Occupational Safety and Health Act

7. Oregon Health Authority

8. Oregon Occupational Safety and Health Act (OR-OSHA) - 29 CFR 1910, 1926

Appendix M1

Attachment 01

Exhibit 02

Engineering Documents, Drawings, and Other Deliverables

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong

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1 M1-01-02-Engineering Documents, Drawings, and Other Deliverables

1.1 Submittals

Contractor shall supply all drawings, calculations and study reports, plans, specifications, and information to the Owner as part of the scope of Work. Documents and information shall include, but are not limited to, the deliverable list in M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table), in each case for the relevant technology (wind, solar, storage) as applicable. Items marked in the submittals table per the applicable technology (wind, solar, storage) shall be submitted for the Owner's review and approval prior to equipment purchase or construction.

Within 60 days of the Effective Date, Parties shall identify and mutually agree upon all OEM equipment submittals and specifications which will be submitted to the Owner and those that the Owner will review. Conformed to construction record drawings (as-builts) shall be provided for selected drawings marked as Level C.

Contractor shall organize a face to face or real time meeting with the Owner prior to Construction to review design documents.

As the project progresses through engineering and construction, the Contractor shall provide to the Owner the current revision of the drawings and documents according to the normal project communication distribution to be decided upon during project kickoff. These distributions shall be provided in electronic copy in native file format.

Upon completion of any drawing or document revision(s), Contractor shall submit the drawing(s) or document(s) within 2 days to the Owner.

1.2 Document Submittal Requirements

1.2.1 Drawings

Drawings requested by the technical specifications are to be sent as directed therein. Drawings associated with this Contract shall be in the English language and English system of units.

Each submitted drawing shall be unique and shall be clearly marked with the name of the Project, facility name, facility designation, specification title, specification number, project equipment or structure nomenclature, component identification numbers, Owner’s name, revision number, and revision history.

Final as-built drawings, including Contractor drawings and vendor drawings, shall be submitted in electronic format on electronic storage device. Each form of media shall be clearly labeled for content and date.

Contractor shall submit all drawings in AutoCAD (.dwg) version 2014 format including bound files, XREF files, 3D models (saved out to

Autodesk Plant 3D 2014 or approved equal), sheet drawing files, and Acrobat Adobe (.pdf) format. All color settings files (*.ctb), font files, block libraries, title blocks, and CAD Standards used on the Project shall follow M1-01-09 (PGE CAD and Numbering Standards). Exceptions shall be submitted to Owner in electronic format that is clearly labeled for content and date.

Two electronic files of all professional engineer (PE) stamped drawings approved for construction shall be submitted to PGE. One file shall be a scan of the PE-stamped and signed (approved) drawing original in (.pdf) format. The second file shall be an AutoCAD (.dwg) drawing file and shall include as-built updates.

Contractor shall create and maintain a master drawing list including, as a minimum, drawing number, revision letter/number, revision date, drawing title, Discipline, Document Status, Document type, Plant System, and cross-reference listing for associated vendor drawing numbers, and date submitted to PGE for review. See below for a list of preferred terms. Contractor shall provide to the Owner an initial copy of the master drawings list prior to issuance of any project drawings at the start of the project. The Master Drawing list will be updated and included with every drawing transmittal. Master drawing list must be compatible with Microsoft Excel. Final electronic master drawing list and program shall be submitted to Owner in electronic format and clearly labeled for content and date.

1.2.2 Design Masters

Contractor shall produce applicable drawings per Owner's standard Design Masters. In addition to standard design requirements, Design Masters dictate scope, size, symbology, nomenclature, and level of information required in a drawing. Contractor to request latest version of Design Masters from Owner prior to initiating any design. Microstation CAD files can be provided. The following apply:

High Voltage Lines

RAS

GSU Transformers

Unit Aux Transformers

Standby Transformer Metering and Protective Relaying One Lines

Three Lines

DC Metering and Protective Relaying Schematics

Panel Layout Drawings

Wiring Diagrams

Bill of Materials

Medium Voltage Switchgear and Generator Breaker Three Lines

DC Control Schematics

SCADA Block Diagram

SCADA DC Power Schematic

SCADA Panel Layout Drawings

SCADA Wiring Diagrams

SCADA Bill of Materials.

1.2.3 Other Requirements:

Submittals shall be accompanied by copies of native, electronic design files (e.g., AutoCAD .dwg file, PLS-CADD .bak file, electrical model files (PSS/E, EasyPower, ETAP, CYME), etc.), including for interim design transmittals (e.g., 30%, 90%, etc. as applicable) and As-Built Drawings.

All design submittals shall be provided in a common and consistent coordinate system. Such coordinate system shall be subject to Owner approval.

All design submittals (including product sheets, mix designs, verification procedures, installation procedures, testing procedures, etc.) shall be approved by the applicable engineer of record prior to submitting to Owner. An approval stamp from such engineer(s) of record shall be included on the submittal to indicate such approval.

Owner's review and approval of submittals will not relieve Contractor of responsibility for any deviation from the Requirements unless Contractor has in writing called Owner's attention to such deviation at the time of submission, and Owner has given written concurrence in and approval of the specific deviation. Approval by Owner shall not relieve Contractor from responsibility for errors or omissions in submittals.

As-Built Drawings: As-Built Drawings shall be issued as the next sequential revision from previous releases. The revision block shall state "As Built". All clouds, revision diamonds, and other interim control markings shall be removed, and all information listed as "later" or "hold" shall be completed. The As-Built Drawings shall include a final bill of materials, and native copies of all drawings and layouts. As-Built Drawings shall be created in the latest version of AutoCAD, or in the version of AutoCAD utilized by Owner, as applicable. As-Built Drawings shall comply with PGE Exhibit M1-01-09.

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 state where the Project is located. Such professional engineer(s) shall be registered in the applicable discipline for the drawings being signed and sealed.

1.3 Document Identification

Documents submitted by the Contractor for review shall be clear and legible and shall bear the Project Name in addition to the following:

1. Purchase order number
2. Project Facility – Unit Number – System number
3. Contractor's reference drawing number
4. Document revision status
5. Owner's documentation number (less submittal number)

This information shall be placed on the documents in or near the title block

Documents submitted shall be assigned an Owner documentation number assigned by the originator using the convention below. This number shall appear on the copy returned to the Contractor and shall be transferred by the Contractor to the Contractor's original, so that the document number will appear on subsequent submittals.

Correspondence including emails shall contain the Project Facility – Unit Number – System number, specification number, and equipment identification number.

All correspondence between Owner and Contractor shall be sequentially numbered as follows and provided in the subject line of emails:

AAA-BBB-SSSS-YYYY.X

Where:

AAA denotes the company originating the correspondence.

BBB denotes the company receiving the correspondence.

SSSS denotes the specification number

YYYY denotes the correspondence sequential number

X denotes the revision number of the correspondence beginning with zero.

Resubmittals shall bear the original submittal number and append a number sequentially as follows.

AAA-BBB-SSSS-YYYY.1

AAA-BBB-SSSS-YYYY.2

etc.

The Project Documentation Coordinator ([GPDC@PGN.com] for Owner; [ ] for Contractor) is responsible for assigning the correspondence number and maintaining their respective company transmittal log.

All correspondence shall be distributed electronically.

1.4 Document Review and Approval

The Contractor and Owner shall participate in 30%, 60%, 90%, and Issued for Construction (IFC) design and model reviews for each engineering package / discipline.

Design level	Description
30% Design	Most, if not all, of the design submittals may be conceptual in nature, without having all exact details defined. 30% design documents shall be provided as a single comprehensive submittal. To the extent possible, all PDFs shall be combined into a single file. For example, 30% design documents level of detail shall include (at minimum): • General arrangement drawings • Single line drawings • Cable and road layouts • Equipment specifications and data sheets Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

60% Design	Design documents intended to represent a reasonably complete design package. Many of the design submittals may be conceptual in nature, without having all exact details defined. 60% design documents shall be provided as a single comprehensive submittal. To the extent possible, all PDFs shall be combined into a single file. For example, 60% design documents level of detail shall include (at minimum): • Design Basis: • Design criteria for each engineering discipline • Contractor's equipment and system designation methods • List of systems and system designations Electrical Package: Schematics and single line drawings detailing: collection system circuits, ac collection system, auxiliary and backup power, MET stations, SCADA/DAS and communications systems, grounding design Wiring details including: specifications for all conductor types, conduit, protective devices and relays; ampacity calculations for all conductors; voltage drop calculations for all conductor runs; wiring details, minimum bend radii, conductor termination details, conduit fittings, etc. Equipment arrangement including conduit entry Supporting documentation for all components including: specification of all requirements for all components, manufacturer's datasheets, installation manuals, operations and maintenance manuals Civil/Structural Package: Calculations in accordance with Specifications • Geotechnical and Hydrology Reports • Structural inspection results/reports • Detailed Site layouts with elevation and topographic detail depicting mounting configurations for all equipment, grading plans, etc. • Foundation designs • Corrosion analysis Refer M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

90% Design	Design documents intended to represent a nearly complete design package for final approvals prior to being issued for permit approval. The 90% design documents shall be provided as a single comprehensive submittal. For example, 90% design documents level of detail shall include (at minimum): • An updated version of the 60% design documents with revisions and additional detail where applicable. • Shall include equipment ratings for all power systems equipment, bus Work, enclosures, protective devices, etc. • Include all detailed information required to obtain all necessary construction permits from the AHJ • Commissioning Plan • Acceptance Test Plan • Final Energy Estimate Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.
IFC Design	Design documents intended to provide all required information for Subcontractors to construct the Project. IFC design documents shall be provided as a single comprehensive submittal. IFC design documents shall include, at minimum, complete and fully detailed submittals (all applicable drawings and calculations) for the following: • An updated version of the 90% design documents with revisions and additional detail where applicable. • Shall include all completed test results such as pile uplift and lateral resistance testing • Shall address any responses/comments from the AHJ Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.
As-Built (AB) Design Documents	Design documents intended to reflect design changes after the release of the IFC design documents and to document the design of the as-constructed facility. All changes from the IFC documents shall be approved by Owner. Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

Where drawings or other documents are required, these documents shall be submitted for review in accordance with the Contractor's drawing submittal schedule. Drawings, specifications, and performance data submitted will be reviewed for adherence to the specification, suitability of design, equipment selection, conformance to design criteria, interfacing data, and for general information

regarding plant operating characteristics. They shall include erection diagrams and other details, such as interface connections. Identification numbers shall be used to identify items on the documents. The sequence of submission of documents shall be such that information is available for an effective review of each document when it is received. Information on drawings shall be checked by the Contractor for accuracy before submission for review.

Owner will update the Master Document List indicating the documents have been reviewed and will email the transmittal to Contractor.

All documents and drawings submitted by Contractor for the first cycle will be reviewed by Owner and returned with comments within 20 Business Days after receipt of the documents or as agreed to between Owner and Contractor. For subsequent review cycles, a 15 Business Day cycle will be followed or as agreed to between Owner and Contractor.

Contractor documents will be considered received after documents have been posted and Owner has received email notification of the posting.

Contractor may request, in writing, expedited review for specific documents and drawings. All requests will be considered.

1.4.1 Documents / Drawings

Documents, including drawings and electronic models, submitted for review shall be provided in the document's original (native) format with another copy in Adobe Acrobat (.pdf) format. A separate file shall be provided for each unique document number. Multiple sheets with one unique document number can be submitted as one file.

All revisions shall be noted in redline format, where applicable. All drawing revisions shall be clouded.

1.4.2 Status Level Convention

Upon completion of a review, the reviewer will rename the document by appending one of four Status Levels at the end of the document file name. The status level assignments shall be as follows:

S1 = No Exception Taken. Contractor May Proceed with Fabrication or Construction

S2 = Revise as Noted and Resubmit. Contractor May Proceed Based on Making Revisions Noted.

S3 = Does Not Meet Specification Requirements. Revise and Resubmit. Hold Fabrication.

S4 = For Information Only.

Status Level S1: Documents and drawings that receive status level S1 are approved.

Status Level S2 and S3: Documents and drawings that receive status level S2 or S3 shall be resubmitted, with comments incorporated in the next revision. Documents and drawings resubmitted for review shall clearly show changes made to them from previous revisions. All changes on drawings shall be clearly designated with revision clouds or shall include a revision list on the drawings. Revision clouds from previous revisions shall be removed. Changes on other documents shall be circled or a separate list of changes to the documents shall be provided. If a separate list of changes to the documents is provided it shall be named as the original document with "_COMMENTS" appended to the end of the file name. Any comments not incorporated must be noted and explanation given, in writing, for the exclusion.

1.4.3 File Naming Convention

Reviewed documents returned to Contractor will utilize the Contractor assigned file name, but be modified to indicate comments were appended as follows:

For Documents:

Return Document File Name:

Supplier File Name_Rev_PGE_S#.pdf

For Drawings:

Supplier Drawing #_Sheet_Rev_PGE_S#.pdf

1.4.4 Resubmittal Naming Convention

Resubmittals shall bear the original submittal number and append a number sequentially. Following initial submittal of a document or drawing by Contractor, that document or drawing shall not be resubmitted until Owner comments have been received and incorporated by Contractor.

1.5 Document Transmittals

All correspondence that transmits data, documents, drawings and other information that is considered a contract deliverable (or affects the design, construction, commissioning or operation of the project), is to be transmitted with a transmittal letter. An email with transmittal number in subject line and transmittal letter attached shall be issued to alert Owner that documents/drawings were submitted. Informal correspondence can be transmitted via email or other means and will not require a transmittal number.

Document transmittals shall be in accordance with a specified project schedule.

Submittals shall be in accordance with the following:

- Prints shall be sharp, clear, and suitable for direct reading. The prints shall be black line reproducible on bond paper. Scanned submittals are not permitted.
- Hardcopy documents shall be folded, collated sets mailed flat in a regular mailing envelope. Electronic formats of documents shall be submitted on CD, DVD or electronic storage device (as appropriate) and shall be adequately protected to prevent damage during shipment.
- Drawing or engineering databases shall be included in the document transmittals with programs to access and maintain the information and must be compatible with Microsoft Excel.

1.5.1 Spare Parts List

The vendor shall provide a recommended Spare Parts list for regular equipment maintenance. The Spare Parts list shall be submitted in Microsoft Excel spreadsheet format.

1. Entries into the electronic parts list shall conform to the following:

   Description using the Noun, Modifier, Characteristic 1, Characteristic N, Standards Requirements:

2. Example description of an existing item in PGE's for – 36 IN 5/8 double arming bolt

   BOLT, DOUBLE ARMING, 5/8 IN X 36 IN, SQUARE HEAD, WITH 4 SQUARE NUTS, HOT DIP GALVANIZED PER ASTM A153, MADE IN ACCORDANCE WITH ANSI C135.1, PER ASTM A36, 12,400LB MINIMUM TENSILE STRENGTH

Description Element	Identify by answering the question:	Descriptor	Abbreviation Spelled out
Noun	What is it?	BOLT,	
Modifier	What kind?	DOUBLE ARMING,	
Dimensions	What size?	5/8 IN X 36 IN	
Characteristic	What is specific about this item?	SQUARE HEAD	
Characteristic	What is specific about this item?	WITH 4 SQUARE NUTS,	This is more of a requirement
Standard Requirements	Standard to adhere to?	HOT DIP GALVANIZED PER ASTM A153,	Specific Standard
Standard Requirements	Standard to adhere to?	MADE IN ACCORDANCE WITH ANSI C135.1,	Specific Standard
Standard Requirements	Standard to adhere to?	PER ASTM A36,	Specific Standard
Characteristic	What is specific about this item?	MIN TENSILE STRENGTH OF 12.400 LBS	This is more of a requirement

A. Dimensions Descriptors

Dimensions shall be spelled out to avoid confusion for the ordering party, the vendor, or Owner. Standard dimension descriptors should be adopted as follows:

Abbreviation	Description
DIA	Diameter
L	Long
W	Width, wide
D	Deep, depth
IN	Inches
FT	Feet
TPI	Thread per inch
TPM	Thread per millimeter

Universally accepted numeric descriptors of dimensions are to be used also. For example: Bolt, 1-1/2 IN-18x36 IN L

- 1-1/2 IN = Diameter
- 18 = Threads per inch
- 36 = Length

1.5.2 Standards Requirements Reference

Requirements based on particular standards shall be included in the following format:

Standard Abbreviated	Specific Standard Number
ASTM	A153
ANSI	C135.1
ASTM	A36

1.5.3 Special Characters

Information NOT to be Included in the Item Description:

Manufacturer's Name

There are places in PGE Owner PeopleSoft and Maximo software systems that are designated to keep this information.

Manufacturer's Model Number

There are places in PGE Owner PeopleSoft and Maximo software systems that are designated to keep this information.

Vendor's Name

Vendor's Catalog Number

Slang terms to describe items

Terms used in the trades shall not be used as item descriptors unless those terms are universally used by all manufacturers and throughout the industry.

Example: bell insulator is a lineman's term for a suspension insulator or dead end insulator. Manufacturers recognize this item as suspension insulator, not as bell insulator.

1.5.4 Use of Special Characters in Descriptions

Item Descriptions may contain any of the following characters:

Description	Character
Comma	,
Period	.
Hyphen	-

Item Descriptions must not contain any of the following special characters as they interfere with the Maximo to PeopleSoft interface.

Description	Character	Description	Character
Quotation Mark	"	Dollar Sign	$
Ampersand	&	Percentage	%
Apostrophe	'	Asterisk	*
Less Than	<	Pound Sign	#
Greater Than	>	Exclamation Point	!
Question Mark	?	At Sign	@
Equal	=	Caret	^
Plus	+	Backslash	\
Underscore	_	Square Brackets	[ ]
Vertical Bar	|	Round Brackets	( )
Grave Accent	`	Curly Brackets	{ }
Tilde	~		

1.5.5 Instruction Manual

The Contractor shall furnish draft and final instruction manuals for the unloading, storage, installation, operation, and maintenance of the equipment. The manuals shall be delivered as specified in the Contract. The electronic versions of the manuals shall be word searchable PDF format, fully indexed and shall not be protected. The index shall link to the pages referenced in the index and the bookmarks shall coincide with the required tabs in the paper form.

1.5.6 Content

Manuals shall include the table of contents and index tabs (if multiple volumes are required, a table of contents listing materials included in each volume shall be supplied for each volume) specific to the furnished equipment. All pages shall be sequentially numbered.

1.5.7 Design

Description of the equipment and systems including accessory components, including nameplate ratings, illustrations showing elevations, cross section, and all details of the equipment with all parts named, and numbered.

When multiple model numbers are shown on the drawings, the equipment supplied for the project shall be clearly identified.

Specifications, test data, and all performance curves specified in the technical specifications.

- Outline drawing - final. Assembly drawings - final.
- All fluid systems schematics and piping diagrams. Electrical wiring diagrams.
- Motor Information Sheets.
- Electric Actuator Information Sheets.
- Control Panel Arrangements, including interior equipment arrangements identifying the individual components.
- Program, software, and firmware configuration, modeling, editing, and troubleshooting guides.

1.5.8 Installation

- Instructions for receiving, inspection, storage, and handling of equipment prior to installation.
- Installation instructions including step-by-step alignment and calibration procedures.
- Online and offline inspection procedures.
- Lists of trips and alarms, complete with set points.
- Calibration Data Sheet for each adjustable instrument included in the scope of supply.
- List of acceptable lubricants, insulating fluids, flushing fluids, hydraulic fluids, and fluid additives.

1.5.9 Operation

Complete and detailed operating instructions, including safety precautions, startup procedures, shutdown procedures, normal operation procedures, non-standard event procedures, and freeze protection requirements and philosophy of operation. Operating procedures and instructions shall provide the operator with information when and how to operate the equipment, including precautions, limitations and set points. Procedures listed in step-by-step sequence shall include preoperational

checkout, startup, normal, remote, or emergency modes of operation, and stopping or shutting down part or all of the subject equipment. Troubleshooting charts and tables shall be used to list likely evidence of malfunction and what could be responsible. The effect of loss of normal power and effect of electricity supply frequency drop shall be addressed.

1.5.10 Maintenance

Detailed minor and major maintenance instructions, including description, maintenance checklist, step-by-step instructions for replacing the major components, use of special tools furnished, including but not limited to the following:

- Preventive Maintenance Schedule for all equipment with servicing procedures including instructions for dismantling and/or replacing components and routine electrical and mechanical procedures, tests, and checks for cleaning, lubricating and otherwise caring for equipment. These procedures shall include calibration and maintenance of interlocks and other safety features. The Preventive Maintenance Schedule shall be provided in an MS Excel® spreadsheet (or another consolidated database, if approved).

Step-by-step procedures for all anticipated equipment repairs.

Troubleshooting guide.

Illustrated parts breakdown including parts list including American Society for Testing and Materials (ASTM) designation (if applicable), and a list of recommended spare parts. Complete replacement parts list shall include manufacturers' part number for ordering, description, the quantity used, and the applicable item number, and drawing references.

- Recommended six (6) month layup procedure.
- List of maintenance tools furnished with the equipment.
- Safety provisions.
- Torque values for critical bolts.
- Field disassembly and assembly.
- Field overhaul of specific components.
- Tube plugging instructions including plug dimensions and recommended material.
- Overhaul instructions.
- Control system troubleshooting instructions.

- Lubrication instructions including system flushing.

The above listed requirements are the minimum requirements; however, requirements that are clearly not applicable to the equipment may be deleted with Owner's approval. Additional information that is necessary for proper operation and care of the equipment shall also be included.

The electronic versions of the O&M manuals shall be word searchable PDF format, fully indexed and shall not be protected. The index shall link to the pages referenced in the index and the bookmarks shall coincide with the required tabs in the paper form. Manuals exceeding 100 MG file size will be broken into smaller parts and labeled accordingly (e.g. XXXXXX_Manual_Part_1_of_X.PDF)

The descriptions shall not be general, applicable to any type and size of Contractor's equipment, but shall be specific with (whenever possible) references to drawings submitted by Contractor.

Manuals which contain information on multiple manufacturer models shall have the model used at Project highlighted.

1.5.11 Equipment Storage

The Contractor shall furnish complete and accurate storage records for any equipment, materials, or other Work that was previously produced, manufactured, constructed, or otherwise produced and that will be incorporated into the Project. For the avoidance of doubt, this shall include any transformers, wind turbines, or other equipment that was previously manufactured for tax qualification purposes (e.g., PTC). Storage documentation to be provided shall include visual inspection and testing records.

1.6 Project Workbook

At the conclusion of the project and prior to final completion (as defined for the applicable Project type – e.g., Wind Plant Final Completion or Solar Plant Final Completion), the Contractor shall provide the Project Workbook listing the Project documentation as specified below.

Potential terms to be used in Project Workbook drop-down menus:

Document Types:

- Bid Document
- Budget
- Calculation
- Certificate

- Collection System
- Construction Work Package
- Contract
- Correspondence
- Design Basis
- Drawing
- Easement
- Estimate
- GIS
- Historical Document
- Incident Reports
- Inspection
- Invoice
- Job Books
- License
- Manual
- Meeting
- Model
- Permit
- Photograph
- Plant Systems
- Presentation
- Plan/Procedure
- Proposal
- Purchase Order
- Regulatory
- Report
- RFI

- RFP
- Schedule
- Schematic
- Site Certificate
- Specification
- Submittal
- Transmittal
- Vendor Information
- Video
- Welding

Disciplines:

- Architectural
- Geotechnical
- Civil
- Communication
- Electrical
- Instrumentation & Control
- Mechanical
- Project Management
- Structural
- General
- Environmental
- HVAC
- Plumbing
- Fire Protection

Document Status

- 30%, 60%, and 90% design package
- As-Built

- Final Project Document
- Issued For Approval
- Issued For Construction
- Issued For Contract
- Issued For Information
- Issued for Record
- Issued For Review
- Mark-Up
- Redline
- S1 - No Exception taken. Proceed in accordance with Specification.
- S2 - Minor Comments, Revise and Return, Proceed with Construction, or fabrication.
- S3 - Major Comments, Revise and Return, DO NOT proceed with construction or fabrication.
- S4 - For Information Only
- Superseded

KEY

Level A:	Contract Documentation - Documentation submitted prior to execution of the Agreement
Level B:	Construction Documentation - Documentation to be submitted prior to the commencement of Work on Site or issuing of any completion certificate
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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Certification	3rd party structural design certificate	Third-party Registered Professional Engineer's Certificate confirming the suitability of the Wind Turbine foundation(s) and that they are in accordance with the As-built drawings.			X			
Certification	Acceptance certificates	All completed Acceptance Certificates for Works prior to Substantial Completion milestone			X	X		
Certification	Calibration certificates	Copies of calibration certificates for all instrumentation mounted on all met stations/masts, provided by recognized independent agencies and done in accordance with the appropriate calibration standards.		X			4 weeks after met station installation	
Certification	Capacity and Availability test report	Upon satisfactory completion or upon failure of the Capacity and Availability Test, as the case may be, the Contractor will issue an Acceptance Test Certificate to that effect.			X	X		
Certification	Civil Works concrete and grout design supporting information	Contractor shall provide evidence from field, production or trial tests to justify the design of the concrete or grout mix proposed.		X		X	3 months after Agreement execution	
Certification	Electrical safety certficates	Electrical Safety Certificates for all electrical works to Applicable Laws, Regulations and Standards		X		X	Prior to energization	
Certification	Electrical system certificates of compliance	All electrical certificates of compliance			X			
Certification	Factory acceptance test reports	Copies of test certificates for all routine factory tests applied to all major items included in the Work, including Wind Turbines, and electrical system components including, but not limited to, switchgear, power transformers, instrument transformers, protection relays and revenue metering systems.		X			8 weeks prior to start of relevant site work	
Certification	Factory acceptance test reports for electrical components	FAT certificates to be provided by Contractor shall include, but not necessarily be limited to, the following components: • Transformers, including: o Substation main power MV/HV transformer/s o Auxiliary MV/LV transformer/s o Wind Turbine MV/LV transformers o Reactive plant transformers (if applicable) • Instrument transformers (i.e. CTs, VTs) • Reactive plant equipment (if applicable) • HV and MV switchgear and switchboards • LV distribution boards (AC and DC) • Cabling (HV, MV, LV and fiber optic) • HV and MV surge arrestors • Protection relays • Metering systems (revenue, check and power quality) • UPS systems • Stand-by diesel generator, and • Switchroom batteries and chargers		X			Prior to delivery to Site	
Certification	Factory acceptance test reports for wind turbine components	FAT certificates to be provided by Contractor shall include, but not necessarily be limited to, the following components: • Rotor • Blades • Gearbox (where applicable) • Step-up transformer • Generator • Yaw system • Main bearings • Service crane		X			Prior to delivery to Site	

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			A	B	C			
		• Wind Turbine tower • Service ladder • Service lift • Fall arrest and safety systems						
Certification	Performance test report	Report summarizing test as specified. Upon satisfactory completion or upon failure of the Performance Test, the Employer will issue an Acceptance Test Certificate to that effect.			X	X		
Certification	Permanent on-site buildings	Permanent building designs shall be independently checked and approved by a certified structural engineer		X			6 weeks prior to building work	
Certification	Power Curve Test Report and Certificate	Upon satisfactory completion or upon failure of the Power Curve Test, as the case may be, the Consultant shall issue to Owner a report and a Performance Test Certificate to that effect.			X			
Certification	Protection settings signoff	Written endorsement by the interconnection provider in respect of all protection settings of the Project		X			Prior to Plant energization	
Certification	Reinforcement specifications and testing certificates	Certificates confirming manufacturers and processors of steel reinforcement hold a valid certificate of approval.		X			6 weeks prior to start of relevant work	
Certification	SCADA system warranty and results	Documentary evidence that the SCADA system is sufficient for recording and analysis of the data for the warranty tests; and confirmation and detailed report of how the SCADA system stores data and provides values to enable availability calculations.		X			6 weeks prior to start of relevant work	
Certification	Type test certificates	Type Test Certificates for any piece of Plant or Equipment		X			8 weeks prior to start of relevant site work	
Certification	Wind Turbine certification	Type certification or design assessment of the Wind Turbine applicable to the proposed Wind Turbine configuration	X			X	Agreement close	
Certification	Wind Turbine geotechnical certification	Geotechnical certification from a qualified geotechnical engineer confirming design founding conditions in the base of the excavation prior to pouring the foundation or blinding.		X			6 weeks prior to start of relevant work	
Design	Civil works	30% Design including the following: • Buildings and structures • Roads • Crane pads • Site drainage • Earthwork and compaction • Met mast foundation/footings • HV/MV substation foundation/footings • Site landscaping • Site restoration/reclamation		X		X	3 months after Agreement execution	
Design	Civil works	60% Design: An updated version of 30% Design with revisions and additional detail where applicable: • Detailed foundation design drawings required. • ALTA survey map		X		X		
Design	Civil works	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Civil works	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Civil works	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			

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			A	B	C			
Design	Electrical collector system	30% Design including the following: • Wind Power Plant collector system SLD, showing connection to Wind Turbine step-up MV/LV transformers, all junction boxes, ground reference transformers (if applicable) and Wind Turbines; protection SLD to be incorporated or provided separately • Cable route layout for collector system, including including details of creek and road crossings approximate in-line joint locations (if applicable). Diagram shall include GPS coordinates of Wind Turbines and meteorological masts • Earthing drawings		X		X	3 months after Agreement execution	
Design	Electrical collector system	60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required.		X		X		
Design	Electrical collector system	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Electrical collector system	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Electrical collector system	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility including the following: • A GIS database which shall include all as-built cable routes recorded in a minimum of 10 meter steps and in-line joints (if installed). • MV Protection Schematics • MV CB Control Schematics • LV Air CB Schematics • UPS Schematic • Battery Charger Schematic • Distribution Board schedules • Cable schedules (HV, MV and LV) • LV systems and auxiliary generator schematics • As-built MV Switchroom GA drawings, including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc. • As-built Wind Turbine transformer kiosk GA drawings (if applicable), including LV cabling between Wind Turbine and transformer kiosk			X			
Design	Fire Protection System documentations and drawings	Including as a minimum: • Fire Risk Evaluation/Fire Protection Design Basis Document • Complete and detailed design drawings for each system. Drawings shall clearly indicate all wiring and equipment that is supplied or installed by Contractor. Drawing shall call out any design and material requirements (manufacture and code/standard). Contractor is responsible for reviewing materials and designs as part of the overall fire protection system, to ensure compliance with codes, standards and manufacturers' requirements. • Site fire protection plan drawings		X		X	3 months after Agreement execution	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Hydraulic calculations • Room integrity test results for clean agent suppression systems • Detailed control panel drawings • Detailed communication drawings						
Design	Fire Protection System documentations and drawings, as builts	Including as a minimum: • Operation and Maintenance manuals shall be provided. • Complete all required documentation and obtain necessary inspection required for the fire protection systems to be operated. Signed and filled out test forms shall be provided for each system provided. • As built drawings			X	X		
Design	Meteorological station	30% Design drawing and specification of the following: • Information on the Met Masts installations including number of Permanent Met Masts	X			X	Agreement close	
Design	Meteorological station	60% Design including the following (if applicable): • An updated version of 30% Design with revisions and additional detail where applicable • Mast general layout • Instrumentation specifications and calibrations; • Proposed locations and non-wake-affected sectors • Earthing and lightning protection • Mast instrumentation & mounting arrangements • Aviation warning markings (e.g. marker balls) • Enclosures and cabling • Fencing/protection • UPS • Power supply and SCADA connection		X		X		
Design	Meteorological station	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Meteorological station	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Meteorological station	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			
Design	Permanent on-site buildings	30% Design including but not limited to the following: • Layout • Elevation drawings • Structural • Architectural • Fire rating • Hold down	X			X	Agreement close	
Design	Permanent on-site buildings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required.		X		X		

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			A	B	C			
Design	Permanent on-site buildings	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Permanent on-site buildings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Permanent on-site buildings	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			
Design	Pre-engineered metal buildings (if applicable)	Including, but not limited to: • Detailed shop and erection drawings and product data • Foundation loads, anchor bolt setting diagrams, and details of required anchorage to concrete foundations • All calculations used in the development of building and anchor bolt design and of fabrication drawings		X		X	1 week after Agreement execution	
Design	Substation	30% Design including the following (as applicable): • Substation general arrangement drawing • Main power transformer(s) • Wind Turbine 34.5 kV system interface drawings, showing MV switchgear and Wind Turbine transformer • Manufacturer specifications for all reactive power compensation equipment (if applicable) and associated transformers • Protection equipment and switchgear specifications (including MV/HV substation, Wind Turbine-located MV switchgear, NER/NET if applicable), including insulating medium, description of interlocking and protection, thermal, fault and insulation ratings, IP level, manufacturer and standards compliance, relevant type test certificates • LV systems, diesel generator and associated equipment specifications, including battery and UPS capacities/back-up time • Revenue and power quality meter specifications • Drawings and schematics for Wind Turbine-located MV switchgear (if applicable), including configuration, placement, connections, civil works and/or mounting arrangements, cable terminations, and • Single line diagram (SLD) of substation, including main power transformer, reactive power compensation resources; protection SLD to be incorporated or provided separately		X		X	3 months after Agreement execution	
Design	Substation	60% Design including the following: • An updated version of 30% Design with revisions and additional detail where applicable		X		X		

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Main power MV/HV transformer specifications and drawings, including MVA rating, nominal voltage rating, on-load tap changer (OLTC) configuration, AVR, insulating medium, vector group, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, fire protection, corrosion protection, load and no-load loss guarantees, oil/water separator and bund details, manufacturer and standards compliance. Also required is the Type test certificate (considering environmental conditions, corrosion, cyclic loading, peak voltages and fire risk) and a fitness for purpose statement. • Submittals as required in Appendix M1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.						
Design	Substation	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Substation	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Substation	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			
Design	SCADA and communications network	30% Design including the following: • Information on the communications system, including specifications and drawings • Information on the SCADA system, including specifications and drawings • Fiber optic network drawings • Fiber optic splicing drawings, fiber optic distribution panel drawings • Complete list of all the data points and operational parameters applicable to the Contractor's proposed SCADA system. • Documentation describing how the availability and performance is calculated, stored and analysed in the SCADA system.		X		X	3 months after Agreement execution	
Design	SCADA and communications network	60% Design including the following (if applicable): • An updated version of 30% Design with revisions and additional detail where applicable • I/O connections drawings • Network used to communicate (transmission medium, network topology, communication protocols and fault tolerance) • Interfaces • Network layout • Point addressing scheme • Grounding requirements • Redundancy and UPS • Sensor locations and sensor orientations • Remote access • Viewing and display • Data collection and storage • Control		X		X		

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			A	B	C			
		• Reporting • Software and licenses • Comprehensive user manual explaining the operation and use of all the functions • Hardware manuals for all hardware and computers systems • Documentation including manuals, quality control, installation, commissioning and testing procedures						
Design	SCADA and communications network	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	SCADA and communications network	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	SCADA and communications network	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility including the following: • Detailed architecture, interfacing and component product identification • Network Data Communication, detailed wiring diagram • Fiber optic network • Interfacing • Power supply – SCADA distribution board SLD			X			
Design	Site layout/plans	Proposed Preliminary Layout including (as applicable): • Wind Turbines (including padmount transformers) • Landowner boundaries • Public roads • Access roads • Inverter stations • Cable routes • Laydown areas • Meteorological stations • Substation • Transmission line • Borrow pits • Batch plant(s) • Permanent and temporary buildings	X			X	Agreement close	
Design	Site layout/plans	30% Design including the following (as applicable): • An updated version of Preliminary Layout with revisions and additional detail where applicable • Junction boxes • Ground-reference transformers • Foundations/footings • Crane pads/hardstands • Crane paths • Drainage and erosion control features • Spares, parts, tools and permanent storage • Temporary utilities, and • Fencing, gate, signage and label details		X		X	3 months after Agreement execution	

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			A	B	C			
Design	Site layout/plans	60% Design: An updated version of 30% Design with revisions and additional detail where applicable		X		X		
Design	Site layout/plans	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Site layout/plans	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Site layout/plans	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility.			X			
Design	Spare parts, tools, and permanent storage	30% Design including the following: • List of components and consumables that do not satisfy the Design Life for Work including additional information				X		
Design	Spare parts, tools, and permanent storage	60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required.		X		X		
Design	Spare parts, tools, and permanent storage	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Spare parts, tools, and permanent storage	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Interconnection/Gen-Tie lines	30% Design including the following (if applicable): • Transmission line route including proposed pole/tower locations • Transmission line typical span and pole/tower drawings • Proposed transmission line structures and foundations • Approved Rebar Shop Drawings • Approved Concrete Mix Design • Power Cable Data Sheets • OPGW/Fiber Optic Cable Data Sheets		X		X	3 months after Agreement execution	
Design	Interconnection/Gen-Tie lines	60% Design including the following (if applicable): • An updated version of 30% Design with revisions and additional detail where applicable • Power line systems PLS-CADD model • All geotechnical data, including LPILE and SHAFT program inputs • Detailed foundation design drawings • Transmission line profile design • Structure assembly drawings, including required tolerances for installation • Drawings showing details of conductor clearances and member clearances • Drawings showing clearances of conductor sagging and existing vegetation and other objects • Line route survey drawings and data • Design of access routes, including drawings • Pole assembly		X		X		

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Pole erection • Conductor, and • OPGW stringing, earthing, jointing and terminations						
Design	Interconnection/Gen-Tie lines	90% Design: An updated version of 60% Design with revisions and additional detail where applicable: • Rebar/Anchor Bolt Mill Certs. • Anchor Bolt Tension Test Data. • Operational test of all equipment when complete, prior to Electrical Substantial Completion. • Mill certs for embedment ring.		X		X	6 weeks prior to start of relevant work	
Design	Interconnection/Gen-Tie lines	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable: • Concrete Cylinder Test Results • Foundation-concrete air test results. • Foundation-concrete slump test results. • Ground loop test. • Foundation-compaction test dry density and moisture content of fill. • Grout cube strength test results.		X		X		
Design	Interconnection/Gen-Tie lines	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			
Design	Wind Power Plant Collection System Cable Route Layout and associated design drawings	Layout and associated design drawings including, but not limited to: • MV cable route diagram, including details of creek and road crossings • Trench layout diagrams, showing cross-section of all buried cable configurations • LV cable route diagrams between the Wind Turbines and transformer kiosks (if applicable)		X		X	3 months after Agreement execution	
Design	Wind Turbine foundations	30% Design including the following: • Design basis document prepared by the foundation designer, outlining standards, methods and approach to be used in the foundation design. • Wind Turbine standard foundation design • Proposed foundation design types used for costing estimate based on preliminary assessment of Wind Power Plant • Foundation design, construct & test philosophy • General arrangement drawings		X		X	3 months after Agreement execution	
Design	Wind Turbine foundations	60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required.		X		X		
Design	Wind Turbine foundations	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Wind Turbine foundations	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		

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			A	B	C			
Design	Wind Turbine foundations	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility.			X			
Design	Wind Turbine general descriptions and diagrams	30% Design including the following: • Nacelle • Hub (including electrical and hydraulic systems as applicable); • Blades • Tower sections including internals (platforms, ladders, hatches, control cabinets and safety equipment) • Gearbox (if applicable) • Generator including bearings, cooling system • Mechanical braking system • Hydraulic systems • WTG Electrical cabinets • Cooling system • Condition monitoring system • Safety equipment • Service lift • Single line diagram of the Wind Turbine(s) , in sufficient detail to show all protective devices, overvoltage protection, isolation and earthing facilities • Wiring diagrams (three-wire) for all main power and auxiliary circuits in the Wind Turbines • Wind Turbine earthing drawings • Wind Turbine MV system interface drawings, showing MV switchgear and Wind Turbine Transformer • Control system block diagram of the Wind Turbines		X		X	3 months after Agreement execution	
Design	Wind Turbine general descriptions and diagrams	60% Design: An updated version of 30% Design with revisions and additional detail where applicable		X		X		
Design	Wind Turbine general descriptions and diagrams	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Wind Turbine general descriptions and diagrams	IFC Design Packagge: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Wind Turbine general descriptions and diagrams	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility and to include a complete Bill of Materials at least 3 levels deep where applicable for all major components, ie manufacturer info of wind turbine, gearbox, high speed bearings, sun gear, etc.			X			
Licenses	Software licenses	All licenses, software keys, hardware keys (dongles) and the like for all software included in the Works.			X			
List	Sub-contractors list	List of all sub-contractors to be included as approved sub-contractors.	X			X	Agreement close	
Manuals	O&M Manuals	Draft, comprising Overview and Manuals from key equipment suppliers; equipment maintenance requirements		X		X	120 business days prior to commissioing activities	
Manuals	O&M Manuals	Complete and final O&M Manuals, including but not limited to (as applicable): • Overview of the Plant Works			X		30 business days prior to commissioning activities	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• All relevant specifications • All details for the safe and effective use, operation and maintenance of the complete Plant Works • Procedure to mitigate grease contamination from oil leaks or other contaminants that can enter blade bearing. • System description • Safety Plan with Supporting Lock-out-tag-out procedures • Equipment startup procedures • Equipment shutdown procedures • Equipment warning and trip setpoints • Normal system operations controls • Abnormal system operations controls • Equipment fault codes • Troubleshooting guides • Maintenance intervals and tasks; including: • Procedures • Tools • Inspection criteria, as required • Systems Descriptions describing normal and abnormal control for system components • Condition monitoring intervals and tasks; including: • Inspection procedures • Inspection criteria						
Manuals	SCADA system documentation	The SCADA system shall be supplied with three sets of comprehensive, complete and up-to-date documentation packages relevant to all the hardware and software supplied. This shall include but not limited to (as applicable): • A comprehensive user manual explaining the operation and use of all the functions • Detailed descriptions of the underlying theory and calculations employed especially with regard to availability and power curve measurements. These shall include complete details of any data processing carried out by the Wind Turbine controllers • A complete electrical wiring diagram showing connections to the controller and the communications links • Hardware manuals for all hardware and computers systems • An administrator manual for system administration and configuration • Quality control, installation and commissioning documentation			X			
Permits	Permits	Permits including but not limited to: • 1200c (NPDES and Sediment and Erosion control) • Removal/fill • Septic • WPCF		X		X	5 business days upon obtaining	
Plan	Capacity test plan	Method Statement describing the Contractor's proposal to perform Capacity Test and Availability Test in accordance with the requirements set in the Specifications.		X		X	6 months after Agreement execution	

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			A	B	C			
		• Details of the equipment to be used • Any deviations • The methodology for dealing with those deviations • Details of the site calibration procedure						
Plan	Civil works, concrete procedure	A procedure for on-Site concrete batching, including as a minimum: • Source of materials • Transport plan • Quality control If Contractor proposes to utilize a pre-existing off-Site batch plant, details shall be provided on the concrete supplier including: • Quarry materials suppliers and any additives required • How the delivery of concrete to site is to be managed Contractor shall additionally provide a method statement for forming cold joints should concrete supply be disrupted.		X		X	2 months after Agreement execution	
Plan	Critical Lift Plans	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.		X		X	Prior to mobilizing to Project Site	
Plan	Document control plan	The document control plan shall address how documents are transmitted, named, reviewed, tracked, and edited.		X		X	2 weeks after Agreement execution	
Plan	Emergency response plan	Emergency response procedures and information		X			1 month prior to accessing Site	
Plan	Environment Management Plan	Including, but not limited to: • NPDES permit • SPCC Plan • Noxious weeds management plan • Cultural resources plan • Stormwater plan • Drinking water plan		X		X	1 month after Agreement execution	
Plan	Environment Management Plan	Operations Phase SPCC Plan		X		X	Prior to Substantial Completion	
Plan	Geotechnical Execution Plan	The name, office location, and qualification statement for proposed geotechnical engineer. 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.		X		X	Prior to initiating subsurface investigations	
Plan	Grounding and bonding plan	Plan and details, including fence as applicable		X		X	6 weeks prior to start of relevant work	
Plan	Hazardous Material Management plan	Plan includes spill and recovery procedures.		X		X	1 month prior to accessing Site	
Plan	HSE management plan	Updated and final. This shall include a comprehensive list of all HSE laws and Applicable Standards applicable to the Work		X			1 month prior to accessing Site	
Plan	Typical commissioning plan	Proposed installation and commissioning plan	X			X	Agreement close	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Plan	Installation and commissioning plan, Commissioning Test Manual	Procedure describing pre-commissioning and commissioning tests on all items in preparation for completion of individual Section of Works and to reach Substantial Completion.		X		X	30 days before start of comissioning	
Plan	Loss of grid power procedure	Provide procedures to achieve the aim of ensuring the Work is able to withstand periods without grid electrical power.	X			X	Agreement close	
Plan	Project management plan	Proposed Project Plan including: • List of key personnel with CVs • Project organization diagram • Project schedule including all milestone dates for completion of Work	X			X	Agreement close	
Plan	Project management plan	Including: • Construction project manager and key team members (including curricula vitae) • Project organization diagram • Communication plan • Permits, licenses, certifications and agreements required • Procurement and sub-contracting plan • Project schedule and payment milestones (as defined in Appendix 01 Exhibit 01 Annex 04 Milestone Payment Schedule) • Resource loading plan • Environment, health and safety plan including description of HSE system and associated certificates • Quality control / quality assurance plan (including equipment inspections and factory acceptance tests) • Management of Owner and other external interfaces • Change control plan – including change order process • Escalation matrix – how and when to escalate issue for resolution		X		X	30 days after Agreement execution	
Plan	Project quality plan	Proposed Quality Management Plans applicable to: • Design of the Work • Manufacture of the Work • Transportation and storage of the Work • Installation and erection of the Work • Testing, commissioning, and Substantial Completion of the Work • Shall include, where appropriate, references for FATs of major components • Description of quality management system and associated certificates		X		X	45 days following NTP	
Plan	Project quality plan	Update and final Project specific quality management plan		X			1 month following Owner comments	
Plan	Project schedule	The Schedule shall include, but not be limited to, the following: • Schedule Basis Memorandum • Engineering activities (i.e. engineering studies, calculations, and designs) • Procurement activities • Material and equipment deliveries • Construction activities • Tie-ins to existing plant systems • Equipment factory tests • Interfaces with Owner and other external interfaces		X		X	8 weeks after NTP	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Major milestones • Milestone payments, if applicable • Startup and commissioning activities • Testing activities						
Plan	Site Specific Safety and Health Plan	Including elements as specified in Appendix M1 Attachment 01 Exhibit 06 – Safety, Health, and Environment. • Resumes of Safety Professional	X			X	Agreement close	
Plan	Solid Waste Recycling/Recovery plan	Plan for solid waste recycling and recovery.		X		X	1 month prior to accessing Site	
Plan	Storm Water Pollution Prevent Plan (SWPPP) or Sediment and Erosion Control Plan	As required		X		X	1 month prior to accessing Site	
Plan	Testing, inspection and test plans	Proposed testing plan including but not limited to: • Proposed commissioning procedures including but not limited to: o the Commissioning Tests o the Acceptance Tests o the Performance Tests o SCADA • Details of any Tests on Completion that may threaten the safety of the Plant		X		X	2 months prior to start of relevant work	
Plan	Tower Rescue Plan	Per M2-01-01		X		X	Prior to beginning turbine erection	
Plan	Training program	Details of training program required to support the off-site and in-field training of Owner's personnel.	X			X	Agreement close	
Plan	Training program	Hard and electronic copies of all training material.			X			
Plan	Transportation plan	Procedure for delivery to Site for main transformer, inverter stations and other critical equipment and oversize loads		X		X	1 month prior to Site mobilization	
Plan	Transportation plan	Proposed shipping and access routes and major onsite access plan	X			X	Agreement close	
Plan	Turbine Manufacturing Schedule	Per M2-01-01, Section 10.2.1		X		X	As noted in M2-01-01	
Plan	Wind performance test plan	Draft of Project Equipment Performance test	X			X	Agreement close	
Plan	Wind performance test plan	Power Performance Testing Procedure describing the procedure to be undertaken by the Power Performance Testing consultant to measure the power curves of the selected Wind Turbines. • Details of the equipment to be used • Any deviations between the actual conditions for the Power Performance Testing and the requirements specified by the Power Performance Testing Procedure • The methodology for dealing with those deviations • Details of the site calibration procedure		X			2 months prior to start of relevant work	
Plan	Wind performance test plan	Updated and final version		X			1 month prior to start of relevant work	
Plan	Work plans	Procedures for execution of all Work including details of number of personnel and vehicles that will be on site at all the different phases of the Project		X		X	2 months prior to start of relevant work	
Report	As left settings	Alarm set points, complete I/O database including description of each I/O			X			
Report	Civil work geotechnical investigation report	Geotechnical investigation of HV/MV substation, access roads, hardstands, underground cabling, Wind Turbine & Met Mast foundation/footing sites.		X		X	2 months after Agreement execution	

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			A	B	C			
Report	Civil works 3rd party structural design report	Third-party Registered Professional Engineer's Report confirming the suitability of: • The permanent buildings • Any other structures as required to be certified under the local building and/or structural codes		X			6 weeks prior to start of relevant work	
Report	Civil Works Civil/Structural design report	The design report shall contain, as a minimum, all method statements, design inputs, design calculations, specifications, design drawings, cross sections, layouts and studies regarding: • Borehole logs and relevant geotechnical test results for the HV/MV substation • HV/MV substation foundations/footings; • Met Mast foundations/footings • Crane hardstands • Access roads • Permanent buildings (including structural, architectural, fire rating and hold down details) • Site drainage • Site landscaping • Site restoration		X		X	3 months after Agreement execution	
Report	Document register	Proposal defining the contract drawings and documents in the form of a document register	X			X	Agreement close	
Report	Document register	Update of document register.		X				
Report	Electrical balance of plant power system studies and design calculations reports	Updated Electrical Design Report following any design changes during construction.			X			
Report	Electrical studies	Include Easypower/Aspen software model and complete system one line diagram, where applicable. Electrical studies including, but not limited to the following: • Auxiliary power study • Coordination study • Arc flash hazard study • Insulation coordination • GSU transformer sizing • DC/UPS sizing • Grounding calculation • Harmonics study • Subsynchronous resonance study (if applicable) • Field effect study		X		X		
Report	Electrical studies	Update and final report			X		One month prior to Substantial Completion	
Report	Electrical system optimization report	Final optimization of power cable and overhead conductor size		X			6 months after Agreement execution	
Report	Equipment list	List of all equipment		X				
Report	Equipment maintenance records	Maintenance records for equipment			X			
Report	Failure Modes and Effects Analysis	Provide for critical supplied systems and assets: • Known / common failure modes • Potential failure modes and historical/expected mean time between failures • Severity on operation relative to the system provided		X		X	3 months after Agreement execution	

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			A	B	C			
		• Methods of detection based on vendor supplied Preventive Maintenance (PM) or Predictive Maintenance (PdM) Procedures • Improvements due to design modifications, additional PM or PdM measures or optional equipment.						
Report	Final substantial completion test reports	Completed installation and commissioning checklists, including commissioning test results, for the entire Plant electrical Works, including, but not limited to, MV/HV Transformer/s, auxiliary transformers, Reactive Plant (if applicable), protection systems and switchgear, transformers and switchgear, MV cables, fiber optic cables, metering, LV equipment, auxiliary generator, in-line cable joints (if applicable), earthing connections, terminations and joints.			X			
Report	Foundations Civil/Structural design report	Including but not limited to the following: • Design loads for all structural components • Design calculations including all assumptions • Demonstration of suitability of all structural components in extreme wind conditions and over the design life • Wind tunnel test results • Modal analysis results • Detailed foundation specifications • Concrete and Grout Design and the mix proposed as described in this document • Borehole logs and relevant geotechnical test results for each Wind Turbine site • All partial safety factors • Decision trees • Reinforcement specifications and testing, and • Conclusions		X		X	3 months after Agreement execution	
Report	Foundation Inspection Report	Per M2-01-01, Section 4.2.4		X		X	With each Foundation Completion Certificate	
Report	Geotechnical investigation report	Comprehensive geotechnical investigation, including and as applicable: • Inverter Station • MV/HV Substation • Access Roads • Hardstands • Underground Cabling • Met Station footing sites • Other permanent structures or buildings including the O&M facility • Soil Resistivity (Electrical and Thermal) Surveys		X		X	2 months after Agreement execution	
Report	Grid connection documentation	Update to all required grid connection documentation.			X			
Report	HSE report	Final HSE report and risk register			X			
Report	HV/MV electrical system design report	Design of proposed electrical systems including, but not limited to: • Single Line Diagrams (SLD) for MV/HV Substation, reactive plant and collector system, incorporating protection (or provided separately) • Earthing general arrangement (GA) drawings and schematic diagrams		X		X	6 months after Agreement execution	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Substation GA drawings, including overall GA drawing, MV switchroom GA drawings (including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.), lightning mast locations • Schematic diagrams and distribution board schedules for MV switchroom equipment, LV supplies and metering • Details of equipment redundancy • Electronic copies of all studies, models, rating evaluations, etc. performed for the above requirements. Specific software and version information to be provided by Owner.						
Report	Hydrology and flood study	To confirm the design for flood requirements for a 1 in 100-year flooding event.		X		X	Prior to relevant design work	
Report	Installation and commissioning reports	The results of all inspections, checks and tests carried out, together with any subsequent analysis. Including but not limited to protective relay calibration tests, trial of equipment operation summary, and manufaturer field service reports.			X		Within 30 business days of commissioning	
Report	Lightning protection study	Detailed assessment of lightning risk to personnel and Works in accordance with Applicable Standards.		X		X	2 months prior to start of relevant work	
Report	Master drawing list	Table of all drawings including drawing number, revision letter/number, revision date, drawing title, discipline, document status, document type, plant system, and cross-reference listing for associated vendor drawing numbers, and date submitted to PGE for review.		X		X	As drawings are submitted	
Report	Meeting minutes	Meeting summary and reports		X	X		3 days following meeting	
Report	Met station/mast installation report(s)	An installation report for each mast including, but not limited to: • Details of installer • Installation date • Grid coordinates of mast (including details of coordinate system and datum) • Elevation of mast above sea level • Mast and equipment details including, but not limited to: o Mast dimensions o Instrumentation types, serials numbers and installation heights and positions o Dimensions and orientations of all booms and arms installed on the mast o Data logger configuration and details o Commissioning details o Reference photos		X			1 month after installation	
Report	Met station/mast maintenance log(s)	Each installed mast shall have a maintenance log detailing all work carried out on the individual mast. The maintenance log shall be such that can be used by Owner for the continuing operation of the mast over its Design Life.			X			
Report	Mounting structure preliminary study	Preliminary design information including footing design, construct & test philosophy; general arrangement drawings	X			X	Agreement close	
Report	Project schedule	Update as monthly progress reporting showing status, variance, constraints, actual versus planned progress.		X	X	X	monthly	
Report	Project status report	Weekly template provided by Owner. Monthly report to include, as a minimum, for that month: • Safety statistics, issues, and events • Summary of events including equipment delivery dates and status		X	X	X	monthly and weekly	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Major activities accomplished during past month and those planned for the coming month • Project schedule update • Milestone payment schedule status • Earned Value Quantities Report (EVQR) • Contract progress S-curves • Contract overall man-hours S-curves • Contract overall staffing histograms • Contract overall craft histograms • Key quantity S-curves • Risks, delays, and quality concerns						
Report	Project workbook	List of Project documentation			X		Prior to Final Completion	
Report	Punch list	Documentation listing and detailing any and all minor non-conformances and proposed rectification not required to be completed prior to Substantial Completion.			X			
Report	Quality assurance package	Complete sets of quality assurance documentation for each of the defined construction milestones referenced in the Specifications (commonly recorded via construction job books).			X			
Report	Reactive Plant Voltage Regulation & Reactive Power Control Design Report	Voltage regulation and reactive power flow control and coordination study to demonstrate the proposed methods of integration and coordination of voltage and reactive power control devices.		X			3 months after Agreement execution	
Report	Risk assessment report	Risk Assessment Analysis		X		X	30 days after Agreement execution	
Report	Risk assessment report	Periodic submission of risk report showing updates and control measures		X			As updated	
Report	Special tools and vehicles	List of all the tools, vehicles or voice communications equipment required for the safe and effective operation and maintenance of the Plant stating whether the Employer is required to purchase this equipment or not.	X			X	Agreement close	
Report	Special tools and vehicles	Update to special tools and vehicles list		X			6 months after Agreement execution	
Report	Storage records	Storage records for any equipment, materials, or other work that was previously produced, manufactured, or constructed, per Section 1.5.11 of Attachment M1-01-02.		X		X	Prior to shipment from original storage location	
Report	Test reports	The results of all inspections, checks and tests carried out, together with any subsequent analysis including documentation of all Acceptance, and Performance Tests (if complete) and applicable certifications. The final commissioning test summary shall be prepared and document the results of all commissioning tests. • Any mutually agreed upon deviations from the Commissioning Test Manual procedures • Instrument calibration sheets and certificates • Test data, including corrected test data • Field notes (weather conditions, observations, etc.) • Test calculations • Any deficiencies or issues identified during, or as a result, of testing • Conclusions • Signatures of Contractor and Commissioning Manager			X	X	Within 5 days after test completion	
Report	Topographic survey, pre-construction	See Appendix M1 Attachment 02 Exhibit 01 – General Civil Requirements		X			2 months after Agreement execution	

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			A	B	C			
Report	Topographic survey, post construction	See Appendix M1 Attachment 02 Exhibit 01 – General Civil Requirements			X			
Report	Transformer field inspections and tests	Upon delivery to the Site, transformer supplier shall perform and record the following: • Check impact recorder • Check blocking • Check transformer trank and fittings • Inspect bushings • Internal inspections - moister, coil supports, etc. • Check all parts have been delivered • Perform field tests and compare to FAT • Check all accessories • Provide all additional field inspections, adjustments, and tests recommended by the transformer manufacturer.			X		Within 5 days of delivery	
Report	Interconnection line civil/structural design report	Foundation and structure design for every pole location, including but not limited to the following: • Design loads • Design calculations including all assumptions • Demonstration of suitability of all structural components in extreme wind conditions and over the design life • Detailed foundation specifications • Concrete and grout mix design proposed • Borehole logs and relevant geotechnical test results • All partial safety factors • Decision trees • Reinforcement specifications and testing		X		X	3 months after Agreement execution	
Report	Interconnection line earthing verification report	Earthing Verification Report, which verifies through measurement of the as-built earthing systems, that the HV Transmission Line will be safe for the lifetime of the Facility. This shall include measurements of step and touch potentials.		X			2 months prior to energization	
Report	Interconnection line other documentation	Including, but not limited to the following: • Electrical design report, including conductor selection (size, current rating, resistance, number of circuits, type, strength, etc.), insulation, loading, clearances, conductor sagging, etc. • Earthing study and earthing design drawings • Specifications for all components, including conductors, insulators, optical ground wire (OPGW) and hardware. • Equipment data sheets for all engineered equipment items to be provided as part of the Facility. Data sheets shall include a concise description of performance rating, materials, and design data. • Calculations to confirm audible noise, radio frequency interference, electric field and magnetic fields satisfy the regulatory requirements and Applicable Standards. • Work method statements, ITPs (inspection and test plans) and commissioning plans for all HV transmission line works, including concrete testing, foundations, pole assembly, pole erection, conductor and OPGW stringing, jointing and terminations • Test Procedures (functional and Acceptance and Reliability test procedures for acceptance.		X		X	3 months after Agreement execution	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Pole schedule • Line schedule • Minimum clearances for maintenance capability • Lists of special tools furnished with the equipment for erection and maintenance to be provided by Owner • Requirements for storage and protection of equipment upon receipt and following installation, but prior to start up;er • Spare parts list (after design) • Earthwork specifications • Concrete specifications • Structural steel specifications • OPGW/Fiber optic cable specifications • Engineered Equipment Specifications • Grounding Calculations and Details • Signage						
Report	Interconnection line stringing test report	Compress sample mid span joints, as well as phase conductor dead/end assemblies for each wire type used on the project			X	X	Prior to stringing commences	
Report	Interconnection line, post construction	Documentation including, but not limited to the following: • Operation and maintenance manuals for all Contractor-supplied equipment; • Sectional drawings showing materials and construction; • QA/QC books • System Turn Over Packages (TOP) • Test Reports			X	X		
Report	Transportation study	A report that details the proposed access roads to be used together with any off-Site road improvement required and conditions of transportation. Off-Site road improvements shall include road cross sections and construction details. Pre-delivery condition survey of the transport route to the Site access point.		X		X	1 month prior to site mobilization	
Report	Transportation study	Condition survey of the transport route to the Site access point post-delivery of all major loads & equipment.			X			
Report	Wind electrical balance of plant power system studies and design calculations reports	Electrical Design Report(s) with detailed calculations indicating method, assumptions and outcomes of design and dimensioning of all elements in the EBoP, having regard to the potential output of the Wind Turbines, the characteristics of the Work, Owner's reliability and availability requirements and prudent industry practices. The Electrical Design Report shall include without limitation: • Load flow study, including voltage levels at all buses, cable rating calculations and loss calculation at zero, partial and full loads, and annualized losses in percentage of annual energy • Fault study showing minimum and maximum fault levels at all buses • Soil Electrical Resistivity Survey results, in sufficient number of locations to allow design of the entire Wind Power Plant earthing system		X			8 months after Agreement execution	

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			A	B	C			
		• Earthing study, based on justifiable assumptions and proving conclusively that the Site shall be safe for the lifetime of the Facility, addressing transferred potentials and step and touch voltages • Protection study and protection settings report, showing compliance with Owner's requirements and other relevant requirements • Harmonics and flicker study • Insulation co-ordination study • Reactive Power and Voltage Control Report						
Report	Wind SCADA Design report	Details of Wind Turbine interfacing, Wind Power Plant and Wind Power Plant HV/MV substation and 33kV equipment with design inputs, design criteria, design outputs comprising: • Systems Architecture Diagram showing all components in block form, specifically identifying redundant elements and interfaces • System platform details including details of software OS & hardware for SCADA platform including details of redundant elements and expected availability • Data map and interfacing details • Identification of all data points, interfacing points, including how the interconnection and interfacings are to be provided as described in this document • Fiber optic architecture		X		X	8 months after Agreement execution	
Report	Wind Turbine noise report	Noise assessment detailing the predicted Wind Power Plant noise at stakeholder and non-stakeholder receiver locations.	X			X	Agreement close	
Report	Wind Turbine site specific statement of compliance	Including the following: • Site specific statement of compliance for the design assessment from a Certification Body which demonstrates that the combined system of Wind Turbine and Wind Turbine towers is designed to withstand the Site conditions for the full Design Life. • All reports associated with the site-specific statement of compliance for the design assessment.		X			Once received	
Report	Wind Turbine site suitability report	Provision of evidence and a statement of site suitability if conditions are outside type certified conditions	X			X	Agreement close	
Specifications	Civil works specifications	Where not covered by the Site Layout, an outline of proposed BoP/BOS Civil Works, including but not limited to: • Overview, specifications • Details of reinforcement • Site testing	X			X	Agreement close	
Specifications	Contractor specifications	Including the following: • Standards as identified by Contractor as being relevant to the Work • Equipment suppliers detailing locations, and where major components of the Work shall be manufactured	X				Agreement close	
Specifications	Electrical control documentation	Vendor data sheets for main electrical components in the Wind Turbines, including generator, main circuit breaker and converter/inverter (if present)		X		X	Duration of Agreement	
Specifications	Grid connection documentation	All required information to assist Owner in its application for Grid Connection.	X	X		X	Duration of Agreement	

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			A	B	C			
Specifications	Grid connection documentation	Including: • Generating System Design Data Sheets • Contractor shall supply a completed performance standard template stating the proposed level of compliance to each access standard in accordance with the TSP's GPS		X			Duration of Agreement	
Specifications	HV/MV transformer specifications	Proposed substation transformer specification which shall include at a minimum the following details: • Transformer layout • Ratings and Design Life • Auxiliary Supply • Radio Interference • Short Circuit Withstand Capacity • Earth Tremors • Insulation Levels • Noise Levels and Vibration • Temperature Rise Limits • Magnetising Current and Flux Density • Transformer Core and Windings • Transformer Losses • Transformer Construction • Transformer Tank • Transformer Oil and Valves • Oil Conservator Tank • Cooling Equipment • Temperature Measuring Equipment • Gas and Oil Actuated Relay • Pressure Relief Devices • Gaskets and Flanges • Marshalling Box • Auxiliary and Control Wiring • Terminations • Bushings • Surge Diverters • Degree of Polymerisation (DP) • Inspection and Testing • Shipping	X			X	Agreement close	
Specifications	Manufacturer storage specifications	Manufacturers' storage and protection requirements/recommendations for all equipment and materials should be provided to Owner prior to delivery		X		X	1 month prior to delivery	
Specifications	Material safety data sheets	As required		X			As received	
Specifications	Other plant equipment as applicable (e.g. transformer, switchgear, cables, DC combiner box, met station)	The following documents shall be submitted by the Contractor. • Datasheet • Track records • Type test certificates to Applicable Standards and test reports • Accelerated test certificates (if available) • Warranty terms	X			X	Agreement close	
Specifications	Permanent on-site buildings	Functional description and preliminary design specifications including:	X			X	Agreement close	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Layout • Elevation drawings • Structural • Architectural • Fire rating • Hold down						
Specifications	Reinforcement specifications and testing specifications	Reinforcement specifications, testing, FATs		X			6 weeks prior to start of relevant work	
Specifications	SCADA and communications network	Functional description and preliminary design specifications including: • Information on the communications system, including specifications and drawings • Information on the SCADA system, including specifications and drawings	X			X	Agreement close	
Specifications	SCADA instrumentation specifications	Copies of calibration sheets for all sensors/transducers as appropriate in accordance with the appropriate calibration standards. Sensors/transducers shall include those mounted on: • Temporary and Permanent Wind Turbine met masts • Switchgear • Monitored equipment • Statcom equipment, and • Power Quality Metering			X			
Specifications	Substation specifications	Functional description and preliminary design specifications including: • Substation general arrangement drawing • Reactive power compensation resources (if applicable) • Reactive power compensation support and voltage control philosophy • Protection philosophy • Primary and secondary system key equipment specifications • HV and MV switchgear, neutral earthing resistors or neutral earthing transformers (if applicable)	X			X	Agreement close	
Specifications	Welding procedure specfications	Document demonstrating welding procedure shall meet all requirements of the AWS D1.1 code		X		X	6 weeks prior to start of relevant work	
Specifications	Wind collection system specifications	Functional description and preliminary design specifications including: • Primary and secondary system key equipment specifications, including step-up Wind Turbine transformer • Optimization of power cable and overhead conductor size	X			X	Agreement close	
Specifications	Wind collection system specifications	Detailed specification and design drawings: • Cable specifications and schedules for all HV, MV, LV, earthing and fiber optic cabling (including MV/HV substation and collector system) • Full technical specifications for all termination kits, jointing kits, lugs and connectors to be used in the primary power circuits of the Wind Power Plant and in the earth network • In-line cable jointing kits		X		X	3 months after Agreement execution	
Specifications	Wind Turbine foundations concrete and grout specifications	Including minimum strength required for any concrete or grout forming part of the wind turbine foundation design		X		X	3 months after Agreement execution	
Specifications	Wind Turbine instrumentation specifications	Specification and calibration certificates where applicable of the following Wind Turbine instruments:		X			1 month prior to start of relevant work	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
		• Nacelle anemometers • Nacelle wind vanes • Thermometers and other temperature measurement devices such as thermostats • Yaw and pitch sensors or transducers • Accelerometers • Main drive train vibration sensors and collection system • Tower sway/vibration sensor and collection system • Other condition monitoring sensors						
Specifications	Wind Turbine specifications	Specification(s) of wind turbines proposed for the Site including (for each proposed turbine type and operating mode): • Technical description and drawings of main components • Description of operational envelope and control system • Failure Modes and Effects Analyses • Maintenance schedule, included routine and major overhaul activity • Operational track record and performance including up-to-date installation figures for the proposed wind turbine model • Warranted power and thrust coefficient curves for the purpose of warranty calculations • Independently certified power curve measurement report • Warranted sound power levels and tonality for the purpose of warranty calculations • Independently certified noise measurement report • Independent Power quality measurement report • Confirm wind turbine meets the requirements of the applicable grid code	X			X	Agreement close	
Specifications	Wind Turbine specifications	Full technical description of all main components		X		X	2 months prior to start of relevant work	
Specifications	Wind Turbine transformer specifications	Functional description and preliminary design specifications including: • Transformer specifications, including MVA rating, nominal voltage rating, tap changer details, insulating medium, vector group, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, fire protection, corrosion protection, load and no-load loss guarantees, manufacturer and standards compliance. • Transformer design drawings, including enclosure, fittings, locations and bund details. • Transformer type test certificate and a fitness for purpose statement (considering environmental conditions, corrosion, cyclic loading, peak voltages and fire risk)	X			X	Agreement close	

Appendix M1

Attachment 01

Exhibit 07

Security and Compliance

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
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1 General

1.1 Specifications

In addition to specifications outlined herein, Contractor shall comply with the requirements provided in M1-05-04 (Communication, SCADA, and Metering Facilities). Additional requirements based on project type (wind, solar, or energy storage) shall comply with the respective requirements in M2-01-01 (Wind Plant Specifications), M3-01-01 (Solar Photovoltaic Plant Specifications), and M4-01-01 (Energy Storage Technical Specifications).

2 SCADA Cyber Security

In this section, the term “SCADA” specifically refers to the plant control system. This is not intended to influence or dictate requirements for the substation or Transmission System Operator.

Contractor shall incorporate all security appliances in the collector substation control house and Owner’s security center into the SCADA system. SCADA system to be compliant with NERC Critical Infrastructure Protection (CIP) and Owner’s internal standards.

In the event Owner is responsible for maintaining the SCADA system and/or performing day-to-day operations at the site, Owner shall have input on which security applications are used to conform with internal requirements. If Owner is not performing any day-to-day maintenance the operator shall have say of specific applications, but the requirements still apply.

2.1 Patch Management

Contractor will include a patch management system capable of deploying patches for all software, hardware, and integrated third-party applications within the SCADA system.

Contractor will evaluate, test, and provide appropriate patches to all devices and software within the SCADA system or any other provided system.

Contractor will install patches on all systems according to industry best practices to reduce operational risk due to cyber incidents. At minimum, patches should be installed on an annual basis.

2.1.1 Anti-Virus & Whitelisting

Contractor will supply an anti-virus and whitelisting system capable of managing all assets within the SCADA system.

Contractor will install whitelisting software on all Windows and Unix-based endpoints within the SCADA system and have a procedure to keep the system in restricted (blocking) mode while the system is operating.

Contractor will install anti-virus software on all Windows-based endpoints and provide ongoing definition updates according to industry best

practices to reduce operational risk due to cyber incidents. At minimum, definitions should be updated on a monthly basis.

Contractor will provide a list of all applications that need to be whitelisted on all provided equipment.

2.1.2 Backup and Restoration

Contractor will provide a backup and management system capable of taking operating system backups of all SCADA equipment for the purposes of rapid restoration in the event of a system failure or cyber incident.

Contractor will install backup and restoration software on all Windows and Unix-based devices within the SCADA system. The system must be configured to take automated backups and Contractor must have a procedure for validating backup validity.

Other devices within the SCADA system and support systems (such as networking devices) must be configured to have their configurations, firmware, and any other applicable configuration files pulled automatically on a scheduled basis.

Backups may be stored locally to the site; however, an offline backup must be maintained for incident recovery. The offline backup must be regularly updated, at minimum once per year.

2.1.3 Security Logging

Contractor will provide a log management system capable of collecting, analyzing, and alerting on logs generated by the SCADA system.

All Windows, Unix, and Syslog-capable devices within the SCADA system must be configured to send logs to the log management system.

Log management system must be continuously monitored by a Security Operations Center (SOC) using industry best practices for log correlation and incident reporting.

Contractor must inform PGE of any event or incident that could detrimentally affect the operations of the SCADA system within 24 hours of when it was detected.

Contractor will provide a log management system capable of collecting, analyzing, and alerting on logs generated by the SCADA system.

2.1.4 Vulnerability Management

SCADA Contractor will provide a mechanism for alerting Owner in the event of a vulnerability or exploit that affects the SCADA system within 10 working days after discovery.

SCADA Contractor will disclose the existence and reasons for any identified backdoor codes.

2.2 System Management

In the event Owner is responsible for maintaining the SCADA system and/or performing day-to-day operations at the site, the following requirements apply. If Owner is not performing any day-to-day maintenance, this section does not apply.

2.2.1 Device Management

Contractor will turn over management of all servers, applications, application and networking devices within the SCADA system or any other provided system to the Owner at the conclusion of the SAT. This will include Domain Administrator privileges.

Contractor must provide validated patches for the system for all provided equipment for operational life of this equipment.

Contractor will provide information on all required communications through the firewalls prior to the factory acceptance test.

Contractor will properly harden all devices including uninstalling unused software components and disabling unnecessary services and ports prior to the site acceptance test.

Contractor will provide documentation detailing all applications, utilities, system services, scripts, configuration files, databases, and all other system requirements during the site acceptance test.

2.2.2 Account Management

Contractor will supply or integrate with an Owner-provided domain controller to manage all authentication within the SCADA system and all support systems.

All default and guest accounts must be removed prior to the factory acceptance test.

Contractor will supply a list of accounts which need to be active on the SCADA system. These accounts must be approved by the Owner.

All accounts within the SCADA systems and support systems will adhere to least privilege permission schemes.

All passwords will adhere to Owner’s password policy.

Contractor will notify Owner within 24 hours of an employee, who has access to the SCADA system or any support system, quits or is terminated with cause.

Contractor will notify Owner within 3 days when an employee, who has access to the SCADA system or any support system, retires or changes position, or otherwise no longer needs access to the system.

No local accounts will be enabled within the generation SCADA system.

Contractor will provide all password change procedures/requirements during the site acceptance test.

2.3 SCADA Network Design

2.3.1 Network Segmentation

The individual SCADA system components must be logically segmented from each other. The following networks shall remain separate where technically feasible:

a. Domain Controllers

b. SCADA Servers

c. User workstations

d. Controllers/PLCs

e. Auxiliary Systems

f. Monitoring systems

g. Terminal/VPN Servers

h. Independent strings/loops of remote devices

Contractor will provide and enforce ACLs and port security address lists for all communications between subnets.

Contractor will provide and document secure network architecture where higher security zones originate communications to less secure zones.

All unencrypted protocols (FTP, telnet, HTTP, etc.) shall be disabled in lieu of their encrypted counterparts (SFTP, SSH, HTTPS, etc.).

2.3.2 Wireless Communications

Wireless technologies such as microwave, cell, Bluetooth, Wi-Fi (802.11x), ZigBee, WirelessHART, or other wireless technologies shall not be used within the SCADA system.

2.3.3 High Availability and Redundancy

All critical systems, to be jointly determined by Owner and Contractor, shall have redundant hardware and software operating in a high-availability mode.

2.3.4 Network Space

In the event Owner is responsible for maintaining the SCADA system and/or performing day-to-day operations at the site, the following requirements apply. If Owner is not performing any day-to-day maintenance, this section does not apply.

Owner will provide Contractor with banks of IPs that can be used for devices within the SCADA system or other support systems.

Contractor will provide Owner with a list of devices with associated IP address prior to the factory acceptance test.

2.3.5 Security Design Workshops

In the event Owner is responsible for maintaining the SCADA system and/or performing day-to-day operations at the site, the following requirements apply. If Owner is not performing any day-to-day maintenance, this section does not apply.

Owner, Contractor, and any pertinent subcontractor (including SCADA Contractor) will have at minimum 5 security design workshops lasting no less than one hour each.

These interactive meetings will allow the Contractor to present the methods used for conforming to the requirements of PGE Cyber Security Policies and Procedures and relevant compliance requirements.

The minimum topics that will be covered in these workshops are:

a. Review of requirements
b. Presentation of hardware and software products to be used.
c. Implementation plan
d. Long term system maintenance, operation, and support requirements
e. Network design and requirements

2.4 Remote Access

All remote access traffic must be fully encrypted.

All remote access where a user interfaces with any part of the SCADA system or support system will require multi-factor authentication.

Under no circumstances will the SCADA system or any support system have direct access to the internet.

All remote access to the control system network must be performed through a VPN.

VPN connections must have logging, alarming, and monitoring to protect SCADA system from unauthorized modification or use.

2.5 Incident Response/Disaster RecoverY

Contractor shall provide existing Incident Response and Disaster Recovery plans for the SCADA network.

Contractor shall work with the Owner to address deficiencies in Contractor's Incident Response and Disaster Recovery plans.

2.6 Site Acceptance Test

Prior to the site acceptance test the Contractor shall:

- Ensure all devices are patched to their most current level.
- Provide current configuration files for all devices.

Firewall rules, as well as all other access control mechanisms, will be enabled throughout the duration of the SAT.
All Firewall rules and router ACLs will be verified at the SAT.
Remote access and remote access restrictions must be tested as part of the SAT.

2.7 Physical Security

Contractor shall provide a lockable or locking enclosure for all control system components.

All physical security networks must be separate from SCADA networks.

3 Generation Physical Security System

3.1 General Design

Contractor shall provide the necessary below grade, and above grade infrastructure for PGE's security system that includes, but is not limited to the following requirements:

A centralized point for the security system and cabling to be housed and secured, either on a concrete foundation and an outdoor rated 4 post communications rack with a heating and cooling system, or adequate wall space of 8' X 8' in an indoor location or an indoor rated 4 post communications rack mounted in a temperature controlled secured room to be provided by Contractor.

All underground conduits provided by the Contractor and will be a minimum of 2" PVC routed from the centralized location to the appropriate point and stubbed up and capped with an 8" X 8" Non-metallic weatherproof enclosure unless otherwise specified.

There will be (1) conduit provided by the Contractor from the centralized area to the closest point on the fence line stubbed up 24" – 30 "for the Fence Detection System. If the Fence line is more than 2,600' in length, another conduit will also be needed and will be identified during design for placement.

There will be (1) conduit provided by the Contractor from the centralized location to wherever the PGE communication equipment is housed to provide a

communications pathway for the security system. If both systems are housed internally inside the same rack or building, it is acceptable to use cable tray if it is available in leu of conduit.

For each gate either personnel or vehicle there will be (1) conduit provided by the Contractor under each gate stubbed up 24”-30” and 12”-20” for both edges of the gate.

For each gate either personnel or vehicle there will be (1) conduit provided by the Contractor for the access control and Intrusion detection systems back to the centralized security location.

There will be enough camera locations within the project’s exterior within the footprint of the fence line to view the entire area without obstruction. This may require the Contractor to install footings and poles. PGE’s preference for these poles is a 16’-20’ non-metallic pole.

All internal locations may have camera coverage depending on type of work location:

a. Substation Control House – 100% coverage
b. Switchgear building – 100% coverage
c. Communications Room – 100% coverage
d. Control system Room – 100% coverage
e. All others to be determined during design process

All building external doors shall have a Contractor provided pathway for a camera that is mounted to the building to cover the entrance of the external door that goes to the centralized security system.

For all buildings there will be a location for at least (1) intrusion detection keypad and (1) access control card reader typically mounted near the main entry point and will require the Contractor to provide the pathway though the building and to the centralized security system location and mounting boxes for the equipment.

For all external doors to any building, the Contractor will provide pathway and mounting boxes for the needed security requirements, which will include at a minimum, but is not limited to door contact, REX, electronic locking mechanism, and card reader.

For all internal building doors, there will be a discussion during design on whether to secure any doors with a security system, the one exception to this is an internal communications room will require access control and this pathway through the building and to the centralized security system, and mounting boxes will be provided by Contractor at a minimum to meet the same requirements as an external door.

All keyways on all doors must be capable of housing an E-Lock core made by Assa-Abloy

All doors with access control must have electrified door lever sets with integrated request to exit devices and power door hinges.

3.2 Site Lighting

Site lighting shall be provided at the following locations:

a. All plant vehicle and pedestrian entrances

b. Entry doorways to all buildings

c. Parking areas

d. Substation or switchyard

Site lighting shall include light fixture, mounting poles, lighting controls, etc., as applicable.

Light fixtures shall be suitable for outdoor locations in wet locations.

Light fixtures shall be light emitting diode (LED) type.

All site lighting equipment shall be UL listed.

Lighting control shall consist of a HAND-OFF-AUTO switch.

Photocells shall be used for automatic control.

Photocells shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness.

Photocells shall be rated at 1800 VA, 120 volts ac.

Photocells shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

Site lighting fixtures shall be installed in accordance with the equipment manufacturer's installation instructions.

Lighting fixtures shall be installed plumb and level and aimed as specified on the drawings, as applicable.

For storage projects, other applicable requirements in M1-05-03 (Substation Design and Construction Specification)

3.3 Security Fencing Perimeter with Gates

8-foot high mini-mesh or expanded metal fencing with 3 barbed wire strands, as specified below or as approved by Owner

a. Fence fabric shall be 1" mesh, #9 gauge wire, Class 2 Zinc-coated steel.

b. End, corner, and pull posts shall be type 1, 2.375 inch nominal outside diameter and be hot dipped galvanized with a minimum average zinc coating of 1.8 oz./ft.2 (0.55 kg/m2) meeting ASTM F-1083 for standard weight (Schedule 40) galvanized pipe.

c. Tension wire shall conform to ASTM A-824 Type I, Aluminum-coated, 0.40 oz/ft2 (122g/m2) or Type II Zinc-coated Class 2, 1.20 oz/ft.2 (366g/m2)

d. Post tops shall consist of ornamental tops or combination tops with barbed wire supporting arms, as required. When so required, or when a top rail is to be provided, the top shall be provided with a hole suitable for the through-passage of the top rail. The post tops shall fit over the out-side of posts and shall exclude moisture from posts.

e. Tension bars shall not be less than 3/16 inch (4.76mm) by 3/4 inch (19.05mm) and not less than 2 inches (50mm) shorter than the normal height of the fabric with which they are to be used. One tension bar shall be provided for each end and gate post, and two for each comer and pull post.

f. Ties or clips of adequate strength shall be provided in sufficient number for attaching the fabric to all line posts at intervals not exceeding 15 inches (380mm); and not exceeding 24 inches (610mm) when attaching fabric to top rail or tension wire.

Powered, keycard-controlled sliding or swinging gate

a. One for access to O&M building entrance/parking area

b. One for access to storage/laydown area

c. Both of widths large enough to provide easy ingress to the facility for a full-size tractor trailer combo

4 Substation Physical Security

The Project Substation shall meet the same physical security requirements as the rest of the site and as noted in this specification.

The Project Substation shall have access detection, control, and monitoring provisions to ensure that Owner is able to capture, record and monitor all personnel, authorized or unauthorized that enter the site area and must be compatible with Owner's existing security system. Contractor shall coordinate the preferred access control methodology with Owner along with additional provisions such as video monitoring and motion detection.

5 NERC and WECC Compliance

Contractor shall proactively consider NERC and WECC Compliance in the Project. New facilities connecting to the Bulk Electrical System (BES) require significant coordination with affected entities and specific planning and timely milestones will be required. The contractor will establish a schedule to ensure adherence to any standard issued by the North American Electric Reliability Corporation (NERC) or the Western Electric Coordinating Council (WECC) allowing for or applicable to the commissioning and operation of the Project.

Below are the current standards the contractor is expected to comply with:

1. **BAL-005-0.2b R1.1:** Generation facilities must be included within the metered boundaries of a Balancing Authority.

2. **BAL-005-0.2b R12:** Tie Line metering requirements
3. **CIP-002 R1:** Generator Owner will determine BES impact for generation resources.
4. **CIP-003 R2:** Generator Owner will implement controls to ensure low impact rating is met for all applicable CIP requirements.
5. **EOP-005-2 R4:** System Restoration Plan must be submitted to Peak for approval before any planned BES modification that would change the implementation.
6. **FAC-008-3 Facility Ratings:** Contractor to provide facility rating documentation of installed components.
7. **IRO-010/TOP-003:** There are a number of data specifications requiring modeling information to be submitted to Peak and others 30 days before the change to the network.
8. **MOD-001-2 R2:** ATCID methodology must take into account generation and transmission additions.
9. **MOD-025-2 R1 and R2:** real and reactive power capability verification
10. **MOD-026-1 R2 and R4:** generator excitation control system or plant volt/var control function model verification
11. **MOD-027-1 R2 and R4:** turbine/governor and load control or active power/frequency control model verification
12. **PRC-001-1.1 R5:** GOP must notify TOP in advance of changes in generation that could require changes to Protection Systems, and TOP must notify other TOPs of the same.
13. **PRC-005 R1, R2, R3, R4, and R5:** Generator Owner must perform, and document battery maintenance is a timely manner.
14. **PRC-019-2 R2:** verify coordination of voltage regulating system controls, (including in-service limiters and protection functions) with the applicable equipment capabilities and settings of the applicable Protection System
15. **PRC-024-2 R1 and ER2:** verify generator frequency and voltage protective relaying does not trip the applicable generating unit(s) within the “no trip zone” of PRC-024 Attachment 1 and Attachment 2
16. **PRC-025-2 R1:** verify generator relay settings are in accordance with PRC-025-1 – Attachment 1
17. **VAR-001-4.1 E.A. 15 and E.A. 17:** verify that generating equipment uses voltage set point, and complies with external voltage control loop specification established by these requirements
18. **VAR-002-4 (all):** comply with operation and notification requirements during testing and upon initial commercial operation

19. **VAR-002-WECC-2 R1:** have AVR in service and in automatic voltage control upon initial commercial operation
20. **VAR-501-WECC-3**: (all): comply with settings. Testing and operational requirements established by this Standard

The standards listed are subject to change and the contractor will need to communicate specific planning and timely milestones to Owner to ensure all regulatory compliance obligations are met.

Appendix M1

Attachment 01

Exhibit 09

PGE CAD and Numbering Standards

[Content to be provided at time of contracting]

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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Appendix M1

Attachment 04

Exhibit 02

General Transformer Specification

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

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1 Scope of Work

1.1 Description

This specification covers the general design, construction, and operating requirements for oil-immersed outdoor station type power transformers including solar/wind substation Generator Step Up (GSU) transformers.

Manufacturer shall provide Owner with a manufacturing schedule that includes an anticipated beginning date, end date, and duration in terms of calendar days for the following deliverables:

- Purchase of materials
- Drawings including submittal and approval processes
- Production including core, coil, tank, and connection assembly
- Final assembly including the vapor phase process, a pretanking inspection
- Factory acceptance testing
- Shipment and delivery to the substation site/storage

1.2 Design Requirements

Transformer cooling shall be ONAN/ONAF/ONAF at 55 degrees C rise on a 50 C ambient.

The transformer specified herein shall be designed, manufactured, and tested in accordance with all applicable regulations, codes, IEEE including IEEE C57.12.00 and IEEE C57.12.90, and NEMA standards, except as otherwise required by this specification.

The transformer shall be designed to comply with all elevation requirements, including corrective calculations which consider elevation in IEEE C57.12.90.

The transformer shall be designed to have impedance ratings as defined in the transformer supply agreement and corresponding data sheets. Transformer impedance ratings will comply with the ANSI standard tolerance of +/- 7.5% of guaranteed impedance ratings.

Transformer high-voltage to low-voltage winding angular displacement shall be zero degrees.

Noise level shall comply with NEMA standards and shall not exceed requirements as set forth in ANSI C57.12.00 when energized at rated voltage, rated frequency, and when carrying no load.

The manufacturer’s proposal shall list any additional standards, and codes the manufacturer intends to invoke in the performance of the requirements of this specification.

Control wiring and alarms shall be in accordance with PGE Design Masters (see drawings that will be provided as an Addendum or upon request). Current versions of Design Masters shall be requested by the manufacturer prior to starting design of transformer.

1.3 Inspection

Manufacturer shall give Contractor/Owner two months advance notice of the following hold points so that a Contractor/Owner representative may be present.

Design Review

Core and coil nesting

Pre-tanking

Factory acceptance testing

Design review drawings shall be submitted for approval, 3 weeks prior to the design review meeting or as otherwise noted. The design review submittal shall include, but is not limited to the following:

1. General Outline Drawings
2. Component Outline Drawings (including bushing and surge arresters)
3. Transformer Nameplate Drawings
4. Current Transformer Magnetization and Correction Ratio Curves
5. Current Transformer Connection Drawings
6. Control Schematic and Wiring Diagrams
    a. Wiring diagrams shall show all external connections to be made by Contractor
    b. Wiring diagrams shall show all internal wiring connections made by the manufacturer
    c. Wiring diagrams shall be “point to point” wiring
    d. Drawing shall show operating voltage and current ratings of fuses and circuit breakers
7. Control Cabinet Arrangement and Connection Drawings
8. Detailed Test Plan listing all tests in sequence
9. List of all transformer parts to be shipped including spare parts
10. Short-circuit test data as described in the section 4.4(A) of this specification

1.4 Shipping

All bushings, surge arresters, and radiators shall be removed from the transformer prior to shipment. The openings left in the transformer tank from their removal shall be covered with metal plates for shipment. Transformer shipping should follow IEEE C57.150 (Transformer Transportation).

If the transformer tank is to be shipped filled with oil, it shall be covered with a nitrogen gas blanket.

Positive pressure of nitrogen gas shall be maintained between 1 psi to 5 psi at all times during shipment.

If the transformer tank is to be shipped without oil, the tank shall be filled with dry air.

Positive pressure of dry air shall be maintained between 1 psi to 5 psi at all times during shipment.

Manufacturer shall provide dew point at time of shipment.

Bushings shall be marked with the corresponding winding that they were used for during testing.

Rail, ship, or truck shipping methods are acceptable. Transformer Center of Gravity (COG) should be clearly indicated using appropriate symbols. At least two functional impact recorders and GPS locator shall be installed on transformer. Rail car shall be equipped with end-of-car hydraulic cushioning devices, GPS locator and impact detector. If shipped by rail, “Do Not Hump” signage shall be attached to rail car.

1.5 Storage

Storage during/after shipping, and before installation shall be in accordance with IEEE C57.150, manufacturer’s written requirements/recommendations, and with manufacturers approval of conditions and maintenance, including confirmation of no impact to warranty. Storage measures will include oil fill and dry nitrogen blanket (for long storage durations – nitrogen pressure to be between 1 psi to 5 psi), power to control panel heater, and periodic inspection and gauge readings, all in accordance with manufacturer requirements and approval. Unassembled components shall be stored in accordance with manufacturer requirements/recommendations, in original shipping containers, and protected from weather.

1.6 Reference Standards

This equipment shall be built and tested in accordance with the applicable standards and its supplements listed in M2-01-01 (Wind Plant Specifications) (the “Wind Spec”), M3-01-01 (Solar Photovoltaic Plant Specifications) (the “Solar Spec”), and M4-01-01 (Energy Storage Technical Specifications) (the “BESS Spec”), as applicable.

2 Materials

2.1 General

Materials and components shall be new, undamaged and shall conform to pertinent NEMA and IEEE standard specifications and the following requirements.

All components and parts shall be readily available in the United States. All components shall be readily identifiable by manufacturer's name and part number.

Metric sizes are not acceptable.

2.2 Core and Windings

Contractor shall specify the winding ratings for each terminal designation, including the voltage rating, continuous current rating, BIL rating, and catalog number. BIL ratings shall be determined as per IEEE C57.12.00.

Except for pad-mount transformers, all windings shall be copper. Aluminum windings may be used pad-mount transformers only.

All windings shall be insulated with thermally upgraded paper and verified with long-duration test per IEEE C57.100.

Where applicable Netting Continuously Transposed Cable (CTC), Epoxy Bonded, is preferred.

All windings, except tertiary winding, shall have a through-circuit capacity MVA rating at a 60°C rise, of the max MVA rating of the transformer.

The average winding temperature rise shall not exceed 60°C above ambient (a maximum 30°C average 24-hour ambient, and a 45°C maximum ambient).

The maximum hottest-spot winding temperature rise shall not exceed 80°C rise over ambient (110°C continuous with 30°C ambient, 120°C short-term emergency rating with 40°C ambient).

The hottest-spot of the interior of the core should never exceed 85°C rise over ambient (125°C at 45°C ambient) to avoid gassing, and the core surface temperature must not exceed the thermal capability of the insulation or parts touching the core.

Tertiary windings (if required) shall be a delta connected stabilizing winding, and be self-protecting for short circuits at all bushing terminals. Refer to the detailed specification to determine if tertiary should be buried or brought out. Tertiary windings shall have a kVA capacity of no less than 35% of the transformer’s ONAN rating.

1. Tertiary windings that are brought out may be used for station service.
2. Assume no system impedance for short circuit calculations.

3. Tertiary windings that are buried shall be designed with provisions to have the tertiary be brought out only for factory testing.
4. Tertiary winds that are buried shall have one corner of the delta brought out with two leads, from adjacent legs. These leads shall be bonded and grounded externally.

The transformer shall be designed with impedances sufficient to make the transformer self-protecting. Manufacturer shall assume that the transformer will be operated from an infinite bus.

Nuts, bolts, and clamps of the core assembly shall be provided with positive locking devices to prevent loosening caused by vibration or change of shape or position during transportation or operation. The complete core and winding assembly shall be removable from the tank for repairs.

Nomex insulation shall be used between the core and clamping structure.

For GSU's only: fiber optic temperature probes shall be installed, and provisions shall be made for monitoring system as noted below.

1. Monitoring system and sensors shall be LumaSense Technologies QualiTROL 408-12 or Owner approved equivalent.
2. Location of sensors - Fiber optic probes shall be located at the hottest winding spots as determined by manufacturer's calculations.
3. Number of sensors - Install two in each winding (for example in case of three-phase three-winding (primary, secondary, and tertiary) GSU, each winding shall have six sensors)
4. All fiber optic temperature probes shall be connected through a tank penetration box with tank wall feed-through with proper identification. (Phase, winding, Probe 1 or 2, etc.…).
5. The fiber optic tank penetration box shall be mounted on upper tank wall.

2.3 Bushings

Contractor shall specify the bushing ratings for each terminal designation, including the voltage rating, continuous current rating, BIL rating, and catalog number. BIL ratings shall be determined from the insulation coordination study as specified in the Wind Spec, the Solar Spec, the BESS Spec, or M1-04-01 (General Electrical Study Requirements) as applicable and shall meet applicable requirements in the following standards: IEEE C57.12.00, ANSI C57.19.01, ANSI 21, ANSI 24, and ANSI C57.12.10.

Acceptable manufacturers for the bushings are provided in the Wind Spec, the Solar Spec, and the BESS Spec, as applicable.

All bushings shall be bolted on.

The bushing color shall be ANSI 70 (light gray).

Bushings shall be resin impregnated synthetic (RIS) condenser capacitive graded type and shall contain no oil.

RIS bushings shall be supplied with an air-side insulator with HTV silicone rubber adhered directly to the RIS condenser body having low stress teardrop tip and no visible parting lines.

If bushings are mounted at an angle other than vertical, the angle shall not exceed 30 degrees. The bushings shall be mounted so as to provide maximum clearance to the isolated phase bus enclosure, if applicable.

All standard routine tests as prescribed by ANSI/IEEE C57.19.00 shall be performed on every bushing at levels and requirements equal to or better than specified in ANSI/IEEE C57.19.01 for oil impregnated paper bushings.

HV bushing top terminal shall conform to the requirements of IEEE Standard C57.19.01.

Bushings 35 kV and lower shall have the 200 kV BIL rating as defined in IEEE Standard C57.19.01.

Bushings shall have 20% current margin over transformer winding rating at full load with maximum cooling.

Bushings to be attached to bus duct shall be rated to 125°C hot spot temperature with no additional loss of life.

The manufacturer shall not provide bushing terminal connectors.

Bushings with bolted bottom connections shall have spade connectors with NEMA hole spacing, through bolts, and nuts. Bolted connections shall have a minimum of 4 bolts per connection.

The neutral bushing shall be identical to low voltage line bushings if voltage ratings are the same.

The neutral bushing shall be connected to a ground pad near the base of the transformer using a continuous conductor of not less than 250-kcmil flexible copper cable or equivalent flat copper bar.

Bushing monitors may be included as a line-item option.

2.4 Surge Arresters

Manufacturer shall supply metal-oxide type surge arresters for all high-voltage bushings, low-voltage bushings, and for the high-voltage and low-voltage neutrals.

Contractor shall specify the surge arrester ratings, including the duty cycle rating (station class), MCOV rating, manufacturer, type, and catalog number for each terminal designation.

A ground loop shall be furnished, of not less than 250-kcmil flexible copper cable, which is connected from one ground pad on one side of the transformer through the three low voltage arrester ground terminals to another ground pad on the opposite side of the transformer. Also, similar separate ground loops shall be provided for the high voltage and tertiary surge arresters.

Arresters shall be mounted so that the spacing between the energized end of the arrestor and the top of the in-phase bushing is no less than half the minimum recommended phase to ground clearance for the selected arrestor. Furthermore, the spacing between the grounded end of the arrester and bottom of the in-phase bushing shall be no less the minimum recommended phase to ground clearance for the selected arrester.

2.5 Instrument Transformers

A list of approved instrument transformer vendors is provided in the Wind Spec, the Solar Spec, and the BESS Spec, as applicable.

All instrument transformers shall be C800 relay accuracy per IEEE Std. C57.13.

All instrument transformers shall have a thermal rating factor (T.R.F.) of 2.0.

All current transformer leads internal to the tank shall use ETFE insulated wire with a minimum temperature rating of 150ºC. All current transformer leads shall run the full length from the current transformer to the CT tank wall penetration box without any splices.

All taps from all current transformer secondary windings shall be connected to short-circuiting type terminal blocks located in the control cabinet.

Bushing current transformer wiring shall be a minimum of stranded No. 12 AWG, copper, terminating on ring-type terminals.

2.6 Control Cabinet

The main control cabinet shall house cooling equipment controls, electronic transformer monitor, relays, meters, test switches, indicating lights, manual control equipment, and terminal blocks.

Main control cabinet and any auxiliary control cabinets shall be a non-condensing, weatherproof, metal enclosure mounted on transformer.

The middle of the cabinet(s) shall be approximately 5 feet vertically from transformer base for easy access.

Cabinet shall be no smaller than 6 feet wide and 5 feet tall.

Cabinet shall have a minimum of two doors which shall each have:

1. A handle connected to a three-point latch to provide ease of opening and closing.

2. Door stops to hold door in "open" position. Door stops shall not interfere with opening the relay and control panel.
3. Provisions for padlocking in the “closed” position.
4. A small, clear, tempered glass window with a UV-proof coating and an aluminum hinged cover that can be lifted for viewing the transformer monitor display. Alternatively, the transformer monitor may be mounted on a swing-panel inside the control cabinet.

Cabinets shall be ventilated to avoid temperature extremes that may damage any of the contents.

Conduit entrance plate shall be removable from inside the cabinet.

Cabinets & Panels shall be configured to provide easy access to all components and their wiring during installation, testing, and maintenance.

Mounting devices on the cabinet ceiling and bottom is not acceptable.

If panel mounted equipment is used, the panels shall be hinged to swing-out for convenient access to all wiring.

Provide pockets to hold drawings and instruction books inside the control cabinet doors.

2.7 Electrical Items

Control cabinet design shall follow requirements of IEEE C57.148 and the following:

1. Interior illumination with on-off switch activated by cabinet door shall be installed on the ceiling of the control cabinet. The interior lighting shall illuminate the front of the swing panel in addition to the rest of the cabinet. A minimum of two cabinet lights with 800 lumens or more shall be installed.
2. As a minimum, a 200 watt positive temperature coefficient heater, with fan, for 120-volt AC operation shall be installed. The manufacturer shall determine if more than one 200 watt heater is required.
3. One exterior-rated 120-volt AC duplex, 20-amp, three-wire grounding-type GFI receptacle shall be installed on the exterior of the control cabinet.
4. Two interior 120-volt AC duplex, 20-amp, three-wire grounding-type GFI receptacle shall be installed inside the control cabinet.

Control cabinet instrument transformers shall follow requirements of IEEE C57.13.

Multi-breaker overload protection shall be provided for items 1, 2, 3 & 4 above.

Separate breaker overload protection shall be provided for each monitoring device: the transformer monitor, dissolved gas & moisture monitor, and bushing monitor.

Manufacturer shall supply a spare one-pole 120-volt, 20-amp breaker for use by Contractor and PGE.

All Contractor external connections for power sources, relays, alarm, and trip circuits shall be wired to terminal blocks and clearly labeled.

Manufacturer shall provide 20% spare open/unused terminal blocks for Contractor's and PGE's future use.

Any spare or unused contacts of any device used shall be connected to terminal blocks for Contractor's and PGE's future use.

Indicating lights shall have LED type displays with appropriately sized resistors in series for 125-volt DC operation. Lights shall be compatible with ET-16 lamps.

All DC circuits shall operate from an ungrounded 125V DC source. All DC equipment, including relays and alarm controls, shall be suitable for continuous operation over a range of 102-140 volt for 125V DC source.

Any device capable of producing a surge voltage in control or alarm circuits shall be furnished with surge suppressors to limit the surge voltage. Properly rated MOVs are to be applied on the AC coils. Properly rated diodes are to be applied on the DC coils.

All equipment rated 600 volts and less shall have a dielectric withstand capability of a minimum of 2500 volts, as described in IEEE Standard C37.90. Should such voltage level exceed the capability of the equipment, means shall be provided as a part of the device to protect the device against damage by voltage in excess of its withstand capability.

All lugs used for any internal compartment wiring will be of the non-insulated ring type. The indent mark from the indent tool must be clearly visible.

All control terminations made to be modular compression terminal blocks or device terminals shall be made using bare tin-plated copper ferrules. The indent mark from the compression tool shall be clearly visible.

All wiring shall be stranded, No. 14 AWG, or larger, unless otherwise specified.

All PLC and transformer monitor input (analog and discrete) wiring shall be stranded, No. 18 AWG.

Device grounds and neutrals shall be directly connected to neutral and ground buses and shall not be daisy-chained through other devices between taps.

All operating controls and indicators accessed by operating personnel in the normal operation and testing of equipment shall be located such that personnel are not unnecessarily exposed to live parts.

All circuits to the control cabinet shall be routed through flexible seal tight conduit. Conduit penetrations into control cabinet shall be conduit hubs for sealing. (Lock nuts

with RTV are not acceptable.) Conduit penetrations shall only be made in the side wall of the cabinet.

2.8 De-energized Tap-changing Equipment (DETC)

The DETC shall not limit the loading of the transformer and shall be capable of a loading that is 150% of the maximum current rating.
DETC shall be furnished to provide plus and minus 5 percent adjustment of the high-voltage winding voltage in 2 ½ percent steps with 2 steps above and 2 steps below rated high voltage.
DETC shall have an external operating mechanism with provisions for pad-locking in each position. The mechanism shall be easily accessible to personnel standing on the transformer foundation.
The tap position indicator shall use the letters A, B, C, D, and E, where “A” is the setting with the highest voltage magnitude, “C” is the center tap, and “E” is the setting with the lowest voltage magnitude.

2.9 Energized Tap Changer (OLTC)

When specified by the transformer supply agreement or by data sheet, a load tap changer shall be provided per the requirements of this section.

1. Design in accordance with ANSI C57.12.10 and project-specific transformer data sheets.
2. Load tap changing equipment shall be housed in a separate compartment mounted on the main transformer tank designed to prevent any interchange of oil between the compartment and the tank.
3. Equipment for the manual control of the tap changing equipment shall be furnished in a weatherproof compartment mounted adjacent to the tap changing equipment compartment in a location to allow access and operation from the ground.
4. The tap changer shall have full rated kVA on taps up to 110% of the rated voltage and a current rating corresponding to the full load current at rated voltage on taps below rated voltage.
5. When specified to be designed for parallel operation, all equipment required for control of the load tap changer using the circulating current method of control shall be provided. This equipment shall include a selector switch for selecting parallel or individual operation, all required paralleling reactors and current transformers, and an overcurrent relay with two circuit closing contacts for remote alarms.
6. The OLTC shall be designed for 500,000 electrical and mechanical operations before vacuum bottle or contact replacement is necessary to maintain normal operation.

7. The tap changer shall be completely wired and shall include the following features:
    a. Voltage testing terminals
    b. All required current transformers.
    c. "Remote-Local" control switch.
    d. "Raise-Lower" control switch for local control.
    e. Provisions to operate tap changer by hand. Interlock shall be provided to prevent operation by electrical controls when hand operation is being performed
    f. Limit switches and stops for full raise and full lower positions and for preventing over travel.
    g. Adjustable time delay to provide sufficient delay in the first step of a raise or lower tap change.
    h. Operations counter.
    i. Space heater, lamp, and GFI-protected convenience receptacle in control cabinet.
    j. Tap position indicator mounted on the tap changer compartment.
    k. Tap position transducer with 4-20 mA output proportional to tap position.
    l. Tap position transmitter shall be compatible with remote tap position indicator provided by transformer vendor.
    m. Any additional equipment required for manual operation from either the transformer or a remote location.

2.10 Auxiliary Power Source

Contractor will provide the following power sources:

1. Two (2) 480 volt AC, three phase, 60 hertz, three-wire grounded sources
2. 125 volt DC, ungrounded two-wire source.
3. The manufacturer shall provide main Multi breaker disconnecting devices for the power sources described above.

Manufacturer shall supply automatic transfer equipment to transfer to an alternate source upon loss of the normal source. An alarm contact shall be provided to indicate a transfer to the alternate source.

2.11 Oil and Oil Preservation System

The transformer oil shall be provided by the transformer manufacturer.

If the transformer is to be supplied with oil, the oil shall be new Type II inhibited transformer mineral oil that meets ASTM D3487.

Oil used in testing or supplied with transformer or furnished in components, such as bushings, shall contain less than 1-ppm of PCB.

All oil used or furnished with the transformer and used during factory acceptance testing shall meet ASTM Standard D1275 Modified (b), Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils.

A conservator tank oil preservation system shall be used. The transformer shall include the following:

1. Oil expansion tank (OET) of the conservator system shall be capable of withstanding full vacuum.
2. There shall be no air contact with oil in the OET. This shall be accomplished by a nitrile air cell (diaphragm not allowed) vented to the outside air through a dehydrating breather. The breather shall be installed at eye level to allow for access without a ladder. Acceptable dehydrating breather manufacturers shall be Messko MTraB. The use of other manufacturers is subject to Owner approval.
3. Air cell shall be designed for flange installation; clamps not allowed.
4. A sealed entry into the air cell shall be provided to permit calibration of the oil level gauge.
5. Each end of the OET shall have sealed entry ports to adjust the bladder.
6. OET shall be of sufficient volume to operate through an ambient temperature range of minus 29°C to plus 43°C without causing a low-oil-level alarm or exceeding recommended full-oil level upper limit.
7. Two SHUT-OFF VALVES shall be provided in the oil line between OET and main tank. One at the entry point to the OET capable of holding full head of oil in OET, one at entry to main tank that will hold under full vacuum on the main tank.
8. Piping shall be provided between the oil and air space of the OET to equalize the pressure on both sides of the air cell during vacuum oil filling. A vacuum-proof valve shall be installed at the highest practical point on the oil expansion tank (OET) to isolate the two areas after the operation is completed.

2.12 Gasketed Joints

Nitrile (BUNA-N) elastomer gaskets shall be used to make pressure tight joints on the oil filled transformer. Gaskets made of cork-only or neoprene-only are not acceptable.

Gaskets that are not continuous shall be “vulcanized joint nitrile gaskets” and not have a butt or scarf joint.

O-ring gaskets are preferred for bushing flanges and manhole covers.

Flanges shall be provided with mechanical stops or grooves to prevent over compression of gasket when tightened.

Joints shall be designed so that gasket material will not be exposed to the weather.

2.13 Tank

The manufacturer shall provide the following on the transformer tank:

1. The transformer shall be single-tank.
2. At least two manhole covers for transformer inspection; they shall be 24 inches or larger in diameter and shall be bolted. Additional access manholes may be requested for larger transformers.
3. Radiator valves at inlets and outlets of tank to permit removal of radiators without draining oil from tank.
    a. Radiators shall have at least one lifting eye, a vent plug in the top header, and a drain plug in the bottom header.
    b. No gasketed joints are allowed between the valves and the tank.
    c. Valves shall provide minimum restriction of oil flow.
    d. Valves shall be lockable butterfly type valves. Flapper type valves are not allowed.
    e. Paint shall not interfere with the operation of valves.
4. Two-inch lower oil-drain globe-type valve with oil sampling device provided on discharge side of valve. Valve shall allow essentially full drainage.
5. Two-inch upper oil-fill globe-type valve connection.
6. An external 1-in, pipe shall be provided between the tap changer compartment and the main tank located not more than 3 in. below the top of each compartment. A 1-in, ball valve shall be installed for manifolding between the two tanks.
7. Core ground leads shall be brought out of the main transformer tank wall through an insulated, porcelain bushing, and connected to a separate grounding pad at an external location.

a. Grounding pad shall be identified and located within 6 feet of the transformer base.

b. A protective cover shall be provided for the core ground bushing.

8. Five grounding pads with tapped holes (NEMA 2-hole Standard); one on each corner of the transformer base, and one for the core-ground leads detachable connector.

9. If tank ribs are used for expansion space, permanent labels, noted in 3.3 (B.3) shall be attached to each rib that it is pressurized. Tank weld seams inside pressurized ribs shall be avoided. Drain plugs shall be provided for pressurized ribs.

10. Tank weld seams that are behind tank ribs shall have an inspection plug installed to verify weld integrity.

11. The entire interior of the transformer tank shall be primed white with a primer that will not affect the electrical characteristics of the oil.

12. Provide one-inch valve approximately one foot above oil drain valve for connection of an air supplier during maintenance. Valve shall be plugged with a removable plug.

13. Gas sampling valve to vent gasses from transformer tank or gas accumulation relay.

14. Seven dry thermometer wells shall be installed in the main tank for specified or future thermal devices, to be used as follows:

a. Dial-type Top Oil Thermometer.

b. Top Oil Temperature (for transformer monitor)

c. Top Oil Spare.

d. Top Oil by Radiator Header Pipe (spare)

e. Bottom Oil by Radiator Header Pipe (for transformer monitor).

f. Dial-type Winding Temperature Thermometer

15. Spare thermometer wells shall contain a removable metal plug incapable of corrosion (brass, stainless steel, etc.).

16. The high voltage bushing H2 shall be on the same centerline as the low voltage bushing X2 (not necessarily on the tank centerline).

17. Low voltage and tertiary bushings that are external to the tank shall be spaced no less than 30 inches center-to-center.

2.14 Cooling Equipment

2.14.1 Fan Motors

1. A list of approved fan manufacturers is provided in the Wind Spec, the Solar Spec, and the BESS Spec, as applicable.
2. Cooling fans shall be rated 60 Hz and 115/230Vac (for single-phase) or 208-230/460Vac (for three-phase).
3. Motors shall be suitable for operation in wind-driven rain. Motor bearings shall be ball-bearing, self-lubricating, sealed-type, designed for continuous as well as intermittent duty.
4. Motors shall be fitted with flexible cable terminating on self-locking, weatherproof connectors.
5. Manufacturer shall provide disconnecting devices, control switches, control relays, starting equipment with undervoltage protection, and separate overload protection for each fan motor.
6. Manufacturer shall provide Elapsed Time Meters capable of counting 99,999 hours, non-reset, to record each fan group's running time to the nearest hour.

2.14.2 Radiators

1. Heat exchangers are not to be substituted for radiators, unless otherwise specified.
2. Radiator materials shall have melting points in excess of 1000°C. Materials used for welding or brazing the radiators shall also have melting points in excess of 1000°C.

2.14.3 Fan Blades

1. Fan blades shall be made of corrosion-resistant metal.
2. Fans shall have OSHA-approved safety guards.

2.14.4 Cooling Equipment Control

1. The temperature monitoring equipment described in 2.15 (D) shall be utilized to control cooling.
2. A three-position "ON-OFF-AUTO" SWITCH shall be provided for automatic and manual control of cooling equipment.
3. A toggle switch shall be provided in the control cabinet to provide manual switching between Stage 1 and Stage 2, regardless of APT programming.

2.15 Accessories

Accessory devices are to be insulated from ground for use with 125 DC source. Exception: Online dissolved gas & moisture monitor shall be powered by 120 volts AC.

All devices in the control cabinet shall be provided with a stainless steel nameplate indicating their function. This nameplate shall include all impedance ratings at rated voltage, no-load and load losses, current transformer ratings and locations, maximum operating pressures, tank vacuum filling pressure, oil level as measured below the manhole flange, and current ratings at all load tap changer or de-energized tap changer taps.

Alarm and trip circuits shall operate at 125 volts DC.

2.15.1 Transformer Monitoring

A transformer monitor shall be provided. Acceptable transformer monitoring systems manufacturer is APT Eclipse Monitor.

The transformer monitor shall be mounted on the swing panel in the main control cabinet and shall be visible through a viewing window on the door.

2.16 Monitored Signals

1. Discrete Signals - Refer to the attached transformer control schematic for alarms/annunciation required.
2. Analog Signals – The following analog signals shall be wired to the monitor.
   a. LV Winding Currents (X1, X2, and X3)
   b. Cooling Motor Current (Stage 1 and Stage 2)
3. RTD Temperature Signals and Sensors – The following RTD sensors shall be wired to the monitor.
   a. Top Oil
   b. Bottom Oil by Radiator Header

2.17 Cooling Control

1. Manual Control - The monitor will have the provisions to force individual banks of cooling to turn on under manual control. The transformer monitor will continue to monitor the cooling motor current against the expected current levels.
2. Automatic Control – The monitor shall have provisions to automatically control cooling.
   a. Separate set points for all stages of cooling will be provided for calculated winding temperature and measured top oil temperature.

b. Fan stage alternating will be programmable to allow for Stages 1 and 2 to be alternated on a daily basis, equalizing fan cycling.

c. A period of daily fan cycling will be programmable to exercise fan motors during periods of inactivity.

2.18 Sensors

1. Resistive Temperature Detectors (RTD's)
   a. RTD's shall be installed in dry wells
   b. RTD's shall have insulation rated to at least 200°C.
   c. RTD's of length greater than 10cm shall be 3-4 wires compensating for lead resistance.
   d. Maximum allowed error shall be +/- 1°C.
   e. Each RTD cable shall be at least 3 feet (91.4 cm) longer than necessary. Excess cable shall be coiled and shall be located within one foot (30.5 cm) of the RTD to facilitate RTD testing.
   f. The signal cable shield shall be grounded at the transformer monitor case.

2.19 AC Current Transducers/Signal Conditioners

1. Current transducers or signal conditioners shall be non-intrusive and shall not require disconnecting sensed current signal for removal or installation.
2. The signal cable shield shall be grounded at the transformer monitor case.

2.20 Construction

1. The manufacturer shall ensure the monitor is programmed prior to and functional during factory testing.
2. The manufacturer shall program the monitor with a current PGE settings file obtained from the monitor manufacturer. Settings shall be reviewed by PGE before programming.
   a. On-line Dissolved Gas and Moisture Monitor
   b. An on-line dissolved gas & moisture monitor shall be provided. Acceptable on-line dissolved gas & moisture monitor manufacturer and model shall be Qualitrol Serveron TM8-F or Owner approved equivalent.
   c. Monitors that require oil circulation shall be plumbed to main tank valves (described below) with flexible stainless steel tubing. Installation of tubing and monitor shall be performed in field by Qualitrol Serveron.
   d. Two stainless steel ball-type valves, full-port, shall be installed for the monitor on the transformer main tank. The first shall be located near the top of the tank, 12 inches below the lowest expected oil level, in an area with oil

circulation, and shall be plumbed as the monitor's oil input from the main tank. The second shall be located at least 18 inches above the level of the drain valve and at least 48 inches away from the first valve, and it shall be plumbed as the oil return line from the monitor to the transformer. Valve size shall be 1/2" with female NPT outlet.

e. The monitor shall be provided with a dust cover over the monitor's manual oil sampling port.

f. Commissioning of monitor shall be performed in field by Qualitrol Serveron.

g. Magnetic Liquid-level Indicators

h. Acceptable liquid level gauge manufacturer shall be Messko.

3. One Main Tank Liquid-Level Indicator shall be located on the main tank wall and consist of the following:

   a. An alarm contact for low oil level.

   b. A trip contact that engages at an oil level at least 1.50 inches below the alarm level but at a level that will not cause damage to the transformer.

   c. No contacts are required for transformers with conservators. This gauge will be used for local oil level indication only.

   d. One Conservator Tank Liquid-Level Indicator shall be located on the conservator tank wall and consist of the following:

   e. An alarm contact for low oil level.

   f. A trip contact that engages at an oil level at least 1.50 inches below the alarm level but at a level that will not cause damage to the transformer.

4. The alarm and trip circuits shall include adjustable time delay relay set to delay annunciation or tripping after the contacts close.

5. Time delay relays shall be Signaline Model No. 360, 48 or 125 VAC/DC, 1-1023 seconds.

6. The trip circuit shall use a Qualitrol seal-in-relay 909-300-01 to provide a seal-in, trip and alarm for the trip circuit. For transformers with a conservator tank, the trip contacts from the main tank and conservator tank liquid level gauges shall be connected in series.

7. Alarms and/or trips shall not occur due to cold oil (minus 5°C for alarm and minus 15°C for trip). The trip shall not occur above the low-level mark on gauge.

2.20.1 Pressure Relief Devices

Acceptable pressure relief manufacturer shall be Messko. A minimum of two devices shall be located on the cover of the main tank, on opposite corners.

1. For inert gas pressure systems, a pressure relief of 8 PSI is required.
2. For conservator tank pressure systems, a pressure relief of 8 PSI is required.
3. One device shall be located on the Load-Tap-Changing compartment.
4. A pressure relief of 8 PSI is required.

2.20.2 Rate-of-Rise Fault Pressure Relay

Rate-of-Rise fault pressure relay and seal-in reset switch with alarm and tripping contacts.

2.20.3 Rapid Pressure Rise Relay

1. Qualitrol relay model 900-1, with Qualitrol seal-in-relay 909-300-01.
2. Qualitrol relay shall be installed in oil space.

2.20.4 Buchholz Relay

1. Cedaspe model EE3-ML + RG3.3, with Qualitrol seal-in-relay 909-300-01, and the following alarm and trip contacts.
   a. One Form-C trip contact for oil surge
   b. One Form-A trip contact for low oil level
   c. One Form-C alarm contact for gas accumulation

Trip and alarm contacts shall be connected to terminal blocks.

Sudden Pressure Relay shall operate on rate-of-rise pressure change to protect transformer against damage due to internal faults.

Relay shall be insensitive to pressure pulses caused by electrical disturbances such as magnetizing inrush currents, through faults, or mechanical shocks that may be caused by the normal operation of the transformer.

2.20.5 Bladder Integrity Relay

For a conservator tank system, a relay shall be installed to verify the integrity of the bladder system. Acceptable bladder integrity relay manufacturer shall be TREE Tech MBR.

2.20.6 Dial-Type Top-Oil Thermometer

Acceptable temperature gauge manufacturer shall be Messko.

Thermometer shall have three adjustable alarm contacts which close on temperature rise.

Mount remote readout less than 7 feet from transformer base.

2.20.7 Dial-Type Winding Thermometer

Dial-type winding thermometer and seal-in reset switch with alarm and tripping contacts.

Acceptable temperature gauge manufacturer shall be Messko.

For single phase, three winding transformers: Each winding shall have one thermometer.

For three phase, single tank transformers: Thermometer shall be furnished for B phase LV winding

Each thermometer shall have four adjustable contacts (alarm, trip, and two spare) which close on temperature rise.

The winding temperature indicator shall incorporate a current transformer responsive to its associated winding current, calibrating resistor, temperature detector element, and heater all mounted and connected to simulate the hot spot temperature of the winding.

The trip circuit shall use a Qualitrol seal-in-relay 909-300-01 to provide a seal-in, trip and alarm for the trip circuit.

Mount remote readout less than 7 feet from transformer base.

2.20.8 Transformer Nameplate

In addition to the requirements of IEEE C57.12.00, the transformer nameplate shall include the following:

1. Contractor transformer equipment number in upper left hand corner with extra-large lettering.
2. The current rating of the OLTC
3. The turns ratio of internal series or auto-transformers.
4. The minimum number of gallons of oil required to cover the core and coils.
5. The main tank & OLTC pressure & vacuum information (pressures shall be shown in PSI).
6. An adjacent nameplate shall show the various slings and lift positions required for proper lifting for the completely assembled transformer. It shall indicate whether the transformer may be lifted when filled with oil.
7. If tap voltages are not equally spaced, actual calculated tap voltages shall be indicated.
8. Transformer capacity ratings shall be stated in MVA, not kVA.
9. A simple plan view outline of the transformer showing bushings, control cabinet, OLTC tank and DETC handle locations.

10. Current transformers tap ratio tables.

2.20.9 Fiber Optic Connector Panel

Provide one Corning model CCH-CP12-25T fiber optic connector panel, installed in housing Corning model SPH-01P.

2.20.10 Ethernet Switch

Ethernet switch to convert Ethernet connections from transformer monitor and dissolved gas monitor to Ethernet fiber shall be provided. Acceptable manufacturer shall be Ruggedcom.

Switch shall be mounted inside control cabinet.

Minimum six RJ-45 ports shall be provided.

Minimum three ST multimode fiber connections shall be provided.

2.21 Alarms/Annunciator

All alarm/annunciation points shall be wired to the transformer monitoring device.

3 Execution

3.1 Tank

3.1.1 Design

Tanks shall be of oil and gas-tight steel plate construction.

1. All seams shall be welded.
2. All butt welds shall be full penetration.
3. Weld slag and spatters shall be removed.
4. Field installation shall not require welding.
5. Corner welds on the tank are not allowed.

Tank and compartment walls shall be reinforced to permit drawing full vacuum on each compartment, with oil in adjacent tanks or compartments.

Tank and all other oil-filled compartments shall be designed to withstand, without permanent deformation, an internal pressure of 10 PSI.

Transformer designs using an oil expansion conservator tank shall be designed to channel all generated gases to a Gas Accumulation Relay. Gas-channeling piping shall not cause a tripping hazard for personnel walking on the transformer cover.

The CENTER OF GRAVITY shall be visibly and permanently marked on two adjacent sides of the tank and shall be appropriately identified as follows:

1. “CENTER OF GRAVITY - COMPLETE” for the completely assembled transformer filled with oil.
2. “CENTER OF GRAVITY - SHIP” for the transformer filled with oil, but without the radiators, bushings, and lightning arresters.

Lifting lugs shall be provided for lifting the completely assembled transformer.

Jacking bosses shall be provided at all four corners of base for jacking the completely assembled transformer with oil.

1. Boss pads shall be located a minimum of 13 inches above the transformer foundation
2. The area above the pads shall be clear of obstructions.

Transformer tank shall withstand skidding or rolling the transformer with oil, bushings, and radiators in a direction parallel to either center line of the tank.

Provision for anchors or tie downs to the foundation shall be provided.

Provide weatherproof penetration box for current transformer leads on upper tank wall.

3.1.2 Cover

Cover shall be welded to tank.

Opening(s) shall be provided to facilitate installation and removal of bushing current-transformers without removal of the tank cover.

The transformer cover shall have external lifting eyes, which shall be welded on.

All manholes, hand holes, and inspection openings shall have a gasketed, bolted cover with external lifting provisions.

All openings in the tank cover employing gaskets shall be raised above the cover surface to prevent the accumulation of water around the gasket joints.

Covers shall not trap any gas generated in transformer.

Lifting eyes shall be welded inside the tank cover at all 4 corners and approximately 1 foot from each wall to be used for emergency man lifting.

Install Pelsue FB-SW1 (same as former UNI-Hoist NUH-4000-2) weld on adapter plates for confined space entry/retrieval system.

1. One retrieval system adapter plate shall be located near each man-hole.
2. One retrieval system adapter plate shall be located on the edge of the transformer, near the clean side of the transformer as recommended by retrieval system manufacturer.
3. Quantity and spacing between plates to be determined based on transformer capacity and manufacturer requirements.

Manufacturer shall apply non-skid paint on the entire transformer tank cover.

3.2 Sound

The transformer shall be designed to comply with a decibel rating of -10 dB relative to NEMA TR1

3.3 Safety Features

3.3.1 Clearance

There shall be sufficient clearance from ground to live parts, in accordance with the NESC, to permit access to parts, which require adjustments or examination by operators while the transformer is energized.

3.3.2 Caution Labels

For nitrogen gas pressure systems a caution label shall be provided on the top of each manhole cover. The nameplate shall read as follows:

“DANGER, Pressurized with Nitrogen Gas –

1. Reduce gas pressure to zero before opening.
2. Ventilate with dry air and follow confined entry procedure to enter the transformer.”

For conservator-type transformers a caution label shall be provided on the top of each manhole cover. The nameplate shall read as follows:

“WARNING, Oil must be removed from the conservator tank before opening.”

For tank ribs that are pressurized a caution label shall be provided on each pressurized rib. The label shall read as follows

“DANGER, Rib is pressurized, do not drill, puncture or weld.”

For manholes mounted on the tank wall a caution label shall be provided on each manhole cover. The label shall read as follows

“WARNING, Oil must be removed from the main tank before opening.”

For transformers with a de-energized tap changer a caution label shall be provided next to the de-energized tap changer handle. The label shall read as follows:

“DANGER: Do not operate the de-energized tap changer with the transformer energized.”

3.4 Seismic

The transformer and all of its components shall be qualified in accordance with IEEE Standard 693 and IBC code. Transformer shall meet the requirements of the High Seismic Qualification Level.

At a minimum the follow upgrades shall be included to ensure qualification:

1. Additional radiator supports
2. Additional conservator supports
3. Additional control cabinet supports
4. Increased bracing of the active part

A note shall be added to the nameplate that indicates that the transformer was designed to meet the IEEE 693 High Seismic Qualification Level.

A finite element analysis shall be done and report, verified by a registered professional engineer, shall be submitted to verify the High Seismic Qualification Level.

4 Factory Tests

4.1 General

The manufacturer shall notify Contractor at least 30 days prior to commencement of testing so that a Contractor/Owner representative may witness the tests. The manufacturer shall notify Contractor immediately of any delays.

The tests specified in IEEE Standard C57.12.00 and manufacturer's quality control tests, shall be performed, except as stated in this specification.

Tests, which have been run on other transformers of essentially duplicate designs, are not acceptable in lieu of the tests specified, except as stated in this specification.

All tests shall be performed in accordance with IEEE Standard C57.12.90, unless otherwise specified by the Contractor/Owner. The manufacturer shall notify Contractor immediately of any test results not in compliance prior to any modifications and retesting.

Contractor/Owner will accept the transformer only if it has passed all tests to Contractor/Owner's satisfaction.

All dielectric tests shall be performed after the heat run.

All tests shall be performed on all units (including duplicates).

4.2 Specific Tests

4.2.1 Bushing Tests

Immediately after receiving the bushings into the factory, the bushings shall be thoroughly inspected, cleaned, and shall receive power factor and capacitance tests.

4.2.2 Winding Resistance Tests

Resistance measurements and impedance voltage tests of all windings on rated voltage connection and at tap extremes.

1. The same method shall be used to determine both cold-resistance and hot-resistance values (same winding resistance meter, same test leads, same connections, same current, etc.).
2. The same method shall be used to determine both the temperature associated with the cold-resistance test and the temperature associated with the hot thermal tests (same measuring device, same RTDs/probes, same calculation to determine mean oil temperature, etc.).
3. Cold resistance measurements shall be made in the following tap positions:
4. Windings with a DETC: neutral and extreme tap positions
5. Resistances for windings in a delta configuration shall be measured phase-to-phase.
6. Resistances for windings in a wye configuration shall be measured phase-to-neutral.

4.2.3 Ratio Tests

Ratio tests on rated voltage connection and on all tap connections.

4.2.4 Polarity Tests

Polarity and phase-relation tests on rated voltage connection.

4.2.5 No-Load Losses

The no-load losses test shall be repeated after dielectric tests (repeated with 100% voltage, with tap changers in the nominal positions). The test shall be sustained for at least 10 minutes to help ensure the core is well demagnetized for subsequent tests.

Values from the repeat test shall be used to evaluate actual losses compared to the guarantee losses stated in the Proposal.

No-load losses and excitation current shall be reported at 60 Hz, and 90%, 100%, 105%, 110% rated voltages (before and after dielectric tests).

4.2.6 Excitation Tests

Excitation current test at 100 percent, 105 percent, and 110 percent of rated voltage on the rated voltage tap.

1. Excitation tests shall be performed before the impulse tests.
2. The 100 percent test shall be repeated after the impulse test.

4.2.7 Load Loss and Impedance Tests

Impedance and load loss at rated current and rated frequency on the rated self-cooled ONAN connection and on the tap extremes.

4.2.8 Zero Sequence Test

Measured zero sequence impedances (primary-to-secondary, secondary-to-tertiary, and primary-to-tertiary as applicable) shall be reported in the certified test report, at the ONAN rating and the following voltage taps:

1. Units with only a DETC: neutral and extreme tap positions
2. Units with only a load tap changer: neutral and extreme tap positions

4.2.9 Temperature Rise Tests

Temperature rise tests shall be per IEEE Standard C57.12.90.

1. ONAN temperature rise test.
    a. Winding resistance measurement taken on one phase.
2. ONAF temperature rise test.
    a. Winding resistance measurements taken on all three phases.
    b. The tank wall surfaces shall be checked for hot spots with thermal imaging camera when the top oil temperature has stabilized.
    c. Thermal images shall be provided to Contractor/Owner electronically with the test report.
    d. Overload Test shall immediately follow the ONAF temperature rise test.
    e. With all cooling equipment in operation, and after the top oil rise is re-established and with the total losses of the ONAF rating being applied, the loading shall be increased to 125% of maximum ONAF rating and held until stabilized.
    f. Winding resistance measurement shall be taken on the hottest phase recorded from the ONAF temperature rise test.
    g. The top oil rise shall be limited to 60°C rise over 50°C ambient (110°C absolute).
    h. The hot spot rise shall be limited to 80°C rise over 50°C ambient (130°C absolute).
3. Any test shall be terminated if the winding, lead, bushing, and metal hot-spot temperature exceeds 80°C rise over 50°C ambient.
4. Top & bottom oil temperature, simulated hottest-spot winding temperature, and fiber optic temperatures shall be operational and recorded at intervals of

30 minutes or less. Any test shall be terminated if any fiber optic hot spot winding temperature exceeds 140°C.

5. Transformer monitor and fiber monitor (defined in Section 2.15.1) shall be configured to record all temperatures from RTD and fiber optic temperature probes at 1 minute intervals prior to heat run tests. Transformer monitors shall be energized and shall log all temperature inputs for the duration of all heat run tests.
6. The online DGA monitor specified in 2.15 (E) shall be fully plumbed, commissioned, and operating during the heat run tests.

4.2.10 Dissolved Gas Analysis (DGA)

DGA samples shall be taken from the main tank as follows and shall be analyzed using test method ASTM D3612:

1. Prior to any testing.
2. After ONAN temperature rise test.
3. After ONAF temperature rise test shutdowns.
4. After overload test or before dielectric tests if not performed on the same day.
5. After dielectric tests.
6. Prior to shipping if the transformer is being shipped filled with oil.

Cumulative dissolved gases in oil resulting from any test shall not exceed:

Gas	After ONAN or ONAF Test	After Dielectric Tests
Acetylene	0 ppm	0 ppm
Hydrogen	10 ppm	15 ppm
Carbon Monoxide	20 ppm	40 ppm
Carbon Dioxide	200 ppm	200 ppm
Methane	2 ppm	4 ppm
Ethylene	1 ppm	2 ppm
Ethane	2 ppm	4 ppm

4.2.11 Impulse Test

Switching and lightning impulse tests shall be performed in accordance with the requirements of IEEE C57.12.90 and IEEE C57.12.00. Measurement of test voltages shall be performed based on IEEE Std. 4.

The dielectrics tests shall be performed in the following sequence:

1. Lightning impulse tests (on all terminals)

2. Switching impulse tests
3. Applied potential test
4. Induced potential test

4.2.12 Applied Potential Test

Applied potential tests shall be performed in accordance with the requirements of IEEE C57.12.90 and IEEE C57.12.00 at low frequency (below 500 Hz) and duration of 1 minute. Measurement of test voltages shall be performed based on IEEE Std. 4.

4.2.13 Induced Potential Test

RIV measurements (in microvolts) and partial discharge measurements (in picocoulombs) shall be performed at the end of all dielectric tests Values shall be recorded for each phase in both microvolts and picocoulombs.

1. The test shall be recorded on at least 6 channels (3 RIV and 3 PD).
2. Limiting criteria for the test is as follows:
    a. Maximum RIV < 100 microvolts
    b. Maximum PD < 300 picocoulombs
    c. Increase of RIV during 60 minutes does not exceed 30 microvolts
    d. Increase of PD during 60 minutes does not exceed 50 picocoulombs
    e. No steadily rising trend in RIV or PD during the last 20 minutes
    f. The RIV and PD of any one phase shall not be higher than 200% of another phase (desire somewhat symmetrical values across phases)
3. If the limiting criteria is near the failure limit and/or is steadily increasing near the conclusion of the test, the test length shall be extended indefinitely until a confident judgment can be made as to whether the transformer has passed or failed.

4.2.14 Audible Sound Level Tests

Sound level tests shall be performed per IEEE C57.12.00 and IEEE C57.12.90.

1. Performed at the tap position that produces the highest audible sound level.
2. The test shall be performed a second time with both the first and second stages of auxiliary cooling energized.
3. The test report shall include all test data taken with corresponding locations of microphones at all tap settings in accordance with the referenced standards.

4.2.15 Insulation Power Factor and Excitation Tests

Power factor and excitation tests of the transformer, with bushings and oil installed, shall be performed at 10 KV before and after dielectric and load tests are complete.

1. The individual tested power factors of the winding-to ground insulation and of the inter-winding insulation (CH, CL, and CHL by Doble Method II) shall not exceed 0.50 percent at 20°C top oil temperature.
2. Power factors for bushings C1 and C2 shall be tested.

4.2.16 Current Transformer Tests

The insulation resistance and polarity of all current transformers shall be tested.

4.2.17 Sweep Frequency Response Analysis (SFRA)

Provide Sweep Frequency Response Analysis test (at nominal test positions) on all windings using Doble SFRA test equipment. To ensure the core is free of any residual magnetization due to impulse tests, the SFRA test shall follow the repeated no-load test (after impulse test). The test shall be performed with the DETC in the maximum voltage position (all winding in the circuit).

4.2.18 Furanic Compound Analysis

Analysis shall be performed after all tests, prior to removing test oil from transformer, on the main tank, DGA-syringe sample using test method ASTM D5837.

4.2.19 Oil Quality Tests

If the transformer is to be shipped with oil, oil quality tests shall be performed on the oil shipped in the transformer prior to shipping. The sample for the oil quality tests shall be taken from the main tank. The oil quality tests shall include the following:

1. Interfacial Tension @ 25°C, min, dynes/cm – ASTM D971
2. Dielectric Breakdown, min, KV – ASTM D1816
3. Power factor, max 25°C, % – ASTM D924
4. Power factor, max 100°C % – ASTM D924
5. Water, max, ppm – ASTM D1533
6. PCB content, ppm – EPA 8082
7. Acid Number, mg KOH/g – ASTM D974
8. Any oil that will be provided with the transformer shall be tested for corrosive sulfur in accordance with ASTM D1275 Modified (b) and shall be classified as

non-corrosive. A copy of this report shall be provided upon delivery of the transformer.

9. Oxidation Inhibitor content, % by weight – ASTM D2668
10. Relative density – ASTM D1298

4.3 Test Report

All test data shall be recorded in the Test Report. The Test Report shall be accompanied by copies of the raw hand-written data sheets used to record test results, including, but not limited to:

1. Tests completed for setup and calibration.
2. Tests repeated due to incomplete test records.
3. Test failures.
4. Test records incorporated into the final report.

The manufacturer shall e-mail a copy of the certified test report to Contractor/Owner for approval prior to shipment. Final copies of the test report shall be included in each instruction book and provided in electric form to Contractor/Owner. The report shall include a short summary noting any abnormal results and stating if the unit has passed or failed. The following test data shall be provided for review.

1. Winding Resistance (All tests)
2. No-load losses, Load losses & Impedance tests (All tests)
3. Excitation Current (All tests, 100%, 105%, 110% and 100% after dielectric tests)
4. TTR Results (All taps with deviation from equally spaced taps)
5. Impulse tests (including waveform comparisons, i.e. reduced wave vs. full wave, chopped wave 1 vs. chopped wave 2, etc.)
6. Induced voltage test results (all micro-volt and pico-coulomb readings)
7. Sound Level (All data points)
8. 10kV Power Factor and Excitation data (in test report and separately in Doble .XML file)
9. Doble SFRA test results (in test report and separately in Doble .SFRA files)
10. Oil sample results (All tests, including DGA, oil quality, furanic compounds, and corrosive sulfur)
11. Bushing Power Factor and Capacitance Tests (in test report and to be included in Doble .XML file specified in item 8 above)

12. Provide continuous log, in the test report and EXCEL file, of all temperatures (fiber, bottom and top oil, top and bottom header, ambient, and customer temperature gauges) and transformer loading, with date and time stamps for the temperature rise and overload tests. Provide shutdown plots of resistance.

The Test Report shall show the stray loss ratio, i.e.:

1. SFL = Stray losses / Full Load Losses
2. Full Load Losses = Total load losses - I^2R Losses X 100 % / Total load losses The Test Report shall show no-load losses at 90 percent, 100 percent, 105 percent, and 110 percent of rated voltage.

The Test Report shall show the manufacturer's quality control sound level test, including noise data by location.

The Test Report shall include ratio test results with deviation from equally spaced taps.

The Test Report shall show induced voltage test results in time vs. measurement table format. (Both RIV and picoCoulombs.)

The Test Report shall indicate PCB level of oil used for tests.

The Test Report shall include winding temperature indicator calibration value and the winding hot spot temperature rise above top oil for every heat run test shutdown.

Test Report shall include all oil test reports, including the manufacturer's ASTM D3487. The D3487 test should be from one of the tankers that deliver oil to the transformer manufacturer during the time our transformer is being filled or tested.

4.4 Short Circuit Requirements

The manufacturer shall furnish information and type test data to document that a transformer of similar design that is being furnished is capable of withstanding, without damage, the mechanical stresses caused by short circuits imposed at the bushing terminals of the secondary windings under the conditions specified in the American National Standard for Distribution and Power Transformer Short-Circuit Test Code (C57.12.90, Part II).

The transformer shall be capable of withstanding maximum expected short circuit currents which flow to any winding due to a fault at any terminal at 1.05 per-unit voltage for the maximum duration as defined by the interconnection agreement or PGE specifications, whichever is longer.

5 Assembly and Oil Filling:

The Contractor shall furnish all labor, supervision, material, and equipment required to attach all auxiliary equipment that is shipped separate from the transformer tank(s) and completely fill the transformer(s) with oil.

Prior to oil filling, the following tests shall be performed on the oil:

1. Moisture content
2. Dielectric strength
3. Power factor
4. Interfacial tension
5. Neutralization number
6. After filling with oil, check transformer(s) for oil and pressure leaks.

Facilities for lifting the coil and core assembly shall be provided by the manufacturer and shall comply with ANSI C57.12.10.

6 Field Inspections and Tests

The transformer supplier shall perform and record the following field inspections and tests upon delivery of the transformer(s) to the site:

1. Check impact recorder
2. Check blocking
3. Check transformer tank and fittings for the following:
    a. External damage
    b. Paint finish
    c. Attached fittings
    d. Oil leakage, if shipped oil-filled
    e. Positive pressure or vacuum in tank
4. Inspect bushings
5. Perform the following internal inspections:
    a. Check for moisture
    b. Check coil supports
    c. Disconnect core ground and measure insulation to ground to verify no unintentional grounds
    d. Check for any visible insulation damage
    e. Check for any loose parts
6. Check that all parts have been delivered and report and expedite shipment of any missing or damaged parts
7. Provide and record the following field tests:

a. Insulation resistance
b. Each winding-to-ground and to other windings
c. Core-to-ground
d. Winding ratio tests on all tap positions
e. CT ratio and polarity tests
f. Dissolved gas analysis sampled at least one day after energized

8. Compare results with factory test report and inform Contractor/Owner of any discrepancies.
9. Check and report on all accessories for proper operation, including the following:
    a. Cooling fans
    b. Oil pumps, if applicable
    c. Cooling controls
    d. Pressure relief device
    e. Sudden pressure relay
    f. Magnetic liquid level indicator
    g. Winding temperature indicators
    h. Liquid temperature indicator
    i. Pressure-vacuum indicator
    j. Tap changer
    k. Winding temperature detectors
10. Provide all additional field inspections, adjustments, and tests recommended by the transformer manufacturer.

Appendix M1

Attachment 05

Exhibit 04

Communication, SCADA, and Metering Facilities

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	25Aug23	Rev 2, see redline changes throughout	Jeremy Morris	Craig Armstrong	CPA	Craig Armstrong

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1 M1-05-04-Communication, SCADA, and Metering Facilities

1.1 Communication Facilities

1.1.1 GENERAL

1.1.2 SUMMARY

A. This Section summarizes the communications systems the Contractor shall provide as part of their proposal. The following specifications include detailed SCADA specification sections:

1. M2-01-01 (Wind Plant Specifications)
2. M3-01-01 (Solar Photovoltaic Plant Specifications)
3. M4-01-01 (Energy Storage Technical Documents)

B. The SCADA section in those specifications includes the following:

1. General
2. Main SCADA Components
3. SCADA Device Requirements
4. Interfaces
5. Fiber Optic Network Design
6. Fiber Optic Installation
7. Fiber Terminations and Testing
8. Availability and Reliability
9. Cyber Security
10. Viewing and Display
11. Reporting
12. Support for Warranty Calculations
13. Remote Alerts
14. Time Base and Date Formats

C. This Section summarizes the communications systems not covered within those specifications.

D. The proposal shall address four aspects of the telecommunications design.

1. Intra-site Communications - the Network shall primarily be an Ethernet Fiber network to support intra-site data and voice communications needs.
2. Substation Interconnect - Contractor shall incorporate plans for the communications needs required to interconnect the facility to the bulk electric power system. This may include transfer trip and any of special or remedial protection schemes needed for the interconnection of the facility to the bulk electric power system. This design shall meet any requirements from the interconnecting utility, the Public Utility Commission, and/or the Independent System Operator for SCADA or Metering.
3. PGE Connectivity - to support remote monitoring and operation of the facility. This will include one or more data links back to PGE operations center. This shall include connectivity for both the Primary SCADA link as well as the plant operational data link serving plant operations such as sending operational and maintenance data to a historian, allowing remote access and control, and voice communications to the facility.
4. PGE Local Data Collection – a data collection system will be installed to interface directly with the local plant control system (OEM SCADA) for the purposes of data collection, aggregation, and reporting.

1.1.3 TELECOMMUNICATIONS APPROACH

A. The Contractor shall provide a bid that both meets these specifications and allocates a budget for the design, procurement, and construction of these telecommunications facilities. The site network and the interconnection requirements should be known and the design and costs of these facilities should be accounted for and well understood. The communications link to PGE will depend greatly on the location, size, and type of facility proposed, and therefore the Contractor shall propose a solution that meets these functional specifications. Contractor shall coordinate the communications systems for Substation and O&M Building to ensure compatibility and cost effectiveness and obtain owner's approval. During negotiations, this aspect of the design may be revised based on site specific conditions. An allowance for each of these four sections (Intra-site Communications, Substation Interconnect, PGE Connectivity, and Local Data Collection) shall be provided. The proposal price will not be revised if the ultimate solutions remains within these allowances.

1.1.4 TELECOMUNCATIONS FACILITES

A. The facilities shall consist of the following:

1. Communications during construction: The Contractor shall provide a communications network to be used during construction, and specifically communications services to the on-site trailers used during construction. A minimum of 5 Mbps Ethernet link shall be provided to each PGE trailer, along with (2) phone lines per trailer, which may be either VOIP or POTS. The Ethernet link shall only be dedicated to PGE and no other users.
2. Intra-Site Network: The Contractor shall provide a data network that extends from a central substation or O&M building to all equipment enclosures throughout the facility that house microcontroller equipment.
    a. This network shall be constructed such that it supports the following applications:
        i. Shall support the Real-time control for the operation of the plant.
        ii. Shall support remote monitoring for the Owner to gather operational data from microprocessor-controlled equipment.
        iii. Shall support monitoring of weather information.
        iv. Shall allow the Owner to remotely access remotely configurable equipment to make settings changes and firmware upgrades.
        v. Shall support the use of Voice at each enclosure, desk, conference room, or security control point.
        vi. Shall support the use of Video where required for security and operations of the plant.
        vii. Shall include Wireless Access Points in Office locations.
        viii. Offices and conference room areas will have multiple data/analog wall jack locations. Each location will have two CAT6 station cables home run back to the Communications room where it will

terminate in the main distribution field (MDF) enclosure on a specified 110 patch panel.

b. The network shall be capable of meeting the following specifications:

i. Use IP/Ethernet communications over a fiber and copper network.

ii. At least 60 Strands of single mode (SM) fiber shall be installed between all buildings as part of the project. Fiber shall be configured in a logical ring and where possible into a diverse optical ring.

iii. Category 6 copper shall be used for all connections between switches and equipment within a building.

iv. Use gigabit Ethernet connections

v. Use VLANS for segmentation of traffic

vi. Use Quality of Service to Prioritize traffic flows

vii. Use Rapid Spanning Tree or other advanced ring convergence protocols.

viii. Support POE where phones or wireless access points are installed.

ix. Use managed equipment that support the following:

x. Centralized authentication via RADIUS or TACACS

xi. Centralized logging via Syslog

xii. Use hardened network equipment rated for the environment in which it will be installed.

3. Interconnection to Bulk Electric Power System:

a. Determine specific equipment required by the Utility/Transmission Owner and the System Operator, specifically relating to SCADA, metering, and telemetering due to the interconnection agreement as well as equipment required to complete the indicated control and protection requirements.

b. Build any fiber, microwave, or leased facilities needed in order to tie facility into bulk electric power system.

c. Follow Western Electricity Coordinating Council (WECC) teleprotection standards.

4. PGE Communications Circuits:

a. Contractor shall provide the following communication circuits, each with the respective parameters given. These communications circuits can be delivered over the one or more aggregate leased circuits if possible. These circuits may make use of a private data network or a leased facility from a common carrier. The Contractor's proposal shall include the capital cost for construction, as well as the estimated monthly recurring cost if applicable. The Contractor shall make use of the PGE equipment listed below where such equipment is required:

Circuit Name	LOC A	LOC Z	Type	Capacity	Latency	Avail.	Circuit Description
O&M CORPORATE NETWORK	O&M	PGE WHQ	ETH	25 Mbps	100 msec	99.00%	CORPORATE NETWORK SERVICE
INTRA-SITE NETWORKING	SUBSTATION	O&M	ETH	1 Gbps	0.05 msec	99.00%	CORP NETWORK & SECURITY LAN
SUB REMOTE ACCESS LAN	SUBSTATION	PGE WHQ	ETH	1.5 Mbps	0.5 sec	99.00%	REMOTE ACCESS LAN FOR PROTECTION & AUTOMATION GROUP
SUB COMM TECH LAN	SUBSTATION	PGE WHQ	ETH	1.5 Mbps	0.5 sec	99.00%	REMOTE ACCESS LAN FOR COMM TECHS
PRIMARY AGC+SCADA	SUBSTATION	PGE WHQ	ETH	64 kbps	0.5 sec	99.95%	SERIAL DNP 3.0 AUTOMATIC GENERATION CONTROL AND SCADA
SECONDARY AGC+SCADA	SUBSTATION	PGE WHQ	ETH	64 kbps	0.5 sec	99.95%	SERIAL DNP 3.0 AUTOMATIC GENERATION CONTROL AND SCADA
METERING	SUBSTATION	PGE WHQ	ETH	64 kbps	0.5 sec	99.90%	METERING DATA

1.1.5 OTHER COMMUNICATIONS CIRCUITS/SERVICE

PGE will not be responsible for any Vendor's long-term ISP or phone system at the site.

1.1.6 TELECOMMUNICATIONS EQUIPMENT

A. In each major facility provide space for (4) adjacent Communications racks. For the Plant and Switchyard/Substation facilities, locate the Communications racks in the same room or adjacent to the relay equipment racks. For the O&M Building or Administration Building, in addition to the Communications racks, provide (4) racks for IT Operations and (2) racks for Corporate Security Operations. Locate the Communications racks in the same room or adjacent to racks dedicated for IT Operations and Corporate Security. Each room to include 4'x8' fire-rate plywood backboard (white). Cabinets shall be installed with 36" clearance in rear of cabinets and 42" in the front. 36" clearance must also be allocated on the sides of the cabinets unless adjacent to another cabinet or communications rack.

B. Provide a -48VDC power system capable of supplying the load with an 8-hour reserve time at each major facility.

C. Communications equipment shall be grounded per Motorola R56 standards in O&M and Administration Buildings. Grounding in the Switchyard/Substation shall follow IEEE 80 standard industry practices.

D. Provide a SATRAD-G2 satellite phone system with exterior antenna, rack mount equipment, and a dedicated desk phone.

E. Equipment specified for this project shall be of the same manufacturer and model as PGE uses in their existing communications systems:

1. Dual-post Rack – Chatsworth "Clear", 19" x 84"
2. Ethernet Switch – Cisco
3. VoIP Phone - Cisco
4. Wireless Access Point – Cisco
5. Service Aggregation Node – Nokia 7705-SAR-8 with support cards
6. Fiber Patch Panel – Clearfield FxDS, with SC/UPC Connectors
7. ADSS Fiber Cable – OFS AT-3BE17NT-060-CMEA (60-CNT)
8. OPGW Fiber Cable – AFL DNO-8234 (48-CNT)

9. Splice Cases – Tyco FOSC-450D
10. -48 VDC Fuse Panel – Telect GMT Dual Feed 20/20-position
11. -48 VDC Charger Panel – Valere; CK4D-ANL-VC shelf, min 24 hours battery recharging capability while under load
12. -48 VDC Battery (Plant or Switchyard/Substation) – C&D (flooded) or East Penn Deka Unigy II (VRLA) w/ one-piece base and interlocking cells, min 8 hours carry time
13. -48 VDC Battery (O&M or Admin Building) – C&D (flooded) or East Penn Deka Unigy II (VRLA) w/ one-piece base and interlocking cells, min 8 hours carry time

1.2 SCADA System-Local Data Collection

1.2.1 General

A. Contractor will provide suitable space, power, and environment control to house the PGE equipment necessary to facilitate the collection of plant control system data.

1. In addition to the Telecommunications, IT Operations, and Physical Security communication racks, Vendor will also provide space for Owner to install (1) 30” x 42” x 84” fully-enclosed, lockable, 4-post network cabinet with venting doors in either the O&M communication room or the Substation.
2. Cabinet shall be installed with 36” clearance in rear of cabinet and 42” in the front. 36” clearance must also be allocated on the sides of the cabinet unless adjacent to another cabinet or communications rack.
3. Vendor shall supply and install fully redundant HVAC systems and humidity control in whatever location the houses the Data Collection Cabinet, with sufficient cooling for all equipment in that location.
4. Vendor shall provide (1) 30A, 240V circuit to each cabinet.

1.2.2 SCADA Hardware and Software Requirements

A. Contractor will provide the following equipment for Owner’s data collection system. Contractor will install all equipment in the provided cabinet in coordination with Owner at least 90 days prior to Substantial Completion. Once installed, Contractor will turn over all equipment and licenses to Owner for configuration.

B. Owner will have final approval on what hardware and software is provided to ensure system operations. If the specific devices below are not available or if the OEM has announced any end of support for the hardware or software, Owner will provide equivalent models for the Contractor to procure (at Contractor's cost).

a. 1x AR3150 (APC NetShelter SX 42U Deep Rack Enclosure) with 2x AR3150 (0U PDU mounts) and 1x AR7714 (rack roof brush strip)

b. 1x 4-node Dell VxRail Custer (E660F or newer). Each server should be single-socket with an Intel Xeon 6346 or better with 256GB RAM and 4-port SFP28 network card. Storage should be all-flash with a total usable space of 20TB, with the ability to expand to at least 45TB in the future.

c. 2x Cisco C9300X-48TX (or newer) with C9300X-NM-8Y and stack cables with 5-year DNA license

d. 16x Cisco SFP-10/25G-CSR-S= Transceivers

e. 8x Dell-compatible 10BASE-T SFP+ Copper RJ45 Transceivers

f. 2x Cisco FPR-1120 (or newer), with 5-Year Malware and Threat licenses

g. 1x Eaton 9PX8KSP

h. 2x Schneider AP8870

i. 1x Black Box LES1516A

j. 1x Recessed 19" rack-mounted DIN Rail with terminal blocks and 30A 2-pole breaker

k. 1x 1U Mixed-use (copper & fiber) feed-through patch panel

l. Software and Licenses:

i. All server cluster fully licensed with vSphere Enterprise Plus and vSAN (version 8 or newer)

ii. Windows Server 2022 (or newer) Datacenter licenses for all CPU Cores

iii. 2x Microsoft SQL Server 2019 (or newer) Standard licenses

iv. Emerson Ovation Green (MiScout) data collector software, configured in High Availability mode, with sufficient licenses for provided system.

C. Contractor, in coordination with OEM SCADA Vendor, shall:

1. Make available all datapoints within the OEM SCADA System to the Owner, including individual tower/panel/battery values, directly from the OEM SCADA System to PGE's Data Collection system.

   a. If PGE is responsible for day-to-day maintenance or control of the plant, this system shall have read/write access to the OEM SCADA System and act as an overlay-SCADA from which operators can use to manage and control the facility.

   b. If PGE will not be responsible for any day-to-day maintenance, the system shall have read-only access.

2. Ensure data values are available in the native resolution in which they were collected, up to 1Hz.

3. Configure the OEM SCADA system to allow Owner data collection system to pull all live, historical, and alarm data using one or more of the following methods:

   a. OPC UA

   b. UPC DA

   c. ODBC

   d. Direct queries to tower controllers using native protocol

1.3 METERING and TELEMETRY FACILITES

1.3.1 GENERAL

A. PGE requires one owner per Point of Interconnection.

1.3.2 DIRECT TELEMETRY REQUIREMENTS

A. PGE requires two communication paths for controlling and operating generation that is settled within its Balancing Authority Area:

1. Direct, real-time telemetry (SCADA) from RTU (site) to RTU (PGE control center)

2. ICCP over WECC Operations Network (WON)

1.3.3 METERING REQUIREMENTS

A. PGE requires primary and backup metering for each metered point. Meters shall be sourced from wound-type instrument transformers for

voltages 230kV and below. Meters shall be accessible via PGE's MV90 system for accounting purposes.

1.4 PROCESS DATA FOR PATTERN RECOGNITION

As a minimum, Contractor shall install instrumentation and make the process data available to access by Owner in the Plant's Control System for following systems and equipment (as applicable):

1.4.1 Hydro Turbine

A. Turbine Guide RTD
B. Lower Guide RTD
C. Upper Guide RTD
D. Thrust Bearing RTD
E. Lube Oil Pressure
F. Lube Oil Temperature
G. Gen Turbine Local Ambient Temp
H. Turbine Guide Bearing X VIBR
I. Turbine Guide Bearing Y VIBR
J. Upper Guide Bearing X VIBR
K. Upper Guide Bearing Y VIBR
L. Lower Guide Bearing X VIBR
M. Lower Guide Bearing Y VIBR
N. Wicket Gate Position
O. Wicket Gate Pressure
P. Cooling Water Pressure
Q. Cooling Water Temperature
R. Forebay Level
S. Tailrace Level

1.4.2 Wind Turbines

A. Pitch - Blade A/B/C Pitch Motor Current
B. Pitch - Blade A/B/C Pitch Motor Voltage
C. Pitch - Blade A/B/C Pitch Position
D. Pitch - Blade A/B/C Hydraulic Oil Accumulator Pressure
E. Pitch - Pitch Pressure Output From Hydraulic Power Unit
F. Pitch - Pitch Oil Temperature - Outlet Hydraulic Power Unit
G. Pitch - Pitch Oil Accumulator Temperature
H. Pitch - Pitch Controller Panel Temperature
I. Pitch - Pitch Bearing A/B/C Vibration
J. Hub - Hub Temperature
K. Hub - Ice Detection System
L. Main Bearing(S) - Main Bearing Temperature
M. Main Bearing(S) - Main Bearing Vibration

N. Main Bearing(S) Oil Lubrication System - In Line Metal Particle Counter
O. Main Bearing(S) Oil Lubrication System - Oil Filter Differential Pressure
P. Main Bearing(S) Oil Lubrication System - Oil Pump Amps
Q. Main Bearing(S) Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
R. Main Shaft - Main Shaft Brake Pressure
S. Main Shaft - Main Shaft Brake Accumulator Pressure
T. Main Shaft – Shaft RPM
U. Gearbox – All Bearing Temperatures
V. Gearbox - Gearbox Lube Oil Pressure, Before Filter
W. Gearbox - Gearbox Lube Oil Pressure, After Filter
X. Gearbox - Planetary Vibration
Y. Gearbox - High Speed Shaft Vibration
Z. Gearbox - Intermediate Speed Shaft Vibration
AA. Gearbox - Oil Temperature - Gearbox Sump
BB. Gearbox Oil Lubrication System - In Line Metal Particle Counter
CC. Gearbox Oil Lubrication System - Oil Filter Differential Pressure
DD. Gearbox Oil Lubrication System - Oil Pump Amps
EE. Gearbox Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
FF. Generator - Winding Temperature 1/2/3
GG. Generator - Generator Drive End Bearing Temperature
HH. Generator - Generator Non-Drive End Bearing Temperature
II. Generator - Generator Drive End Bearing Vibration
JJ. Generator - Generator Non-Drive End Bearing Vibration
KK. Generator - Phase A/B/C Voltage
LL. Generator - Phase A/B/C Current
MM. Generator - Power Factor
NN. Generator - Heat Exchanger Water Inlet/Outlet Temperatures
OO. Generator – Shaft Torque
PP. Generator – Frequency (generator side)
QQ. Generator – Shaft RPM
RR. Generator – Active Power
SS. Generator – Reactive Power
TT. Yaw - Yaw Position
UU. Yaw - Yaw Brake Accumulator Pressure
VV. Yaw - Yaw Brake Pressure
WW. Yaw – Yaw Motor/Gear Temperature
XX. Tower - Wind Speed Primary
YY. Tower - Wind Speed Secondary
ZZ. Tower - Wind Direction
AAA. Tower - Nacelle Temperature
BBB. Tower - Tower Base Temperature

CCC. Tower - Control Panel(S) Temperature
DDD. Tower – Converter Inside Compartment Temperature
EEE. Tower – Converter Coolant Pressure
FFF. Tower – Converter Coolant Temperature
GGG. Tower – Frequency (grid side)
HHH. Tower – Phase A/B/C Voltage (grid side)
III. Tower – Phase A/B/C Current (grid side)
JJJ. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Cooling Media
KKK. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Panel Air At Cooler
LLL. Tower - Transformer Temperature
MMM. Tower - Ambient Temperature
NNN. Tower – Air Density
OOO. Tower - Sway
PPP. Tower – Error Code
QQQ. Tower – Operational State
RRR. Main Breaker - Status
SSS. Main Breaker - Faults
TTT. Main Breaker - Temperature
UUU. Main Breaker - Fan Ampere
VVV. Meteorological Station - Air Temperature
WWW. Meteorological Station - Cell Temperature
XXX. Meteorological Station - Relative Humidity
YYY. Meteorological Station - Wind Speeds At 10 meter, 1/2 Hub Height, and Hub Height
ZZZ. Meteorological Station - Barometric Pressure
AAAA. Meteorological Station – Air Density
BBBB. Switchgear - Breaker Phase Currents
CCCC. Switchgear - Breaker Phase Voltages
DDDD. Switchgear - Breaker Status
EEEE. Switchgear - Relay Fault Codes
FFFF. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

1.4.3 PV Field

A. Combiner Box - DC Output Voltage
B. Combiner Box - DC Output Current
C. Combiner Box - DC Current per String
D. Combiner Box - Combiner Box Interior Temperature
E. Inverter - DC Input Voltage
F. Inverter - DC Input Current
G. Inverter - AC Output Voltage
H. Inverter - AC Output Current

I. Inverter - AC Power
J. Inverter - AC Frequency
K. Inverter - AC Reactive Power
L. Inverter - Energy Totalizer
M. Inverter - Inverter Temperatures
N. Inverter - Inverter Status
O. Inverter - Faults/Alarms
P. Inverter - Ground Current
Q. Meteorological Station - Air Temperature
R. Meteorological Station - Cell Temperature
S. Meteorological Station - Relative Humidity
T. Meteorological Station - Wind Speed
U. Meteorological Station - Global Irradiance
V. Meteorological Station - Plane of Array Irradiance
W. Meteorological Station - Solar Module Back Panel Temperature(s) - 10% of Modules
X. Switchgear - Breaker Phase Currents
Y. Switchgear - Breaker Phase Voltages
Z. Switchgear - Breaker Status
AA. Switchgear - Relay Fault Codes
BB. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

1.4.4 Oil-Cooled Transformers

A. Active Power
B. Reactive Power
C. High Side Amps (by phase)
D. High Side Voltage (by phase)
E. Ground Current
F. Low Side Voltage (by phase)
G. Control Voltage
H. Control Panel Temperature
I. LTC Tap Position
J. Oil Pump Amps
K. Oil Pump Discharge Pressure
L. Fan Bank Amps
M. LTC Tank Oil Temperature
N. Main Tank Oil Temperature
O. Top Oil Temperature
P. High Voltage Winding Temperature
Q. Low Voltage Winding Temperature
R. Nitrogen Pressure
S. Local Ambient Temperature
T. Moisture Percentage

U. Gas Analyzer H2
V. Gas Analyzer O2
W. Gas Analyzer N2
X. Gas Analyzer CO
Y. Gas Analyzer CO2
Z. Gas Analyzer CH4
AA. Gas Analyzer C2H6
BB. Gas Analyzer C2H4
CC. Gas Analyzer C2H2
DD. Gas Analyzer H2O
EE. Infrared Camera Temperatures

1.4.5 Dry Transformers

A. Active Power
B. Reactive Power
C. High Side Amps (by phase)
D. High Side Voltage (by phase)
E. Ground Current
F. Low Side Voltage
G. Low Side Amps
H. Control Voltage
I. Control Panel Temperature
J. Cooling Fan Amps
K. High Voltage Winding Temperature
L. Low Voltage Winding Temperature
M. Local Ambient Temperature

1.4.6 Switchgear / Motor Control Centers

A. Control Panel

1. Control Panel Voltage
2. Control Panel Temperature

B. 4160 VAC and Higher Bus

1. Connected Joints Temperature Via Fiber Optic Infrared Measurement

C. MCC Bucket

1. Load Amps
2. Load Voltage
3. Power Factor
4. Bucket Temperature
5. Cooling Fan Amps

1.4.7 Heat Exchangers

A. Inlet/Outlet Temperatures
B. Process Flows

1.4.8 Pump / Fan Motors Greater than 100 HP

A. Motor Stator Temperature
B. Local Ambient Temperature
C. Motor Amps
D. Motor Power Factor
E. Motor Voltage